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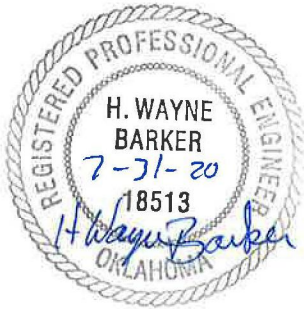
**Catoosa TAG Office
 Cherokee Nation of Oklahoma
 Owner Review**

July 31, 2020

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SECTION 01 45 29 - TESTING LABORATORY SERVICES

PART 1: GENERAL

1.1 SUMMARY

- A. Section Includes: Requirements for the Contractor to engage a qualified, independent testing laboratory to conduct specific tests, where the Contractor is required to do so in this contract. List of tests and schedule below is to be considered a minimum. Additional testing may be required to insure quality. Contractor shall obtain and review reports or recommendations prepared by professional consultants such as Geotechnical Engineers, Structural Engineers or other consultants for additional or more stringent requirements for testing. This section is only intended to be applied to sitework construction. Refer to Architectural/Structural documents for testing related to building, building foundation or other architectural items.

1.2 SUBMITTALS

- A. Test Reports: The Contractor shall provide 4 copies of test reports to the Owners Representative. Reports shall include testing facility name, address, telephone number, and names of full-time responsible officers.

1.3 QUALITY ASSURANCE

- A. Approval of Laboratory: The qualified, independent testing laboratory, which will be conducting the specific tests required in this contract, must have authority or be licensed to operate in the State in which the project is located. The testing laboratory shall be approved by the Owners Representative prior to the Contractor beginning work.
- B. Responsibilities of Laboratory:
 - 1. Test samples of mixes submitted by the Contractor.
 - 2. Provide qualified personnel at project site. Cooperate with the Owners Representative and Contractor in performance of services.
 - 3. Perform specified sampling and testing of products and materials in accordance with specified standards.
 - 4. Ascertain compliance of materials and mixes with requirements of specifications.
 - 5. Promptly notify the Owners Representative and Contractor of observed irregularities or non-conformance of work, products, or materials.
 - 6. Attend preconstruction meetings and progress meetings, if requested.
- C. Limitations on Laboratory:
 - 1. Laboratory may not release, revoke, alter, or enlarge on requirements of specifications or technical recommendations.
 - 2. Laboratory may not approve or accept partial portions of the work.
 - 3. Laboratory may not assume duties of the Contractor unless approved in writing by the Owners Representative.

1.4 SEQUENCING AND SCHEDULING

- A. Establishing Testing Schedule:
 - 1. By advance discussion with the testing laboratory, determine the time required for the laboratory to perform its test and to issue its findings.
 - 2. Provide required time within the construction schedule.
- B. Revising Testing Schedule: When construction schedule changes are necessary during construction, coordinate such changes with the testing laboratory as required.

PART 2: PRODUCTS

- A. Reports: Shall include:
 - 1. Date issued.
 - 2. Project title and number.
 - 3. Name of inspector.
 - 4. Date and time of sampling or inspection.
 - 5. Identification of product and specification sections.
 - 6. Location in the Project.
 - 7. Type of inspection or test.
 - 8. Date of test.
 - 9. Results of tests.
 - 10. State conformance or non-conformance with Contract Documents.

- B. Interpretation: When requested by the Owners Representative, provide interpretation of test results.

PART 3: EXECUTION

3.1 FIELD QUALITY CONTROL

- A. Contractor Requirements: See individual specifications "Field Quality Control" paragraph for specific testing requirements. When applicable, the Contractor shall:
 - 1. Deliver to agency or laboratory at designated location, adequate samples of materials proposed to be used which require testing, along with proposed mix designs.
 - 2. Cooperate with laboratory personnel, and provide access to the Work.
 - 3. Provide incidental labor and facilities:
 - a. To obtain, handle, and label or identify samples at the site or at source of products and materials to be tested.
 - b. To facilitate tests.
 - c. To provide storage and curing of test samples.
 - 4. Ensure samples are taken by qualified testing personnel.
 - 5. Coordinate the laboratory test frequency and timing with the Owners Representative.
 - 6. Ensure tests are completed according to the testing schedule.
 - 7. Furnish test reports within 7 working days after tests have been completed.

B. Building and Bridge Field Testing:

<u>Item</u>	<u>Location</u>	<u>Reference</u>	<u>Frequency</u>	<u>Remarks</u>
Structural Fill	foundation	AASHTO T 238	1/1500 sf or 4 Tests per 8- inch Lift min.	field density & moisture content
Structural Fill	source	AASHTO T 248	1/soil type	field sample/ splitting
Structural Fill	source	AASHTO T 90 type	1/soil	plastic index
Embankment	foundation	AASHTO T 238	1/2500 sf per lift	field density & moisture content

Embankment	source	AASHTO T 248	1/soil type	field sample/ splitting
Embankment	source	AASHTO T 90	1/soil type	plastic index
Aggregate	under floor slab	AASHTO T 27	1/source	plastic index
Aggregate	under floor slab	AASHTO T 238	1/1500 sf per lift	field density and moisture content
Concrete	structural	ASTM C 31	1 set/50 cubic yards or per day	cylinder; 1 set= 4 cylinders
Concrete	structural	ASTM C 143	1/truck	slump
Concrete	structural	ASTM C 2311/truck		air content fresh concrete

C. Roads/Streets Field Testing:

<u>Item</u>	<u>Location</u>	<u>Reference</u>	<u>Frequency</u>	<u>Remarks</u>
Subgrade	along centerline	AASHTO T 145	1/5000 sf	AASHTO soil classification
Subgrade	left shoulder centerline right shoulder	AASHTO T 238	1 test/5000 sf or 8-inch lift	in-place density and moisture content
Subbase/left shoulder Base centerline		AASHTO T 238	1/5000 sf	in-place density and moisture content
Asphalt	finished	AASHTO T 230	1/5000 sf	in-place density

D. Parking Area Field Testing:

<u>Item</u>	<u>Location</u>	<u>Reference</u>	<u>Frequency</u>	<u>Remarks</u>
Subgrade	source	AASHTO T 45	1/soil class	AASHTO soil
Subgrade	random	AASHTO T 238	1/2500 sf or 8-inch lift	in-place density
Subbase Base pattern	random	AASHTO T 238	1/2500 sf	in-place density and moisture content
Asphaltic pattern	random	AASHTO T 230 ASTM D 2950	1/250 tons	in-place density

E. Building and Bridge Laboratory Testing:

<u>Item</u>	<u>Location</u>	<u>Reference</u>	<u>Frequency</u>	<u>Remarks</u>
Structural	source	AASHTO T 99	1/soil class	moisture/density Fill
Structural Fill	source	AASHTO T 27	1/soil class	sieve analysis/ unified soil classification
Aggregate	underfloor	AASHTO T 27	1/source	sieve analysis
Embankment	source	AASHTO T 99	1/soil class	moisture/density relationship
Embankment	source	AASHTO T 27	1/soil class	sieve analysis
Concrete cylinder		ASTM C 39	1/set	cylinder compressive strength

F. Roads/Streets Laboratory Testing:

<u>Item</u>	<u>Location</u>	<u>Reference</u>	<u>Frequency</u>	<u>Remarks</u>
Subbase/crusher or Base	stockpile	AASHTO T 27	1/1000 tons or 1/day	sieve analysis
Subgrade	embankment	AASHTO T 99 or T 180	1/soil class	moisture/density relationship
Subbase/source		AASHTO T 180	1/source	moisture/density relationship
Subbase/random Base		AASHTO T 27	1/1000 tons	sieve analysis
Asphalt Concrete	haul truck	AASHTO T 164 ASTM D 2172	1/250 tons	% asphalt in mix
Asphalt Concrete	haul truck	AASHTO T 27	1/250 tons	sieve analysis

G. Utility Trench:

<u>Item</u>	<u>Location</u>	<u>Reference</u>	<u>Frequency</u>	<u>Remarks</u>
Backfill	Trench	AASHTO T 238	1/150 lf of trench per lift	in place moisture/density

3.2 POST-TENSIONING OF CONCRETE

- A. Inspection Prior to Concreting: Inspect tendons, drape of tendons, and plates for compliance prior to concreting.

- B. Concrete Testing: As required in this section except make three test cylinders representing each area to be tensioned and cylinders shall be cured in the same manner as the concrete they represent. Make compression test prior to determine minimum specified strength required for post-tensioning.
- C. Post-tensioning: Observe post-tensioning operation and record actual force and elongation applied to each tendon.
- D. Submit a report for the following:
 - 1. Inspection of placement and post-tensioning of all strands.
 - 2. Size, number, location, and drape of strands and the post-tensioning loads imposed. Check elongation of tendons within ranges established by manufacturer.
- E. Compression Test Reports:
 - 1. Furnish certified compression test report to the Owners Representative. On test report indicate following information:
 - a. Cylinder identification number and date cast.
 - b. Specific location at which test samples were taken.
 - c. Type of concrete, slump, and percent air.
 - d. Compressive strength of concrete in psi.
 - e. Weight of lightweight structural concrete in pounds per cubic feet.
 - f. Weather conditions during placing.
 - g. Temperature of concrete in each test cylinder when test cylinder was molded.
 - h. Maximum and minimum ambient temperature during placing.
 - i. Ambient temperature when concrete sample in test cylinder was taken.
 - j. Date delivered to laboratory and date tested.

3.3 FLOOR SLABS

- A. Test flatness and levelness according to ASTM E 1155.

3.4 CONCRETE REINFORCEMENT

- A. Provide manufacturers mill certification and test report.

3.5 SHOTCRETE

- A. Inspection and Material Testing:
 - 1. Provide field inspection and testing service to certify that shotcrete has been applied according to drawings and specifications.
 - 2. Periodically inspect and test proportioning equipment for accuracy and report deficiencies to the Owners Representative.
 - 3. Sample and test mix ingredients as necessary to insure compliance with specifications.
 - 4. Sample and test aggregates daily and as necessary for moisture content. Report instances of excessive moisture to the Owners Representative.
 - 5. Certify that ingredients and proportions and amounts of ingredients in shotcrete conform with approved trial mixes.
- B. Shotcrete Sampling:
 - 1. Provide a technician at site of placement to perform shotcrete sampling.
 - 2. Take cores according to ACI 506R.
 - 3. Insure maintenance of water-cement ratio established by approved trial mix.
 - 4. Verify specified mixing has been accomplished.
- C. Laboratory Tests of Field Sample Panels:

1. Test compression test core for strength according to ACI 506R. For each test series of three cores, test one core at 7 days and one core at 28 days. Use the remaining core as a spare to be tested at either 7 or 28 days as required. Compile laboratory test reports as follows: Compressive strength test shall be the result of one core, except when the one core shows evidence of improper sampling or testing, in which case it shall be discarded and strength of the spare core shall be used.
 2. Submit certified compression test reports to the Owners Representative. On the test report, indicate the following information:
 - a. Core identification number and date cast.
 - b. Specific location at which test samples were taken.
 - c. Compressive strength of shotcrete in psi.
 - d. Weather conditions during placing.
 - e. Temperature of shotcrete in each test core when test core was taken.
 - f. Maximum and minimum ambient temperature during placing.
 - g. Ambient temperature when shotcrete sample was taken.
 - h. Date delivered to laboratory and date tested.
- D. Submit inspection reports certification and instances of noncompliance to the Owners Representative.

3.6 MORTAR AND GROUT

- A. Take and test samples of mortar and grout according to ASTM C 91 for conformance with specified strength requirements.

3.7 STRUCTURAL STEEL

- A. Provide shop and field inspection and testing services to certify structural steel work is done in according to drawings and specifications.
 1. Welding shall conform with AWS D1.1 Structural Welding Code.
 2. Prefabrication Inspection:
 - a. Review design and shop detail drawings for size, length, type and location of all welds to be made.
 - b. Approve welding procedure qualifications either by prequalification or by witnessing qualifications tests.
 - c. Approve welder qualifications either by certification or retesting.
 - d. Approve procedure for control of distortion and shrinkage stresses.
 - e. Approve procedures for welding according to applicable portions of Section 4, AWS D1.1.
 3. Fabrication and Erection:
 - a. Inspect welding equipment for capacity, maintenance and working condition.
 - b. Verify specified electrodes and handling and storage of electrodes according to AWS D1.1
 - c. Inspect preparation and assembly of materials to be welded for conformance with AWS D1.1.
 - d. Inspect preheating and interpass temperatures for conformance with Table 4.2, AWS D1.1.
 - e. Verify that quality of welds meet the requirements of Paragraph 10.17, AWS D1.1. Verify quality of shop and field butt welds greater than 1/2 inch by ultrasonic procedure. Ultrasonic procedure shall conform to Section 6, Part C, AWS D1.1.
 - f. Correction of rejected welds shall be made in according to Paragraph 3.7, AWS D1.1.
 - g. Inspect high-strength bolted connections according to AISC M 017 using ASTM A 325 or A 490 bolts.

- B. Submit inspection reports, record of welders and their certification, and identification, and instances of noncompliance to the Owners Representative.

END OF SECTION

SECTION 01 45 34 - TESTING OF PIPING SYSTEMS

PART 1: GENERAL

1.1 SUMMARY

- A. Section Includes: Testing of pressure water/sewer lines and gravity sewer system lines.

1.2 QUALITY ASSURANCE

- A. Flow meters shall record the actual volume plus or minus 2 percent.
- B. Air test gauges shall be ANSI B40.1-80, Grade 3A (plus or minus 0.25 percent of full scale accuracy), 15 psi dial range.
- C. Water test gauges shall be ANSI B40.1-80, Grade 2-A (plus or minus 0.5 percent of full scale accuracy), dial range approximately twice the required test pressure.

1.3 SUBMITTALS

- A. As specified in General Conditions, or if specifically requested by Owners Representative.
 - 1. Accuracy certification by approved independent testing laboratories for flow meters and test gauges. Certifications shall be dated no more than 90 days before actual system testing.
 - 2. Before testing, provide the following information:
 - a. All Tests: Describe precautions that will be taken to protect system equipment that might be damaged under test pressures, and the proposed method for rerouting sewer flows where the system must remain in service.
 - b. Air Sewer Tests: Describe the proposed method for testing where existing sewer service laterals enter the main being tested. Describe safety devices on air test equipment, and personnel safety precautions during air tests.

1.4 PROJECT CONDITIONS

- A. Testing shall not be performed until each system has been flushed or thoroughly cleaned in accordance with procedures in the sections that describe line installation.
- B. Test potable water lines before disinfecting.

1.5 CONTRACTOR'S OPTION

- A. For gravity sewer lines the Contractor may use either the water leakage or air test.

PART 2: PRODUCTS

2.1 MATERIALS

- A. Testing Water: Shall be suitable for drinking unless otherwise approved in writing by the Engineer before use. Owner will provide to the Contractor water for filling lines and making tests at a rate equal to the Owner's cost.

PART 3: EXECUTION

3.1 GENERAL

- A. Testing: Conduct the performance and acceptance tests of the piping systems. Furnish necessary equipment, labor, and materials to conduct the testing. Testing shall be conducted in

the presence of the Owner's Representative after backfilling and compaction are complete. Contractor shall provide any incidental taps, corp stops, temporary valves, temporary plugs, fittings etc. necessary to perform testing at no cost to the Owner.

- B. Notification: Notify the Owner's Representative at least 24 hours prior to testing.
- C. Procedure: Prior to testing, remove equipment which would be damaged by the test pressure from the system in which it is installed. Ensure thrust blocks have sufficiently cured. Replace removed equipment after testing. Systems may be tested in sections as work progresses; however, previously tested portions shall become a part of the later test of the composite system. Repair leaks. Test time will be accrued only while full test pressure is exerted or subjected on the system.

3.2 PRESSURE WATER/SEWER LINES

- A. Filling Line: Fill line with water slowly and eliminate air in the line. A pump connected to the pipe shall provide the specified test pressure, measured at the point of lowest elevation. Contractor shall furnish pump, pump connection and all necessary apparatus including gauges and meters to complete the test.
- B. Test Pressure: Maintain pressure of 150 percent of maximum anticipated operating pressure or the maximum working pressure of the pipe, whichever is greater, on the section being tested. The duration of the test shall be 30 minutes after the line has been brought up to test pressure. If the line sustains less than 5% pressure drop within the 30 minute period, a leakage test of two hours duration shall be performed. Should any test of pipe in place disclose leakage than that specified, the Contractor shall, at his own expense, locate and repair the defective joints, pipe or fitting, repeat test until leakage is within the specified allowances.
- C. Leakage: Leakage is defined as the quantity of make-up water supplied into the newly laid pipe, or any valved section of it, necessary to maintain the specified leakage test pressure after the pipe has been filled with water and air expelled, as stated above. Do not use paints, asphalts, tars, or other types of pipe compounds to eliminate leaks. No pipe installation shall be accepted until leakage does not exceed 10 gallons per inch of pipe diameter per mile of pipe per 24 hours at 150 psi, which is tabulated below:

Pipe Diameter (Inches)	Allowable Leakage (Gal. per 2 Hr. per 1000 ft.)
1 ½	0.24
2	0.32
2 ½	0.39
3	0.47
4	0.63
6	0.95
8	1.26
10	1.58
12	1.89

3.3 GRAVITY SEWER

- A. General: Perform water or air leakage and light tests as specified below. A finished plumbing test, as indicated below, shall be performed on building gravity sewer lines, drain lines, and vent systems. Lines shall be flushed clean prior to testing. All wyes, tees, stubs and service laterals shall be plugged with flexible jointed caps, or acceptable alternate, securely fastened to withstand the internal pressure. Such plugs or caps shall be readily removable. All lines will be tested.

B. Tests for Lines Located Inside Buildings

1. Water Test: The water test shall be applied to the drainage system either in its entirety or in sections. If applied to the entire system, openings in the piping shall be tightly closed, except the highest opening. The system shall be filled with water to the point of overflow. If the system is tested in sections, each opening shall be tightly plugged except the highest opening of the section under test. Each section shall be filled with water, but no section shall be tested with less than a 10-foot head of water. In testing successive sections, at least the upper 10 feet of the next-preceding section shall be tested, so that no joint or pipe in the building (except the uppermost 10 feet of the system) shall have been subjected to a test of less than a 10-foot head of water. The water shall remain in the system, or in the portion under test, for at least 1 hour before inspection starts. The system shall not leak. The test-water level shall be maintained to within 1 inch during the test period.
3. Finished Plumbing: After the plumbing fixtures have been installed and the traps filled with water, the connections shall be tested and proved watertight. This test shall consist of flushing water closets, urinals, and discharging full lavatory's and other fixtures through the system.

C. Tests for Lines Located Outside of Buildings & Public Lines

1. Exfiltration Test: Make leakage test upon the completion of each pipe section between manholes by closing the lower end of the section to be tested and the inlet sewer of the upper manhole with stoppers, inflatable plugs or by other means approved by the Engineer. Fill the pipe and manhole with water to completely fill the pipe to an elevation two (2) feet above the top of pipe or 2 feet above groundwater elevation, whichever is greater. The Contractor shall fill the pipe to the test level prior to the time of exfiltration testing to permit normal absorption into the pipe walls. Duration of the test shall be two hours. No section of sewer will be accepted until exfiltration does not exceed 10 gallons per inch diameter per mile per 24 hours, as tabulated below. When leakage in excess of this amount is detected repairs shall be made and the line successfully retested before acceptance of the sewer.

Pipe Diameter (Inches)	Allowable Leakage (Gal. per 2 Hr. per 1000 ft of pipe)
6	0.95
8	1.26
10	1.58
12	1.89
15	2.37
18	2.84

2. Air Testing: Flush clean the section to be tested. Seal and isolate the section to be tested with plugs or stoppers. Determine the test duration for the section under the test by computation from the applicable equations shown in ASTM C-828, or from prepared air test tables. The pressure holding time is based on an average holding pressure of 3 psi (21kPa) gage or a drop from 3.5 psi (24 kPa) to 2.5 psi (17 kPa) gage.

Add air until the internal pressure of the sewer line is raised to approximately 4.0 psi (28kPa) gage. After an internal pressure of approximately 4.0 psig is obtained, allow time for the air pressure to stabilize. The pressure will normally show some drop until the temperature of the air in the test section stabilizes. When the pressure has stabilized and is at or above the starting test pressure of 3.5 psi gage, commence the test. Before starting the test, the pressure may be allowed to drop to 3.5 psi. Record the drop in pressure for

the test period. If the pressure has dropped more than 1.0 psi gage during the test period, the line is presumed to have failed. The test may be discontinued when the prescribed test time has been completed even though the 1.0 psi drop has not occurred.

The following table has been prepared utilizing applicable equations from ASTM C-828. It is based on an allowable air loss of 0.0015 cf/min/sf of internal pipe surface, a maximum air loss per test section of 3.5 cf/min. The table applies when testing one pipe diameter only throughout the test section and ignores 4-inch and 6-inch lateral sewers.

AIR TEST TABLE
MINIMUM TEST TIME FOR VARIOUS PIPE SIZES

Nominal Pipe Size, Inches	T (time) min/100 ft.	Nominal Pipe Size, Inches	T (time) min/100 ft.
4	3.77	24	22.78
6	5.67	27	28.85
8	7.57	30	35.62
10	9.43	36	51.28
12	11.33		
15	14.17		
18	17.00		

The test may be used as a presumptive test to enable the installer to determine the acceptability of the line prior to backfill and subsequent construction activities. However, testing for acceptance by the Owner will only be performed after backfill and compaction.

The air test may be dangerous if, because of lack of understanding or carelessness, a line is improperly prepared. It is extremely important that the various plugs be installed and braced in such a way to prevent blowouts. As a safety precaution, pressurizing equipment may include a regulator or relief valve to avoid over pressurizing and damaging an otherwise acceptable line. Personnel shall not be allowed to enter manholes during the test procedure.

Should a test on sections of pipeline have an air loss rate greater than that permitted, locate and repair the defective joints or pipes and retest until the air loss rate is within the specified allowance as shown in the table above.

4. Light Test: Light held in pipe at one manhole shall be visible from next manhole as a full circle of light.
5. Deflection Testing: Thirty days after backfill operations, PVC sewer pipe shall be measured for vertical deflection using a deflection testing mandrel. Maximum ring deflection of the installed pipe shall be limited to 5% of the average inside diameter as defined by ASTM D2680. All pipe exceeding the allowable deflection shall be replaced by the Contractor at no additional cost to the Owner.

END OF SECTION

SECTION 01 74 16 – CLEANUP(SITE MAINTENANCE)

1.0 GENERAL

1.1 DURING CONSTRUCTION

The Contractor shall at all times keep the job site as free from all materials, debris, and rubbish, as is practicable and shall remove same from any portion of the job site, when, in the opinion of the Owner, it becomes objectionable or interferes with the progress of the project.

1.2 FINAL

Upon completion of the work, the Contractor shall remove from the site, material, tools and equipment belonging to him, and leave the site with an appearance acceptable to the Engineer.

1.2.1 Clean Equipment and Materials: The Contractor shall thoroughly clean all equipment and materials installed by him and shall deliver all such materials and equipment in a bright, clean, polished and new-appearing condition.

1.2.2 Restoration of Landscape Damage: Any landscape feature scarred or damaged by the Contractor's equipment or operations shall be restored as nearly as possible to its original condition at the Contractor's expense. The Owner will decide what method of restoration shall be used.

1.2.3 Post-Construction Cleanup and Obliteration: The Contractor shall obliterate all signs of temporary construction facilities such as haul roads, work areas, structures, foundations of temporary structures, stockpiles of excess or waste materials or any other vestiges of construction, as directed by the Owner.

1.2.4 Restoration of Roads/pavements: The Contractor shall be responsible for restoring all roads to driveable condition, equal to or greater than original condition.

1.2.5 Restoration of Fence: The Contractor shall be responsible for reconstructing all fences, removed or damaged during construction, to original condition.

END OF SECTION

SECTION 02 41 13 - DEMOLITION

1.0 GENERAL

1.1 DESCRIPTION

The section covers the demolition or removal of any existing structures, pavement, curb & gutter, or other improvements that may interfere with the proposed construction and/or designated to be removed.

2.0 EXECUTION

2.1 DEMOLITION

The items identified or conflicting shall be removed before performing final site grading. Demolition shall be performed in a manner to insure no interruption in service to the existing facilities. Contractor shall be responsible for insuring that any temporary services or replacement services have been installed prior to removals. Maintenance of access shall be coordinated with the Owner.

Items to be salvaged or delivered to the Owner shall be removed in such a way to minimize damage and maintain functionality for future use.

All paving shall be removed by full depth sawcuts, unless otherwise noted, to provide a flush surface for new adjoining construction.

2.2 DISPOSAL

Contractor shall be responsible for removal and disposal of all existing equipment, structures, paving, and other materials scheduled for demolition or removal. Contractor shall be responsible for transporting and proper disposal of items scheduled to be removed from site. Disposal shall be in accordance with all Federal, State, and Local regulations that may govern.

Any equipment or items to be retained by the Owner shall be removed and placed at a location designated by the Owner. Disposal of concrete and other debris scheduled to be completely removed shall be the responsibility of the Contractor.

Items that are to be removed and salvaged and/or delivered to Owner shall be either delivered to a storage location on-site or to a location to be determined by the Owner. Salvaged material/items shall be removed, handled, and transported in a manner to minimize damage.

2.3 DEPTH OF DEMOLITION OR REMOVAL

It shall be the responsibility of the Contractor to insure that all items to be demolished or removed are done so to a level below grade in such a manner as to permit the construction of all improvements.

END OF SECTION

SECTION 03 21 00 - STEEL REINFORCEMENT(SITEWORK)

1.0 GENERAL

1.1 DESCRIPTION

1.1.1 Work included: Provide concrete reinforcement where shown on the drawings specified herein, and as needed for a complete and proper installation.

1.1.2 Related Work:
Division 03 30 53: Cast-in-Place Concrete

1.2 QUALITY ASSURANCE

1.2.1 Use adequate numbers of skilled workers who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Division.

1.2.2 Comply with pertinent provisions of the following, except as may be modified herein:

- A. ACI 318
- B. CRSI "Manual of Standard Practice"

1.3 SUBMITTALS

1.3.1 Comply with pertinent provisions of General Conditions.

1.3.2 Product data: After the Contractor has received the Owner's Notice of Award, submit:

- A. Materials list of items proposed to be provided under this Division.
- B. Manufacturer's specifications and other data needed to prove compliance with the specified requirements.
- C. Shop Drawings showing details of bars, anchors, and other items, if any, provided under this Division.

1.4 PRODUCT HANDLING

1.4.1 Delivery and Storage:

- A. Use necessary precautions to maintain identification.
- B. Store in a manner to prevent excessive rusting and fouling with dirt, grease, and other bond-breaking coatings.

2.0 PRODUCTS

2.1 REINFORCEMENT MATERIALS AND ACCESSORIES

2.1.1 Bars: Provide deformed billet steel bars complying with ASTM A615, using grades shown on the Plans. Grade 60 unless otherwise noted.

2.1.2 Steel Wire:

- A. Comply with ASTM A82.

B. For tie wire, comply with Fed Spec QQ-W-461, annealed steel, black, 16 gage minimum.

2.1.3 Welded Wire Fabric: Provide welded steel, complying with ASTM A185. Sheets only.

2.1.4 Bolsters, chairs, spacers, and other devices for spacing, supporting and fastening reinforcement in place:

- A. Use wire bar type supports complying with CRSI recommendations, unless otherwise shown on the Plans.
- B. Do not use wood, brick, or other non-complying material.
- C. For slabs on grade, use supports with sand plates or horizontal runners where base materials will not support chair legs.

2.2 FABRICATION

2.2.1 Fabricate reinforcing bars to conform to the required shapes and dimensions, with fabrication tolerances complying with the CRSI Manual.

2.2.2 In case of fabricating errors, do not straighten or rebend reinforcement in a manner that will weaken or injure the material.

2.2.3 Reinforcement with any of the following defects will not be acceptable:

- A. Bar lengths, depths, and/or bends exceeding the specified fabrication tolerances.
- B. Bends and/or kinks not shown on the Plans.
- C. Bars with reduced cross-section due to excessive rusting or other cause.

3.0 EXECUTION

3.1 SURFACE CONDITIONS

Examine the areas and conditions under which work of this Division will be performed. Correct conditions detrimental to timely and proper completion of the work. Do not proceed until unsatisfactory conditions are corrected.

3.2 INSTALLATION

3.2.1 General:

- A. Comply with the specified standards for detail and method of placing reinforcement and supports, except as many be modified herein.
- B. Clean reinforcement to remove loose rust and mill scale, earth, and other materials which reduce or destroy bond with concrete.
- C. Position, support, and secure reinforcement against displacement by formwork, construction, and concrete placing operations.
- D. Locate and support reinforcement by metal chairs, runners, bolsters, spacers, and hangers, as required.
- E. Place reinforcement to obtain minimum coverages for concrete protection.

- F. Arrange, space, and securely tie bars and bar supports together with the specified tie wire.
- G. Set wire ties so twisted ends are directed away from exposed concrete surfaces.

3.2.2 Install welded fabric in as long lengths as practicable, lapping adjoining pieces at least one full mesh.

3.2.3 Provide sufficient numbers of supports, and of strength to carry the reinforcement.

3.2.4 Do not place reinforcing bars more than 2" beyond last leg of any continuous bar support.

3.2.5 Do not use supports as bases for runways for concrete conveying equipment and similar construction loads.

3.3 SPLICES

3.3.1 Lap Splices: Tie securely with the specified wire to prevent displacement of splices during placement of concrete.

3.3.2 Splice Devices:

- A. Obtain approval from the Owner's Representative prior to using splice devices.
- B. Install in accordance with manufacturer's written instructions.
- C. Splice in a manner developing at least 125% of the yielding strength of the bar.

3.3.3 Welding: Is not permitted unless otherwise noted. If otherwise noted, then perform in accordance with AWS D1.4-79.

3.3.4 Do not splice bars except at locations shown on the drawings, or as otherwise specifically approved by the Owner's Representative.

3.4 TESTING

Materials to be sampled at the building site shall have been delivered thereto at least 72 hours before needed.

END OF SECTION

SECTION 03 30 53 - CAST-IN-PLACE CONCRETE (SITEWORK)

1.0 GENERAL

1.1 DESCRIPTION

- 1.1.1 This section covers all cast-in-place concrete, including, forms, finishing, curing and other appurtenant work.
- 1.1.2 Transit mix concrete will be permitted if it meets the requirements of this section and is mixed and delivered in accordance with ASTM C94.

2.0 MATERIALS

2.1 GENERAL

Cement: ASTM C150, Type I or III unless otherwise noted;
Coarse Aggregate: Crushed rock, washed gravel or other inert material conforming to ASTM C33;
Water: Potable, clean and free from deleterious substances;
Reinforcing Steel: ASTM A615, Grade 60; unless otherwise noted;
Welded Wire Fabric: ASTM A185;
Forms: (No wood rot or deteriorated wood shall be accepted)
Plywood - Waterproof, resin-bonded, exterior type, face to concrete Grade B or better;
Lumber - Straight, uniform width and thickness and free from knots, offsets, holes, dents and other surface defects;
Chamfer Strips -3/4" clear white pine, surface against concrete planed;
Form Coating - Industrial lubricants "Non-Crete" form coating, Protex "Pro-Cote" or equal;
Expansion Joints - Preformed, bituminous type ASTM D994, unless otherwise noted;
Air Entraining Admixture: ASTM C60
Water Reducing Admixture: ASTM C494 Type A
Fly Ash: No more than 15% cement replacement
Moisture Retaining Cover: Polyethylene film, or polyethylene coated burlap meeting ASTM C171.

2.2 PROPERTIES

The minimum concrete compressive strength as determined by ASTM C39 shall be:

Minimum Strength: 3,500 psi at 28 days, unless noted otherwise
Air Entrainment: 4-6% (in all concrete)
Water Reducer: ASTM C494 Type A in all concrete
Calcium Chloride: Not Permitted
All admixtures, except High Range Water Reducers, shall be added to the concrete at the batch plant.

2.3 BATCHING AND MIXING

- 2.3.1 Mix design shall be in accordance with ACI-301, Section 4. Each mix design shall be submitted to Owner's Representative for approval prior to incorporation into the project. Concrete shall be furnished by an acceptable ready-mixed concrete supplier and shall conform to ASTM C94.

- 2.3.2 The consistency of concrete shall be suitable for the placement conditions. Aggregates shall float uniformly throughout the mass and the concrete shall flow sluggishly when vibrated or spaded. The slump shall be kept uniform.

3.0 EXECUTION

3.1 GENERAL

- 3.1.1 The limits of each concrete pour shall be predetermined by the Contractor and shall be acceptable to the Owner. Limitations shall be in accordance with ACI recommendations, unless otherwise approved, in writing, by the Owner. All concrete within such limits shall be placed in one continuous operation.
- 3.1.2 Placement shall comply with AI 301. Before concrete is placed, forms, reinforcements, water stops, anchor bolts and embedments shall be rigidly secured in proper position; all dirt, mud, water and debris shall be removed from the space to be occupied by concrete; all surfaces encrusted with dried concrete from previous placement operations shall be cleaned.
- 3.1.3 Concrete shall be conveyed to the point of final deposit by methods which prevent separation or loss of ingredients. Concrete shall be placed in final position without being moving laterally in the forms more than 5 feet.
- 3.1.4 Footings shall be poured separately from the slab.

3.2 HOT WEATHER CONCRETING

- 3.2.1 Except as modified herein, hot weather concreting shall comply with ACI 305. At air temperatures of 90F or above, concrete shall be kept as cool as possible during placement and curing. The temperature of the concrete when placed in the work shall not exceed 90F. Retempering with water is not allowed.
- 3.2.2 Plastic shrinkage cracking, due to rapid evaporation of moisture, shall be prevented. Concrete shall not be placed when the evaporation rate (actual or anticipated) equals or exceeds 0.2 lbs per sq. ft. per hour, as determined by The American Concrete Institute.

3.3 COLD WEATHER CONCRETING

- 3.3.1 Except as modified herein, cold weather concreting shall comply with ACI 306. The temperature of concrete at the time of mixing shall be not less than that shown in the following table for corresponding outdoor temperature (in shade) existing at the time of placement.

Outdoor Temperature	Concrete Temperature
Below 10F	70F
Between 10F and 45F	60F
Above 45F	45F

- 3.3.2 When placed, heated concrete shall not be warmer than 80F.
- 3.3.3 When freezing temperatures may be expected during the curing period, the concrete shall be maintained at a temperature of at least 50F for five days or 70F for three days after placement. Concrete and adjacent form surfaces shall be kept continuously moist. Sudden cooling of concrete shall not be permitted.

3.4 FINISHING

- 3.4.1 All exposed surfaces shall be given a steel float finish unless noted otherwise.
- 3.4.2 Screeded surfaces shall be given an initial float finish as soon as the concrete has stiffened sufficiently for proper working. Any piece of coarse aggregate which is disturbed by the float or which caused a surface irregularity shall be removed and replaced with mortar. Initial floating shall produce a surface of uniform texture and appearance with no unnecessary working of the surface.
- 3.4.3 Initial floating shall be followed by a second floating at the time of initial set. The second floating shall produce a finish of uniform texture and color. Unless additional finishing is specifically required, the completed finish for unformed surfaces shall be the float finish produced by the second floating. All holes, voids or irregularities shall be filled.
- 3.4.4 Floating shall be performed with hand floats or suitable mechanical compactor floats.

3.5 TESTING

- 3.5.1 Field control tests, consisting of slump tests and making compression test cylinders, shall be performed by qualified personnel in the presence of the Owner. The Contractor shall provide all equipment and supplies and the services of one or more employees as necessary for the field control testing.
- 3.5.2 All testing required for preliminary review shall be made by an acceptable independent testing laboratory at the expense of the Contractor. Field control cylinders made during the progress of the work will be compression tested at the expense of the Contractor.
- 3.5.3 The frequency hereinafter specified for each field control test is a minimum. If additional field control tests are necessary, in the opinion of the Owner, all such tests shall be made in accordance with the limits prescribed in Section 01 45 29.

END OF SECTION

SECTION 03 35 36 - CONCRETE FINISHING(SITEWORK)

1.0 GENERAL

1.1 DESCRIPTION

- 1.1.1 Work included: provide finishes on cast-in-place concrete as called for on the drawings, specified herein, and needed for a complete and proper installation. Confirm all finishes with Owner's Representative prior to construction.
- 1.1.2 Related Work:
Division 03 30 53: Cast-in-Place Concrete.

1.2 QUALITY ASSURANCE

Use adequate numbers of skilled workers who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Division.

1.3 SUBMITTALS

- 1.3.1 Comply with provisions of General Conditions.
- 1.3.2 Product data: After the Contractor has received the Owner's Notice of Award, submit:
 - A. Materials list of items proposed to be provided under this division.
 - B. Manufacturer's recommended installation procedures which, when approved by the Owner's Representative, will become the basis for accepting or rejecting actual installation procedures used on the work.

2.0 PRODUCTS

2.1 MATERIALS

Carefully study the drawings and these Specifications, and determine the location, extent, and type of required concrete finishes.

3.0 EXECUTION

3.1 SURFACE CONDITIONS

Examine the areas and conditions under which work of this Division will be performed. Correct conditions detrimental to timely and proper completion of the work. Do not proceed until conditions are correct.

3.2 FINISHING

Definition of Finishing Tolerances:

- A. Exterior Flatwork: "Class B per ACI 347": True plane within ¼" in five feet as determined by a five foot straightedge placed anywhere on the slab in any direction.

Site retaining walls: "Class A per ACI 347". True plane within 1/8" in five feet as

determined by a five foot straightedge placed anywhere on the wall in any direction.

- B. Unless otherwise directed by the Owner's Representative, provide the texturing in one direction only.
- C. Exterior Flatwork: Provide "medium" coarse broom texturing as directed by the Owner's Representative or otherwise called for on the drawings. Fill and patch all honeycomb, spalls, tie holes, etc. rub surface with carborundum brick.

Site retaining walls: Fill and patch all honeycomb, spalls, tie holes, etc. rub surface with carborundum brick. Surfaces exposed to view shall be rubbed or otherwise coated with a grout plaster to provide a uniform finish adequately bonded to the structure.

3.3 CURING AND PROTECTION

3.3.1 Beginning immediately after placement, protect concrete from premature drying, excessively hot and cold temperatures, and mechanical injury.

3.3.2 Temperature, Wind, and Humidity:

A. Cold Weather:

- (1) When the mean daily temperature outdoors is less than 40 degrees F, maintain the temperature of the concrete between 50 degrees F and 70 degrees F for the required curing period;
- (2) When necessary, provide proper and adequate heating system capable of maintaining the required heat without injury due to concentration of heat;
- (3) Do not use combustion heaters during the first 24 hours unless precautions are taken to prevent exposure of the concrete to exhaust gases which contain carbon dioxide.

B. Hot weather: When necessary, provide wind breaks, fog spraying, shading, sprinkling, ponding, or wet covering with a light colored material, applying as quickly as concrete hardening and finishing operations will allow.

C. Rate of temperature change: Keep the temperature of the air immediately adjacent to the concrete during and immediately following the curing period as uniform as possible and not exceeding a change of 5 degrees F in any one hour period, or 50 degrees F in any 24 hour period.

3.3.3 Protection from Mechanical Injury:

- A. During the curing period, protect the concrete from damaging mechanical disturbances such as heavy shock, load stresses, and excessive vibration.
- B. Protect finished concrete surfaces from damage from construction equipment, materials, and methods, by application of curing procedures, and by rain and running water.
- C. Do not load self-supporting structures in such a way as to over stress the concrete.

END OF SECTION

SECTION 05 52 14 - ORNAMENTAL AND MISCELLANEOUS METALS

1.0 GENERAL

1.1 DESCRIPTION

- 1.1.1 Furnish materials, labor, tools, equipment, services, operations and incidentals necessary to complete all miscellaneous and ornamental exterior sitework metal work indicated on the drawings and specified, including all supplementary parts, anchors, sockets, inserts, bolts, hardware or other accessories required to complete and install each item and provide a functional system in accordance with OSHA and ADA regulations. Appropriate structural calculations for metallic railings, stairs, guardrails shall be provided to show conformance with design requirements of applicable codes. Live loads, dead loads, and impact loads shall be considered. Calculations should also include sizing of anchor bolts, welds, etc.
- 1.1.2 Work under this section includes all exterior sitework related ornamental and miscellaneous metals that are not part of the structural steel or parts that are specifically included in other sections. Where such items are included and specified in other sections in the specifications, but by trade agreements and jurisdictions the work must be executed under this section, it shall be the responsibility of the Contractor to coordinate the furnishing and installing of such items. Architectural and items inside proposed buildings are not included in this specification.
- 1.1.3 Many items indicated on the drawings are described and detailed to the extent that it is not necessary to list them in the specifications. The fact that the items are not included or listed in this section does not relieve the Contractor of the responsibility of furnishing and installing these items.

2.0 SHOP DRAWINGS AND SUBMITTALS

- 2.1 Submit shop drawings for each fabricated metal item specified herein or indicated on the drawings. Show pertinent details of construction and connection to other work; list all materials, gauges, thicknesses, finishes, colors, fasteners, anchors, and other similar items that completely describe how the items are fabricated and installed. Contractor shall verify dimensions in the field to insure fit. Shop drawings shall be submitted for approval prior to fabricating items.
- 2.2 Cut sheets and specifications on manufactured items shall be submitted for approval prior to ordering items. Submittal shall include complete description of each item, listing all materials, finishes, thicknesses, gauges, anchoring, method of connection to adjoining work and other similar data that completely describe each item and how the item is to be installed.
- 2.3 The contractor shall furnish samples of manufactured items and custom fabricated items for review and approval.

3.0 FIELD MEASUREMENTS

Contractor shall accurately field measure all job conditions and indicate these conditions and dimensions on all shop and installation drawings.

PART 2 - PRODUCTS

1. MATERIALS

- A. Steel, not otherwise specified: Standard Specifications for Structural Steel for bridges and buildings, serial designation A7, of ASTM, as amended to date.
- B. Cast Iron: Soft, tough, gray iron, ASTM A-48-48.
- C. Aluminum bars, rods, extrusions, pipe and tube: ASTM B221, alloy 6063.
- D. Galvanized steel pipe: Federal Specification WW-P-406, type 2, zinc coated.
- E. Steel sheets and strips: Federal Specification QQ-S-636.
- F. Stainless Steel: Type 304, 18-8 composition, finishes as indicated on each item.
- G. Steel Tubing: Mechanical welded, bright finish steel tube.
- H. Paint Primer: Pittsburg Speedhide Inhibitive Red Primer.
- I. Grout: Por-Rok Cement, as manufactured by Hallemite Lehn & Fink Industries, Products Division of Sterling Drug, Inc.
- J. Black Pipe: Extra strong, conforming to ASTM Specification A53, Grade B.

2. ITEMS

- A. Pipe handrails and railings shall be fabricated of 1 1/2" OD extra strong black pipe. All joints shall be welded solid, welds ground smooth. Railing shall be inserted into steel plate/pipe handrail anchors, or bolt down anchor plates, as indicated on the drawings.
- B. Steel Ladders (General): 24" wide, length indicated on the drawings or as required to span job conditions, fabricated of low carbon steel with 3" x " square steel tubing rails, 3/4" diameter rungs spaced 12" o.c. Extend rungs through rails, and weld. Provide anchors at top, bottom and 4'-0" o.c. between design to hold ladder 8" clear of face of wall.
- C. Ships ladder shall be fabricated of 10" x 15.3 channel stringers, 8" galvanized welded treads with checkered plate nosing, 1-1/2" diameter pipe rail and mounting brackets. Treads shall be welded to stringers continuous along the entire joint, on both sides. Provide shoe brackets secured to concrete floor and wall and welded to stringers. Pipe rail shall be welded to stringer.
- D. Hangers, where necessary or required, shall be 1/2" threaded rods, secured to 1/2" wedge rod anchor set in concrete and 1 - 1/2" x 3" Unistrut Rack Mounting Channel. Provide a minimum of two hangers per installation.
- E. Provide miscellaneous steel angles that are not part of the structural steel.
- F. Furnish and install miscellaneous steel members for bracing of hollow metal door frames, changes in ceiling heights and other similar conditions.

Material shall be steel angles, channels, plates, brackets, and similar types of items welded to form structural frame or support as indicated on the drawings or as required by job conditions. Secure miscellaneous items to structural system. Hollow metal door frames

located in steel stud partitions shall have steel channel or steel angle extensions or bracing from the frame to the structural system above.

- G. Furnish and install all miscellaneous steel angle sections indicated on the drawings, or as required by job conditions, for lintels carrying masonry over openings and miscellaneous bracing, clip angles and like items.
- H. Furnish and install all miscellaneous steel angles, channels, brackets, fasteners, etc., required to support wall-mounted equipment, ceiling-mounted equipment, floor-mounted equipment and other similar related items of equipment as indicated on the drawings. Items shall be welded construction, secured to building to support items indicated.
- I. Furnish and install other miscellaneous structural shapes where indicated on drawings or required but not specified.

PART 3 - EXECUTION

1. WORKMANSHIP

- A. Perform workmanship to highest standards for trade involved; carefully assemble work true to lines, planes, and design.
- B. Use templates and patterns for proper fitting of hardware and other accessories.
- C. Perform welding continuous along entire line of contact, except where tack welding is permitted. Where exposed, grind welds smooth in conformance with American Welding Society Code for Welding in Building Construction, latest edition. Where specified, welds are to be filled and sanded before painting.
- D. Perform bolting, where indicated or permitted with proper size of bolts. Draw nuts tight and upset threads except where tack welding is permitted. All bolts, nuts, washers, etc., exposed to the elements shall be cadmium plated or non-rusting type.
- E. Insofar as possible, fit and shop assemble work ready for erection. Execute work in strict accordance with drawings, details and approved shop drawings. Shop and/or field weld connections except where nature of material or item specifically calls for other means of fastening. Such fasteners shall in all cases be countersunk and finished flush with exposed surfaces.
- F. All items constructed of ferrous metals shall be either shop primed or field primed with specified paint. Items shop primed shall be touched up in field after installation. Where components are assembled to conceal part of the metal, the concealed metal shall be primed and painted prior to fabrication. Final finish of the metal shall be as noted on the drawings or specifications. Paint color shall be selected by the Owner.

2. INTEGRATION WITH THE WORK

Provide all items to appropriate trade when such items are to be built into masonry, concrete, tile, etc., prior to time required by that trade. Measure all construction prior to fabrication of metal items to assure perfect fit.

END OF SECTION

SECTION 31 11 00 - CLEARING AND GRUBBING

PART 1: GENERAL

1.1 SUMMARY

- A. Section Includes: Clearing of vegetation, and grubbing of stumps, roots, and debris; disposal of unutilized materials; and other incidental work related to preparing the site for later use.

1.2 DEFINITIONS

- A. Clearing: Clearing shall consist of the felling, trimming, and cutting of obstructions such as trees into sections and the satisfactory disposal of the trees and other surface vegetation designated for removal, including down timber, trees, brush, and rubbish occurring in the areas to be cleared.
- B. Grubbing: Grubbing shall consist of the removal and disposal of below-surface stumps, roots larger than 3-inches (75 millimeters) in diameter, and matted roots from the designated grubbing areas.
- C. Hazardous Waste: Substance likely to cause death or injury by reason of being explosive, flammable, poisonous, corrosive, oxidizing, irritating, or otherwise harmful; and includes, but is not limited to flammable dust, flammable fiber, combustible liquid, dangerous chemical, flammable gas, liquified flammable gas, and flammable liquid.

1.3 PROJECT/SITE CONDITIONS

- A. Work Limits: Area to be cleared and grubbed will be the excavation area or disturbed area identified by the project work. Scalping of topsoil during clearing operations will not be permitted.
- B. Burning of Debris: Shall not be permitted, unless specifically authorized. Contractor shall be responsible for obtaining all necessary permits, licenses and approvals from jurisdictions having authority.
- C. Landscape Preservation: Protect vegetation outside the work limits from injury. Existing trees and shrubs shall not be disturbed or damaged.

1.4 SUBMITTALS

- A. Tree Wound Paint: Submit three copies of manufacturer's literature and one container of tree wound paint that is to be used on this project.
- B. Herbicide: Submit three copies of manufacturer's literature and one container of herbicide to be used on this project.
- C. Records: Submit three copies of written permission to dispose of materials other than salable timber on private property.

PART 2: PRODUCTS

2.1 PREPARED PRODUCTS

- A. Tree Wound Paint: Bituminous based material of standard manufacture specially formulated for tree wounds.

- B. Herbicide: Comply with Federal Insecticide, Fungicide, and Rodenticide Act, Title 7 U.S.C. Section 136, for requirements on Contractor licensing, certification, and record keeping.

PART 3: EXECUTION

3.1 PROTECTION

- A. Roads and Walks: Keep roads and walks free of dirt and debris at all times. Damage to existing surfaces shall be repaired at no expense to the Owner.
- B. Utility Lines: Protect existing utility lines that are indicated to remain in service from damage. Notify the Owner's Representative immediately of damage to or an encounter with an unknown existing utility line. Contractor shall be responsible for contacting utility companies in the area to determine location of their respective utilities. When utility lines which are to be removed are encountered within the area of operations, the Contractor shall notify the Owner's Representative 72 hours prior to interruption of the service. Utility service interruption shall only occur after the approval of the Owner's Representative and the utility owner.

3.2 CLEARING

- A. Requirements: Clear trees, stumps, roots, brush, and other vegetation in areas to be graded; cut off flush with or below the original ground surface, except such trees and vegetation indicated or directed to be left standing. Trees designated to be left standing within the cleared areas shall be trimmed of dead branches 1-1/2 inches (40 mm) and shall be trimmed of all branches the heights indicated on the drawings. Limbs and branches to be trimmed shall be neatly cut close to the bole of the tree or main branches. Cuts more than 1-1/2 inches (40 mm) in diameter shall be painted with an approved tree-wound paint. Trees and vegetation to be left standing shall be protected from damage incident to clearing, grubbing, and construction operations by the erection of barriers or by such other means as the circumstances require. Clearing shall also include the removal and disposal of existing obstructions that obstruct, encroach upon, or otherwise obstruct the work.

3.3 GRUBBING

- A. Requirements: Material to be grubbed, together with logs and other organic or metallic debris not suitable for foundation purposes, shall be removed to a depth of not less than 18 inches (450 mm) below the original surface level of the ground in areas indicated to be grubbed and in areas indicated as construction areas under this contract, such as areas for buildings, and areas to be paved. Depressions made by grubbing shall be filled with suitable material and compacted to make the surface conform with the original adjacent surface of the ground.
- B. Low Embankment Areas: When the finished subgrade is less than 3 feet (1 m) above the original ground, remove stumps, roots, and debris to a minimum of 6 inches (150 mm) below the original ground. Backfill stump and root holes with approved material and compact before placing embankment material.
- C. High Embankment Areas: When the finished subgrade is 4 feet or more from the original ground, stumps may be cut flush and left in place. Removal of undisturbed stumps and roots and nonperishable solid objects will not be required. The surface of the original ground shall be scarified before starting the embankment operation.

3.4 EXPLOSIVES

- A. Requirements: The use of explosives is prohibited.

3.5 SALVAGE

Items to be salvaged, if any, shall be identified on the plan sheets.

3.6 DISPOSAL

- A. Requirements: Material that is not to be salvaged shall be removed from the project site and legally disposed of by a combination of burying and removal. Burning will not be permitted without approval.

END OF SECTION

SECTION 31 14 13 - TOPSOILING

PART 1. GENERAL

1.1 INSPECTION

- A. Not less than 10 days prior to the commencement of topsoiling operations, the Owners Representative shall be notified of the offsite sources from which topsoil is to be furnished. The material will be inspected to determine whether the selected topsoil meets the requirements. The topsoil shall be approved prior to use.

PART 2. PRODUCTS

2.1 TOPSOIL

- A. All topsoil necessary to complete the work shall be obtained from topsoil stockpiles, from grading and excavating operations and/or from approved topsoil sources off of Owner's property. Topsoil from approved sources and stockpiled topsoil shall be natural, friable, topsoil characteristic of representative soils in the vicinity that produce have growths of crops, grass, or other vegetation. Topsoil shall be free from tree roots, stones, shale, parent and other materials that hinder grading, planting, plant growth and maintenance operations, and free from noxious and other objectionable weed seeds and toxic substances.
- B. Run soil tests prior to topsoil sample approval and at the Architect's discretion throughout topsoil installation. Testing expenses will be borne by the contractor. Topsoil that does not meet the following requirements will not be accepted.
 - 1. Natural Organic Content: By dry oven weight, as measured by "wet Digestion process" to be not less than 1.5%.
 - 2. P.H. of Topsoil: No more than 7.6.
 - 3. Sand Content: No more than 50% oven dry weight.

PART 3. EXECUTION

3.1 TILLAGE

- A. Immediately prior to dumping and spreading the topsoil, the subgrade shall be double tilled to a depth of 2 inches using a chisel plow with the chisels set not more than 8 inches apart. Tillage shall be accomplished across the slope.

3.2 PLACING TOPSOIL

- A. Topsoil shall be uniformly distributed and evenly spread to an average thickness of 6 inches, with a minimum thickness of 5 inches. Topsoil shall be spread so that planting can proceed with little additional soil preparation or tillage. Surface irregularities resulting from topsoiling or other operations shall be leveled to prevent depressions. The grades shall be adjusted to assure that the planted grade shall be 1 inch below the adjoining grade of any surface area. Topsoil shall not be placed when the subgrade is frozen, excessively wet or compacted, extremely dry, or in a condition detrimental to the proposed planting or grading.

3.3 CLEANUP

- A. Prior to topsoiling, vegetation that may interfere with operations shall be mowed, grubbed, and raked.

The collected material shall be removed from the site. The surface shall be cleaned of stumps, and tones larger than 1 inch in diameter, and roots, cable, wire and other materials that might hinder the work or subsequent maintenance shall also be removed.

3.4 REPAIR

- A. Where any portion of the surfaces becomes gullied or otherwise damaged, the affected area shall be repaired to establish the condition and grade prior to topsoiling, and then shall be re-topsoiled as specified in paragraph 3.2.A.

END OF SECTION

SECTION 31 22 19 - SITE GRADING

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes: Stripping and storage of topsoil, excavating, filling, grading, and other related work to prepare the site.
- B. Refer to Plan General Notes and Project Geotechnical Report(s) for additional project specific information. All soil placed in fill or embankment areas shall be approved or in accordance with Geotechnical Engineers recommendations.

1.2 DEFINITIONS

- A. Unclassified Excavation: Shall consist of the material excavation and placement regardless of its nature. All excavation shall be considered unclassified unless specifically stated in the Bid Schedule.
- B. Rock Excavation: Removal of material shall be considered rock excavation when it consists of igneous, metamorphic, and sedimentary rock which cannot be excavated without blasting or the use of a tractor having a power rating in excess of 370 horsepower, with a rear-mounted, heavy-duty, single-tooth, ripping attachment.
- C. Common Excavation: Removal of materials which can be excavated using a rear-mounted, heavy-duty, single-tooth ripping attachment mounted on a crawler tractor with a power rating of 370 horsepower or less shall be considered common excavation.
- D. Muck Excavation: Shall consist of the removal and disposal of deposits of saturated or unsaturated mixtures of soils and organic matter not suitable for foundation material regardless of moisture content.
- E. Fill Material: Shall be mineral soil free from peat, frozen material, brush, trees, roots over 50 mm (2 inches) in diameter and rocks over 150 mm (6 inches) in greatest diameter obtained from site during excavation.
- F. Topsoil: Surface soil approximately 150 mm (6 inches) in depth that supports growth of vegetation and contains organic matter. Topsoil shall be free from subsoil, debris, and stones larger than 25 mm (1 inch) in diameter.

1.3 QUALITY ASSURANCE

- A. Failure Criteria: Not limited to the following:
 - 1. Formation of pools of moisture where positive drainage is intended for proper function or otherwise indicated on the drawings.
 - 2. Settlement of fill.
 - 3. Flow of moisture toward, or entrapment against, structures or building foundations.

1.4 PROJECT/SITE CONDITIONS

- A. Environmental Conditions: Do not attempt to grade frozen or saturated material. Water dry material to prevent dust.

PART 2: PRODUCTS

2.1 MATERIALS

- A. General: See definitions.
 - 1. Silt Barrier: A silt barrier shall be constructed to prevent silt from traveling off site. The geotextile fabric shall be made of ultra-violet resistant material, silt-film fabric having the following characteristics:
 - a. Grab strength, according to ASTM D 4632: 90 lbs.(200 kg)
 - b. Burst strength, according to ASTM D 751: 145 lbs.(320 kg)
 - c. Elongation, according to ASTM D 4632: 15 percent @ 45 lbs.(100 kg)
 - d. Permeability coefficient, according to ASTM D 4491, at a constant head of 50 mm: 0.2 mm/sec.
 - e. Apparent opening size, according to ASTM D 4751: U.S. Standard Sieve Number 20 minimum.
 - f. Retained strength after accelerated weathering and ultra-violet exposure, according to ASTM D 4355: 70 percent.

PART 3: EXECUTION

3.1 EXAMINATION

- A. Verification of Conditions: Verify the grade elevations existing on the site. Notify the Owner's Representative immediately if existing site elevations differ from those shown in the project drawings and when adjustments are required to provide finish elevations indicated. Site drainage shall be considered of prime importance.

Contractor shall review plan sheets, general construction notes and geotechnical investigations and report for additional requirements. Plan notes shall supercede these specifications.

3.2 PREPARATION

- A. Clearing: Section 31 11 00 - Clearing and Grubbing.
- B. Stripping Topsoil: Strip and stockpile topsoil in the location approved by the Owners Representative.
- C. Scarifying: Sod and vegetation shall be removed from the surface upon which the fill shall be placed. The cleared surface shall be completely broken up by scarifying to a minimum depth of 8 inches. Scarifying furrows shall be a maximum of 3 feet (900 mm) apart and shall be parallel to the center line of the fill. No fill materials shall be placed upon unapproved surface.

3.3 INSTALLATION

- A. Excavation: Section 31 23 00 - Excavation and Fill.
- B. Grades: When not otherwise indicated shall be level, or uniform slopes between points where elevations are given, or between such points and existing finished grades. Changes in slopes shall be rounded. Grades shall slope away from structure. Contractor shall insure that positive drainage is maintained at all times to prevent ponding of water. Typically spot elevations given are to top of sod or paving. Contractor shall adjust grading elevations as necessary to account for final surface.
- C. Compaction Methods: Fill material shall be spread over the full area of the cross section of the fill to a maximum loose layer thickness of 8 inches. Compact according to Section 312300 - Excavation and Fill, before the next layer is spread. Use vibratory, pneumatic tire, smooth-steel wheel, or sheepsfoot rollers to obtain the required degree of compaction. During placing and compacting of the fill material, the optimum moisture content shall be maintained by wetting or drying as required. Slopes shall be benched before placement of fill on said slopes.

- D. Frozen Material: Fill shall not be placed when either the material or the surface on which it is to be placed is frozen.
- E. Homogeneous Mass: Successive loads of material shall be dumped on the earthfill to produce the best practicable distribution of the material. The in-place materials shall be free of lenses, pockets, streaks, or layers of materials differing substantially in texture or gradation from the surrounding materials.
- F. Topsoil: Topsoil to be used for landscaping shall be spread uniformly over compacted material to grades, 6 inches thick minimum, and compacted firmly in place. Upon completion of grading operations, spread topsoil from the stockpile onto lawn areas and areas disturbed by grading operations.

3.4 FIELD QUALITY CONTROL

- A. Testing: Furnish necessary equipment, labor, and materials to conduct the testing. Testing shall be conducted in the presence of the Owner's Representative who shall be given 48-hour notice before tests are to be conducted. Arrange for a certified independent testing laboratory, according to the requirements of Section 01 45 29 - Testing Laboratory Services, to perform the required testing, recording, and distributing of the results.
- B. Compaction: Fill material shall be compacted to a minimum density of 95 percent of the maximum dry density obtained by AASHTO T 99, Method C, unless noted otherwise.

END OF SECTION

SECTION 31 23 00 - EXCAVATION AND FILL

PART 1: GENERAL

1.1 SUMMARY

- A. Section Includes: Excavation, borrow excavation, embankment construction, placement, and disposal of materials as shown on the drawings.
- B. Related Sections
 - Testing Laboratory Services Section 01 45 29
 - Clearing and Grubbing Section 31 11 00

1.2 DEFINITIONS

- A. Unclassified Excavation: Consists of the material excavation and placement regardless of its nature. All excavation and fill shall be considered Unclassified unless types B through E, listed below, are specifically listed in the Bid Schedule.
- B. Rock Excavation: Removal of material is rock excavation when it consists of igneous, metamorphic, and sedimentary rock which cannot be excavated without blasting or the use of a tractor having a power rating in excess of 370 horsepower, with a rear-mounted, heavy-duty, single-tooth, ripping attachment.
- C. Common Excavation: Removal of materials which can be excavated using a rear-mounted, heavy-duty, single-tooth ripping attachment mounted on a crawler tractor with a power rating of 370 horsepower or less shall be considered common excavation.
- D. Muck Excavation: Shall consist of the removal and disposal of deposits of saturated or unsaturated mixtures of soils and organic matter not suitable for foundation material regardless of moisture content.
- E. Fill Material: Shall be suitable mineral soil free from organics, frozen material, brush, trees, roots over 2 inches (50 mm) in diameter and rocks over 6 inches (200 mm) in greatest diameter obtained from site during excavation. Fill material quality may be specified to meet certain project requirements. Refer to plan notes and project geotechnical report for specific requirements.
- C. Topsoil: Surface soil approximately 6 inches (150 mm) in depth that supports growth of vegetation and contains organic matter. Topsoil shall be free from subsoil, debris, and stones larger than 1 inch (25 mm) in diameter.

1.3 PROJECT/SITE CONDITIONS

- A. Excess Material: Usable excess material excavated shall be used in the embankment construction before the use of borrow is allowed. Borrow wasting is not permitted.
- B. Borrow Material Source: Furnish the borrow material source, unless an a source or sources shown on the drawings, subject to use restrictions or requirements as noted.
- C. Fencing: When fencing is removed, replace the fencing to the same condition as it was before removal. The Contractor shall be responsible for the livestock confinement when a portion of a fence is removed.

- D. Drainage of Borrow Pits: Borrow pits, gravel pits, quarry sites, and waste or disposal areas shall be excavated so that water will not collect and stand.

PART 2: PRODUCTS

2.1 MATERIALS

- A. General: See definitions.
- B. Fill Material: Shall be obtained from the unclassified excavation, or from approved borrow areas. Material from excavation shall be used unless it contains frozen earth, debris, does not comply with any quality restrictions, or is specified in other sections to be replaced. Materials removed in clearing and grubbing shall not be used for backfill or embankment.

PART 3: EXECUTION

3.1 PREPARATION

- A. Clearing and Grubbing: The area to be excavated, and the surface area to be covered by fill material, shall be thoroughly cleared and stripped of vegetative matter, brush, trees, stumps, roots, loose rocks, and other objectionable materials including sand, gravel, silt, and debris in channels within the foundation areas. Dispose of debris.
- B. Borrow Areas: Notify the Owner's Representative sufficiently(14 Days) in advance of opening borrow areas. This allows cross section determination of elevations and measurements of the ground surface after stripping. also, the borrow material can be tested before being used. Allow sufficient time for testing the borrow(14 Days). Borrow areas shall be bladed and left in such shape as to permit accurate measurements after excavation has been completed. Do not excavate beyond the dimensions and elevations established, and no material shall be removed prior to staking out and cross-sectioning of the site. The finished borrow areas shall be approximately true to the line and grade established by agreement.
- C. Prewatering: Excavation areas and borrow pits may be prewatered before excavating the material. The area to be excavated shall be moistened to the full depth from the surface to the bottom of the excavation. The application of water shall be controlled so that the excavated material will be near the optimum moisture content as specified in paragraph 3.3A Testing, below. When necessary, prewatering shall be supplemented to assure that embankment material and backfill material moisture content comply with paragraph 3.3A Testing, below.
- D. Preparation for Grading: Prior to beginning embankment operations in an area, necessary clearing and grubbing in that area shall have been completed and accepted by the Owners Representative. No embankment materials shall be placed upon an unapproved surface.
 - 1. Embankment Greater Than 4 feet (1200 mm) High: When embankments greater than 4 feet (1200 mm) are to be constructed, the cleared surface shall be completely broken up by plowing or scarifying to a minimum depth of 6 inches (150 mm). Scarifying or furrows shall be a maximum of 3 feet (900 mm) apart, and shall be parallel to the centerline of the embankment. This area shall then be compacted beginning with the first lift, as specified in paragraphs 3.3B Moisture Content and 3.3C Compaction.
 - 2. Embankment 4 feet (1200 mm) High or Less: When embankments 4 feet (1200 mm) high or less are to be constructed, sod and vegetation shall be removed from the surface upon which the embankment is to be placed, and the surface of the original ground shall be scarified as described in paragraph 3.1D1, and shall be compacted as described in paragraphs 3.3B Moisture Content and 3.3C Compaction, before starting the embankment operation.

3.2 INSTALLATION

- A. Explosives: The use of explosives is prohibited.

- B. Excavation: Excavate where shown on the drawings and typical sections, unless staked otherwise. Excavate on a straight grade between the control points shown on the drawings unless staked otherwise. Existing structures which are disturbed or damaged by construction activity shall be reset, repaired, or replaced at the Contractor's expense.
- C. Subgrade Compaction: In areas where earthfill, or granular embankments are to be constructed and in areas where excavation exposes the subgrade surface upon which improvements will be constructed, the subgrade shall be compacted as specified in paragraphs 3.3B Moisture Content and 3.3C Compaction below, before embankment construction begins.
- D. Disposal of Materials: Excess and unsuitable material, including rock and boulders that cannot be used in embankments, shall be disposed of off-site unless otherwise approved by the Owners Representative.
- E. Use of Borrow Material: Do not use borrow material until after the suitable materials obtained from required excavation have been placed in the fill, unless otherwise directed by the Owners Representative. When more borrow is placed than is required, and required excavation is wasted, the waste shall be replaced in the borrow area at the Contractor's expense.
- F. Overburden: Overburden shall be stripped from borrow pits, aggregate pits, and quarries, and stockpiled for later use. After a pit has served its purpose, waste material outside of the pit shall be moved back into the pit. The pit shall be neatly sloped and trimmed. Side slopes shall be flattened to a 4:1 slope. Stockpiled overburden material shall then be spread uniformly over the sides and bottom of the pit area, and vegetation established.
- G. NOT USED
- H. Fill Material: Slope surfaces shall be horizontally benched before placement of fill on slopes. Fill shall be spread over the full width of the cross section of the embankment to a maximum loose thickness of 8 inches (200 mm), and shall be compacted as specified in paragraphs 3.3B Moisture Content and 3.3C Compaction below, before the next layer is spread. Use sheepsfoot, vibratory, pneumatic tire, or smooth-steel wheel rollers to obtain the required degree of compaction. The in-place materials shall be free of lenses, pockets, streaks, or layers of materials differing substantially in texture or gradation from the surrounding materials. Proof rolling shall be performed as indicated on the plans.
- I. Frozen Material: Shall not be placed, nor be placed upon a frozen surface.

3.3 FIELD QUALITY CONTROL

- A. Testing: Furnish necessary equipment, labor, and materials to conduct the testing. Testing shall be conducted in the presence of the Owners Representative who shall be given 48 hours notice before any test is to be conducted. Arrange for a certified independent testing laboratory, according to the requirements of Section 01 45 29 - Testing Laboratory Services, to perform the required testing, recording, and distributing of the results.
- B. Moisture Content: During placing and compacting of fill material, the optimum moisture content (-2 percent to +2 percent) as determined by AASHTO T 217 or AASHTO T 239, unless otherwise approved, shall be maintained by wetting or drying. Moisture range may vary depending upon material. Contractor shall place material in accordance with recommendations provided by Geotechnical Engineers recommendations, if available.
- C. Compaction: The fill material shall be compacted to a minimum density of 95 percent of the maximum dry density as determined by AASHTO T 99, Method C unless noted otherwise.

END OF SECTION

SECTION 31 23 33 - TRENCHING

PART 1: GENERAL

1.1 SUMMARY

- A. Section Includes: Trenching, backfilling, and compacting for the installation of utility lines.

1.2 DEFINITIONS

- A. Unclassified Excavation: Shall consist of the material excavated, including earth, shale, rock, gravel, debris or other material excavated or otherwise removed in the preparation of the trench and its handling, placement, or disposal.

1.3 QUALITY ASSURANCE

- A. Failure Criteria: Not limited to the following:
 1. Settlement of backfill below natural ground surface.
 2. Evidence of leakage of the piping.
 3. Malfunctioning of buried electrical or piping systems.

1.4 PROJECT AND SITE CONDITIONS

- A. Borrow Sources: Shall be as approved by the Engineer prior to excavation.
- B. Environmental Conditions:
 1. Excavate areas that have become saturated with oil, gasoline, or bituminous products to a depth of 12 inches (300 mm) beyond contaminated materials; backfill with approved material.
 2. Finish slopes according to the drawings. The final surface shall be similar to a surface obtained by using a farm disk or harrow parallel to the contours and shall blend with the adjacent terrain. Hand rake as necessary to remove excess material in areas inaccessible to construction equipment. Grade to produce a well-drained surface. Excess material from trench excavation shall be placed over the backfill in an inverted "U" shape, however it must not impede drainage.

PART 2: PRODUCTS

2.1 MATERIALS

- A. General: Material excavated shall be considered unclassified.
- B. Backfill Material: When the type of backfill material to be placed above the standard bedding material is not indicated on the Drawings or specified, the backfill may be made with excavated material, provided that such material, in the opinion of the Engineer is suitable for backfill. In the event excavated material is not suitable, standard bedding material shall be used. Backfill material shall not contain ice or frozen earth, debris, or be of a high moisture content. Materials removed in clearing and grubbing shall not be used for backfill. Backfill shall not contain rock larger than 3 inches in diameter.
- C. Standard Bedding Material:
 1. Standard Bedding Material (SBM) shall meet the requirements of ASTM D-2321 or ASTM C12 for the class of materials described in this subsection.
 - Class I. Class I shall be an angular, ¼ in. to 1 ½ in. graded crushed stone.

Class II. Class II shall include coarse sands and gravels with maximum particle size of 1-1/2 in. These materials may have small percentages of fines, but shall be generally granular and non-cohesive, either wet or dry. Class II materials shall include Unified Soil Classification system Soil Types GW, GP, SW and SP.

Class III. Class III shall include fine sands, sand-clay mixtures and gravel-clay mixtures. USCS Soil Types GM, GC, SM and SC are included in this class.

- D. Sod Materials: Shall consist of the grass mat from a lawn or cultured grass area, which has sufficient root mat to remain together when rolled or removed from the trench area. Grass and soil, which will not reasonably remain intact, shall be considered topsoil.

PART 3: EXECUTION

3.1 PREPARATION

- A. Clearing: Provide minimum disturbance to existing grass and sod. Dispose of debris at a location off site. All debris to become the property of the Contractor.
- B. Topsoil: Strip topsoil, or in the absence of topsoil, strip the top 4 to 6 inches of surface material and store in stockpile areas. Do not excavate into the underlying, original topsoil at stockpiles. Place previously stripped topsoil onto disturbed-earth areas upon completion of the backfilling operation.
- C. Utilities: Before starting excavation, establish the location and extent of underground utilities in the work area. Protect active utility services uncovered by excavation. Notify the Engineer immediately if utilities are damaged. Damage to utilities shall be repaired or replaced at the Contractor's expense.
- D. Cutting Pavement, Curbs, and Gutters: Make cuts with parallel, straight lines, minimum of 1 foot wider than trench width on each side of trench or pit edge.
- E. Protection of Excavation: Construct and maintain shoring, bracing, underpinning, and sheet piling necessary to protect the excavation and adjacent structures.
- F. Dewatering: Keep the excavation dewatered so that pipe, forming, and concrete work can be carried on under dewatered conditions. Dispose of excess water in a manner that will avoid damage to adjacent property.

3.2 INSTALLATION

- A. General:
 - 1. Restore disturbed areas of existing bituminous pavements.
 - 2. Restore disturbed areas of existing concrete structures.
- B. Trench Excavation: Shall be excavated so that pipe can be laid to the alignment and grades shown on the Drawings. Excavate trenches in rock to a depth of at least 4 inches, but not exceeding 12 inches, below pipe bottom. Depth is dependent upon type of pipe. See Details.
 - 1. When over-excavation occurs, repair the area by backfilling with approved bedding material and compacting to 95 percent maximum dry density according to AASHTO T 99, Method C.
 - 2. When frost action occurs, remove frozen soil and replace with approved soil compacted to 95% of maximum dry density as determined by AASHTO T 99, Method C.

3. When soil becomes saturated above the optimum moisture content, manipulate or dry the material to optimum moisture content and compact, or remove soil down to firm material and place backfill before construction proceeds.
- C. Removal of Materials by Explosives: The use of explosives is prohibited unless specifically authorized by OWNER and local authorities.
 - D. Standard Bedding Material (SBM): Shall be placed as shown on the drawings, carefully placed and compacted along the entire length of the pipe to be installed to the limits of trench excavation, until the thickness specified is obtained. Fine grade the trench bottom throughout and provide uniform and continuous support for each section of pipe or conduit except at bell holes or depressions necessary for making proper joints.
 1. Gravity Pipelines: Standard Bedding Material shall be placed simultaneously on each side of pipe and shall be carefully compacted in accordance with the specifications for the type of pipe to be installed.
 - a. Class I SBM requires little or no compaction due to the nature of the angular particles.
 - b. Class II SBM shall be compacted to a minimum of 85% Standard Proctor Density using hand or mechanical tamping methods.
 - c. Class III SBM shall be compacted to a minimum 90% Standard Proctor Density using hand or mechanical methods. Avoid above optimum moisture conditions.
 2. Pressure Pipelines: SBM shall be placed simultaneously on each side of pipe and compacted sufficiently to maintain proper grade and alignment.
 - E. Trench Backfill: Flooding of trench for consolidation of backfill will not be permitted.
 1. Place backfill to avoid damaging or moving the pipe. Place backfill in 6-inch maximum loose lifts to a depth of 1.5 foot over the top of the pipe. Backfill operations shall be completed within 100 ft. or less of the finished line at all times as directed by the Engineer. Provide compaction as required by specifications and material type.
 - F. Utility Line Marking: Shall be done according to Section 33 05 26 - Utility Line Marking.

3.3 FIELD QUALITY CONTROL

- A. Testing: Contractor shall furnish necessary equipment, labor, and materials to conduct the testing. Testing shall be conducted in the presence of the Inspector, who shall be given 48 hours notice before any test is to be conducted. Arrange for a certified, independent testing laboratory, according to the requirements of Section 01 45 29 - Testing Laboratory Services, to perform the required testing, recording, and distributing of the results.
- B. Testing of Pipe Lines: Shall be done according to Section 01 45 34 - Testing of Piping Systems.

END OF SECTION

SECTION 31 25 00-EROSION CONTROL

1.0 GENERAL

1.1 DESCRIPTION

The work under this section consists of providing all work, materials, labor, equipment, and supervision necessary to provide and construct erosion control measures necessary to protect property and the environment. Included are the following topics:

Provide erosion & stormwater control in accordance with the following references:

- Oklahoma Department of Environmental Quality Stormwater General Permit for Construction Activities, Latest revision or amendment;

Or for projects on Federal/Indian Trust Lands,

- U.S. EPA Construction General Permit
<http://cfpub.epa.gov/npdes/stormwater/cgp.cfm> , Latest revision or amendment;

1.2 SUBMITTALS & DOCUMENTATION

The Contractor will submit or provide the following to the Owner:

- Construction Site Erosion Control Plan, if required. Contractor shall mark-up or create additional versions of the Erosion Control Plan that is included in these documents showing additional or alternate erosion control measures as needed due to the Contractors means and methods throughout all phases of construction.
- Submittals for materials used to implement the erosion control plan.

1.3 EROSION CONTROL PLAN/SWP3

For project disturbing one acre of land or more:

The contractor shall provide a Stormwater Pollution Prevention Plan (SWP3) in accordance with Oklahoma Department of Environmental Quality and/or Environmental Protection Agency stormwater requirements. The contractor shall complete and submit any required documents, including but not limited to the Notice of Intent(NOI), Notice of Termination(NOT) to applicable agency having jurisdiction.

Contractor shall be responsible for insuring the completion of the SWP3 and compliance with the applicable General Permit.

Contractor shall comply with all the requirements of the erosion control plan, and the requirements of the General Permit to Discharge. Erosion control and storm water management practices shall be installed and maintained in accordance with the erosion control plan and General Permits.

Contractor shall provide all erosion control practices necessary to protect property and the environment. Erosion control and storm water management practices shall be installed and maintained in accordance with the erosion control plan and the applicable General Permit. The contractor shall update and modify the erosion control plan as needed for phasing of work. A copy of the current erosion control plan shall be maintained at the project site.

2.0 MATERIALS

2.1 GENERAL

When the design or contract includes permanent erosion control or stormwater control features, the contractor may employ these items to control erosion and stormwater during construction activities. However, these features shall be fully cleaned and restored to the original design providing full function for the intended permanent use prior to acceptance of the work.

2.2 TEMPORARY SILT DIKES

Temporary silt dikes shall be triangular-shaped, having a height of at least eight to ten inches (8" - 10") in the center with equal sides and a sixteen- to twenty-inch (16" - 20") base. The triangular-shaped inner material shall be urethane foam. The outer cover shall be a woven geotextile fabric placed around the inner material and allowed to extend beyond both sides of the triangle two to three (2' - 3') feet. Standard length of each dike will be seven feet (7') unless otherwise indicated on the plans. The dikes shall be attached to the ground with wire staples. The staples shall be No. 11 gauge wire and be at least six to eight (6" - 8") inches long. Staples shall be placed as indicated on the installation detail.

2.3 SILT SCREEN FENCE

Fabric shall be a woven polypropylene geotextile fabric

Silt screen fences shall be installed at least 6 feet from the right-of-way or property line, unless otherwise noted. Framework supports shall have a maximum spacing of 10 feet center to center, or as shown on the construction plans. Filter material shall be secured to the ground between supports to prevent the material from curling or rolling up. Silt screen fences may be removed or left in place as determined by the Engineer.

Silt screen fences shall be kept free from debris and sediment build up. Sediment removal shall be removed at the direction of the Engineer. Material removed shall be disposed of in a manner and location approved by the Engineer. After the sediment removal has been completed, the control devices shall be left in operable condition. Any damage to the control devices shall be replaced at the Contractor's expense.

2.4 EROSION MAT

Erosion mat shall consist of a machine produced wood excelsior mat with interlocking fibers that form a continuous web. Cover the mesh on one side with an extruded plastic netting with mesh size no greater than 1" x 2".

2.5 STAPLES

Permanent installations: Use biodegradable staples in accordance with manufacturer's recommendations for materials being anchored. Wood and metal staples are not allowed for permanent installations.

2.6 RIPRAP

Riprap shall be the class specified and shall conform to Oklahoma Department of Transportation Standard Specifications for Highway Construction Section 713, Type I Riprap. 12 inch stone size.

2.7 COMPOST FILTER SOCK

Compost filter sock is a biodegradable wood compost filled tube used to prevent erosion. Provide filter sock in accordance with AASHTO specification MP 9-06. Minimum 12 inch size.

2.8 TRACKING PAD STONE

The aggregate for tracking pads shall be 3 to 6 inch clear or washed stone. All material shall be retained on a 3-inch sieve.

2.9 SOIL STABILIZERS

Soil stabilizers shall be non-asphalt-based products of the type approved by Owner.

2.10 SOIL TACKIFIERS
Soil tackifiers shall be non-asphalt-based products of the type approved by Owner.

2.11 POLYMERS
Polymers used to settle suspended sediment shall meet the requirements of the WDNR Technical Standards.

3.0 EXECUTION

3.1 GENERAL

Install and maintain erosion control measures as required by the erosion control plan throughout phases of the project. Notify Construction Representative of modifications to the erosion control plan as dictated by Contractor's means and methods, construction phasing or by differing site conditions.

Contractor shall provide all erosion control measures necessary to prevent and manage polluted runoff from the construction site and discharge of sediment onto adjacent property, into storm sewers or waters of the state.

Perform all work in accordance with manufacturer's instruction where these specifications do not specify a higher requirement.

3.2 GRADING AND EARTHWORK

Install temporary or permanent erosion control measures applicable to each phase of grading or land disturbance prior commencing on that phase.

Clear only those areas designated for the placement of improvements or earthwork before placement of the final cover. Perform stripping of vegetation, grading, excavation, or other land disturbing activities in phases to minimizing exposure of bare soil. Do not clear the site of topsoil, trees, and other natural ground covers before the commencement of construction. Retain natural vegetation and protect until the final ground cover is placed.

Do not stockpile soil within 25 feet of any roadway, parking lot, paved area, or drainage structure or channel. Provide temporary stabilization and erosion control measures on disturbed areas and soil stockpiles which will remain for a period of more than 7 consecutive calendar days.

Remove surplus excavation materials from the site immediately after rough grading. The disposal site for the surplus excavation materials shall also be subject to these erosion control requirements.

3.3 DRAINAGE

Divert roof drainage and runoff from all undisturbed areas upslope of the site around disturbed areas. Minimize runoff on exposed soil. Provide measures to remove sediment, and debris.

Convey clean or treated runoff to the nearest adequate stormwater facility. Do not discharge water in a manner that will cause erosion or sedimentation of the site or receiving stormwater facility.

Protect storm sewer inlets and catch basins with inlet protection devices.

Provide ditch checks or silt dikes in swales or ditches to reduce the velocity of water in the channel.

Dewatering discharge shall be routed to a sedimentation basin or sedimentation vessel to reduce the discharge of sediments. Do not discharge water in a manner that will cause erosion or sedimentation of the site or receiving stormwater facility.

3.4 TRACKING CONTROL

Construct and maintain Tracking Pads in accordance with the Technical Standards. Provide each entrance to the site with a stone tracking pad at least 50 feet in length with a minimum thickness of 12 inches. The tracking pad shall be the full width of the egress point. Inspect tracking pads on a daily basis and replace aggregate when no longer effective.

If necessary, provide a crushed aggregate paved parking area.

If applicable, wash water shall be discharged to sedimentation basins, sedimentation vessels, or other such control areas. Untreated wash water shall not be routed to storm sewers or waters of the state.

3.5 MAINTENANCE

Contractor shall inspect all erosion control measures within 24 hours of the end of each rainfall event that exceeds 0.25", or daily during periods of prolonged rainfall, or weekly during periods without rainfall. Immediately repair and/or replace any and all damaged, failed, or inadequate erosion control measures.

Re-apply soil stabilizers, tackifiers, polymers and anionic polyacrylamides as needed to prevent erosion of exposed soil.

Maintain records of all inspections and any remedial actions taken on-site.

Remove any sediment reaching a public or private roadway, parking lot, sidewalk, or other pavement. Do not remove tracked sediments by flushing. Completely remove any accumulations not requiring immediate attention at least once daily at the end of the workday.

Frequently dispose of all waste and unused construction materials in licensed solid waste or wastewater facilities. Do not bury, dump, or discharge, any garbage, debris, cleaning wastes, toxic materials, or hazardous materials on the site, on the land surface or in detention basins, or otherwise allow materials to be carried off the site by runoff onto adjacent lands or into receiving waters or storm sewer systems.

SECTION 31 25 73 – TEMPORARY SILT FENCE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings, Bidding Requirements, Contract Forms, Conditions of the Contract and Division 1 - General Requirements apply to the work of this section.

1.2 DESCRIPTION OF WORK

- A. This work shall consist of furnishing, installing, maintaining and removing a barrier-fence designed to remove suspended particles from the water passing through it. The quantities of temporary silt fence shown on the plans may be increased or decreased based on weather, construction procedures, and actual site conditions that occur during construction of the project. Such variations in quantity will not be considered as alterations in the details of construction or a change in the character of the work.
- B. The contractor shall install a silt fence construction of geotextiles. Hay-bales may be substituted if approved by Engineer.

PART 2 - PRODUCTS

2.1 HAY BALES

- A. Rectangular, commercially sized bales, with densely packed hay, securely bound with wire or plastic strips.

2.2 GEOTEXTILES

- A. This specification provides criteria for wire-supported geotextile silt fence as well as a self-supporting geotextile silt fence.
- B. Fibers used in the manufacture of geotextiles shall consist of long-chain synthetic polymers, composed of at least 85% by weight polyolefins, polyesters, or polyamides. They shall be formed into a network such as that the filaments or yarns retain dimensional stability relative to each other, including selvages. The geotextile shall be specific for its intended purpose. The geotextile shall be free from any treatment or coating which might adversely alter its physical properties after installation.
- C. Geotextile rolls shall be furnished with suitable wrapping for protection against moisture and extended ultraviolet exposure prior to placement. Each roll shall be labeled or tagged to provide product identification sufficient for inventory and quality control purposes. Rolls shall be stored in a manner which protects them from the elements.
- D. Posts: Either wood, steel or synthetic posts may be used. Posts shall have a minimum length of 36 in. plus burial depth and be of sufficient strength to resist damage during installation and to support applied loads.
- E. Support Fence: Wire or other support fences shall be at least 32 in. high and strong enough to support applied loads.
- F. Prefabricated Fence: Prefabricated fence systems may be used provided they meet all of the above material requirements.

PART 3 - EXECUTION

3.1 CONSTRUCTION REQUIREMENTS

The Contractor shall install a temporary silt fence as shown on the plans, and at other locations as required. Fence construction shall be adequate to handle the stress from sediment loading.

- A. Hay-Bales: Shall be installed per the details shown on the plans.
- B. Geotextile Fence: Shall be installed per the details shown on the plans.
- C. It is the Contractor's responsibility to maintain the integrity of silt fences as long as they are necessary to contain sediment runoff. The Contractor shall inspect all temporary silt fences immediately after each rainfall and at least daily during prolonged rainfall. Any deficiencies shall be immediately corrected by the Contractor. In addition, the Contractor shall make a daily review of the location of the silt fences in areas where construction activities have changed the natural contour and drainage runoff to ensure that the silt fences are properly located for effectiveness. Where deficiencies exist, additional silt fences shall be installed. Should the silt fence become damaged or otherwise ineffective while the barrier is still necessary, it shall be repaired promptly.
- D. Sediment deposits shall either be removed when the deposit reaches approximately one-half of the height of the silt fence or a second silt fence shall be installed.
- E. The silt fence shall remain in place as long as needed. Upon removal, the Contractor shall remove and dispose of any excess silt accumulations, dress the area to give a pleasing appearance, and vegetate all bare areas. The fence materials will remain the property of the Contractor and may be used at other locations provided the materials meet their intended purpose.

END OF SECTION

SECTION 31 41 34 - EXCAVATION, TRENCHING, & SHORING

PART 1. GENERAL:

1.1 DESCRIPTION:

- A. This section covers deep excavations and supporting systems for trenches to protect the safety of workers, provide suitable means for constructing sewer lines, and to protect public or private property, including existing utilities.
- B. Detailed designs for proposed shoring, etc. shall be submitted and designed by a registered professional engineer employed by the contractor for the architects review prior to starting work. The Owner, Architect, Architect's consultants and their agents and employees do not in any way assume responsibility for the shoring design to be utilized by the Contractor. Contractor shall assume the entire responsibility for all shoring, etc. and make good any damage caused by or due to improper supports or failure of shoring, etc. in any respect.

1.2 EXISTING STRUCTURES:

- A. Where existing buildings, other utilities, streets, highways, or other structures are in close proximity to the trench, adequate protection shall be provided by the use of sheeting and shoring to protect the structure, street, or highway from possible damage. In the case of utilities, the Contractor may elect to remove the utility provided that the removal and subsequent replacement meets with the approval of the Architect, Engineer, the utility owner, or whoever has jurisdiction of the structure. In all cases, it shall be the responsibility of the Contractor to protect public and private property and any person or persons who might, as a result of the Contractor's work, be injured.

PART 2. EXECUTION

2.1 EXCAVATIONS, TRENCHING, AND SHORING:

- A. The Contractor shall include in his bid price and be solely responsible for trench safety provisions meeting the requirements of the United States Department of Labor Occupational Safety and Health Administration. The Contractor shall, as a minimum, provide trench safety provisions as shown on the plans and conforming to the following regulations, as contained in Subpart P, Part 1926 of the Code of Federal Regulations, shall be complied with along with all other applicable Subparts and Regulations not herein contained:

1. Subpart P - Excavations, Trenching, and Shoring:

a. General Protection Requirements:

- 1) Walkways, runways, and sidewalks shall be kept clear of excavated material or other obstructions and no sidewalks shall be undermined unless shored to carry a minimum live load of one hundred and twenty-five (125) pounds per square foot.
- 2) If planks are used for raised walkways, runways, or sidewalks, they shall be laid parallel to the length of the walk and fastened together against displacement.
- 3) Planks shall be uniform in thickness and all exposed ends shall be provided with beveled cleats to prevent tripping.
- 4) Raised walkways, runways, and sidewalks shall be provided with plank steps on strong stringers. Ramps, used in lieu of steps, shall be provided with cleats to insure a safe walking surface.
- 5) All employees shall be protected with personal protective equipment for the protection of the head, eyes, respiratory organs, hands, feet and other parts of the body as set forth in Subpart E. of this part.

- 6) Employees exposed to vehicular traffic shall be provided with and shall be instructed to wear warning vests marked with and made of reflectorized or high-visibility material.
- 7) Employees subjected to hazardous dusts, gases, fumes, mists or atmospheres deficient in oxygen, shall be protected with approved respiratory protection as set forth in Subpart D of this part.
- 8) No person shall be permitted under loads handled by power shovels, derricks, or hoists. To avoid any spillage employees shall be required to stand away from any vehicle being loaded.
- 9) Daily inspections of excavations shall be made by a competent person. If evidence of possible cave-ins or slides is apparent, all work in the excavation shall cease until the necessary precautions have been taken to safeguard the employees.

b. Specific Excavation Requirements:

- 1) Prior to opening an excavation, effort shall be made to determine whether underground installations, i.e., sewer, telephone, water, fuel, electric lines, etc. will be encountered, and if so, where such underground installations are located. When the excavation approaches the estimated location of such an installation, the exact locations shall be determined and when it is uncovered, proper supports shall be provided for the existing installation. Utility companies shall be contacted and advised of proposed work prior to the start of actual excavation.
- 2) Trees, boulders and other surface encumbrances, located so as to create a hazard to employees involved in excavation work or in the vicinity thereof at any time during operation shall be removed or made safe before excavating is begun.
- 3) The walls and faces of all excavations in which employees are exposed to danger from moving ground shall be guarded by a shoring system, sloping of the ground, or some other equivalent means.
- 4) Excavations shall be inspected by a competent person after every rainstorm or other hazard-increasing occurrence and the protection against slides and cave-ins shall be increased if necessary.
- 5) The determination of the angle of repose and design of the supporting system shall be based on careful evaluation of pertinent factors such as: Depth of cut, possible variation in water content of the material while the excavation is open; anticipated changes in materials from exposure to air, sun, water, or freezing; loading imposed by structured, equipment overlying material, or stored material; and vibration from equipment, blasting, traffic, or other sources.
- 6) Supporting systems, i.e., piling, cribbing, shoring, etc. shall be designed by a qualified person and meet accepted engineering requirements. When tie rods are used to restrain the taping, sheeting or other retaining systems, the rods shall be securely anchored well back of the angle of repose. When tight sheeting or sheet piling is used, full loading due to ground water table shall be assumed, unless preventing by weep holes or drains or other means. Additional stringers, ties and bracing shall be provided to allow for any necessary temporary removal of individual supports.
- 7) All slopes shall be excavated to at least the angle of repose except for areas where solid rock allows for line drilling or presplitting.
- 8) The angle of repose shall be flattened when an excavation has water conditions, silty materials, loose boulders, and areas where erosion, deep frost action, and slide planes appear.
 - a) In excavations which employees may be required to enter, excavated or other material shall be effectively stored and retained at least 2 feet or more from the edge of the excavation.
 - b) As an alternative to the clearance prescribed in sub-paragraph (1) of this paragraph, the employer may use effective barriers or other effective retaining devices in lieu

thereof in order to prevent excavated or other materials from falling into the excavation.

- 9) Sides, slopes, and faces of all excavations shall meet accepted engineering requirements by scaling, benching, barricading, rock bolting, wire meshing, or other equally effective means. Special attention shall be given to slopes which may be adversely affected by weather or moisture content.
- 10) Support systems shall be planned and designed by a qualified person when excavation is in excess of 20 feet in depth, adjacent to structures or improvements, or subject to vibration or ground water.
- 11) Materials used for sheeting, sheet piling, cribbing, bracing, shoring, and underpinning shall be in good serviceable condition, and timbers shall be sound, free from large or loose knots, and of proper dimensions.
- 12) Special precautions shall be taken in sloping or shoring the sides of excavations adjacent to a previously backfilled excavation or a fill, particularly when the separation is less than the depth of the excavation. Particular attention also shall be paid to joints and seams of materials comprising a face and the slope of such seams and joints.
- 13) Except in hard rock, excavation below the level of the base of footing of any foundation or retaining wall shall not be permitted, unless the wall is underpinned and all other precautions taken to insure the stability of the adjacent walls for the protection of employees involved in excavation work or in the vicinity thereof.
- 14) If the stability of adjoining buildings or walls is endangered by excavations, shoring, bracing, or underpinning shall be provided as necessary to insure their safety. Such shoring, bracing or underpinning shall be inspected daily or more often, as conditions warrant, by a competent person and the protection effectively maintained.
- 15) Diversion ditches, dikes, or other suitable means shall be used to prevent surface water from entering an excavation and to provide adequate drainage of the area adjacent to the excavation. Water shall not be allowed to accumulate in an excavation.
- 16) If it is necessary to place or operate power shovels, derricks, trucks, materials, or other heavy objects on a level above and near an excavation, the sides of the excavation shall be sheet-piled, shored, and braced as necessary to resist the extra pressure due to such superimposed loads.
- 17) Blasting and the use of explosives shall be performed in accordance with Subpart U of this part.
- 18) When mobile equipment is utilized or allowed adjacent to excavations, substantial stop logs or barricades shall be installed. If possible, the grade should be away from the excavation.
- 19) Adequate barrier physical protection shall be provided at all remotely located excavations. All wells, pits shafts, etc. shall be barricaded or covered. Upon completion of exploration and similar operations, temporary wells, pits, shafts, etc. shall be backfilled.
- 20) If possible, dust conditions shall be kept to a minimum by the use of water, salt, calcium chloride, oil or other means.
- 21) In locations where oxygen deficiency or gaseous conditions are possible, air in the excavation shall be tested. Controls as set forth in Subpart d, D and E of this part, shall be established to assure acceptable atmospheric conditions. When flammable gases are present, adequate ventilation shall be provided or sources of ignition shall be eliminated. Attended emergency rescue equipment, such as breathing apparatus, a safety harness and line, basket stretcher, etc. shall be readily available where adverse atmospheric conditions may exist or develop in an excavation.
- 22) Where employees or equipment are required or permitted to cross over excavations, walkways or bridges with standard guardrails shall be provided.
- 23) Where ramps are used for employees or equipment, they shall be designed and constructed by qualified persons in accordance with accepted engineering requirements.

24) All ladders used on excavation operations shall be in accordance with the requirements of Subpart L of this part.

c. Specific Trenching Requirements:

- 1) Banks more than 5 feet high shall be shored, laid back to a stable slope, or some other equivalent means of protection shall be provided where employees may be exposed to moving ground or cave-ins. Refer to Table P-1 as a guide in sloping of banks. Trenches less than 5 feet in depth shall also be effectively protected when examination of ground indicates hazardous ground movement may be expected.
- 2) Sides of trenches in unstable or soft material, 5 feet or more in depth, shall be shored, sheeted, braced, sloped or otherwise supported by means of sufficient strength to protect the employees working within them. See Tables P-1, P-2 (following paragraph (1) of this section).
- 3) Sides of trenches in hard or compact soil, including embankments, shall be shored or otherwise supported when the trench is more than 5 feet in depth and 8 feet or more in length. In lieu of shoring, the sides of the trench above the 5 foot level may be sloped to preclude collapse, but shall not be steeper than a 1 foot rise to each 1/2 foot horizontal. When the outside diameter of a pipe is greater than 6 feet, a bench of 4 foot minimum shall be provided at the toe of the sloped portion.
- 4) Materials used for sheeting and sheet piling, bracing, shoring, and underpinning, shall be in good serviceable condition and timbers used shall be sound and free from large or loose knots, and shall be designed and installed so as to be effective to the bottom of the excavation.
- 5) Additional precautions by way of shoring and bracing shall be taken to prevent slides or cave-ins when excavations or trenches are made in locations adjacent to backfilled excavations, or where excavations are subjected to vibrations from railroad or highway traffic, the operation of machinery, or any other source.
- 6) Employees entering bell-bottom pier holes shall be protected by the installation of a removable-type casing of sufficient strength to resist shifting of the surrounding earth. Such temporary protection shall be provided for the full depth of that part of each pier hole which is above the bell. A lifeline, suitable for instant rescue and securely fastened to a shoulder harness, shall be worn by each employee entering the shafts. This lifeline shall be individually manned and separate from any line used to remove materials excavated from the bell footing.
 - a) Minimum requirements for trench timbering shall be in accordance with Table P-2.
 - b) Braces and diagonal shores in a wood shoring system shall not be subjected to compressive stress in excess of values given by the following formula:

$$S = 1300 - \frac{20L}{D}$$

$$\text{Maximum ratio } \frac{L}{D} = 50$$

Where:

L = Length, unsupported, in inches.

D = Least side of the timber in inches.

S = Allowable stress in pounds per square inch of cross-section.

- 7) When employees are required to be in trenches 4 feet deep or more, an adequate means of exit, such as a ladder or steps shall be provided and located so as to require no more than 25 feet of lateral travel.
- 8) Bracing or shoring of trenches shall be carried along with the excavation.
- 9) Cross braces or trench jacks shall be placed in true horizontal position, be spaced vertically, and be secured to prevent sliding, falling or kickouts.

- 10) Portable trench boxes or sliding trench shields may be used for the protection of personnel in lieu of a shoring system or sloping. Where such trench boxes or shields are used, they shall be designed, constructed, and maintained in a manner which will provide protection equal to or greater than the sheeting or shoring required for the trench.
- 11) Backfilling and removal of trench supports shall progress together from the bottom of the trench. Jacks or braces shall be released slowly and in unstable soil, ropes shall be used to pull out the jacks or braces from above after employees have cleared the trench.

TABLE P-1

Approximate Angle of Repose for

<u>Soil Type</u>	<u>Slope of Sides of Excavations</u>
Solid Rock, Shales or Cemented Sand and Gravel	90 degrees
Compacted Angular Gravels	63 degrees 26' (1/2:1)
Recommended Slope for Average Soils	45 degrees (1:1)
Compacted Sharp Sand	33 degrees 41' (1-1/2:1)
Well Rounded Loose Sand	26 degrees 34' (2:1)

NOTE: Clays, silts, loams or non-homogenous soils require shoring and bracing. The presence of ground water required special treatment.

d. Definitions Applicable To This Subject:

- 1) "Accepted Engineering Requirements (or practices)" - Those requirements or practices which are compatible with standards required by a registered architect, a registered professional engineer, or other duly licensed or recognizable authority.
- 2) "Angle of Repose" - The greatest angle above the horizontal plane at which a material will lie without sliding.
- 3) "Bank" - A mass or soil rising above a digging level.
- 4) "Belled Excavation" - A part of a shaft or footing excavation usually near the bottom and bell-shaped; i.e., an enlargement of the cross section above.
- 5) "Braces (trench)" - The horizontal members of the shoring system whose ends bear against the upright or stringers.
- 6) "Excavation" - Any man-made cavity or depression in the earth's surface, including its sides, walls, or faces, formed by earth removal and producing unsupported earth conditions by reasons of the excavation. If installed forms or similar structures reduce the depth-to-width relationship, an excavation may become a trench.
- 7) "Faces" - See paragraph "k." of this section.
- 8) "Hard Compact Soil" - All earth materials not classified as running or unstable.
- 9) "Kick-outs" - Accidental release or failure of shore or brace.
- 10) "Sheet pile" - A pile, or sheeting, that may form one of a continuous interlocking line, or a row of timber, concrete or steel piles, driven in close contact to provide a tight wall to resist the lateral pressure of water, adjacent earth, or other materials.
- 11) "Sides", "Walls", or "Faces" - The vertical or inclined earth surfaces formed as a result of excavation work.
- 12) "Slope" - The angle with the horizontal at which a particular earth material will stand indefinitely without movement.
- 13) "Stringers" (wales) - The horizontal members of a shoring system whose sides bear against the uprights or earth.

- 14) "Trench" - A narrow excavation made below the surface of the ground. In general, the depth is greater than the width but the width of a trench is not greater than 15 feet. o.
"Trench Jack" - Screw or hydraulic type jacks used as cross bracing in a trench shoring system.
- 15) "Trench Shield" - A shoring system composed of steel plates and bracing, welded or bolted together, which support the walls of a trench from the ground level to the trench bottom and which can be moved along as work progresses.
- 16) "Unstable Soil" - Earth material, other than running, that because of its nature or the influence of related conditions cannot be depended upon to remain in place without extra support, such as would be furnished by a system of shoring.
- 17) "Uprights" - The vertical members of a shoring system.
- 18) "Wales" - See paragraph "m." of this section.
- 19) "Walls" - See paragraph "k." of this section.

Additional information may be obtained from the U.S. Department of Labor Occupational Safety and Health Administration (OSHA), 525 Griffin Square Building, Room 602, Dallas, Texas 75202, (214) 767-4731.

B. Trench Box:

1. Contractor may purpose, as an alternate, the use of a sliding or moveable trench box instead of trench shoring.
2. Contractor shall submit details and full design data for the trench box to the Engineer for review and approval.

C. Government Agency Approval:

1. Contractor shall submit trench safety design to the appropriate government agencies for approval in accordance with current requirements.

END OF SECTION

SECTION 32 11 23 - AGGREGATE BASE COURSE

PART 1: GENERAL

SUMMARY

- A. Section Includes: Furnishing, Placing and Compacting crushed aggregate on a prepared surface for use as a base course.
- B. Related Sections: Contractor shall refer to the Oklahoma Department of Transportation Standard Specifications for Highway Construction, Latest Revisions. Materials and construction methods shall conform with ODOT Standard Specifications.

SUBMITTALS

- A. General: Submittals shall be according to General Conditions
- B. Test Data: Submit three copies of test data for the Contractor-furnished aggregate to be used on this project. Testing shall have been performed by an independent testing laboratory within 12 month of submitting the report for approval.
- C. Certificates of Conformance: Submit three copies of written certification from the supplier of the Contractor-furnished aggregate to be used on this project that it conforms to the requirements of this specification section.
- D. Samples: If requested, submit three samples of each gradation of aggregate to be used on this project.

QUALITY ASSURANCE

- A. Quality Assurance Plan: Submit a written Quality Assurance Plan for approval by the Owners Representative. The plan shall include but not be limited to testing procedures and frequency of tests to ensure that the requirements of these specifications are met.
- B. Stockpiles: Segregate differing aggregates.

DELIVERY, STORAGE AND HANDLING

- A. Delivery: Mitigate spillage or damage that occurs during delivery.

WARRANTY

- A. Requirements: Aggregate base found to be defective within 12 months after work completion, shall be replaced at the Contractor's expense. Overlaying material that must be replaced because of defective base material shall also be replaced at the Contractor's expense.

PART 2: PRODUCTS

2.1 MATERIALS

- A. Contractor-Furnished Crushed Aggregate: Shall consist of hard, durable particles or fragments of crushed stone or crushed gravel. Shall be crushed to the size and quality requirements for crushed aggregate materials normally used locally in the construction and maintenance of highways.

1. The base aggregates shall have a maximum size of [1-1/4] inch. Plasticity index for base aggregates shall be less than 6. Base aggregates shall be uniformly graded from coarse to fine and shall be free of vegetable matter and clay balls.
- B. Aggregate for Untreated Subbase or Base: Shall consist of hard, durable particles or fragments of crushed stone, or crushed aggregate. Materials that break up when alternately frozen and thawed or wetted and dried shall not be used.
1. Coarse aggregate is the material retained on the Number 10 sieve and shall have a percentage of wear of not more than 50 as determined by AASHTO Method T 96.
 2. Fine aggregate is the material passing the Number 10 sieve and shall consist of natural or crushed sand and fine mineral particles. The fraction passing the Number 200 sieve shall not be greater than two-thirds of the fraction passing the Number 40 sieve. For subbase and base courses, the fraction passing the Number 40 sieve shall have a liquid limit not greater than 25 and a plasticity index not greater than 6. For surface courses, the fraction passing the number 40 sieve shall have a liquid limit not greater than 35 and a plasticity index not less than 4 or greater than 9.
 3. Material shall be free from organic matter and lumps or balls of clay.
 4. Not less than 50% by weight of the particles retained on the No. 4 sieve shall have at least one fractured face.
 5. Aggregate gradation shall conform to the requirements of Table 2-1 for the designation shown in the Bid Schedule or on plans. Gradation of each designated size of aggregates shall be obtained by crushing, screening, and blending processes as may be necessary.

TABLE 2-1					
Gradation Target Values for Aggregate Subbase, Base, or Surface Courses (Percentage by weight passing square mesh sieves, AASHTO T 27)					
Sieve Designation	Grading Designation (maximum size)				
	A	B	C	D	E
	subbase	(2 inch)	(1-1/2 inch)	(1 inch)	(3/4 inch)
2-inch		100			
1-1/2-inch	100	40-100	100		
1 inch				100	
3/4-inch	40-100	30-75	57-87		100
1/2-inch				59-89	
3/8-inch	30-75	25-60			
No. 4	25-60	20-50	28-58	35-65	41-71
No. 10	20-43	15-35	15-35		
No. 40	8-26	6-22	7-22	11-27	12-28
No. 200	4-12	0-12	3-10	4-16	5-17
*Tolerances shall not apply to 100% passing requirements.					

PART 3 EXECUTION

3.1 PREPARATION

- A. Requirements: Slide material including culvert inlet and outlet debris, shall be removed and the existing roadbed, including parking areas shall be scarified, bladed, and shaped. The material shall be in conformity with the line, grade, and cross sections shown on the plans or established by the Owners Representative. High places in the road-bed shall be cut to grade and the resulting material hauled and deposited on low areas on fill slopes as approved by the Owners Representative. If depressions or narrow embankments remain, sufficient approved material shall be obtained. Place material to bring the width and surface of the roadway in close conformity with the lines, grades, and cross sections shown on the plans or established by the Owners Representative. The roadbed shall then be rebladed and reshaped. At intersections, the roadbeds of side roads shall be treated similarly, as governed by the grading performed, to provide for proper joining of the proposed and existing riding surfaces. The roadbed shall be compacted. A complete and acceptable foundation shall be constructed. The roadbed shall be in specified condition at the time of placement of the base course, surface course, or pavement. Tolerances for placement shall be as found in ODOT Section 301-General Requirements for Bases

3.2 MIXING

- A. General: Unless otherwise specified, mix the material by one of the following methods During the mixing, water shall be added in the amount necessary to provide the optimum moisture content for compaction.
- B. Stationary Plant Method: The materials shall be mixed in an approved mixer. Water shall be added during the mixing operation in the amount necessary to provide the moisture content for compacting to the specified density. After mixing, the material shall be transported to the job site while it contains the proper moisture content and shall be placed by means of an approved aggregate spreader.
- C. Travel Plant Method: After the material for each course has been placed through an aggregate spreader or windrow sizing device, the material shall be uniformly mixed by a traveling mixing plant. During the mixing, water shall be added in an amount sufficient to provide the necessary moisture content for compacting.
- D. Road Mix Method: After material for each course has been placed, the materials shall be mixed while at required moisture content by means of motor graders or other approved equipment until the mixture is uniform throughout.

3.3 INSTALLATION

- A. General: The material shall be placed on the prepared surface and compacted in layers of the thickness shown on the drawings. When more than one layer is required, each layer shall be shaped and compacted before the succeeding layer is placed.
 - 1. Placing shall be from vehicles equipped to distribute the material in a continuous uniform layer or windrow. The layer or windrow shall be of such size that when spread and compacted, the finished layer shall have the required thickness.
 - 2. When hauling is done over previously placed material, hauling equipment shall be routed uniformly as possible over the entire surface of the constructed layers.
- B. Spreading: When uniformly mixed, the mixture shall be spread smoothly for compaction to the required thickness.

- C. Compacting: Immediately following final spreading and smoothing, each layer shall be compacted to the full width by approved compaction equipment. Rolling shall progress gradually from the sides to the center, parallel to the centerline of the road, or parking area, and shall continue until the surface has been rolled. Irregularities or depressions that develop shall be corrected by loosening the material at these places. Add or remove material until the surface is smooth and uniform. Along curbs, headers, and walls, and at places not accessible to the roller, the base material shall be compacted thoroughly with approved tampers or compactors.
- D. Compacting and Finishing Cement-Treated Base Material: After the cement-treated mixture has been spread, compact the mixture to a density of not less than 95 percent of the maximum density. The density shall be determined on a sample of cement aggregate mixture obtained from the area being processed at the time compaction begins, according to AASHTO T 134.
- E. Watering: Provide water and watering equipment to control dust and obtain required compaction.

3.4 FIELD QUALITY CONTROL

- A. Testing: The Contractor shall make arrangements for a certified independent testing laboratory, according to the requirements of Section 01458 - Testing Laboratory Services, to perform the required testing, recording, and distributing of the results.
- B. Density:
 1. Compaction of each layer shall continue until a density of not less than 95percent of the maximum density determined according to AASHTO T 180 Method D, or other method approved in writing by the Owners Representative, has been achieved.
 2. In-place field density determinations are made according to AASHTO T 191, AASHTO T 205, or other approved method. The use of AASHTO T 224 to correct for oversize particles may be required.
 3. Test holes are made at random during the work to determine the depth of uncompacted layers required to produce the designated depth of material after compacting to the specified density.
 4. Cutting of the test holes and refilling with materials properly compacted shall be done by the Contractor and approved in writing by the Owners Representative.
 5. Mixtures of aggregate, cement, and water that have not been compacted shall not be left undisturbed for more than 30 minutes.
 6. The percentage of moisture in the completed cement-treated base mixture shall be in a range from the optimum moisture content of the mixture to + 2 percentage points, as determined by AASHTO T 134.
 6. The compacting and finishing shall be completed within 2 hr of the time water is added to the cement-treated base mixture. The compacted surface shall be a proper cross section, smooth, dense, and free of compaction planes, ridges, and loose material.
- C. Completed Course Thickness: Shall not vary more than 1/2-inch from the thickness required.
- D. Surface: Will be tested for acceptance by the Contractor with a 10-ft straight edge after the base has been bladed and rolled into a smooth surface. Areas where the surface variation exceeds 1/2 inch in 10 ft shall be reworked until the variation falls within this limit.

3.5 PROTECTION

- A. Cement-Treated Base Materials: Shall be cured with a bituminous curing seal applied within 24 hours after the completion of initial rolling. The surface shall be kept moist until the seal is applied.
 1. The curing seal shall be applied at a rate between 0.10 and 0.25 gal/ yd² of surface. The curing seal shall be applied in sufficient quantity to provide a continuous film over the

base surface. The film shall be maintained at least 7 days unless the treated base is protected by a subsequent course.

2. Cement-treated base shall not be mixed or placed while the atmospheric temperature is below 35 degrees F or when conditions indicate that the temperature may fall below 35 degrees F within 24 hr of placement. Cement-treated base shall not be placed on frozen subgrade or mixed when the aggregate is frozen. Cement-treated base shall be protected from freezing for a period of 5 days after placing and whenever the atmospheric temperature falls below, or is expected to fall below 32 degrees F.

- B. Aggregate Base Course: Contractor may, with Owners Representatives approval, apply Prime Coat of Bituminous Material to seal the aggregate base, to maintain moisture, in instances where the surface course may not be applied immediately.

END OF SECTION

SECTION 32 12 16-ASPHALTIC CONCRETE PAVEMENT

PART 1. GENERAL

1.01 SUMMARY

- A. Section Includes: Furnishing, placing, and compacting one or more courses of bituminous asphaltic concrete pavement on a prepared base.
- B. Related/Referenced Sections: Oklahoma Department of Transportation Standard Specifications for Highway Construction, latest revision and supplementals, Section 411-Plant Mix Asphalt Concrete Pavement; Section 708-Plant Mix Bituminous Bases and Surfaces

1.02 SUBMITTALS

- A. General: Submittals shall be according to this and other project documents.
- B. Certificates of Conformance: Submit three copies of written certification from the supplier of bituminous material used in the mix to be used on this project that it conforms to the requirements of this specification section.
- C. Samples: When specifically requested, submit three samples of each of the following items to be used on this project for approval:
 - 1. Aggregate from each separate source - 25 pounds
 - 2. Aggregate of each different gradation - 25 pounds
 - 3. Mineral filler - 20 pounds
 - 4. Asphalt - 1 gallon
 - 5. Anti-stripping agent, when used
- D. Job Mix Formula: Submit a job mix formula, prepared within one year of submittal, for approval prior to preparing and placing the bituminous mixture. The formulas shall indicate the physical properties of the mixes as shown by tests made by an approved commercial laboratory using materials identical to those to be used on this project. Submit all formulas. The job mix formula for each mixture shall be in effect until modified in writing by the Contractor and approved by the Owners Representative. Provide a new job mix formula for each source change.

1.03 QUALITY ASSURANCE

- A. Quality Assurance Plan: The Contractor shall submit a written quality assurance plan that details his quality control and inspection procedures that will insure compliance with these specifications.
- B. Failure Criteria: Not limited to the following:
 - 1. Creeping, shoving, cracking, raveling, or softening of the asphalt concrete.

1.04 DELIVERY, STORAGE AND HANDLING

- A. Storage: Store aggregates in such a manner as to prevent segregation, contamination, or intermixing of the different aggregate sizes.

1.05 PROJECT/SITE CONDITIONS

- A. Weather Limitations: Place bituminous mixture only during dry weather and on dry surfaces. Place courses only when the surface temperature of the underlying course is greater than 45 degrees F for course thicknesses greater than 1 1/2 inch and 50 degrees F for course thicknesses 1 1/2 inch or less.
- B. Drains: The Contractor shall insure that asphalt surfaces slope toward drains and seal tightly around drain inlets.

1.06 SCHEDULING AND SEQUENCING

- A. Construction Schedule: The Contractor shall submit a written construction schedule for the work, detailing the progress of the construction and solutions to possible conflicts. This schedule shall also indicate start and completion times for various stages of the work.

PART 2. PRODUCTS

2.01 MATERIALS

- A. Liquid/Emulsified Asphalt: Shall be per the typical section or mix design.
- B. Aggregates: Grade and proportion aggregates and filler so that the combined mineral aggregate conforms to the grading specified in ODOT Section 708.
- C. Asphalt Cement: Shall conform to ODOT Section 708

2.02 CONSTRUCTION EQUIPMENT

- A. General: Construction equipment used shall be dependable and adequate for the purpose intended, properly maintained in satisfactory and safe operating condition at all times. Calibrated equipment, such as scales, batching equipment, spreaders and similar equipment, shall have been recalibrated by an approved calibration laboratory within 12 months of commencing work.
- B. Paving Equipment:
 - 1. Spreading Equipment: Self-propelled electronically controlled type, unless other equipment is authorized by the Owners Representative. Equip spreading equipment of the self-propelled electronically controlled type with hoppers, tamping or vibrating devices, distributing screws, electronically adjustable screeds, and equalizing devices. Capable of spreading hot bituminous mixtures without tearing, shoving, or gouging and to produce a finished surface of specified grade and smoothness. Operate spreaders, when laying mixture, at variable speeds between (5 and 45 feet) per minute. Spreader shall have a quick and efficient steering device; a forward and reverse traveling speed; and [automatic] devices to adjust to grade and confine the edges of the mixture to true lines. The use of a spreader that leaves indented areas or other objectionable irregularities in the fresh mix during operations will not be permitted.
 - 2. Rolling Equipment: Self-propelled pneumatic-tired rollers supplemented by three-wheel and tandem type steel wheeled rollers. The number, type and weight of rollers shall be sufficient to compact the mixture to the required density without detrimentally affecting the compacted material. All rollers shall be suitable for rolling hot-mix bituminous pavements and capable of being operated both forward and backward without turning on the mat, and without loosening the surface being rolled. Equip rollers with suitable

devices and apparatus to keep the rolling surfaces wet and prevent adherence of bituminous mixture.

a. Vibratory Rollers: At the Contractor's option, vibratory rollers especially designed for bituminous concrete compacting may be used provided rollers do not impair stability of pavement structure and any underlying layers. Repair depressions in pavement surfaces resulting from use of vibratory rollers at no cost to the Owner. Rollers shall be self-propelled, single or dual vibrating drums, and steel drive wheels, as applicable; equipped with variable amplitude and separate controls for energy and propulsion.

3. Hand Tampers: Shall have a minimum weight of ([25] pounds) with a tamping face of not more than ([200] square inches).

2.03 MIXES

A. Gradation of Aggregates:

A. Testing: The Contractor shall make arrangements for a certified independent testing laboratory, according to the requirements of Section 01 45 29 - Testing Laboratory Services, to perform the required testing, recording, and distributing of the results.

B. Testing Laboratory: The Contractor shall provide a testing laboratory for control and acceptance testing functions during periods of mix production, sampling, and testing and whenever materials subject to the provisions of these specifications are being supplied or tested. The laboratory shall provide adequate equipment, space, and utilities as required for the performance of the specified tests.

PART 3. EXECUTION

3.01 PREPARATION

A. Surface Preparation of Underlying Course: Prior to the laying of the asphalt concrete, clean underlying course of all foreign or objectionable matter with power blowers or power brooms, supplemented by hand brooms and other cleaning methods where necessary.

B. Preparation of Aggregate Surfaces: Immediately before priming an aggregate surface with bitumen, the Owners Representative may order a light application of water to lay dust and improve the absorbency of the surface.

C. Preparation of Bituminized or Concreted Surfaces: All holes in existing surface shall be patched with appropriate material. If so directed by the Owners Representative, the surface shall be cleaned with a power broom or power blower supplemented by hand sweeping as required to remove deleterious matter. The edges of existing pavement, which are to be adjacent to new pavement, shall be cleaned of loose material to permit adhesion of the bitumen.

D. Prime Coat: Furnish and apply a bituminous tack/prime coat over existing asphalt surface and/or base course at a minimum coverage of 0.07 gallons per square yard and 0.40 gallons per square yard, respectively. Bituminous material shall be applied by a self-powered pressure distributor when the road surface is 70 degrees F or more and when the weather is not foggy or rainy. Allow prime coat on base courses to dry for 24 hours and maintain free from traffic. Absorb any excess material with sand. Emulsified asphalt shall be diluted 50-50 with water when used as a tack coat. Tack coat shall be applied between successive layers of asphalt or edges.

3.02 APPLICATION

- A. Placing of Bituminous Material: The pavement shall consist of hot mineral aggregate uniformly mixed with hot bituminous material. Place the pavement in one or more layers, as indicated. Except as otherwise permitted by the Owners Representative, provide lines and grade stakes as necessary for control. Place grade stakes in lanes parallel to the center line of the areas to be paved and suitably spaced for string lining.
- B. Bituminous Mixing Plant: Plants used for the preparation of bituminous mixtures shall conform to AASHTO M 156 and to local or state highway department requirements. The bituminous mixture when required shall be weighed on approved scales or on public scales at the Contractor's expense.
- C. Transportation of Bituminous Mixtures: Transport bituminous material from the mixing plant to the paving site in trucks having tight, clean, smooth beds that have been coated with a minimum amount of concentrated solution of hydrated lime and water or other approved coating to prevent adhesion of the mixture to the truck bodies. Petroleum products will not be permitted for coating truck bodies. If air temperature is less than 60 degrees F or if haul time is greater than 30 minutes, cover each load with canvas or other approved material of ample size to protect the mixture from the loss of heat. Make deliveries so that the spreading and rolling of all the mixture prepared for one day's run can be completed during daylight, unless adequate approved artificial lighting is provided. Deliver mixture to the area to be paved in such a manner that the temperature at the time of dumping into the spreader will be higher than that specified herein. Reject any loads that are below minimum temperature, that have crusts of cold unworkable material, or that have been wet excessively by rain. Hauling over freshly laid material is not permitted.
- D. General Requirements for Use of Bituminous Spreaders: The range of temperatures of the mixtures at the time of spreading shall be between 250 and 300 degrees F. Bituminous concrete having temperatures less than minimum spreading temperature when dumped into the spreader will be rejected. Adjust spreader and regulate speed so that the surface of the course is smooth and continuous without tears and pulling, and of such depth that, when compacted, the surface conforms with the cross section, grade, and contour indicated. Unless otherwise directed, begin the placing along the centerline of areas to be paved on a crowned section or on the high side of area with a one-way slope, and in the direction of the major traffic flow. Place mixture in consecutive adjacent strips having a minimum width of 10 feet, except where the edge lanes require strips less than (10 feet) to complete the area. The thickness of the asphalt mat shall be as indicated on the drawings. Construct longitudinal joints and edges to true line markings. Establish lines parallel to the centerline of the area to be paved, and place string lines coinciding with the established lines for the spreading machine to follow. The number and location of the lines shall be as directed. When specified grade and smoothness requirements can be met for initial lane construction by use of an approved long ski-type device of not less than 30 feet in length and for subsequent lane construction by use of a short ski or shoe, in-place string lines for grade control may be omitted. Place mixture as nearly continuous as possible, and adjust the speed of placing as directed, to permit proper rolling.
- E. Placing of Bituminous Material: The pavement shall consist of hot mineral aggregate uniformly mixed with hot bituminous material. Place the pavement in one or more layers, as indicated. Except as otherwise permitted by the Owners Representative, provide lines and grade stakes as necessary for control. Place grade stakes in lanes parallel to the center line of the areas to be paved and suitably spaced for string lining.

- F. Shoveling, Raking, and Tamping After Machine-spreading: A sufficient number of shovelers and rakers shall follow the spreading machine adding or removing hot mixture and raking the mixture as required to obtain a course that when completed will conform to all requirements specified herein. Broadcasting or fanning of mixture over areas being compacted is not permitted. When segregation occurs in the mixture during placing, suspend spreading operation until the cause is determined and corrected. Correct any irregularities in alignment left by the spreader by trimming directly behind the machine. Immediately after trimming, compact edges of the course by tamping laterally with a metal lute or by other approved methods. Distortion of the course during tamping is not permitted.
- G. Hand-spreading in Lieu of Machine-spreading: In areas where the use of machine spreading is impractical, spread mixture by hand. The range of temperatures of the mixtures when dumped onto the area to be paved shall be between 250 and 300 degrees F. Bituminous concrete having temperatures less than minimum spreading temperature when dumped onto the area to be paved will be rejected. Spread mixture with hot rakes in a uniformly loose layer of a thickness that, when compacted, will conform to the required grade, thickness, and smoothness. During hand spreading, place each shovelful of mixture by turning the shovel over in a manner that will prevent segregation. In no case shall the mixture be placed by throwing or broadcasting from a shovel. Do not dump loads any faster than can be properly placed by available labor.
- H. Compaction of Mixture: Affect compaction by rolling. Begin rolling as soon as placement of the mixture will bear the rollers without undue displacement. Start rolling longitudinally at the extreme sides of the lanes and proceed toward the center of the pavement, or toward the high side of the pavement with a one-way slope. Operate rollers so that each trip will overlap the previous adjacent strip by at least one foot. Alternate trips of the roller shall be of slightly different lengths. Tests for conformity with the specified crown, grade and smoothness shall be made by the Contractor immediately after initial rolling. Before continuing the rolling, correct variations by removing or adding materials as necessary. If directed by the Owners Representative, subject course to diagonal rolling with the steel wheeled roller crossing the lines of the previous rolling while the mixture is hot and in a compactable condition. The speed of the rollers shall be slow enough to avoid displacement of the hot mixture. Correct any displacement of the mixture at once by the use of rakes and fresh mixture, or remove and replace mixture as directed by the Owners Representative. Continue rolling until all roller marks are eliminated and the course has a density of at least 95% but not more than 100% of that attained in a laboratory specimen of the same mixture prepared in accordance with ASTM D 1559. During rolling, moisten wheels of the rollers to prevent adhesion of the mixture to the wheels, but an excess of water creating puddles on the fresh asphalt is not permitted. Operation of rollers shall be by competent and experienced operators. Provide sufficient rollers for each spreading machine in operation on the job and to handle plant output. In all places not accessible to the rollers, compact mixture thoroughly with moistened hand tampers. Skin patching of an area after compaction is not permitted. Remove any mixture that becomes mixed with foreign material or is defective, replace with fresh mixture, and compact to the density of the surrounding area. The roller shall pass over the unprotected edge of the course only when the laying of the course is to be discontinued for such length of time as to permit the mixture to become cold.
- I. Joints: All joints shall present the same texture, density, and smoothness as other portions of the course. Carefully make joints between old and new pavement or within new pavements in a manner as to ensure a thorough and continuous bond between old and new sections of the course. Paint all vertical contact surfaces of previously constructed sections with a thin uniform coat of emulsion or other approved bituminous material just before the fresh mixture is placed.
1. Transverse Joints: The roller shall pass over the unprotected end of the freshly laid mixture only when the laying of the course is to be discontinued. Except when an approved bulkhead is used, cut back the edge of the previously laid course to expose an

even, vertical surface for the full thickness of the course. When exposed, rake fresh mixture against joints, thoroughly tamp with hot tampers, smooth with hot smoothers, and roll. In all cases, transverse joints in adjacent lanes shall be offset a minimum of two feet.

3.03 FIELD QUALITY CONTROL

- A. Testing: The Contractor shall make arrangements for a certified independent testing laboratory, according to the requirements of Section 01 4 29 - Testing Laboratory Services and ODOT Section 411, to perform the required testing, recording, and distributing of the results.

3.04 CLEANING

- A. Requirements: The Contractor shall be responsible for cleanup of all waste, spilled, and excess material as a result of his work.

3.05 PROTECTION

- A. Traffic Control: The Contractor shall provide for controls to prevent unauthorized traffic in or on work areas until those areas are suitably prepared for traffic. Vehicular traffic, including heavy equipment, shall not be permitted on the pavement until the surface temperature has cooled to at least 120 degrees F. Surface temperature shall be measured by approved surface thermometers or other methods approved by the Owners Representative.

END OF SECTION

SECTION 32 13 13 - CONCRETE PAVING

PART 1: GENERAL

1.1 SUMMARY

- A. Section Includes: Concrete or rigid paving. Work consists of furnishing materials for and construction of concrete paving. Paving to be of thickness and section shown on plans or as directed by Engineer.

1.2 REFERENCES

- A. Oklahoma Department of Transportation Standard Specifications for Highway Construction, latest edition and revisions; Section 401-General Requirements for Surfaces; Section 414-Portland Cement Concrete Pavement; Section 701-Portland Cement Concrete.

1.3 QUALITY ASSURANCE

- A. Failure Criteria: Not limited to the following:
 1. Insufficient strength.
 2. Spalling, honeycomb.
 3. Insufficient thickness.

1.4 PROJECT AND SITE CONDITIONS

- A. Site Conditions: Concrete paving shall not be placed on unapproved base course or subgrade. Contractor shall utilize hot weather or cold weather precautions as applicable to protect the integrity of the concrete.

PART 2: PRODUCTS

2.1 MATERIALS/CONSTRUCTION

- A. Concrete shall be as noted on plan sheets, or 3,500psi 28-day compressive strength as a minimum unless noted otherwise.

Cement:	ASTM C150, Type I or III unless otherwise noted;
Coarse Aggregate:	Crushed rock, washed gravel or other inert material conforming to ASTM C33;
Water:	Potable, clean and free from deleterious substances;
Reinforcing Steel:	ASTM A615, Grade 60; unless otherwise noted;
Welded Wire Fabric:	ASTM A185;
Forms:	(No wood rot or deteriorated wood shall be accepted) Plywood - Waterproof, resin-bonded, exterior type, face to concrete Grade B or better; Lumber - Straight, uniform width and thickness and free from knots, offsets, holes, dents and other surface defects; Chamfer Strips -3/4" clear white pine, surface against concrete planed;
Form Coating -	Industrial lubricants "Non-Crete" form coating, Protex "Pro-Cote" or equal;
Expansion Joints -	Preformed, bituminous type ASTM D994, unless otherwise noted;
Air Entraining Admixture:	ASTM C60
Water Reducing Admixture:	ASTM C494 Type A
Fly Ash:	No more than 15% concrete replacement

Moisture Retaining Cover: Polyethylene film, or polyethylene coated burlap meeting ASTM C171.

Liquid Membrane Curing Compound: Meeting AASHTO M148/ASTM C309 Type 2 or Type 1-D. White pigment or red dye.

- B. Finish surfaces to proper line and grade as shown on plans or directed by Engineer.
- C. Paving surface shall receive a "burlap drag" texture and grooved or tined to produce a skid resistant surface.
- D. After surface finishing and as soon as practical, cover and cure the entire surface with cotton or burlap mats; impervious membrane spray; or polyethylene sheeting.
- E. Contractor shall submit a placement & jointing layout plan to Engineer for approval. Joint panel shall be situated to avoid joints within a flowline or swale.
- F. Construction joints may be approved only at locations shown on the plans or approved by the Engineer.
- G. Contraction joints to be placed at a maximum of 15 feet each way, as noted on the plans, or as directed by the Engineer. Contraction joints may be sawcut or formed.
- H. Expansion joints shall be placed to isolate the pavement from structures or fixed objects, such as light foundations, drainage inlets and buildings.
- I. Surface tolerance shall be tested with a 10-foot straightedge. Maximum variation from the testing edge of the straightedge between any two contact points shall not exceed 1/8-inch. Contractor shall correct surface irregularities exceeding the aforementioned tolerance in an acceptable manner.
- J. Exclude traffic from the surface for a period of at least 14-days after the concrete is placed. Paving shall be protected from damage, staining, marring, etc.
- K. Pavement may be rejected because of unsound concrete, uncontrolled cracking, malfunctioning of the sawed joints, spalling, honeycomb, surface irregularities, or insufficient thickness.
- L. Grade changes within the pavement such as crowns, or valleys shall be rounded within five feet each side of the crown or valley to provide a smooth surface.

SECTION 32 16 13-CONCRETE CURB AND GUTTER

PART 1: GENERAL

1.1.1 SUMMARY

- A. Section Includes: Construction of concrete curb and gutter, either together or independently
- B. Related Sections & References: Oklahoma Department of Transportation Standard Specifications for Highway Construction, Section 609-Integral Curb, Combined Curb and Gutter; Section 701-Portland Cement Concrete

1.2 QUALITY ASSURANCE

- A. Failure Criteria: Not limited to the following:
 - 1. Concrete damaged during form removal
 - 2. Concrete chipped, broken, or defaced
 - 3. Concrete out of grade or alignment

PART 2: PRODUCTS

2.1 MATERIALS

- A. Concrete: Shall have a 28-day strength of 3,500 psi and shall conform to the requirements of Section 03 30 53 – Cast in Place Concrete.

2.2 SOURCE QUALITY CONTROL

- A. Inspection: Forms will be inspected and approved by the Owners Representative prior to concrete placement. The Owners Representative will receive two working day notice prior to concrete placement.
- B. Testing: The Contractor shall make arrangements for a certified independent testing laboratory, according to the requirements of Section 01 45 29 - Testing Laboratory Services, to perform the required testing, recording, and distributing of the results.

PART 3: EXECUTION

3.1 PREPARATION

- A. Earthwork: Excavation and embankment for curbs and gutters shall be as described in the applicable provisions of the project documents. Unsuitable material in the subgrade shall be removed to a specific depth and then backfilled with imported backfill. Payment will not be allowed for excavation below grade and for backfill materials required when such excavation is caused by negligence of the Contractor.
- B. Compaction: Subgrade shall be compacted to 95% maximum density according to AASHTO T 99, unless noted otherwise.
- C. Grading: Before forms are set, the subgrade shall be graded to within one inch of established grade, and the area between the sidewalk and the adjacent property shall be shaped to line, grade, and section shown on the drawings. Low areas in the subgrade shall be backfilled with imported backfill and compacted.
- D. Subgrade Moisture: Dry areas in the subgrade shall be thoroughly dampened prior to placing concrete.

3.2 FORMS

- A. General: Forms shall be of wood, metal, or other suitable material and shall extend for the full depth of the concrete. Forms shall be constructed to allow easy removal without prying or hammering against the fresh concrete. Concrete damaged during form removal will be rejected.
- B. Alignment: Set forms to the lines and grades shown on the drawings. Allowable tolerance for setting forms shall be as follows:
 - 1. Top shall not deviate more than 1/8-inch in 10 ft.
 - 2. Alignment shall be within 1/4-inch in 10 ft.
 - 3. On 300-ft radius curves or less, forms shall conform to the radius shown on the drawings.
- C. Bracing: Forms shall be braced to prevent deformation and displacement.
- D. Divider Plates: Shall be of metal.
- E. Preparation: Wooden forms may be oiled or watered immediately before placement of concrete. Water shall be clean. Water shall not be used when the atmospheric temperature is less than 40 degrees F. Steel forms shall be lightly oiled with a good grade of form oil prior to placing concrete. Excess oil shall be removed.

3.3 PLACING AND FINISHING CONCRETE

- A. Placement: Concrete shall be spread uniformly between the forms and thoroughly compacted with a vibrator or other acceptable method.
- B. Curb Machine: The curb or curb and gutter may be constructed by the use of a curb-forming machine provided it produces the required results. When the curb machine is used, contraction joints shall be created in a manner approved by the Owners Representative.
- C. Curb Template: When approved by the Owners Representative, the exposed curb face may be constructed and finished by use of trowel-type templates, shaped to produce the desired contours when operated along approved forms set to the established lines and grades. When the concrete is green, the top, front, or other exposed surfaces of the curb or combined curb and gutter shall be floated with a moist wood float. Form marks and other irregularities shall be removed.
- D. Floating: After compaction and leveling, the concrete shall be floated.
- E. Edging: Joints shall be edged with a 1/4-inch radius edge.
- F. Surface Finishing: The surface shall be brushed with a fiber hair brush in a transverse direction. For the purpose of matching adjacent concrete finishes or for other reasons, the Owners Representative may permit other methods of finishing. No plastering will be permitted.
- G. Contraction Joints: Curbing shall be constructed in sections having a uniform length of 15 ft. maximum unless noted otherwise. Prior to final set of the concrete, joints shall be tooled in the curb to a width of 1/8 inch, except at expansion joints. The sidewalk and curb contraction joints shall match.
- H. Expansion Joints: Shall be placed at intervals of 100ft maximum, using a preformed expansion joint filler extending the full width of the structure, and have a thickness of 3/4 inch. The sidewalk and curb expansion joints shall match. Expansion joint shall also be placed where the curb and gutter abut existing structures, existing paving, etc. Joints shall be sealed with an approved sealant.

3.4 BACKFILLING

- A. Requirements: After the concrete has cured for 14 days minimum, the spaces in front and back of the curb shall be backfilled to the required elevation with material similar to adjacent materials which shall be thoroughly tamped, in layers of not more than 6 inches. The concrete shall be cured for 28 days before paving materials are filled against it.

3.5 PRECAST CONCRETE CURB - NOT ALLOWED

3.6 FIELD QUALITY CONTROL

- A. Inspection: Forms will be inspected and approved by the Owners Representative prior to concrete placement. The Owners Representative will receive TWO working day notice prior to concrete placement.
- B. Testing: The Contractor shall make arrangements for a certified independent testing laboratory, according to the project documents, to perform the required testing, recording, and distributing of the results.
- C. Rejected Concrete Curb: Curbs that are chipped, broken, out of grade or alignment, will be rejected. Replacement curb shall match existing curbing.

3.07 CLEANING

- A. Clean-up: Concrete spilled or splashed on adjacent surfaces shall be thoroughly removed. After form removal, backfill and landscape to match surrounding area.
- B. Excess Materials: Excess and waste material shall be disposed of off the site.

END OF SECTION

SECTION 32 16 14 - CONCRETE SIDEWALKS

PART 1: GENERAL

1.1 SUMMARY

- A. Section Includes: Construction of concrete sidewalks.

1.2 SUBMITTALS

- A. Records: Submit copies of certified delivery tickets for all concrete used on this project.

1.3 QUALITY ASSURANCE

- A. Failure Criteria: Not limited to the following:
 1. Concrete damaged during form removal.
 2. Concrete chipped, broken, or defaced.
 3. Concrete out of grade or alignment.

1.4 SITE CONDITIONS

- A. Placing During Cold Weather: Discontinue concrete placement when the air temperature is below 40 degrees F (5 degrees C).
- B. Placing During Warm Weather: The temperature of the concrete as placed shall not exceed 85 degrees F (30 degrees C) except where an approved retarder is used. The mixing water and/or aggregates shall be cooled, if necessary, to maintain a satisfactory placing temperature. In no case shall the placing temperature exceed 95 degrees F (35 degrees C).

PART 2: PRODUCTS

2.1 MATERIALS

- A. Concrete: Shall have a 28-day strength of 3,500 psi minimum, unless noted otherwise on plans. Water/Cement Ratio ≤ 0.55 . The entrained-air range shall be 5 to 7 percent. The slump range shall be 3-inches (50 mm) plus or minus 1-inch (25 mm) conforming to ASTM C 143.
- B. Reinforcing Steel: When specifically called for on the plans, shall be,
 1. Reinforcement bars: ASTM A 615, ASTM A 616, or ASTM A 617.
 2. Wire mesh reinforcement: ASTM A 185.
- C. Joint Materials:
 1. Expansion joint filler strips shall be premolded, nonextruding type for use in concrete conforming to ASTM D 1751 or ASTM D 1752, (1/2 inch) thick or as noted on the plans.
 2. Joint sealant, self leveling low modulus silicone for use in sealing concrete pavement joints.
- D. Curing Materials: NOTE: If concrete is planned to receive a stain, colored, stamped, or other applied finish, Impervious sheet or membrane-forming curing compound,. Impervious sheet shall be white opaque polyethylene 4 mil thick, conforming to ASTM C 171; waterproof kraft paper; or polyethylene-coated burlap conforming to AASHTO M 182. Membrane-forming curing compound shall be AASHTO M148/ASTM C309 Type 2

or Type 1-D. White pigment or red dye.

- E. Concrete Protection Materials: Linseed oil mixture shall be equal parts, by volume, of linseed oil and either mineral spirits, naphtha, or turpentine. At the option of the Contractor, commercially prepared linseed oil mixtures formulated specifically for application to concrete to provide protection against the action of deicing chemicals may be used except that emulsified mixtures are not acceptable.
- F. Formwork: Form work shall be designed and constructed to insure that the finished concrete will conform accurately to the indicated dimensions, lines, and elevations, and within the tolerances specified. Forms shall be of a height equal to the full depth of the finished sidewalk.
 - 1. Wood Forms: Shall be No. 2 common lumber or better against unexposed concrete surfaces. Wood forms against exposed concrete surfaces shall be dressed and matched boards of uniform thickness and widths not exceeding 10 inches. Plywood, conforming to the requirements for formwork as set forth in the American Plywood Association Concrete Forming Guide, may be used against both exposed and unexposed concrete surfaces. Plywood shall be at least 9/16-inch thick and have not less than 5 plys.
 - 2. Steel Forms: Steel forms shall be channel-formed sections with a flat top surface and with welded braces at each end and at not less than two intermediate points. Ends of steel forms shall be interlocking and self-aligning. Steel forms shall include flexible forms for radius forming, corner forms, form spreaders, and fillers. Steel forms shall have a nominal length of 10 feet (3 m) with a minimum of two welded stake pockets per form. Stake pins shall be solid steel rods with chamfered heads and pointed tips designed for use with steel forms.
- G. Base Course Material: Shall be sand, limestone screenings or select materials.

PART 3: EXECUTION

3.1 PREPARATION

- A. Earthwork: Excavation and embankment for sidewalks shall be as described in the applicable provisions of the specifications. Unsuitable material in the subgrade shall be removed to a specific depth and then backfilled with imported backfill.
- B. Compaction: Subgrade shall be compacted to a min. of 95 percent maximum density according to AASHTO T 99.
- C. Grading: Before forms are set, the subgrade shall be graded to within one inch of established grade and the area between the sidewalk and the adjacent property shall be shaped to line, grade, and section shown on the drawings. Low areas in the subgrade shall be backfilled with imported backfill and compacted.
- D. Subgrade Moisture: Dry areas in the subgrade shall be thoroughly moist when placing concrete. Subgrade shall be free from frost when the concrete is deposited.

3.2 FORMS

- A. General: Forms shall be of wood, metal, or other suitable material and shall extend for the full depth of the concrete. Forms shall be constructed to allow easy removal without prying or hammering against the fresh concrete.
- B. Preparation: Wooden forms may be oiled or watered immediately before placement of concrete. Water shall be clean. Water shall not be used when the atmospheric

temperature is less than 40 degrees F. Steel forms shall be lightly oiled with a good grade of form oil prior to placing concrete. Excess oil shall be removed.

- C. Alignment: Set forms to the lines and grades shown on the drawings. Allowable tolerance for setting forms shall be as follows:
 - 1. Top shall not deviate more than 1/8-inch in 10 feet (3 mm in 3 meter) section.
 - 2. Alignment shall be within 1/4-inch in 10 feet (1.5 mm in 3 meter) section.
 - 3. Transverse slope [as indicated] of 1/4 inch per foot (6 mm per 300 mm) with the low side adjacent to the roadway. Side forms shall not be removed for 12 hours after finishing has been completed.
- D. Bracing: Forms shall be braced to prevent deformation and displacement.

3.3 PLACING AND FINISHING CONCRETE

- A. Concrete Placement: Spread concrete in one layer uniformly between the forms and thoroughly compact with a vibrator and a steel-shod strikeboard.
- B. Floating: After compaction and leveling, the concrete shall be floated with wood floats and finished with a steel float except where designated for exposed-aggregate finish.
- C. Smooth Finish: After straightedging, when most of the water sheen has disappeared, and just before the concrete hardens, finish the surface to a smooth and uniformly fine granular or sandy texture free of waves, irregularities, or tool marks. Produce a scored surface by brooming with a fiber-bristle brush in a direction transverse to that of the traffic.
 - 1. For the purpose of matching adjacent concrete finishes or for other reasons, the Owners Representative may permit other methods of finishing. No plastering will be permitted.
- D. Exposed Aggregate Finish (If specifically required):
 - 1. When concrete has reached initial set, wash retarded-concrete surfaces with water and scrub with stiff-bristle brush until aggregate is sufficiently and uniformly exposed and matches accepted panel samples.
 - 2. If adequate aggregate exposure cannot be obtained with the method specified above, scrub with acid-etch solution until aggregate is sufficiently and uniformly exposed and matches accepted sample panels.
 - 3. Do not over-expose aggregate.
 - 4. When desired finish is achieved, wash and rinse exposed-aggregate finish. If acid etch is used, neutralize before wash and rinse.
- E. Edge and Joint Finishing: Edge sides of walk with 1/2-inch radius edger. Edge transverse joints before brooming; eliminate the ridge and flat surface left by the edger. Ensure corners and edges are solidly filled before edging to prevent crumbling or low areas.
- F. Sidewalk Joints: Sidewalk joints shall be constructed to divide the surface into rectangular areas. Transverse contraction joints shall be spaced at a distance equal to the sidewalk width of 5 feet (1.5 m) on centers, whichever is less, and shall be continuous across the slab. Longitudinal contraction joints shall be constructed along centerline of all sidewalks 10-feet (3 m) or more in width. Transverse expansion joints shall be installed at sidewalk returns and opposite expansion joints, in adjoining curbs. Where the sidewalk is not in contact with the curb, transverse expansion joints shall be installed as indicated. Expansion joints shall be formed about structures and features which project through or into the sidewalk pavement, using joint filler of the type, thickness, and width indicated.
 - 1. Contraction Joints: Transverse contraction joints, cut to a depth of at least 1/4 the thickness of the concrete, prior to final set of the concrete, shall be tooled in

the sidewalks at a distance equal to the sidewalk width or 5 feet (1.5 m) on centers, whichever is less, and shall be continuous across the slab. Longitudinal contraction joints shall be constructed along the centerline of all sidewalks 10 feet(3 m) or more in width] [or as shown on the drawings]. Where practical, the sidewalk and curb contraction joints shall match. Contraction joints must be made within 2 hours of placement.

2. Expansion Joints: Place with top edge not less than 1/4-inch (6 mm) nor more than 1/2-inch (12 mm) below the surface and hold in place to prevent warping during floating and finishing. Place at structures, at driveways, and at points of tangency and curvature.
 - a. Expansion-joint material shall extend the full width of the structure.
 - b. Expansion-joint material shall extend to the subgrade.
 - c. Concrete over the joint filler shall be removed.
 - d. At the end of the curing period, remove filler strips, then carefully clean and fill expansion joints with joint sealer flush with the concrete surface in such manner as to minimize spilling on the walk surface. Concrete at the joint shall be surface dry and the atmospheric and pavement temperatures shall be above 50 degrees F (10 degrees C) at the time of application of joint-sealing materials. Immediately remove spilled sealing material and clean the surface of the walk.
 - (1) Joint Sealing compound shall be installed on all joints.

G. Reinforcement-Steel Placement:

1. Reinforcement steel, when specifically called for in the plans, shall be accurately and securely fastened in place with suitable supports and ties before the concrete is placed.

H. Construction Joints: Shall be formed around all appurtenances such as manholes, utility poles, extending into and through the sidewalk.

3.4 CURING

- A. General Requirements: Concrete shall be protected against loss of moisture and rapid temperature changes for at least 7 days from the beginning of the curing operation. Unhardened concrete shall be protected from rain and flowing water. All equipment needed for adequate curing and protection of the concrete shall be on hand and ready for use before actual concrete placement begins. Protection shall be provided as necessary to prevent cracking of the pavement due to temperature changes during the curing period.
- B. Mat Method: The entire exposed surface shall be covered with two or more layers of burlap. Mats shall overlap each other at least 6 inches (150 mm). The mat shall be thoroughly wetted with water prior to placing on concrete surface and shall be kept continuously in a saturated condition and in intimate contact with concrete for not less than 7 days.
- C. Impervious Sheeting Method: The entire exposed surface shall be wetted with a fine spray of water and then covered with impervious sheeting material. Sheets shall be laid directly on the concrete surface with the light-colored side up and overlapped 12 inches (300 mm) when a continuous sheet is not used. The curing medium shall not be less than 18-inches (450 mm) wider than the concrete surface to be cured, and shall be securely weighted down by heavy wood planks, or a bank of moist earth placed along edges and laps in the sheets. Sheets shall be satisfactorily repaired or replaced if torn or otherwise damaged during curing. The curing medium shall remain on the concrete surface to be cured for not less than 7 days.

- D. Membrane Curing Method: A uniform coating of white-pigmented membrane-curing compound shall be applied to the entire exposed surface of the concrete as soon after finishing as the free water has disappeared from the finished surface. Formed surfaces shall be coated immediately after the forms are removed and in no case longer than 1 hour after the removal of forms. Concrete shall not be allowed to dry before the application of the membrane. If any drying has occurred, the surface of the concrete shall be moistened with a fine spray of water and the curing compound applied as soon as the free water disappears. Curing compound shall be applied in two coats by hand-operated pressure sprayers at a coverage of approximately 200 square feet per gallon (5 square meters per liter) for both coats. The second coat shall be applied in a direction approximately at right angles to the direction of application of the first coat. The compound shall form a uniform, continuous, coherent film that will not check, crack, or peel and shall be free from pinholes or other imperfections. If pinholes, abrasion, or other discontinuities exist, an additional coat shall be applied to the affected areas within 30 minutes. Concrete surfaces that are subjected to heavy rainfall within 3 hours after the curing compound has been applied shall be resprayed by the method and at the coverage specified above. Areas where the curing compound is damaged by subsequent construction operations within the curing period shall be resprayed. Necessary precautions shall be taken to insure that the concrete is properly cured at sawed joints, and that no curing compound enters the joints. The top of the joint opening and the joint groove at exposed edges shall be tightly sealed before the concrete in the region of the joint is resprayed with curing compound. The method used for sealing the joint groove shall prevent loss of moisture from the joint during the entire specified curing period. Approved standby facilities for curing concrete pavement shall be provided at a location accessible to the jobsite for use in the event of mechanical failure of the spraying equipment or other conditions that might prevent correct application of the membrane-curing compound at the proper time. Concrete surfaces to which membrane-curing compounds have been applied shall be adequately protected during the entire curing period from pedestrian and vehicular traffic, except as required for joint-sawing operations and surface tests, and from any other possible damage to the continuity of the membrane.

3.5 BACKFILLING

- A. Requirements: After the concrete has cured for 14 days, remove debris; then backfill, grade, and compact the spaces in front, back, and sides of the sidewalk to the required elevation with material similar to adjacent materials, in layers of not more than 6 inches (150 mm). The concrete shall be cured for 28 days before paving materials are filled against it.

3.5 FIELD QUALITY CONTROL

- A. Inspection: Forms will be inspected and approved by the Owners Representative prior to concrete placement. The Owners Representative will receive one working day notice prior to concrete placement.
- B. Testing: The Contractor shall make arrangements for a certified, independent testing laboratory, according to the requirements of Section 01 45 29 - Testing Laboratory Services, to perform the required testing, recording, and distributing of the results.

3.7 FIELD QUALITY CONTROL

- A. General Requirements: The Contractor shall perform the inspection and tests described and meet the specified requirements for inspection details and frequency of testing. Based upon the results of these inspections and tests, the Contractor shall take the action and submit reports as required below, and any additional tests to insure that the requirements of these specifications are met.

- B. Concrete Testing:
1. Strength Testing: The Contractor shall provide molded concrete specimens for strength tests. Samples of concrete placed each day shall be taken not less than once a day nor less than once for every 250 cubic yards (190 cubic meters) of concrete. The samples for strength tests shall be taken in accordance with ASTM C 172. Cylinders for acceptance shall be molded in conformance with ASTM C 31 by an approved testing laboratory. Each strength test result shall be the average of two test cylinders from the same concrete sample tested at 28 days, unless otherwise specified or approved. Concrete specified on the basis of compressive strength will be considered satisfactory if the averages of all sets of three consecutive strength test results equal or exceed the specified strength, and no individual strength test result falls below the specified strength by more than 500 psi (4 MPa).
 2. Air Content: Air content shall be determined in accordance with ASTM C 173 or ASTM C 231. ASTM C 231 shall be used with concretes and mortars made with relatively dense natural aggregates. Two tests for air content shall be made on randomly selected batches of each class of concrete placed during each shift. Additional tests shall be made when excessive variation in concrete workability is reported by the placing foreman or the Owner inspector. If results are out of tolerance, the placing foreman shall be notified and he shall take appropriate action to have the air content corrected at the plant. Additional tests for air content will be performed on each truckload of material until such time as the air content is within the tolerance specified.
 3. Slump Test: Two slump tests shall be made on randomly selected batches of each class of concrete for every 190 cubic meters, (250 cubic yards,) or fraction thereof, of concrete placed during each shift. Slump shall not be more than [4 inches (100 mm)] for smooth finish walks; and not more than [3 inches (75 mm)] for exposed aggregate walks, as determined by ASTM C 143. Additional tests will be performed when excessive variation in the workability of the concrete is noted or when excessive crumbling or slumping is noticed along the edges of slip-formed concrete.
- C. Thickness Evaluation: The anticipated thickness of the concrete shall be determined prior to placement by passing a template through the formed section or by measuring the depth of opening of the extrusion template of the curb forming machine. If a slip form paver is used for sidewalk placement, the subgrade shall be true to grade prior to concrete placement and the thickness will be determined by measuring each edge of the completed slab.
- D. Surface Evaluation: The finished surface of each category of the completed work shall be uniform in color and free of blemishes and form or tool marks.

3.8 ADJUSTING

- A. Surface Deficiencies and Corrections: Areas which exhibit excessive cracking, discoloration, form marks, or tool marks or which exceed plan grade, surface smoothness, or thickness tolerances shall be corrected as directed by the Owners Representative.
- B. Thickness Deficiency: When measurements indicate that the completed concrete section is deficient in thickness by more than 1/4 inch (6 mm) the deficient section will be removed, between regularly scheduled joints, and replaced.
- C. High Areas: In areas not meeting surface smoothness and plan grade requirements, high areas shall be reduced either by rubbing the freshly finished concrete with carborundum brick and water when the concrete is less than 36 hours old or by grinding the hardened concrete with an approved surface grinding machine after the concrete is

36 hours old or more. The area corrected by grinding the surface of the hardened concrete shall not exceed 5 percent of the area of any integral slab, and the depth of grinding shall not exceed 1/4 inch (6 mm). All pavement areas requiring grade or surface smoothness corrections in excess of the limits specified above shall be removed and replaced.

3.9 CLEANING

- A. Clean-up: Concrete spilled or splashed on adjacent surfaces shall be thoroughly removed. After form removal, backfill and landscape to match surrounding area.
- B. Excess Materials: Excess and waste materials shall be disposed of off the site.

3.10 PROTECTION

- A. General: Completed concrete shall be protected from damage until accepted. The Contractor shall repair damaged concrete and clean concrete discolored during construction. Concrete that is damaged shall be removed and reconstructed for the entire length between regularly scheduled joints. Refinishing the damaged portion will not be acceptable. Removed damaged portions shall be disposed of as directed.
- B. Protective Coating: Protective coating of linseed oil mixture shall be applied to the exposed-to-view concrete surface.
 - 1. Application: Curing and backfilling operation shall be completed prior to applying protective coating. Concrete shall be surface dry and thoroughly clean before each application. Coverage shall be not more than 50 square yards per gallon (11 square meters per liter) for first application and not more than 70 square yards per gallon (15.5 square meters per liter) for second application, except that the number of applications and coverage for each application for commercially prepared mixture shall be in accordance with the manufacturer's instructions. Coated surfaces shall be protected from vehicular and pedestrian traffic until dry.
 - 2. Precautions: Protective coating shall not be heated by direct application of flame or electrical heaters and shall be protected from exposure to open flame, sparks, and fire adjacent to open containers or applicators. Material shall not be applied at temperatures lower than 50 degrees F. (10 degrees C.)

END OF SECTION

SECTION 32 17 23 - PAVEMENT MARKINGS

PART 1: GENERAL

1.1 SUMMARY

- A. Section Includes: Furnishing and applying pavement marking.
- B. Related Sections:

1.2 SUBMITTAL

- A. General: Submittals shall be according to General Conditions.
- B. Manufacturer's Literature: Submit three copies of the manufacturer's descriptive data for the following items to be used on this project.
 - 1. Not used.
 - 2. Paints for roads and streets.
 - 3. Thermoplastic compounds and primer.
 - 4. Manufacturer's Material Safety Data.
- C. Manufacturer's Installation Instructions: Submit three copies of the manufacturer's installation instructions for the following items to be used on this project.
 - 1. Paints for roads and streets.
- D. Certificates of Conformance: Submit 5 copies of written certification from the supplier of the following Contractor-furnished items traffic stripe, paint, to be used on this project that it conforms to the requirements of this specification section.
- E. Not Used
- F. Equipment: Submit three copies of list of equipment to be used on this project for approval by Owners Representative.
- G. Test Reports: Submit test results from field tests specified in this section.
- H. Traffic Control Plan: Submit five copies of the Traffic Control Plan for approval by the Owners Representative prior to commencement of work.

1.3 DELIVERY AND STORAGE

- A. Requirements: Deliver paints, paint materials and thermoplastic compound materials in original sealed containers that plainly show the designated name, specification number, batch number, color, date of manufacture, manufacturer's directions, and name of manufacturer. Provide storage facilities at the job site for maintaining materials at temperatures recommended by the manufacturer.

1.4 WEATHER LIMITATIONS

- A. Requirements: Apply paint to clean, dry surfaces, and unless otherwise approved, only when air and pavement temperatures are above 40 degrees F (5 degrees C) for oil-based materials, 50 degrees F (10 degrees C) for water-based materials, and less than 95 degrees F (35 degrees C). Maintain paint temperature within these same limits.

1.5 WARRANTY

- A. Requirements: Markings which become worn off within four months shall be replaced under the warranty provisions of this Contract. When pavement applied under this Contract is replaced under warranty, the markings shall be replaced as well.

PART 2: PRODUCTS

2.1 MATERIALS

- A. Pavement Marking Paint: Shall conform to the requirements of AASHTO M 248, Type S. The paint shall be homogeneous, easily stirred to smooth consistency, and shall show no hard settlement or other objectionable characteristics during a storage period of 6 months. Pavement marking paints shall comply with applicable state and local laws enacted to ensure compliance with Federal Clean Air Standards. Paint materials shall conform to the restrictions of the local Air Pollution Control District.
 - 1. Color: As specified or required by MUTCD.

2.2 EQUIPMENT

- A. General: Machines, tools, and equipment used in the performance of the work shall be approved by the Owners Representative and maintained in satisfactory operating condition. Submit construction equipment list approval by the Owners Representative.
- B. Identifying Markings: Equipment operating on roads and runways will display low speed traffic markings and traffic warning lights.
- C. Surface Preparation Equipment:
 - 1. Sandblasting Equipment: Sandblasting equipment shall include an air compressor, hoses, and nozzles of proper size and capacity as required for cleaning surfaces to be painted. The compressor shall be capable of furnishing not less than 70.8 liters per sec (150 cfm) of air at a pressure of not less than 90 psi (620 kPa) at each nozzle used, and shall be equipped with traps that will maintain the compressed air free of oil and water.
 - 2. Waterblast Equipment: The water pressure shall be specified at 17.9 MPa (2600 psi) at 60 degrees C (140 degrees F in order to adequately clean the surfaces to be marked.
- C. Street Pavement Paint Equipment:
 - 1. Use equipment that is a self-propelled or mobile-drawn pneumatic spraying machine capable of placing the prescribed number of lines at a single pass as solid lines, intermittent lines or a combination of solid and intermittent lines using a maximum of two different colors of paint as specified.] The machine shall have a speed during application not less than 5 mph (8 kilometers per hour), and shall be capable of applying the stripe widths indicated, at the paint coverage rate specified and of even uniform thickness with clear-cut edges.
 - 2. The spray mechanism shall be equipped with quick-action valves conveniently located, and shall include necessary pressure regulators and gauges in full view and reach of the operator.
 - 3. The paint applicator shall have tanks equipped with suitable air-driven mechanical agitators.
 - 4. Install paint strainers in paint supply lines to insure freedom from residue and foreign matter that may cause malfunction of the spray guns. The paint applicator shall be readily adaptable for attachment of an air-actuated dispenser for the reflective media approved for use.
 - 5. Provide pneumatic spray guns for hand application of paint in areas where the mobile paint applicator cannot be used.
- D. Not Used

- E. Reflective Media Dispenser: Attach dispenser for applying the reflective media to the paint dispenser and operate automatically and simultaneously with the paint applicator through the same control mechanism. Use dispenser capable of adjustment and designed to provide uniform flow of reflective media over the full width of the stripe at the rate of coverage specified at all operating speeds of the paint applicator to which it is attached.
- F. Thermoplastic Application Equipment:
1. Application equipment shall provide continuous mixing and agitation of the material. Application equipment shall be mobile and maneuverable to the extent that straight lines can be followed and normal curves can be made in a true arc.
 2. Maintenance: Conveying parts of the equipment between the main material reservoir and the extrusion shoe or spray gun shall prevent accumulation and clogging. All parts of the equipment which come into contact with the material shall be easily accessible and exposable for cleaning and maintenance.
 3. Sharp Lines: The application equipment shall be so constructed as to ensure continuous uniformity in the dimensions of the stripe. The applicator shall provide a means for cleanly cutting off stripe ends squarely and shall provide a method of applying "skiplines." The equipment shall be capable of applying varying widths of traffic markings.
 4. Reflective Sphere Dispenser: The applicator shall be equipped with a drop-on type bead dispenser capable of uniformly dispensing reflective spheres at controlled rates of flow. The sphere dispenser shall be automatically operated and shall begin flow prior to the flow of composition to assure that the strip is fully reflectorized.
 6. The equipment used for the placement of thermoplastic pavement markings shall be of two general types: mobile applicator and portable applicator.
 7. Mobile Application Equipment: The mobile applicator shall be defined as a truck-mounted, self-contained pavement marking machine that is capable of hot applying thermoplastic by either the extrusion or spray method at widths varying from 3 to 12 inches (75 to 300 mm). The mobile unit shall be capable of operating continuously and of installing a minimum of 20,000 lineal feet (6000 mm) of longitudinal markings in a 8-hour day. Equip the mobile unit with a melting kettle of such capacity as to hold a minimum of 6000 pounds (2700 kg) of molten thermoplastic material. The kettle shall be capable of heating the thermoplastic composition to temperatures of 425 degrees F (218 degrees C). The heating mechanism shall be by means of a thermostatically controlled heat transfer liquid. Heating of the composition by direct flame shall not be allowed. Oil and material temperature gages shall be visible at both ends of the kettle.
 - a. Equip the mobile unit with a spray gun system. The spray system shall consist of a minimum of four spray guns, located two on each side of the truck, and shall be capable of marking simultaneous edgeline and centerline stripes. Surround the spray system (jacketed) with heating oil so as to maintain the molten thermoplastic at a temperature between 190 and 218 degrees C (375 and 425 degrees F); and shall be capable of spraying a stripe of 3 to 12 inches (75 to 300 mm) in width, and in thickness varying from 0.055 to 0.095 inch (1.5 to 2.5 mm), and of generally uniform cross section.]
 8. Portable Application Equipment: The portable applicator shall be defined as hand-operated equipment, specifically designed for placing special markings such as crosswalks, stopbars, legends, arrows, and short lengths of lane, edge and centerlines. The portable applicator shall be capable of applying thermoplastic pavement markings by the extrusion method. It is intended that the portable applicator will be loaded with hot thermoplastic composition from the melting kettles on the mobile applicator. Equip the portable applicator with all the necessary components, including a materials storage reservoir, bead dispenser, extrusion shoe, and heating accessories, so as to be capable of holding the molten thermoplastic at a temperature between 375 and 425 degrees F (190 and 218 degrees C), of extruding a line of 3 to 12 inches (75 to 300 mm) in width, and in thickness of not less than 0.125 inch (3 mm) nor more than 0.190 inch (5 mm) and of generally uniform cross section.

- H. Preformed Tape: Mechanical application equipment shall be used for the placement of preformed marking tape. Mechanical application equipment shall be defined as a mobile pavement marking machine specifically designed for use in applying precoated, pressure-sensitive pavement marking tape of varying widths, up to 12 inches (300 mm). The applicator shall be equipped with rollers, or other suitable compactive device, to provide initial adhesion of the preformed, pressure-sensitive marking tape with the pavement surface. Additional hand-operated rollers shall be used as required to properly seat the thermoplastic tape.

PART 3: EXECUTION

3.1 PREPARATION

- A. New Pavement Curing: Allow new pavement surfaces to cure for a period of not less than 30 days before application of marking materials.
 - 1. Where early painting is required on rigid pavements, a pretreatment with an aqueous solution containing 3 percent phosphoric acid and 2 percent zinc chloride shall be applied to prepared pavement areas prior to painting.
- B. Traffic Controls: Suitable warning signs shall be placed near the beginning of the worksite and well ahead of the worksite for alerting approaching traffic from both directions. Small markers shall be placed along newly painted lines or freshly placed raised markers to control traffic and prevent damage to newly painted surfaces or displacement of raised pavement markers. Painting equipment shall be marked with large warning signs indicating slow-moving painting equipment in operation.
- C. Cleaning: Thoroughly clean surfaces to be marked before application of pavement marking. Remove dust, dirt, and other granular surface deposits by sweeping, blowing with compressed air, rinsing with water, or a combination of these methods as required. Remove rubber deposits, existing paint or other material markings, residual curing compounds, and other coatings adhering to the pavement by waterblasting. Scrub affected areas, where oil or grease is present on old pavements to be marked, with several applications of trisodium phosphate solution or other approved detergent or degreaser and rinse thoroughly after each application. After cleaning oil-soaked areas, seal with shellac or primer recommended by the manufacturer to prevent "bleeding through." Do not commence marking in any area until pavement surfaces are dry and clean.
 - 1. Surfaces shall be recleaned, when work has been stopped due to rain.
 - 2. Cleaning Concrete Curing Compounds: On new portland cement concrete pavements, cleaning operations shall not begin until a minimum of 30 days after the placement of concrete. All new concrete pavements shall be cleaned by either sandblasting or water blasting. When water blasting is performed, thermoplastic and preformed markings shall be applied no sooner than 24 hours after the blasting has been completed. The extent of the blasting work shall be to clean and prepare the concrete surface as follows:
 - a. There is no visible evidence of curing compound on the peaks of the textured concrete surface.
 - b. There are no heavy puddled deposits of curing compound in the valleys of the textured concrete surface.
 - c. All remaining curing compound is intact; all loose and flaking material is removed.
 - d. The peaks of the textured pavement surface are rounded in profile and free of sharp edges and irregularities.
 - e. The surface to be marked is dry.
- D. Removal of Existing or Incorrect Markings:
 - 1. Identification: When markings must be removed because of conflict with new markings, obsolescence, or faulty application, these markings will be identified on a drawing or by the Owners Representative. New preformed and thermoplastic pavement markings shall not be applied over existing preformed or thermoplastic markings.

2. Removal: The Contractor shall use abrasive/air blasting or mechanical abrasives or other technique approved by the Owners Representative. The technique shall meet OSHA and local health and safety standards. Whenever grinding, scraping, sandblasting or other operations are performed the work must be conducted in such a manner that the finished pavement surface is not damaged or left in a pattern that is misleading or confusing. When these operations are completed the pavement surface shall be blown off with compressed air to remove residue and debris resulting from the cleaning work.

3.2 APPLICATION OF PAINT AND REFLECTIVE SPHERES

- A. Dimensions of Marking:
 1. Stripes for a solid line shall be 4 inches (100 mm) wide and for a broken line shall be a 10 ft (3 m) strip with a 30 ft (9 m) gap.
 2. Symbols shall be of the dimensions as shown on the drawings, executed with 4-inch (100 mm) lines.
 3. Stop bars shall be 18 inches (450 mm) wide.
 4. Handicap symbols shall be 5 ft (1.5 m) in height executed with 4-inch (100 mm) lines.
- B. Rate of Application:
 1. Paint: Apply paint evenly to the pavement area to be coated at a rate of 15 mil thickness (wet film) minimum.
 2. Solid Traffic Stripes: For 4 inch ([100]mm) wide stripes the minimum rate of application shall be 16.5 gallons of paint per mile.
 3. Broken Traffic Stripes: For 4 inch ([100]mm) wide stripes the minimum rate of application shall be 4.1 gallons of paint per mile.
 4. Arrows and Letters: Shall be 0.01 gallon per square foot of markings.
 5. Reflective Markings: Apply reflective spheres uniformly to the wet paint.
 - a. On road and street pavement at a rate of 6 pounds of spheres per gallon (719 kg of spheres per cubic meter).
- C. Paint Preparation: The paint shall be thoroughly mixed immediately before application. Apply paint pneumatically with approved equipment at rate of coverage specified. Provide guidelines and templates as necessary to control paint application. Take special precautions in marking numbers, letters, and symbols. Manually paint numbers, letters, and symbols. Sharply outline all edges of markings. The maximum drying time requirements of the paint specifications will be strictly enforced, to prevent undue softening of bitumen, and pickup, displacement, or discoloration by tires of traffic. Discontinue painting operations if there is a deficiency in drying of the markings until cause of the slow drying is determined and corrected.
- D. Protection of Markings: The painted area shall be protected from traffic until the paint is dry.

3.3 CLEANUP

- A. Requirements: Products of the removal shall be cleaned up so as to leave no visible residues and disposed of off the site so as not to contribute to air or water pollution in a manner approved by local authorities.

3.4 COORDINATION AND TRAFFIC CONTROL

- A. Traffic Control at the Work Site: Where pavement marking operations may interfere or conflict with normal vehicular or pedestrian traffic, the Contractor shall submit five copies of the traffic control plan to the Owners Representative for approval. The plan shall be coordinated with local authorities to take activities and contingencies into account.

3.5 FIELD QUALITY CONTROL

- A. Markings: Shall present a clean cut, and uniform appearance. Markings which fail to have a uniform, and satisfactory appearance, either day or night, will be rejected.

- B. Tolerances:
 - 1. The length of painted segment and gap shall not vary more than 6 inches (150 mm) in a 40 foot (12 m) cycle.
 - 2. Painted lines shall be 4 inches (100 mm) wide plus or minus 1/8 inch (3 mm).

- C. Test Results: Examine material at the job site to determine that it is the material referenced in the report of test results or certificate of compliance. A certificate of compliance shall be accompanied by test results substantiating conformance to the specified requirements.
 - 1. Surface Preparations and Application Procedures: Surface preparations and application procedures will be examined by the Owners Representative to determine conformance with the requirements specified. Approve each separate operation prior to initiation of subsequent operations.

END OF SECTION

SECTION 32 92 23 - SODDING

PART 1: GENERAL

1.1 SUMMARY

- A. Section Includes: Preparing the sod bed, furnishing, cutting, hauling, and laying live sod. Also includes furnishing and applying fertilizer, and watering to obtain a thriving stand of vegetation.

1.2 SUBMITTALS

- A. General: Submittals shall be according to General Conditions.

1.3 MAINTENANCE

- A. General: Maintain sodded areas immediately after placement until grass is well established and exhibits a vigorous growing condition. Mow grass at regular intervals as required to maintain at a maximum height of [2-1/2] inches. Do not cut more than 1/3 of grass blade at any one mowing. Neatly trim edges and hand clip where necessary. Immediately remove heavy clippings after mowing and trimming.
- B. Watering: Water when required and in sufficient quantities to prevent grass and underlying soil from drying out.
- C. Rolling: Roll when required to remove minor depressions or irregularities.
- D. Weed Control: When using herbicides, apply according to manufacturer's recommendations. Remedy damage resulting from negligent or improper use of herbicides.
- E. Repair: Immediately repair or replace areas which show deterioration or bare spots.
- F. Protection: Protect sodded areas with warning signs during maintenance period.

PART 2: PRODUCTS

2.1 MATERIALS

- A. Sod: Shall be a living vigorous growth of bermudagrass, having a dense root system contained in suitable sod and free from noxious weeds, stones, and burned and bare spots.
- B. Topsoil: Shall consist of loose, friable, sandy loam free of admixture of subsoil, refuse, stumps, roots, rocks, brush, weeds, or other material which would be detrimental to the proper development of vegetative growth. The minimum and maximum pH values shall be [5] and [8] respectively. Topsoil shall not contain stone or clods larger than 1 inch in diameter.
- C. Agricultural Limestone: Shall be a calcic or dolomitic ground limestone containing not less than 85% of total (calcium and magnesium) carbonates. At least 40% passing a No. 100 sieve and at least 95% passing a No. 8 sieve. Limestone shall conform to the standards of the AOAC and shall comply with existing State and Federal regulations. Rates of application shall be as recommended by the manufacturer or as soil tests indicate. Granulated slag or other natural sources of lime may be used, subject to approval by the Owners Representative of an adjusted application rate that will equal the total neutralizing power of the specified ground limestone.
- D. Commercial Type Fertilizer: Shall conform to Fed. Spec. O-F-241, Type [I] recommended for grass, with 50% of the elements derived from organic sources; of proportion necessary to eliminate deficiencies of topsoil. to the following proportions: nitrogen 10%, phosphoric acid

20%, soluble potash 10% . Fertilizer shall be furnished in bulk or in new, clean, sealed, and properly labeled containers with name, weight, and guaranteed analysis of contents clearly marked. A liquid form of fertilizer containing the minimum percentage of available nutrients may be used.

- E. Pegs For Sod: Shall be of sound wood, at least 8 inches long, roughly square or round, and have a cross-sectional area of approximately 1 in².
- F. Water: Used in the planting or care of vegetation shall be free from oils, acids, alkalis, salts, or any substance injurious to plant life. Water from streams, lakes, ponds, or similar sources shall not be used unless approved by the Owners Representative.

PART 3: EXECUTION

3.1 PREPARATION

- A. Sub-Grade: Fine grade eliminating uneven areas and low spots. Maintain lines, levels, profiles, and contours. Make changes in grade gradual. Blend slopes into level areas.
- B. Material Removal: Remove foreign materials, undesirable plants and their roots, stones, and debris. Do not bury foreign material beneath areas to be sodded. Remove sub-soil which has been contaminated with petroleum products.
- C. Cultivation: Cultivate sub-soil to a depth of [3] inches where topsoil is to be placed. Repeat cultivation in areas where equipment, used for hauling and spreading topsoil, has compacted sub-soil.
- D. Cutting Sod: Cut sod so that top growth shall not be more than 3 inches in height. Cut sod in pieces not exceeding 1 yd², with minimum 1/2inch and maximum 1 inch soil portion.

3.2 INSTALLATION

- A. Placing Topsoil: Spread topsoil to a minimum depth of [4] inches over entire area to be sodded. Place topsoil during dry weather and on dry unfrozen sub-grade. Remove stones, roots, grass, weeds, and debris.
- B. Fertilizing: Apply fertilizer at a rate recommended by manufacturer. Apply after fine grading and prior to compaction. Mix thoroughly into upper [2] inches of topsoil. Apply fertilizer within [48] hrs before laying sod.
- C. Watering: Lightly water to aid the breakdown of fertilizer.
- D. Laying Sod: Lay sod as soon as possible after delivery to prevent deterioration. Lay sod closely knit together with no open joints visible, and pieces not overlapped. Lay smooth and flush with adjoining grass areas, paving and top surfaces of curbs. On slopes 2:1 and steeper, lay sod perpendicular to slope and secure every row with wooden pegs at maximum 2 ft on center. Drive pegs flush with soil portion of sod.
- E. Watering: Immediately water sodded areas after installation. Water in sufficient amounts to saturate sod and upper [4] inches of soil.
- F. Rolling: After sod and soil has dried sufficiently to prevent damage, roll sodded areas to ensure good bond between sod and soil and to remove minor depressions and irregularities. Ensure rolling equipment weight not over 250 lb or less than 150 lb.

END OF SECTION

SECTION 33 05 16 - MANHOLES, VAULTS AND CLEANOUTS

PART 1: GENERAL

1.1 SUMMARY

- A. SECTION INCLUDES: Excavation and furnishing of materials and labor to construct, finish and backfill new standard and drop manholes, vaults, pits and cleanouts.
- B. RELATED SECTIONS. Section 03 30 53 – Cast-in-Place Concrete.
- C. QUALITY CONTROL: Engineer shall have the right to reject structures based upon visual defects including out of roundness, rough interior, discoloration, warping or other defects which could affect the life and function of the structure.

1.2 SUBMITTALS

- A. General: Submittals shall be according with the following.
- B. Manufacturer's Literature and material certification: Submit six copies of the manufacturer's descriptive data and shop drawings for product.

PART 2: PRODUCTS

2.1 MATERIALS:

- A. PRECAST MANHOLES: Precast manholes shall conform to the specifications for Precast Reinforced Concrete Manhole Sections, ASTM C478.
- B. CAST-IN-PLACE CONCRETE MANHOLES, VAULTS AND MANHOLE BASES: Concrete and related materials for cast-in-place concrete manholes, vaults and manhole bases shall conform, as a minimum, to the requirements of Section 03 21 00, and 03 30 53, of the specifications.
- C. STEPS: Manhole steps shall be made of ½” steel bar encased in corrosion resistant polypropylene. Steps shall be No. 5105 as manufactured by Clay & Bailey or approved equal.
- D. CASTINGS:
 - 1. General. Castings for manholes, cleanouts, vaults, pits and other appurtenances shall conform to and be tested in accordance with the specifications for Gray Cast Iron, ANSI/ASTM A48, Class 30. Design shall be according to the standard details. All manhole frames and covers shall have all bearing surfaces machined so that fitting parts will not rattle or rock.
 - 2. Standard Covers. Where standard manhole frames and lids are specified on the plans, they shall be East Jordan Iron Works 2023 frame and cover, reversible manhole ring with 300-24 lid. Cover shall have the words “SANITARY SEWER” cast in the cover. Lamphole frame and lids, where specified shall be Deeter Casting Number 1828, by Deeter Foundry, Inc. or equal. Lids shall be designed for H-20 traffic loading. Reinforcing ribs shall be tapered to allow the lids to slide easily into the frame.
 - 3. Sealed Manhole Covers. Where sealed manhole lids are called for on the drawings, they shall be Neenah R-1915-F2, or equal. Gaskets shall be of the O-ring type placed in a machined recess in the frame. All bolts shall be stainless steel. The cover shall have the words “SANITARY SEWER” cast in the cover.
- E. PIPE SEALS. Pipe seals shall be Z-LOK or A-LOK as manufactured by A-LOK Products, Inc. Kornseal as manufactured by NPC, Inc. or equal.

F. MASTIC:

1. Bitumastic Joint Sealer. The bitumastic joint sealer shall meet or exceed all requirements of Federal Specification SS-S210A and AASHTO M-198, and shall consist of butyl rubber with 90% solids. Elastomeric polyurethane resin-saturated oakum, with 1-inch by 1-inch cross-section may be substituted for the bitumastic elastic material.

2. Trowelable Bitumastic. Trowelable bitumastic shall be a butyl rubber with minimum solids content of 83% by weight. Shrinkage shall be 20% maximum when tested in accordance with ASTM D2453.

G. BENTONITE WATERSTOP: Bentonite impregnated bituminous waterstop shall be used where shown on the Plans. Material shall be "WATERSTOP Rx" as manufactured by American Colloid Co., or equal.

H. WATER PROOF COATING: Water proof coating for the exterior of all precast and cast-in-place manholes shall be Kop-Coat Bitumastic 300-M or equal.

PART 3: EXECUTION

3.1 INSTALLATION

A. General Requirements:

1. Excavation for manholes, vaults, etc. shall be made with the minimum permitted dimensions which allow construction of the manhole in accordance with the Standard Details. Manholes are to be built to an elevation not less than that of the existing ground surface, or as shown on the Drawings.

2. New manholes shall be constructed with the pipe seals firmly embedded in the manhole walls at the proper elevation and orientation. Pipe seals shall be provided for all connections of new lines. Pipe shall be slipped into seals, and when applicable, positioned and firmly clamped. The annular space between the pipe and manhole wall shall be filled with compressible material on the exterior of the manhole. Bedding material shall be carefully placed and compacted around the pipe.

3. New manholes to be constructed over existing lines shall be of the cast-in-place or precast construction. Precast manhole sections shall have preformed blockouts positioned over the existing lines. Contractor shall expose and confirm the vertical and horizontal location of all existing lines associated with the manholes before their manufacture. The joints between the bottom of the base manhole section and the cast-in-place base shall be sealed with two continuous rows of the bitumastic joint sealer. The surfaces of the manhole section and base shall be smooth and flat to result in compression of the mastic. Surfaces shall be clean and dry.

The top of the base slab inside the manhole wall shall be left in a roughened condition to provide a bond for the bench and trough. Pipes shall penetrate until the top of the pipe is flush with the inside manhole wall. The blockout surface and outside of the pipe shall receive one strip of bentonite waterstop before the entire annular space is filled with concrete. The bench and trough shall be constructed of concrete.

4. The bench and trough in precast manholes with precast bases shall be constructed of grout to the lines and grades shown on the plans.

5. Above the base, the manhole bench and trough shall be carefully constructed of solid concrete or grout to maintain proper velocities. Changes in pipe grade, alignment or size shall be made by transition sections of the invert, determined by the lower half of the inlet and outlet pipes. All inverts shall be plastered, troweled and brushed to a smooth, clean surface. Inlet and

oulet pipes shall not project beyond the interior wall of the manhole. Upon completion of the manhole, all waste mortar and debris shall be removed from the invert.

6. Manholes connecting pipes less than 15 in. nominal diameter shall have an internal diameter of 4 ft. unless noted otherwise.

B. MANHOLE BASES:

1. Precast manholes shall have an integrally cast base conforming to ASTM C478 unless noted otherwise.
2. The base of the cast-in-place manholes and precast manholes without precast bottoms shall be constructed of 3000 psi minimum compressive strength concrete; 4" maximum slump.
3. All bases shall be constructed or set on a minimum 8 inches of crushed rock meeting the requirements of ASTM C-33 Gradation No. 1, thoroughly compacted to provide solid foundation.

C. PRECAST CONCRETE MANHOLES:

1. Minimum thickness shall be as shown on the Drawings.
2. All bases shall be constructed or set on a minimum 8 inches of crushed rock meeting the requirements of ASTM C-33 Gradation No. 1, thoroughly compacted to provide solid foundation.
3. Joints between precast reinforced concrete sections shall be sealed using bitumastic joint sealer. Two rows of mastic shall be used in each joint.
4. Adjustment rings under the manhole frame shall be used for adjustment to grade. No more than 8 inches of precast concentric rings may be used to bring the manhole to finished grade. All joints shall be sealed with two rows of bitumastic joint sealer. Bricks shall not be used for grade adjustments.

D. CAST-IN-PLACE MANHOLES:

1. Total water content of the concrete shall not exceed 5.4 gallons of water per 100 lbs of cement in the mix.
2. All bases shall be constructed or set on a minimum 8 inches of crushed rock meeting the requirements of ASTM C-33 Gradation No. 1, thoroughly compacted to provide solid foundation.
3. The base shall have a minimum diameter of 8 inches greater than the outside diameter of the manhole. The base shall have a minimum 10 inch thickness beneath the manhole wall and shall have reinforcing as shown on the drawings.

E. WATER PROOF COATING:

1. When noted on the drawings, the exterior surfaces of cast-in-place and precast manholes shall be waterproofed with two coats of Kop-Coat, Bitumastic 300-M or equal with a total dry film thickness of 16 mils or greater.
2. Coating may be shop or field applied on precast manhole sections.
3. Backfilling of the structure shall not be performed until the coating has fully cured.

3.2 LAMPHOLES: Cleanouts (lampholes) shall be located and constructed as shown on the Drawings. When the concrete cleanout frame base is completed, a standard cleanout frame is to be set in place and closed with a cleanout cover.

3.3 INTERIOR COATING: Where interior coating is required the work shall be performed in accordance with manufacturers recommendations and shall result in a uniform coating of 80 mils minimum dry film thickness on concrete, and 100 mils on brick, free of holes and other imperfections.

3.4 MANHOLE TESTING:

1. All new manholes shall be vacuum tested in accordance with ASTM C-1244 Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test Prior to Backfill . If special conditions exist which would preclude the performance of a vacuum test, an exfiltration test may be performed with approval from the Engineer.
2. Manholes failing testing shall be repaired or replaced by the Contractor at no additional cost to the Owner and retested.
3. Observed inflow or infiltration entering the manhole shall constitute a failure and shall be repaired by the Contractor.
4. Vacuum Testing: Vacuum testing shall be performed as follows:
 - A. The testing shall be done after assembly of the manhole and all connections, prior to backfilling. Any visible leakage in the manhole or structure before during or after the test shall be repaired.
 - B. Contractor shall plug the pipe openings, and securely brace the plugs and pipe.
 - C. With the vacuum tester in place, the contractor shall inflate the compression band to 40 psi to effect a seal between the vacuum base and the structure; connect the vacuum pump to the outlet port with the valve open; and draw a vacuum to 10" Hg (-5psi) and close the valve.
 - D. The time shall be measured for the vacuum to drop to 9 inches Hg (-4.5 psi). Manholes will be considered to have failed if the time to drop 1 inch Hg is less than what is shown in the following table:

	MANHOLE DIAMETER (INCHES)				
Depth (feet)	48 inches	60 inches	72 inches	96 inches	144 inches
4	10	13	16	19	21
8	20	26	32	38	44
12	30	39	48	57	65
16	40	52	64	76	86
20	50	65	80	95	110
24	60	78	96	114	132
Each 2' addl.	+ 5 Sec.	+ 6.5 Sec	+8 Sec	+ 9.5 Sec	+ 11 Sec

3.5 EXFILTRATION TESTING:

1. All incoming and outgoing sewer and service lines shall be plugged by means of mechanical pneumatic plugs.
2. The manhole shall be filled with water in its entirety. Presoaking periods shall not be allowed.

3. Manholes shall be completely filled with water and a 20-minute period commenced immediately. The maximum allowable water drop from the rim to the free water surface within a 20-minute period shall be as follows:

MANHOLE DIAMETER	WATER DROP PER FOOT OF MANHOLE DEPTH
3	0.625
3.5	0.500
4	0.375
5	0.250

END OF SECTION

SECTION 33 05 26 - UTILITY LINE MARKING

PART 1: GENERAL

1.1 SUMMARY

- A. Section Includes: Furnishing and installing utility marking and warning tape capable of being detected electronically and marker posts. Also install 12 Ga. High strength Copper clad tracer wire over all non-metallic pipe or conduit. Install test stations as required.

1.2 SUBMITTALS

- A. General: Submittals shall be according with the following.
- B. Certificates of Conformance: Submit 6 copies of written certification from the supplier of the Contractor-furnished wood marker posts that the preservative treatment conforms to the requirements of this section. Submit copies of written certification from the supplier of the Contractor-furnished marker tape that the materials used in the tape fabrication meet the requirements of this section.

1.3 DELIVERY, STORAGE, AND HANDLING

PART 2: PRODUCTS

2.1 MATERIALS

- A. General: Tapes shall be manufactured specifically for warning and identification of buried utility lines. Metalized tape shall be used to locate non-metallic lines. Tapes shall be inert plastic specially formulated for prolonged use underground and shall be resistant to alkalis, acids and other destructive agents found in the soil. Tape shall be provided in rolls, 3-inch minimum width, color coded for intended service with warning and identification imprinted in bold black letters continuously and repeatedly over entire tape length. Warning and identification shall be "CAUTION BURIED [GAS PIPELINE] [COMMUNICATION CABLE - TELEPHONE] [ELECTRIC CABLE] [SEWER PIPELINE] [WATER PIPELINE] BELOW" or similar wording. Color code and letter coding shall be permanent, unaffected by moisture and other substances contained in trench backfill material.
- B. Color Codes: Shall be as follows:
 - 1. Electric Cable: Red
 - 2. Water Pipeline: Blue
 - 3. Gas Pipeline: Yellow
 - 4. Sewer Pipeline: Green
 - 5. Communication Cable: Orange
- C. Buried Warning and Identification Tape for Use in Trenches Containing Electrical Cable: Shall be 4-mil polyethylene plastic tape conforming to ASTM D 882.
- D. Buried Warning, Identification and Locator Tape for Use in Trenches Containing Non-Metallic Water and Sewer Lines: ASTM D 2103. It shall be 5.5-mil composition film containing one layer of metalized foil laminated between two layers of inert plastic film. Tape shall be detectable by cable locating equipment used to locate underground utility lines.
- E. Timber Posts: When called for, shall be Douglas fir or western red cedar, S4S stock, construction grade, seasoned. Nominal size 4 x 4 x 72 inches. Posts shall have a color-coded warning and identification marker attached. Warning and identification shall be "CAUTION BURIED WATER PIPELINE BELOW" or similar wording.

- F. Drivable, Flexible, Composite Utility Marker: Shall be durable, reinforced composite posts manufactured specifically for warning and identification of buried utility lines. Posts shall be 3-1/2 inches minimum diameter and a minimum of 72 inches in length, color coded for intended service with a 3-inch wide warning and identification decal attached. Post shall include two stainless steel terminal connections and 1-inch diameter screened vent to prevent moisture buildup inside post. Marker shall be Carson Visi-Post Utility Test Station or equal. Warning and identification shall be "CAUTION BURIED (WATER, SEWER, etc.) PIPELINE BELOW" or similar wording. Code and letter coloring shall be permanent. Marker shall be Carson Visi-Post Utility Test Station or equal.
- G. Tracer Wire: Tracer wire shall be a #12 AWG fully annealed high strength copper clad steel conductor (HS-CCS), insulated with a 30 mil, high density, high molecular weight HDPE insulation.
- F. Flush to Ground Mounted Test Station: Shall be a durable reinforced composite device manufactured for use as a device in to aid in the location of underground utilities. Device shall be resistant to chemicals and corrosion. Device shall contain a steel insert molded into the bell for reinforcement and to insure that device is locatable via metallic location device. Device shall have a terminal board for connection of tracer or test wire. Test Station shall be at least 18 inches in length and at least 5 inches in diameter. Test station cap color shall correspond to the respective utilities standard APWA color designation("Water = Blue, Sewer= Green, Electric= red" etc.). Test Station shall be Part Number SP-LID- *2 by Copperhead wire or approved equal. These devices are intended to be used in "developed" and regularly maintained areas where utility marker posts would not be aesthetically pleasing.

PART 3: EXECUTION

3.1 INSTALLATION

- A. Buried Warning and Identification Tape: Install tape continuously in backfill directly over buried utility line, 6 to 10 inches below finished grade. Install tracer wire approx. 12 inches over top of pipe or conduit.
- B. Timber Posts
 - 1. Location: Install timber posts in unpaved and unsodded areas at changes in horizontal direction or intervals not to exceed 1000 feet of sight distance.
 - 2. Installation: Install in a true, vertical plane directly over or immediately adjacent to the utilities to which they relate. Posts shall be buried to provide an anchoring depth of 30 inches.
- C. Drivable, Flexible, Composite Utility Marker & Test Station
 - 1. Location: Install flexible, composite utility marker in unpaved and unsodded areas at changes in horizontal direction or intervals not to exceed 1000 feet of sight distance.
 - 2. Installation: Install in a true, vertical plane directly over or immediately adjacent to the utilities to which they relate. Posts shall be driven to provide an anchoring depth of 18 to 24 inches.
- D. Flush to Ground Mounted Test Station
 - 1. Location: Install test stations in unpaved areas along the utility where practical, install at fire hydrants, at mainline valves, or at least every 1,000 ft.
 - 2. Install in a true, vertical plane directly over or immediately adjacent to the utilities to which they relate.

END OF SECTION

SECTION 33 05 27 - CONNECTION TO EXISTING UTILITIES

1.0 GENERAL

1.1 SCOPE

The work under this item shall include all excavation, furnishing all materials required, construction, finishing and backfilling of connections to existing mains, valves, manholes, additional drop connections to new drop manholes, special connections, services line reconnections, or plugs as indicated on the construction Plans or as directed by the Owner's representative.

2.0 PRODUCTS

2.1 MATERIALS

Materials used in the performance of the work specified herein shall be as specified in other sections of these Specifications.

3.0 EXECUTION

3.1 PLANS

The construction Plans show details of the various connections and they shall be made in accordance with the details unless directed otherwise by the Engineer.

3.2 MANHOLES AND OTHER SIMILAR STRUCTURES

3.2.1 Connections to existing manholes and other similar structures shall be made by cutting into the structure at the specified grade, inserting the pipe, and encasing the joint with concrete. Bentonite impregnated mastic or an approved equal shall be applied to the pipe and manhole wall as shown on the Plans. Contractor shall not break into any existing sewer unless the Owner's Representative is present. Inlet and outlet pipes at the invert shall not project beyond the interior walls of the structure. The structure base and invert shall be cut and reconstructed in such a manner that a proper invert section is maintained. All waste mortar, debris and sharp edges shall be removed from the joints, bottom and invert. Contractor shall remove and replace the structure's steps in the proper location and in accordance with Standard Details if they are not properly located after the connection is made. Any and all diversion or temporary bypass pumping of water or sewage in a wet connection is included in this item.

3.2.2 Plugs shall be constructed of manhole brick and mortar or low-strength concrete, extending at least 1-foot into the line plugged from the structure. The plug shall be watertight and troweled to a smooth finish on the interior of the structure.

END OF SECTION

SECTION 33 05 33 - PLASTIC PIPE

PART 1: GENERAL

1.1 SUMMARY

- A. SECTION INCLUDES: Furnishing and installing Polyvinyl Chloride (PVC) pipe in the trench as specified to the line and grades given. The method of bedding shall be as shown on detailed drawings.
- B. RELATED SECTIONS. Testing, disinfection and other general requirements.
- C. QUALITY CONTROL: Engineer shall have the right to reject pipe based upon visual defects including out of roundness, rough interior, discoloration, warping or other defects which could affect the life and function of the pipe.

1.2 SUBMITTALS

- A. General: Submittals shall be according with the following.
- B. Manufacturer's Literature and material certification: Submit six copies of the manufacturer's descriptive data for pipe size, class and designation required for the project.

PART 2: PRODUCTS

2.1 PVC PRESSURE PIPE AND FITTINGS:

A. AWWA C900 TYPE:

- 1. Where called for in the bid schedule or where required for on plans, PVC shall meet the requirements of AWWA Designation C900. Pipe shall be cast iron outside diameter. Dimension Ratio of the pipe shall be as follows:

Pressure Class	Dimension Ratio
100	25
150	18
200	14

- 2. Pipe and fitting joints of size 2 inches in diameter and larger shall be slip joint, O-ring type joints.
- 3. Fittings for slip joint pipe 2 inches and larger shall be Cast Iron conforming to AWWA C110. Cast Iron fittings shall be designed for a working pressure equal to or greater than that of the pipe it is being used with.

B. ASTM D2241:

- 1. Where called for in the bid schedule or where required for on plans, PVC pipe shall meet the requirements of ASTM D2241. Standard Dimension Ratio of the pipe shall be as follows.

Pressure Class	Std. Dimension Ratio
160	26
200	21

2. Pipe and fitting joints of size 2 inches in diameter and larger shall be slip joint, O-ring type joints. Pipe and fitting joints smaller than 2 inches in diameter may be O-ring type or solvent cement.
3. Fittings for slip joint pipe 2 inches and larger shall be Cast Iron conforming to AWWA C110. Cast Iron fittings shall be designed for a working pressure equal to or greater than that of the pipe it is being used with. Fittings smaller than 2 inch in diameter shall be of the same material as the pipe and shall be designed for a working pressure of at least 50 psi greater than that of the pipe.

2.1 PVC GRAVITY PIPE AND FITTINGS:

A. ASTM D3034:

1. Where called for in the bid schedule or where required for on plans, PVC pipe shall meet the requirements of ASTM D3034. Standard Dimension Ratio of the pipe shall not exceed 35.
2. Pipe and fitting joints of size 2 inches in diameter and larger shall be compressed elastomeric gasket joints. The bell shall consist of an integral wall section with gasket to insure positive seal slip joint, O-ring type joints. Pipe and fitting joints smaller than 2 inches in diameter may be O-ring type or solvent cement.

B. Schedule 40 PVC:

1. Where called for in the bid schedule or where required in the plans, Schedule 40 PVC gravity drain pipe shall meet the requirements of ASTM D1785.
2. Pipe and fitting joints of size larger than 6 inches in diameter and larger shall be compressed elastomeric gasket joints. The bell shall consist of an integral wall section with gasket to insure positive seal slip joint, O-ring type joints. Pipe and fitting joints 6 inches in diameter and smaller may be O-ring type or solvent cement weld type.
3. Fittings for schedule 40 drain pipe shall be PVC Plastic Fittings, Schedule 40 meeting the requirements of ASTM S 2466.

PART 3: EXECUTION

3.1 PRESSURE PIPE

- A. Fittings. All fittings shall be blocked in accordance with the standard details. All newly laid pipe shall be subjected to a hydrostatic pressure test.
- B. Connections. Joints between PVC pressure pipe and vitrified clay, PVC sewer, or other gravity pipe shall be made with special adapters as approved.
- C. Tapping of PVC Pipe. Water service connections shall be made using bronze service clamps. Coupling shall be provided with factory installed brass bushings conforming to ASTM B62 and AWWA C800.

3.2 SEWER PIPE

- A. PVC sewer pipe shall be installed in accordance with the standard details and with ASTM D2321, Recommended Practice for Underground Installation of Flexible Thermoplastic Sewer Pipe, latest edition. Bedding material shall be of the type specified in Section 02221 and shall be compacted accordingly by hand and/or mechanical methods to the depth as shown on standard details.

- B. Thirty days after backfill operations, PVC sewer pipe shall be measured for vertical deflection using a deflection testing mandrel. Maximum ring deflection of the installed pipe shall be limited to 5% of the average inside diameter as defined by ASTM D2680. All pipe exceeding the allowable deflection shall be replaced by the Contractor at no additional cost to the Owner.

END OF SECTION

SECTION 33 10 10 – DUCTILE IRON PIPE

PART 1.0 GENERAL

1.1 DESCRIPTION

The work under this section shall include furnishing, hauling, placing and jointing of ductile iron pipe in the trench or position in specific conformity with the lines and levels illustrated in the construction documents.

1.2 QUALITY CONTROL

The Engineer shall have the right to reject pipe based upon visual defects including out-of-roundness, rough interior, discoloration, warping or other visual defects that, in the opinion of the Engineer, affect the function or the life of the pipe.

1.3 REFERENCED STANDARDS

AWWA C104	American National Standard for Cement-Mortar Lining for Ductile Iron Pipe and Fittings for Water;
AWWA C105	American National Standard for Polyethylene Encasement for Ductile Iron Pipe and Fittings for Water and Other Liquids;
AWWA C110	American National Standard for Ductile Iron and Gray-Iron Fittings, 3-inch through 48-inch, for Water and Other Liquids;
AWWA C111	American National Standard for Rubber-Gasket Joints for Ductile Iron Pressure Pipe and Fittings;
AWWA C115	American National Standard for Flanged Ductile Iron Pipe with Threaded Flanges;
AWWA C151	American National Standard for Ductile Iron Pipe, Centrifugally Cast, for Water and Other Liquids;
AWWA C151	AWWA Standard for installation of Ductile Iron Water Mains and their Appurtenances.

PART 2.0 PRODUCTS

2.1 MATERIALS

2.1.1 Pipe and Fittings:

- A. Where Ductile Iron Pipe 4-inches in diameter or greater is specified or required, it shall conform to and be tested in accordance with current AWWA C151, 350 psi pressure rating.
- B. Where Ductile Iron Fittings are specified or required, they shall conform to and be tested in accordance with AWWA C110. Pressure rating shall be 250 psi. All sleeves shall be the longest of the lengths allowed. Ductile Iron compact fitting shall be in conformance with the current ANSI/AWWA C153, with the exception of solid sleeves.

2.1.2 Joints:

- A. Ductile Iron pipe and fittings shall be jointed with any of the end types as specified below, unless a particular end type is specified. Flange ends shall be used only where specifically noted on the Plans except that the valve connection end of all tapping sleeves shall be flanged. Fittings shall have mechanical joints, unless otherwise noted.
- B. Push-On joints shall conform to and be tested in accordance with AWWA C111.
- C. Mechanical joints shall conform to and be tested in accordance with AWWA C111.
- D. Flanged joints shall conform to and be tested in accordance with AWWA C115 and AWWA C110.
- E. Where restrained joints are required on restrained jointed pipe and fittings, it shall be manufactured in accordance with AWWA C151 and AWWA C110. Joints, gaskets and accessories shall meet all applicable requirements of AWWA C111. Restrained joints shall be provided at the pressure classes indicated on the Plans. Restrained joints may be either the mechanical or the push-on type. Joint shall provide a positive restraint against endwise separation due to the thrust resulting from internal pressure, or external forces. All restrained joint pipe and fittings, as well as other Ductile Iron pipe and fittings, shall be manufactured and supplied by the same manufacturer.
- F. Sleeve couplings shall be Dresser Style 38 or equal, 7"x3/8" designed for the specified pipe pressure class, and shall have middle rings equal in thickness to that of the adjoining pipe. Couplings shall have plain gaskets, Grade 27. All fittings, bolts and related components shall be epoxy coated. Unless noted otherwise, joint hardness shall be provided at sleeve couplings.

2.1.3 Coating, Lining and Polyethylene Wrap:

- A. Interior coatings for ductile iron pipe and fittings shall be standard cement lining for use in water service piping per AWWA C104.
- B. Exterior ductile iron pipe and fittings shall be furnished with asphaltic coating in accordance with AWWA C151. Also, polyethylene tube shall be furnished and installed on all ductile iron pipe, fittings, valves and other appurtenances. Polyethylene tube shall be in accordance with AWWA C105. The material shall be Polytube as manufactured by Polytube Corporation, Birmingham, Alabama, or equal. Tape of polyethylene tube shall be plastic-backed adhesive tape, Polykan #900 or Scotchrap #50 or equal, 2-inches in width. The tube shall be of such length that a 1-foot overlap is provided at each joint in the pipe.
- C. Tube width for each pipe diameter shall be as listed in AWWA C105.

PART 3.0 EXECUTION

3.1 INSTALLATION

Ductile Iron pipe shall be wrapped with polyethylene film as described in AWWA C105. For all pipe, AWWA C600 shall govern the installation. The method of bedding shall be as shown on the Standard Details.

3.1.1 PRESSURE PIPE:

- A. All fittings or specials included as pipe shall be blocked in accordance with the Standard Details.

- B. If a joint is to be deflected, it shall be made up in a straight line before deflecting and shall be in accordance with the manufacturer's recommendation.

3.1.2 GRAVITY PIPE:

- A. Joints between Ductile Iron pipe and other types of pipe shall be made with adaptors as approved by the Engineer. If adaptors are not available, then the joint shall be made as instructed by the Engineer and encased in concrete with 1-foot extending from each side of the joint.
- B. The pipe shall be laid on a firm trench bottom, true to the lines and grades shown in the Plans and/or as given by the Engineer. The laying of the pipe in finished trenches shall be commenced at the lowest point, with the plain end pointing in the direction of flow. The ends of adjoining pipes shall butt against each other for their entire circumference so there is no shoulder or unevenness of any kind.
- C. Pipe grade shall be obtained using laser beam, other electronic equipment or batter boards and a "top line". The equipment and proposed method of use shall be approved by the Engineer.
- D. Clean joint contact surfaces immediately prior to jointing. Use lubricants and other materials recommended by the pipe manufacturer.
- E. Backfill trenches immediately after pipe is laid in accordance with Specifications and standard details provided.

SECTION 33 11 13.06 - HDPE POTABLE WATER PIPE

PART 1: GENERAL

- 1.01 SCOPE: The work in this section consists of providing High Density Polyethylene (HDPE) pipe and fittings.
- 1.02 RELATED WORK SPECIFIED ELSEWHERE: Utility Trenching and Backfilling – Section 31 23 33. Valves – Section 33 12 16. Disinfection – Section 33 13 00 Testing – Section 01 45 34
- 1.03 QUALITY ASSURANCE: References, American National Standards Institute (ANSI), American Society for Testing and Materials (ASTM), Federal Specifications (FS), International Standards Organization (ISO), and manufacturer's printed recommendations.
- 1.04 SUBMITTALS: Material list naming each product to be used identified by manufacturer and type number.
- 1.05 PRODUCT HANDLING: Handle pipe and fittings to insure delivery in a sound undamaged condition.
- 1.06 JOB CONDITIONS: Do not lay pipe when trenches or weather conditions are not suitable for such work.

PART 2: MATERIALS

2.01 PIPE:

- A. 3 Inches and Smaller – Pipe shall be manufactured from a PE 3408 resin listed with the Plastic Pipe Institute (PPI) as TR-4. The resin material will meet the specifications of ASTM D3350-02 with a cell classification of PE:345464C. Pipe shall have a manufacturing standard of ASTM D2737 (CTS). Pipe shall be DR 9 (200psi WPR) unless otherwise specified on the plans. The pipe shall contain no recycled compounds except that generated in the manufacturer's own plant from resin of the same specification from the same raw material. All pipes shall be suitable for use as pressure conduits, and per AWWA C901, have nominal burst values of three times the Working Pressure Rating (WPR) of the pipe. Pipe shall also have the listing of NSF 61.
- B. 4 Inches and Larger - Pipe shall be manufactured from a PE 3408 resin listed with the Plastic Pipe Institute (PPI) as TR-4. The resin material will meet the specifications of ASTM D3350 with a cell classification of PE:345464C. Pipe O.D. sizes 4" to 24" shall be available in both steel pipe sizes (IPS) and ductile iron pipe sizes (DIPS). Pipe O.D. sizes 26" to 54" shall be available in steel pipe sizes (IPS). Pipe shall be DR 9 (200psi WPR) for pipe sizes up to 36" unless otherwise specified on the plans. The pipe shall contain no recycled compounds except that generated in the manufacturer's own plant from resin of the same specification from the same raw material. All pipes shall be suitable for use as pressure conduits, listed as NSF 61, and per AWWA C906 have a nominal burst value of three and one-half times the Working Pressure Rating (WPR) of the pipe.

2.02 FITTINGS:

- A. Butt Fusion Fittings - Fittings shall be PE3408 HDPE, Cell Classification of 345464C as determined by ASTM D3350-02, and approved for AWWA use. Butt Fusion Fittings shall have a manufacturing standard of ASTM D3261. Molded & fabricated fittings shall have a pressure rating equal to the pipe unless otherwise specified in the plans. Fabricated fittings are to be manufactured using Data Loggers. Temperature, fusion pressure and a

graphic representation of the fusion cycle shall be part of the quality control records. All fittings shall be suitable for use as pressure conduits, and per AWWA C906, have nominal burst values of three and one-half times the Working Pressure Rating (WPR) of the fitting.

- B. Electrofusion Fittings - Fittings shall be PE3408 HDPE, Cell Classification of 345464C as determined by ASTM D3350-02. Electrofusion Fittings shall have a manufacturing standard of ASTM F1055. Fittings shall have a pressure rating equal to the pipe unless otherwise specified on the plans. All electrofusion fittings shall be suitable for use as pressure conduits, and per AWWA C906, have nominal burst values of three and one-half times the Working Pressure Rating (WPR) of the fitting.
- C. Flanged and Mechanical Joint Adapters - Flanged and Mechanical Joint Adapters shall be PE 3408 HDPE, Cell Classification of 345464C as determined by ASTM D3350-02. Flanged and Mechanical Joint Adapters shall have a manufacturing standard of ASTM D3261. Fittings shall have a pressure rating equal to the pipe unless otherwise specified on the plans. All adapters, fittings, etc. shall be restrained type to insure that hdpe pipe does not pull out. Additionally, the use of weld on collars, flanges, embedded in concrete to resist thrust shall be installed when required.

PART 3: EXECUTION

3.01 GENERAL:

- A. Pipe and Fittings: Size as indicated on the plans. Install as shown in accordance with manufacturer's recommendations.

3.02 HAULING, UNLOADING and DISTRIBUTING PIPE: During loading, transportation and unloading, every precaution shall be taken to prevent injury to the pipe. No pipe shall be dropped from cars or trucks, or allowed to roll down slides without proper retaining ropes. During transportation each pipe shall rest on suitable pads, strips, skids or blocks securely wedged or tied in place. Any pipe damaged shall be replaced.

3.03 EXCAVATION AND TRENCHING: Section 02321. Prepare trench, backfill and compact in accordance with appropriate specifications. Do not exceed manufacturer's recommended cold bend radius.

3.04 FUSION:

- A. Sections of polyethylene pipe should be joined into continuous lengths on the jobsite above ground. The joining method shall be the butt fusion method and shall be performed in strict accordance with the pipe manufacturer's recommendations. The butt fusion equipment used in the joining procedures should be capable of meeting all conditions recommended by the pipe manufacturer, including, but not limited to, temperature requirements of 400 degrees Fahrenheit, alignment, and an interfacial fusion pressure of 75 PSI. The butt fusion joining will produce a joint weld strength equal to or greater than the tensile strength of the pipe itself.
- B. Sidewall fusions for connections to outlet piping shall be performed in accordance with HDPE pipe and fitting manufacturer's specifications. The heating irons used for sidewall fusion shall have an inside diameter equal to the outside diameter of the HDPE pipe being fused. The size of the heating iron shall be ¼ inch larger than the size of the outlet branch being fused.
- C. Mechanical joining will be used where the butt fusion method can not be used. Mechanical joining will be accomplished by either using a HDPE flange adapter with a

Ductile Iron back-up ring or HDPE Mechanical Joint adapter with a Ductile Iron back-up ring.

D. Socket fusion, hot gas fusion, threading, solvents, and epoxies will not be used to join HDPE pipe.

3.05 INSPECTION: Inspect the pipe for defects before installation and fusion. Defective, damaged or unsound pipe will be rejected.

3.06 TESTING: Pressure testing shall be conducted in accordance with Section 02518, Testing of Piping Systems. For safety reasons, hydrostatic testing only will be used.

3.07 DISINFECTION: In accordance with Section 331300.

SECTION 33 12 16 - VALVES

PART 1: GENERAL

1.1 SUMMARY

- A. Section Includes: Furnishing and installing curb stops, drains, valves, and fittings with valve boxes.
- B. Related Sections

1.2 SUBMITTALS

- A. General: Submittals shall be according with the following.
- B. Manufacturer's Literature: Submit six copies of the manufacturer's descriptive data for the curb stops, valves, and service boxes to be used on this project.
- C. Installation Instructions: Submit six copies of the manufacturer's installation instructions for the curb stops, valves, and service boxes to be used on this project.
- D. Shop Drawings: Submit six copies of shop drawings of the major assemblies and components to be used on this project. A bill of materials shall be furnished with the shop drawings.

PART 2: PRODUCTS

2.1 VALVES

- A. Curb Stops: When specified on the drawings, shall be of standard design, inverted key type curb stops, 125 pound, sizes as indicated on the drawings. Curb stops shall be as manufactured by Ford Meter Box Co. or approved equal.
- B. Ball Valves: Ball valves, when specified or required shall be thermoplastic, manufactured of PVC, with EPDM seats and seals. Valves shall have a minimum pressure rating 150 psi and be the same nominal size as the connecting pipeline, unless otherwise noted on the drawings. Ball valves shall be 1/4-turn from fully open to fully closed, equipped with totally enclosed manual operators, open-closed indicator, and with operating nut suitable for operation with a wrench through the valve box as specified herein. Required force for valve operation shall be no more than 15-foot pounds when line pressure is 50 psig. Ball valves shall be ported such that headloss through the valve is less than that through 10 lineal feet of new PVC piping of the same nominal size. Ball valves shall be Allis-Chalmers, Henry Pratt, or Williamette Iron & Steel or equal.
- C. Gate Valves:
 - 1. Gate valves, 3-inch and smaller shall feature iron body, rated for 250 lb SWP, non-rising stem, "O" ring stem seal using resilient synthetic rubber, inside screw and solid wedge, 2-inch square operating nut.
 - 2. Gate valves, where double disc-parallel seat type gate valves are specified or required, shall conform to and be tested in accordance with the AWWA Standard for Gate Valves 3-inch through 48-inch for water and other liquids, AWWA C-500. Valves shall have double disc parallel seats, non-rising stems, vertical mounting "O" ring stem seal, counter-clockwise opening, and ends to fit the pipe or fitting to which attached, either push-on, mechanical, or flanged connection. Double disc-parallel seat gate valves shall be Crane, Darling, Ludlow-Rensselaer, M & H, Mueller, Smith or equal.

Gate valves, where resilient seat gate valves are specified or required, they shall conform to and be tested in accordance with the AWWA standard for Resilient Seated Gate Valves, 3-inch through 12-inch, Water and Sewer Systems, AWWA C-509. The valve

shall be bubble tight from either direction at a rated design working pressure of 200 psi. The valve shall have a single disc gate with synthetic rubber or rubber-seat bonded or mechanically attached to the disc; non-rising stem; counter clockwise opening, "O" ring stem seals; corrosion resistant interior thermoset epoxy coating acceptable for potable water; and ends to fit the pipe or fitting to which attached. Valve body shall be epoxy coated. Resilient seat gate valves shall be American, Mueller, Waterous, Clow, Kennedy, or equal.

- D. Ball-Type Check Valves: Where ball type check valves are specified for sewer service, the valve shall consist of three components: body, cover and ball – one moving part. The design shall be such that it keeps solids, stringy material, grit, rags, etc., moving through the valve without the need for back flushing. The ball shall clear the water way providing "full flow" equal to the nominal size of the pipe. It shall be non-clog. The ball shall be hollow steel with an exterior of nitrile rubber, it shall be resistant to grease, petroleum products, fats, diluted concentrations of acids and alkalines, tearing and abrasion. The body and cover shall be of gray cast iron, Class 35. Flange drilling shall be in accordance with ANSO B16.1, Class 125.
- E. Swing-Type Check Valves (2-1/2 inch and smaller): Bronze, body, renewable disc, screwed cap, rated 200 PSI as manufactured by Walworth, Houston, TX; Powell, Cincinnati, OH; or approved equal.
- F. Swing Check Valves (2-1/2inch and larger): Where swing type check valves are specified or required for water or wastewater service, they shall conform to and be tested in accordance with the AWWA standard for Swing Check Valves for Ordinary Water Works Service, AWWA C-508. They shall be horizontally mounted, single disc, swing type with a full diameter passage providing minimum pressure loss. Valves shall be of the non-slamming type designed for the future installation of outside lever and weight. Disc faces and seat rings shall be bronze. Ends shall fit the pipe or fitting to which attached. Cast iron body and cover, rated for 250 psi working pressure; external lever and weight, manufactured by Crane, Darling, M & H, Mueller, Smith; Apco, or equal.
- G. Plug Valves: When specified or required, plug valves shall be of the non-lubricated, eccentric type, cast iron body with end type as shown on the drawings. Port area shall be at least 80 percent of the cross sectional area of the same nominal pipe size. Body shall be of Gray Cast Iron, ASTM A126, Class B with resilient plug facings of neoprene for applications up to 189°F. Packings shall be BUNA (VEE) and be adjustable or replaceable without disassembly of valve. Bearing shall be stainless steel or bronze as required. Plug valves shall be as manufactured by DeZurik, Clow or equal. All plug valves of same type, style and duty shall be of one manufacturer.
- J. Air Relief Valve:
1. Where air relief valves are specified or required for water service, the valve shall be heavy duty combination air release and vacuum type for 300 psi water working pressure, tested to 300 psi, of the specified size. Body, cover and baffle shall be cast iron. All internal parts to be either highest quality stainless steel or bronze and the inside of the valve coated with rust inhibitor. Valve shall include special float enclosed in the valve body, with attached lever for opening and closing the air intake or discharge port. A bolted flange top shall provide access to the ball float and interior vent seat. The assembly shall not leak nor shall the valve stick under service conditions. All working parts of the valve shall be made of a non-corrosive material. Air relief valves for water service shall be as manufactured by APCO, Darling, Crispin, Val-Matic, or equal.
 2. Where air relief valves are specified or required for wastewater service, the valve shall be heavy duty sewage combination air release and vacuum release type. Valve shall be designed for a working pressure of 150 psi, the body and cover shall be constructed of cast iron with stainless steel trim and float with Buna-N seat for positive seating.

- K. Pressure Reducing Valves:

1. Pressure Reducing Valves (2-inches and larger). Where specified or required pressure reducing valves 2-inches and larger shall be a pilot controlled, hydraulically operated, diaphragm-actuated globe or angle valve capable of maintaining a constant downstream pressure, regardless of inlet pressure to the valve. The pilot control shall be a direct-acting, adjustable spring-loaded, normally open diaphragm valve. The main valve body shall be constructed of cast iron. All internal metal parts shall be constructed of either high quality stainless steel or bronze. Unless otherwise specified, all pressure reducing valves 2-inch and larger shall be furnished with 250# ANSI flanged ends.

2. Pressure reducing valves (less than 2-inches). Where specified or required pressure reducing valves shall be spring controlled, piston and cylinder type valves capable of maintaining a constant downstream pressure regardless of the inlet pressure. The main body of the valve shall be constructed of either cast iron or bronze. All internal parts shall be of either high grade stainless steel or bronze. Unless otherwise specified, all valves shall be supplied with screw ends (NPT).

2.2 ACCESSORIES

A. Tools: Furnish curb stop box valve keys, shut-off rods, or other tools to operate curb stops, valves and open the top of valve boxes. A minimum of one of each such tool shall be furnished for each style and size installed.

B. Valve Boxes: Valve boxes, where called for, shall include furnishing and installing of valve boxes at the locations shown on the Drawings. The AWWA Standard for the Installation of Gray and Ductile Cast Iron Water Mains, AWWA C600 shall govern the installation as applicable. Exposed parts of valve boxes shall be given one coat of rust inhibitive primer and one finish coat of yellow rubber base paint. Castings for valve boxes shall conform to and be tested in accordance with the specifications for Gray Cast Iron, ASTM A48, Class 30. Standard valve box shall consist of a 5-1/4 inch shaft and drop lid, screw type valve box. Extensions

PART 3: EXECUTION

3.1 INSTALLATION

- A. Valves General: Shall be installed so that each will function freely and no parts are strained.
- B. Pipe Connections: Connect as shown using a cast iron adapter. Extend metallic piping sufficiently beyond the outside face of the box to permit ready connection. Extend a minimum of 5 feet from center of valve box.
- C. Curb Stops: Install on the lines indicated on the drawings; set plumb on a firm base. Foreign matter shall be removed from the interior prior to installation.
- D. Thrust Blocks: Provide concrete thrust blocks at changes in direction of the piping, under gate valves], and other accessories with the bearing surface against undisturbed soil normal to the direction of the thrust.
- E. Valves and Valve Boxes: Valves and valve boxes shall be set plumb, with valve boxes centered directly over the valves and base section firmly screwed to stop or resting on cast iron foot piece, cement block, or compacted backfill. Set top section to allow equal movement above and below finished grade. Final elevation to be as approved by the Contracting Officer. Valve boxes shall be located outside the area of the roads and streets whenever possible. Earth fill shall be tamped around the valve box to a distance of 4 feet on all sides of the box, or to the undisturbed trench face if less than 4 feet. Clean foreign matter from interior of valves before installation. Stuffing boxes shall be tightened and the valve shall be inspected in open and closed positions to ensure that the parts are in proper working order.

3.2 FIELD QUALITY CONTROL

A. Testing: Section 01 45 34 - Testing of Piping Systems.

3.3 CLEANING

A. Disinfection: Section 33 13 00 - Disinfection of Water Distribution.

END OF SECTION

SECTION 33 12 19 - HYDRANTS

1.0 GENERAL

1.1 SCOPE

Work under this heading shall include the furnishing of all labor, materials and equipment necessary to complete the assembly and installation of operable fire hydrants, flush hydrants, yard (bury) hydrants as shown on the Drawings and described herein.

1.2 DELIVERY, STORAGE AND HANDLING

- A. Materials shall be delivered to the site in the manufacturer's original packaging with all labels and place markings intact.
- B. Materials shall be stored and secured off the ground in such a manner that they will not be damaged from contact with other materials or equipment.

2.0 PRODUCTS

2.1 MANUFACTURERS/SUPPLIERS

The equipment and supplies specified in this Section shall be manufactured and/or supplied by American-Darling, East Jordan Iron Works, AVK, or equal.

2.2 FIRE HYDRANTS

- A. Fire hydrants shall be of the dry-top, traffic model design type; conforming to the AWWA Standard for Dry-Barrel Fire Hydrants (AWWA C502). Fire hydrants shall have breakable connection features and shall have the following selective and design specifications. Fire hydrants shall be American-Darling B-84-B, East Jordan Iron Works Model 5CD250, AVK Nostalgic Style Dry Barrel, Clow Medallion or equal (3-way hydrants),

Working Pressure:	150 psi
Bury Depth:	3'0" minimum or as required by Drawings
Inlet Connection:	6" (standard bell or mechanical joint)
Valve Opening Size:	5-1/4"
Turn to Open Direction:	Left (counter-clockwise)
Operating Nut:	1-1/2" pentagon
Nozzle Cap Nuts:	1-1/2" pentagon

Hose Connections:	
3-way	2 - 2-1/2" and 1 - 4-1/2"
2-way	2 - 2-1/2"
1-way	1 - 2-1/2"

Nozzle Attachment to Barrel:	Threaded
Operating Nut Material:	All Bronze
Upper Valve Plate Material:	Bronze
Seat Ring Material:	Bronze
Seat Ring Thread Engagement:	Bronze to Bronze
Bonnet Weather Cap:	Required
Bonnet Lubrication Point:	Externally Accessible
Drain Valve:	Required
Color above Ground:	Red or as directed by Owner

Pumper Nozzle Threading: Contractor to verify with Owner
Hose Nozzle Threading: Contractor to verify with Owner

- B. Where fire hydrant extensions are specified or required, they shall be of the proper design to accommodate the brand of fire hydrant installed. Extensions will be paid for separately only if included in the Bid Schedule.
- C. Nozzle threads shall be determined by the Contractor through coordination with the local fire department prior to ordering. This coordination/determination shall be the sole responsibility of the Contractor. Any misordered fire hydrants shall be replaced by the Contractor at no expense to the Owner.

2.3 YARD (BURY) HYDRANTS

- A. Yard hydrants when specifically called for in the plans shall be of the sanitary type, backflow protected, automatic draining, freezeless type. Yard hydrants shall be as manufactured by Woodford, model S3, or equal.

Max/Min Pressure: 20/100 psi
Bury Depth: 3'0" minimum or as required by Drawings
Inlet Connection: 1" NPT

3.0 EXECUTION

3.1 INSTALLATION

- A. All materials shall be assembled and installed in strict compliance with the manufacturer's instructions.
- B. Do not assemble or install any bent, scratched, or otherwise defaced material. Any question as to acceptability shall be addressed to the Engineer prior to assembly or installation.
- C. All materials are to be installed in a neat and workmanlike manner with all materials installed plumb and square.
- D. Fire hydrants shall be set so that the bottom of the pumper nozzle is not less than 12", nor more than 21", above the finish grade of the ground. Breakable bolts damaged in the installation shall be replaced in kind. If the Mueller hydrant is used, the oil reservoirs shall be filled before the hydrant is set. Concrete blocking shall be placed so that the drain and joints are accessible. Fire hydrant risers and stem extensions of the proper length shall be provided and installed as necessary and in accordance with the manufacturer's recommendations.

END OF SECTION

SECTION 33 13 00 - DISINFECTION OF WATER LINES

PART 1: GENERAL

1.1 SUMMARY

- A. Section Includes: The disinfection of the water system, including valves and any portions of the existing, connecting, water system interrupted by the installation or connection of the improvements. Disinfection or chlorination of water system shall be performed by the Contractor.

1.2 SUBMITTALS

- A. General: Submittals shall be according with the following.
- B. Certificates of Conformance: Submit 6 copies of written certification from the supplier of the Contractor-furnished chlorine that it conforms to the requirements of this specification section.
- C. Reports: Submit six copies of reports from the testing laboratory.

1.3 QUALITY ASSURANCE

- A. Testing Laboratory: Shall be certified or approved for examination of drinking water in compliance with applicable regulations of the State of Oklahoma.

1.4 PROJECT RECORD DOCUMENTS

- A. Disinfection Report: Shall include the following:
 - 1. Type and form of disinfectant used.
 - 2. Date and time of disinfectant injection start time and completion time.
 - 3. Test locations.
 - 4. Initial and 24-hour disinfectant residuals (quantity in treated water) in parts per million (ppm) for each outlet tested.
 - 4. Date and time of flushing start and completion.
 - 5. Disinfectant residual after flushing in ppm for each outlet tested.
- B. Bacteriological Report: Shall include the following:
 - 1. Date issued, project name, and testing laboratory name, address, and telephone number.
 - 2. Time and date of water sample collection.
 - 3. Name of person collecting samples.
 - 4. Test locations.
 - 5. Initial and 24-hour disinfectant residuals in ppm for each outlet tested.
 - 6. Coliform bacteria test results for each outlet tested.
 - 7. Certification that water conforms, or fails to conform, to bacterial standards of the State of Oklahoma.
 - 8. Bacteriologist's signature.

PART 2: PRODUCTS

2.1 MATERIALS

- A. Calcium Hypochlorite: Shall be a commercial product having approximately 70 percent available chlorine by weight. Product shall be labeled and listed as NSF approved for use with potable water.
- B. Sodium Hypochlorite: AWWA B 300.

2.2 MIXES

- A. Calcium Hypochlorite: A five-percent solution shall be made by mixing 5 percent of calcium hypochlorite with 95 percent water by weight. Make into a paste, then thin to slurry by the addition of water. CAUTION: When calcium hypochlorite is used as the source of chlorine, it should be dissolved or suspended in water when introduced into solvent-welded PVC pipe. The dry chemical can react violently with solvent-welding materials. Precautions listed on the calcium-hypochlorite container shall be followed.

PART 3: EXECUTION

3.1 EXAMINATION

- A. Verification of Conditions: Verify that the piping system has been cleaned.

3.2 PREPARATION

- A. Testing: Prior to starting work, Test the water system and related appurtenances according to Section 01 45 34 - Testing of Piping Systems. Flush and disinfect water lines according to AWWA C 651.

3.3 APPLICATION

- A. Disinfection: Disinfect the water distribution system as follows:
 1. Disinfectant: Shall be chlorine in the form of a hypochlorite solution.
 2. Dosage: Chlorine concentration in solution shall be 50 to 80 ppm.
 3. Filling System: Fill the entire water system with the chlorine solution according to AWWA C 651. Open taps and valves and leave open until an odor of the disinfectant is noticeable in the water coming from the outlets. After this occurs, close the taps and valves.
 4. Testing Period: Allow disinfectant to remain in the system for approximately 24 hours. When disinfectant residual is less than 25 ppm, repeat system treatment. During the retention period, operate valves, stops, taps, and other appurtenances to assist the disinfection.
 5. Flushing: Thoroughly flush the system to remove the disinfectant from the system. Permit no more than the residual rate of incoming water, or 1.0 ppm, whichever is greater.
- B. Disposal of disinfecting solution
- C. Bacteriological Examination: The Owner will take samples according to AWWA C 651, Sections 9 and 10.

END OF SECTION

SECTION 33 41 00 - STORM DRAINAGE

PART 1: GENERAL

1.1 SUMMARY

- A. Section Includes: Furnishing and installing storm drainage piping and appurtenances.

1.2 SUBMITTALS

- A. General: Submittals shall be according to General Conditions
- B. Manufacturer's Catalog Data: Submit three copies each of the following contractor furnished items that are to be used on this project:
 - 1. Pipe including fittings and jointing materials.
 - 2. Grout
 - 3. Mortar
 - 4. Gaskets
 - 5. Compression Joints
 - 6. Manhole Frames/Covers
 - 7. Grating and Frames
 - 8. Precast Concrete Manholes, Junction Boxes and Inlets
 - 9. Precast Concrete Base Slabs
 - 10. Concrete Block
 - 11. Bituminous Coating
 - 12. Cold Bituminous Mastic Sealer
- C. Installation Instructions: Submit 3 copies of manufacturer's recommendations for installation procedures of the material to be placed prior to installation.
- D. Certificates of Conformance: Submit three copies of written certification verifying that the Contractor-furnished items below conform to the requirements of this section:
 - 1. Pipe
 - 2. Grout
 - 3. Mortar
 - 4. Gaskets
 - 5. Compression Joints
 - 6. Manhole Frames/Covers
 - 7. Grating and Frames
 - 8. Precast Concrete Manholes
 - 9. Precast Concrete Base Slabs
 - 10. Concrete Block
 - 11. Bituminous Coating
 - 12. Cold Bituminous Mastic Sealer
- E. Field Test Reports: Submit three copies of quality control field tests performed in Part 3 of this section for the following:
 - 1. Compaction Test
 - 2. Infiltration Test
 - 3. Exfiltration Test
 - 4. Hydrostatic Test
- F. Work Plan: Submit 3 copies of the Work Plan when sewer flow is to be interrupted. Include the following items in the plan:
 - 1. Proposed Schedules
 - 2. Methods
 - 3. Materials

4. Equipment

- G. Samples: Submit material samples, when required by the Owners Representative.

1.3 DELIVERY, STORAGE, AND HANDLING

- A. Delivery: Inspect materials delivered to site for damage; damaged goods shall be refused.
- B. Storage: Store with minimum of handling. Do not store materials directly on the ground. Store [plastic piping and jointing materials and] rubber gaskets under cover out of direct sunlight. Keep the inside of pipes and fittings free of dirt and debris.
- C. Handling: Handle pipe, fittings, and other accessories in a manner to ensure delivery to the trench in sound undamaged condition. Take special care not to damage coating and lining on pipe and fittings; if damaged, make repairs. Carry, do not drag pipe to trench.

PART 2: PRODUCTS

2.1 PIPE AND CULVERT MATERIALS

- A. Concrete Pipe and Fittings:
1. Reinforced concrete pipe conforming to ASTM C 76, Class III or IV .
 2. Fittings: Shall of the same strength as the pipe.
 3. Joints: Gaskets and pipe ends for rubber gasket joint shall be according to ASTM C 443. Gaskets shall be suitable for use with sewage. Provide primers and lubricants as recommended by the manufacturer. Concrete pipe joints shall be suitable for use with the joint sealants specified.
 - a. Butyl gaskets.
 - b. ASTM C 443 rubber O-ring gaskets.
 - c. AASHTO M 198, Type B preformed plastic gaskets.
 - d. Joint Mortar: ASTM C 270.
- B. Corrugated Steel Pipe and Fittings: AASHTO M 36, Types I and II.
1. Type I or II pipe with annular or helical corrugations. 16 gauge min. unless specified otherwise.
 2. Type [IR] [IIR] pipe with helical corrugations.
 3. Fabricate fittings of the same material as the pipe with strength not less than that of the pipe, and having the same size and shape of corrugations as the pipe. Helically corrugated pipe and fittings, when used with hugger-type coupling bands, shall have factory-rolled annular corrugations at each end.
 4. Jointing Devices: Coupling bands as specified in ASTM A 760. The circumference of the band shall be such that when coupled, a 3 inch (75 mm) lap will be provided.
 5. Aluminized coating, when specified, shall be in accordance with M274.
- C. ABS Composite Plastic Pipe and Fittings: Poly(Vinyl Chloride)(PVC) or Acrylonitrile-Butadiene-Styrene (ABS) composite pipe and fittings, ASTM D 2680.
1. Jointing materials: ASTM D 2680 solvent cement and primer or ASTM D 3212 elastomeric gasket joints.
- D. Polyvinyl Chloride (PVC) Plastic Piping: ASTM D 3034, SDR 35. Joints shall conform to ASTM D 3212. Gaskets shall conform to ASTM F 477.
1. Polyvinyl Chloride (PVC) Pipe Sized 15 Inch (250 mm) Diameter and Smaller: ASTM D 3034, SDR 35, with ends suitable for elastomeric gasket joints. ASTM F 949 with solvent cement joints or elastomeric gasket joints. ASTM D 3212 elastomeric gasket joints, ASTM D 2564 solvent cement joints and ASTM F 477 gaskets.
- E. Corrugated Plastic Piping: Corrugated poly(vinyl chloride) (PVC) pipe conforming to ASTM F 794 or corrugated, high density polyethylene pipe (HDPE) conforming to AASHTO M252 or

AASHTO M294. PVC fittings with solvent cemented components shall conform to ASTM D 2855 and ASTM F 402.

1. Joints and Jointing Materials: ASTM D 3212 for PVC pipe joints or manufacturer's recommendations for HDPE joints.
2. Corrugated plastic piping shall not be used in areas that will receive rigid or flexible pavements.

F. Polyethylene Piping: The pipe manufacturer's resin certification indicating the cell classification of PE used to manufacture the pipe shall be submitted prior to installation of the pipe. The minimum cell classification for polyethylene plastic shall apply to each of the seven primary properties of the cell classification limits in accordance with ASTM D 3350.

1. Smooth Wall PE Pipe: ASTM F 714, maximum DR of 21 for pipes 3 to 24 inches (80 to 600 mm) in diameter and maximum DR of 26 for pipes 26 to 48 inches (650 to 1200 mm) in diameter. Pipe shall be produced from PE certified by the resin producer as meeting the requirements of ASTM D 3350, minimum cell class 335434C. PE piping shall not be used in areas that will receive rigid or flexible pavements.
2. Corrugated PE Pipe: AASHTO M 294, Type S, produced from PE certified by the resin producer as meeting the requirements of ASTM D 3350, minimum cell class 315412C or 324420C. Pipe walls shall have the following properties:

Nominal Size		Minimum Wall Area (sq mm/m)	Minimum Moment of Inertia of Wall Section (inches ⁴)	Minimum Moment of Inertia of Wall Section	
mm	inches			mm	mm
300	12	3200	1.50	390	0.024
375	15	4000	1.91	870	0.053
450	18	4900	2.34	1020	0.062
600	24	6600	3.14	1900	0.116
750	30	8300	3.92	2670	0.163
900	36	9500	4.50	3640	0.222

PE piping shall not be used in areas that will receive rigid or flexible pavements.

3. Perforated Corrugated Steel Piping: ASTM A 760, Type III, zinc-coated.
4. Perforated Polyvinyl Chloride (PVC) Piping: ASTM D 2729.
5. Perforated Polyethylene Pipe With Filter: AASHTO M 252. Piping shall be heavy duty perforated corrugated polyethylene tubing having uniformly spaced slots with a maximum width of 3.17 mm (1/8 inch). Nylon filter screen shall provide covering for openings in the drain pipe. Lap seams and weld for complete coverage.
 - a. Fittings: ASTM F 405 and ASTM D 543 couplings, tees, and end caps for underdrains shall be heavy-duty polyethylene.

2.2 MISCELLANEOUS STRUCTURES AND MATERIALS

- A. Gravel: Underdrain trench backfill shall be pit run, screening or aggregate base and approved by the Owners Representative.
- B. Cover for Drain Outlet: Shall be 14-gauge galvanized wire mesh (1/4-inch) square opening.
- C. Hose Clamps: Shall be stainless-steel-gear type, (9/16-inch) width.
- D. Drainage Structures: Precast structures may be provided in lieu of cast-in-place concrete except for headwalls and gutters. Pipe-to-wall connections shall be mortared to produce smooth transitions and watertight joints or provided with ASTM C 923 resilient connectors. Bases shall have smooth inverts accurately shaped to a semicircular bottom conforming to the inside contour of the adjacent sewer sections. Changes in direction of the sewer and entering

branches into the manhole shall have a circular curve in the manhole invert of as large a radius as the size of the manhole will permit.

1. Precast Concrete Structures: ASTM C 478. Provide a minimum wall thickness of 5 inches (125 mm). ASTM A 615 reinforcing bars. ASTM A 497 welded wire fabric. ASTM C 443 or AASHTO M198, Type B gaskets for joint connections. Provide a 4 inch (100 mm) layer of clean gravel bedding with a maximum size of 2 inches (50 mm) or as shown on drawings..

E. Masonry Materials:

1. Brick: ASTM C 32, Grade MS, or ASTM C 62, Grade SW, except that the absorption test will be waived.
2. Concrete Masonry Units: ASTM C 139.
3. Mortar: ASTM C 270, Type M.
4. Water: Water for masonry mortar shall be fresh, clean, potable.
5. Grout: ASTM C 476.

- F. Erosion Control Riprap: Provide nonerodible rock not exceeding 15 inches (375 mm) in its greatest dimension and choked with sufficient small rocks to provide a dense mass with a minimum thickness 8 inches or as indicated on drawings.

- G. Manholes, Frames, Grates and Covers: See Related Sections in Specifications/Plan Notes.

H. CATCH BASINS

1. Normal-Traffic, Precast Concrete Catch Basin: ASTM C 478, precast, reinforced concrete, of depth indicated, with provision for rubber casketed joints.
 - a. Base Section: 6-inch (150 mm) minimum thickness for floor slab and 4-inch (100 mm) minimum thickness for walls and base riser section, and having separate base slab or base section with integral floor.
 - b. Riser Sections: 4-inch (100 mm) minimum thickness, 48-inch (1220 mm) diameter(or as required), and lengths to provide depth indicated.
 - c. Top Section: Eccentric-cone type, unless concentric-cone or flat slab top type is indicated. Top of cone of size that matches grade rings.
 - d. Gaskets: ASTM C 443 M, rubber
 - e. Grade Rings: Include two or three reinforced-concrete rings, of 6-9-inch (150 to 229 mm) total thickness, that match frame and grate.
 - f. Steps: fiberglass, individual steps or ladder. Include width that allows worker to place both feet on one step and is designed to prevent lateral slippage off step. Cast steps or anchor ladder into base, riser, and top section sidewalls at 12-16 inch (300-400 mm) intervals. Omit steps for catch basins less than 60 inches (1500 mm) deep.
 - g. Steps: ASTM C 478, individual steps or ladder. Omit steps for catch basins less than 60 inches (1500 mm) deep.
 - h. Pipe Connectors: ASTM C 923, resilient, of size required, for each pipe connecting to base section.
2. Heavy Duty Traffic, Precast Concrete Catch Basins: ASTM C 913, precast, reinforced concrete; designed according to ASTM C 890 for A-16, heavy traffic, structural loading, of depth, shape, and dimensions indicated, with provision for rubber casketed joints.
 - a. Gaskets: Rubber
 - b. Grade Rings: Include two or three reinforced concrete rings of 6-9 inch (150-229 mm) total thickness, that match frame and grate.
 - c. Steps: Fiberglass, individual steps or ladder. Include width that allows worker to place both feet on one step and is designed to prevent lateral slippage off step. Cast steps of anchor ladder into base, riser, and top section sidewalls at 12-16 inch (300-400 mm) intervals. Omit steps for catch basins less than 60 inches (1500 mm) deep.
 - d. Steps: Manufactured from deformed, 1/2 inch (13 mm) steel reinforcement rod complying with ASTM A 615 and encased in polypropylene complying with ASTM D 4101. Include pattern designed to prevent lateral slippage off step. Cast or

anchor into sidewalls with steps at 12-16 inch (300-400 mm) intervals. Omit steps for manholes less than 60 inches (1500 mm) deep.

- e. Pipe Connectors: ASTM C 923, resilient, of size required, for each pipe connecting to base section.
3. Cast-in-Place Concrete, Catch Basins: Construct of reinforced concrete; designed according to ASTM C 890 for structural loading; of depth, shape, dimensions, and appurtenances indicated.
 - a. Bottom, Walls, and Top: Reinforced concrete
 - b. Channels and Benches: Concrete
 - c. Steps: Fiberglass, individual steps or ladder. Include width that allows worker to place both feet on one step and is designed to prevent lateral slippage off step. Cast steps or anchor ladder into sidewalls at 12-16 inch (300-400 mm) intervals. Omit steps for catch basins less than 60 inches (1500 mm) deep.
 - d. Steps: Manufactured from deformed, 1/2 inch (13 mm) steel reinforcement rod complying with ASTM A 615 and encased in polypropylene complying with ASTM D 4101. Include pattern designed to prevent lateral slippage off step. Cast or anchor into sidewalls with steps at 12-16 inch (300-400 mm) intervals. Omit steps for manholes less than 60 inches (1500 mm) deep
4. Frames and Grates: ASTM A 536, Grade 60-40-18 ductile iron designed for heavy-duty service. Include flat grate with small square or short slotted drainage openings.
 - a. Size: 24 x 24 inches (610 x 610 mm) minimum, unless otherwise indicated.
 - b. Grate Free Area: Approximately 50 percent, unless otherwise indicated.
5. Frames and Grates: ASTM A 536, Grade 60-40-18, ductile iron designed for heavy duty service. Include 24-inch (610 mm) ID by 7-9 inch (178-229 mm) riser with 4-inch (100 mm) minimum width flange, and 26-inch (660 mm) diameter flat grade with small square or short slotted drainage openings.
 - a. Grate Free Area: Approximately 50 percent, unless otherwise indicated.

I. STORMWATER INLETS

1. Curb Inlets: Made with vertical curb opening, materials and dimensions according to utility standards.
2. Gutter Inlets: Made with horizontal gutter opening, of materials and dimensions according to utility standards. Include heavy duty frames and grates.
3. Combination Inlets: Made with vertical curb and horizontal gutter openings, of materials and dimensions according to utility standards. Include heavy-duty frames and grates.
4. Frames and Grates: Heavy-duty frames and grates according to utility standards.
5. Curb Inlets: Vertical curb opening, of materials and dimensions indicated.
6. Gutter Inlets: Horizontal gutter opening, of materials and dimensions indicated. Include heavy-duty frames and grates.
7. Combination Inlets: Vertical curb and horizontal gutter openings, of materials and dimensions indicated. Include heavy-duty frames and grates.
8. Frames and Grates: Dimensions, opening pattern, free area, and other attributes indicated.
 - a. Material: ASTM A 536, Grade 60-40-18 minimum, ductile iron casting
 - b. Material: ASTM A 48, Class 30 minimum, gray iron casting.
 - c. Grate Free Area: Approximately 50 percent, unless otherwise indicated.

J. STORMWATER DETENTION STRUCTURES

1. Cast In Place Concrete, Stormwater Detention Structures: Construct of reinforced concrete bottom, walls, and top; designed according to ASTM C 890 for A-16, heavy traffic, structural loading; of depth, shape, dimensions, and appurtenances indicated.
 - a. Ballast: Increase thickness of concrete, as required to prevent flotation.
 - b. Grade Rings: Include two or three reinforced concrete rings, of 6-9-inch (150-229 mm) total thickness, that match 24 inch (610 mm) diameter frame and cover.
 - c. Steps: Fiberglass, individual steps or ladder. Include width that allows worker to place both feet on one step and is designed to prevent lateral slippage off step. Cast or anchor into sidewalls with steps at 12-16 inch (300-400 mm) intervals. Omit steps for structures less than 60 inches (1500 mm) deep.

- d. Steps: Manufactured from deformed, 1/2-inch (13 mm) steel reinforcement rod complying with ASTM A 615 [M] and encased in polypropylene complying with ASTM D 4101. Include pattern designed to prevent lateral slippage off step. Cast or anchor into sidewalls with steps at 12-16 inch (300-400 mm) intervals. Omit steps for structures less than 60 inches (1500 mm) deep.
2. Manhole Frames and Covers: ASTM A 536, Grade 60-40-18, ductile iron castings designed for heavy duty service. Include 24 inch (610 mm) ID by 7-9 inch (178-229 mm) riser with 4 inch (100 mm) minimum width flange, and 26 inch (660 mm) diameter cover. Include indented top design with lettering "STORM SEWER" cast into cover.

PART 3: EXECUTION

3.1 EXCAVATION

- A. Trenching: Excavate trenches as indicated on the drawings. The width of trenches at any point below the top of the pipe shall be not greater than the outside diameter of the pipe plus 24 inches (mm) to permit satisfactory jointing and thorough tamping of the bedding material under and around the pipe. Sheeting and bracing where required shall be placed within the trench width as specified. Care shall be taken not to overexcavate. Where trench widths are exceeded, redesign with a resultant increase in cost of stronger pipe or special installation procedures shall be necessary. Cost of this redesign and increased cost of pipe or installation shall be borne by the Contractor without additional cost to the Owner.
- B. Removal of Unstable Material: Where wet or otherwise unstable soil incapable of properly supporting the pipe, as determined by the Owners Representative, is unexpectedly encountered in the bottom of a trench, such material shall be removed to the depth required and replaced to the proper grade with select granular material. When removal of unstable material is due to the fault or neglect of the Contractor in his performance of shoring and sheeting, water removal, or other specified requirements, such removal and replacement shall be performed at no additional cost to the Owner.

3.2 BEDDING

- A. Concrete Pipe: When no bedding class is specified or detailed on the drawings, concrete pipe shall be bedded carefully in a soil foundation accurately shaped and rounded to conform to the lowest one-fourth of the outside portion of circular pipe or to the lower curved portion of pipe arch for the entire length of the pipe or pipe arch. When necessary, the bedding shall be tamped. Bell holes and depressions for joints shall be only of such length, depth, and width as required for properly making the particular type of joint.
- B. Corrugated Metal Pipe: Bedding for corrugated metal pipe and pipe arch shall be in accordance with ASTM A 798. It is not required to shape the bedding to the pipe geometry. However, for pipe arches, it is recommended to either shape the bedding to the relatively flat bottom arc or fine grade the foundation to a shallow v-shape. Bedding for corrugated structural plate pipe shall meet requirements of ASTM A 807.
- C. Plastic Pipe: Bedding for PVC and PE pipe shall meet the requirements of ASTM D 2321. Bedding, haunching, and initial backfill shall be either Class IB or II material.

3.3 PLACING PIPE

- A. Requirements for All Pipes: Each pipe shall be carefully examined before being laid, and defective or damaged pipe shall not be used. Plastic pipe shall be protected from exposure to the direct sunlight prior to laying as needed to maintain adequate pipe stiffness and meet installation deflection requirements. Pipelines shall be laid to the grades and alignment indicated. Proper facilities shall be provided for lowering sections of pipe into trenches. Lifting lugs in vertically elongated metal pipe shall be placed in the same vertical plane as the major axis of the pipe. Under no circumstances shall pipe be laid in water, and no pipe shall be laid when trench conditions or weather are unsuitable for such work. Diversion of drainage or

dewatering of trenches during construction shall be provided as necessary. Deflection of installed plastic pipe shall not exceed 4.5 percent of the nominal inside diameter. After backfilling has been completed, the Owner may perform a deflection test on the entire length of installed plastic pipeline using a mandrel or other suitable device. Any plastic pipe showing deflections in excess of 4.5 percent shall be removed and replaced at the Contractor's expense. All pipe in place shall be inspected before backfilling, and those pipes damaged during placement shall be removed and replaced.

- B. Concrete Pipe: Install pipe and fittings in accordance with the provisions for rubber gasket jointing and jointing procedures of ACPA 01-103 or of ACPA 01-102, Chapter 9. Make joints with the gaskets previously specified for joints with this piping. Clean and dry surfaces receiving lubricants, cements, or adhesives. Affix gaskets to pipe not more than 24 hours prior to the installation of the pipe. Protect gaskets from sun, blowing dust, and other deleterious agents at all times. Before installation of the pipe, inspect gaskets and remove and replace loose or improperly affixed gaskets. Align each pipe section with the previously installed pipe section, and pull the joint together. If, while pulling the joint, the gasket becomes loose and can be seen through the exterior joint recess when the pipe is pulled up to within 1 inch (25 mm) of closure, remove the pipe and remake the joint.
 - 1. Elliptical and Elliptical Reinforced Concrete Pipe: Placement shall be so that the manufacturer's reference lines designating the top of the pipe will be within 5 degrees of a vertical plane through the longitudinal axis of the pipe. In all backfilling operations, care shall be taken to prevent damage to or misalignment of the pipe.
- C. ABS or PVC Composite Plastic Piping: Install pipe and fittings in accordance with the recommendations of the plastic pipe manufacturer. Make joints with the primer and solvent cement specified for this joint; assemble in accordance with the recommendations of the pipe manufacturer. Handle solvent cement in accordance with ASTM F 402.
- D. PVC Plastic Piping: Install pipe and fittings in accordance with the requirements of ASTM D 2321 for laying and joining pipe and fittings.
- E. Corrugated Plastic Piping: Install pipe and fittings in accordance with the recommendations of the pipe manufacturer. Laying shall be with the separate sections joined firmly on a bed shaped to line and grade.
- F. Corrugated Metal Pipe and Pipe Arch: Install corrugated steel pipe, and fittings in accordance with the general requirements for installation of pipelines and with the recommendations of ASTM A 798, except as otherwise specified in the other subparagraphs hereunder.
 - 1. Pipe laying: Handle pipe carefully so as not to damage. If damage occurs, give damaged areas of pipe and couplings an application of coating equal to that specified for the pipe, as determined by the Owners Representative. Install paved invert corrugated metal pipe with the paved area centered at the bottom.
- G. Multiple Culverts: Where multiple lines of pipe are installed, adjacent sides of pipe shall be at least half the nominal pipe diameter or 3 feet (1 meter) apart, whichever is less.
- H. Subsurface Drainage Piping: The laying of pipe and tile shall proceed upgrade from the lower end of the line, and shall have a uniform pitch to the outlets. Lay drain tile with 1/8 to 1/4 inch (3 to 6 mm) open joints.

3.4 JOINTS

- A. Connections to Existing Lines: Notify Owners Representative in writing at least 10 days prior to date that connections are to be made. Obtain approval of the Owners Representative before interrupting service. Conduct work so that there is minimum interruption of service on existing line.
- B. Concrete Pipe:
1. Cement-Mortar Bell-and-Spigot Joint: The first pipe shall be bedded to the established gradeline, with the bell end placed upstream. The interior surface of the bell shall be carefully cleaned with a wet brush and the lower portion of the bell filled with mortar to such depth as to bring inner surfaces of abutting pipes flush and even. The spigot end of each subsequent pipe shall be cleaned with a wet brush and uniformly matched into a bell so that sections are closely fitted. After each section is laid, the remainder of the joint shall be filled with mortar, and a bead shall be formed around the outside of the joint with sufficient additional mortar. If mortar is not sufficiently stiff to prevent appreciable slump before setting, the outside of the joint shall be wrapped or bandaged with cheesecloth to hold mortar in place.
 2. Cement-Mortar Oakum Joint for Bell-and-Spigot Pipe: A closely twisted gasket shall be made of jute or oakum of the diameter required to support the spigot end of the pipe at the proper grade and to make the joint concentric. Joint packing shall be in one piece of sufficient length to pass around the pipe and lap at top. This gasket shall be thoroughly saturated with neat cement grout. The bell of the pipe shall be thoroughly cleaned with a wet brush, and the gasket shall be laid in the bell for the lower third of the circumference and covered with mortar. The spigot of the pipe shall be thoroughly cleaned with a wet brush, inserted in the bell, and carefully driven home. A small amount of mortar shall be inserted in the annular space for the upper two-thirds of the circumference. The gasket then shall be lapped at the top of the pipe and driven home in the annular space with a caulking tool. The remainder of the annular space then shall be filled completely with mortar and beveled at an angle of approximately 45 degrees with the outside of the bell. If mortar is not sufficiently stiff to prevent appreciable slump before setting, the outside of the joint thus made shall be wrapped with cheesecloth. Placing of this type of joint shall be kept at least five joints behind laying operations.
 3. Cement-Mortar Diaper Joint for Bell-and-Spigot Pipe: The pipe shall be centered so that the annular space is uniform. The annular space shall be caulked with jute or oakum. Before caulking, the inside of the bell and the outside of the spigot shall be cleaned.
 - a. Diaper Bands: Diaper bands shall consist of heavy cloth fabric to hold grout in place at joints and shall be cut in such lengths that they will extend one-eighth of the circumference of pipe above the spring line on one side of the pipe and up to the spring line on the other side of the pipe. Longitudinal edges of fabric bands shall be rolled and stitched around two pieces of wire. Width of fabric bands shall be such that after fabric has been securely stitched around both edges on wires, the wires will be uniformly spaced not less than 8 inches (200 mm) apart. Wires shall be cut into lengths to pass around pipe with sufficient extra length for the ends to be twisted at top of pipe to hold the band securely in place; bands shall be accurately centered around lower portion of joint.
 - b. Grout: Grout shall be poured between band and pipe from only the high side of band, until grout rises to the top of band at the spring line of pipe, or as nearly so as possible, on the opposite side of pipe, to ensure a thorough sealing of joint around the portion of pipe covered by the band. Silt, slush, water, or polluted mortar grout forced up on the lower side shall be carefully forced out by pouring and removed.
 - c. Remainder of Joint: The remaining unfilled upper portion of the joint shall then be filled with mortar and a bead formed around the outside of this upper portion of the joint with a sufficient amount of additional mortar. The diaper shall be left in place. Placing of this type of joint shall be kept at least five joints behind actual laying of pipe. No backfilling around joints shall be done until joints have been fully inspected and approved.

4. Cement-Mortar Tongue-and-Groove Joint: The first pipe shall be bedded carefully to the established gradeline with the groove upstream. A shallow excavation shall be made underneath the pipe at the joint and filled with mortar to provide a bed for the pipe. The grooved end of the first pipe shall be carefully cleaned with a wet brush, and a layer of soft mortar applied to the lower half of the groove. The tongue of the second pipe shall be cleaned carefully with a wet brush; while in horizontal position, a layer of soft mortar shall be applied to the upper half of the tongue. The tongue end of the second pipe then shall be inserted in the grooved end of the first pipe until mortar is squeezed out on interior and exterior surfaces. Sufficient mortar shall be used to fill the joint completely and to form a bead on the outside.
 5. Cement-Mortar Diaper Joint for Tongue-and-Groove Pipe: The joint shall be of the type described for cement-mortar tongue-and-groove joint in this paragraph, except that the shallow excavation directly beneath the joint shall not be filled with mortar until after a gauze or cheesecloth band dipped in cement mortar has been wrapped around the outside of the joint. The cement-mortar bead at the joint shall be at least 1/2 inch (15 mm), thick and the width of the diaper band shall be at least 8 inches (200 mm). The diaper shall be left in place. Placing of this type of joint shall be kept at least five joints behind the actual laying of the pipe. No backfilling around the joints shall be done until the joints have been fully inspected and approved.
 6. Plastic Sealing Compound Joints for Tongue-and-Grooved Pipe: Sealing compounds shall follow the recommendation of the particular manufacturer in regard to special installation requirements. Surfaces to receive lubricants, primers, or adhesives shall be dry and clean. Sealing compounds shall be affixed to the pipe not more than 3 hours prior to installation of the pipe, and shall be protected from the sun, blowing dust, and other deleterious agents at all times. Sealing compounds shall be inspected before installation of the pipe, and any loose or improperly affixed sealing compound shall be removed and replaced. The pipe shall be aligned with the previously installed pipe, and the joint pulled together. If, while making the joint with mastic-type sealant, a slight protrusion of the material is not visible along the entire inner and outer circumference of the joint when the joint is pulled up, the pipe shall be removed and the joint remade. After the joint is made, all inner protrusions will be cut off flush with the inner surface of the pipe. If nonmastic-type sealant material is used, the "Squeeze-Out" requirement above shall be waived.
 7. Flexible Watertight Joints: Gaskets and jointing materials shall be as recommended by the particular manufacturer in regard to use of lubricants, cements, adhesives, and other special installation requirements. Surfaces to receive lubricants, cements, or adhesives shall be clean and dry. Gaskets and jointing materials shall be affixed to the pipe not more than 24 hours prior to the installation of the pipe, and shall be protected from the sun, blowing dust, and other deleterious agents at all times. Gaskets and jointing materials shall be inspected before installing the pipe; any loose or improperly affixed gaskets and jointing materials shall be removed and replaced. The pipe shall be aligned with the previously installed pipe, and the joint pushed home. If, while the joint is being made the gasket becomes visibly dislocated the pipe shall be removed and the joint remade.
 8. External Sealing Band Joint for Noncircular Pipe: Surfaces to receive sealing bands shall be dry and clean. Bands shall be installed in accordance with manufacturer's recommendations.
- C. PVC Plastic Pipes: Joints shall be solvent cement or elastomeric gasket type in accordance with the specification for the pipe and as recommended by the pipe manufacturer. Assemble in accordance with the requirements of ASTM D 2321 for assembly of joints. Make joints to other pipe materials in accordance with the recommendations of the plastic pipe manufacturer.
- E. PE Piping:
1. Smooth Wall PE Plastic Pipe: Pipe shall be joined using butt fusion method as recommended by the pipe manufacturer.
 2. Corrugated PE Plastic Pipe: Water tight joints shall be made using a PVC or PE coupling and rubber gaskets as recommended by the pipe manufacturer. Rubber gaskets shall

conform to ASTM F 477. Soil tight joints shall conform to the requirements in AASHTO-01, Division II, Section 26.4.2.4. (e) for soil tightness and shall be as recommended by the pipe manufacturer.

3. Profile Wall PE Plastic Pipe: Joints shall be gasketed or thermal weld type with integral bell in accordance with ASTM F 894.

F. Corrugated Metal Pipe:

1. Field Joints: Transverse field joints shall be of such design that the successive connection of pipe sections will form a continuous line free of appreciable irregularities in the flow line. In addition, the joints shall meet the general performance requirements described in ASTM A 798. The space between the pipe and connecting bands shall be kept free from dirt and grit so that corrugations fit snugly. The connecting band, while being tightened, shall be tapped with a soft-head mallet of wood, rubber or plastic, to take up slack and ensure a tight joint. The annular space between abutting sections of part paved, and fully paved pipe and pipe arch, in sizes 30 inches (750 mm) or larger, shall be filled with a bituminous material after jointing. Field joints for each type of corrugated metal pipe shall maintain pipe alignment during construction and prevent infiltration of fill material during the life of the installations. The type, size, and sheet thickness of the band and the size of angles or lugs and bolts shall be as indicated or where not indicated, shall be as specified in the applicable standards or specifications for the pipe.
2. Flexible Watertight, Gasketed Joints: Installation shall be as recommended by the gasket manufacturer for use of lubricants and cements and other special installation requirements. The gasket shall be placed over one end of a section of pipe for half the width of the gasket. The other half shall be doubled over the end of the same pipe. When the adjoining section of pipe is in place, the doubled-over half of the gasket shall then be rolled over the adjoining section. Any unevenness in overlap shall be corrected so that the gasket covers the end of pipe sections equally. Connecting bands shall then be centered over adjoining sections of pipe, and rods or bolts placed in position and nuts tightened. Band Tightening: The band shall be tightened evenly, even tension being kept on the rods or bolts, and the gasket shall be closely observed to see that it is seating properly in the corrugations. Watertight joints shall remain uncovered for a period of time designated, and before being covered, tightness of the nuts shall be measured with a torque wrench. If the nut has tended to loosen its grip on the bolts or rods, the nut shall be retightened with a torque wrench and remain uncovered until a tight, permanent joint is assured.

- G. Subsurface Piping: Joints between the tile shall be covered with one thickness of the jointing material specified; material shall overlap the joint not less than 4 inches (100 mm) on each side and shall cover the tile for not less than the upper half or more than the upper two-thirds of the circumference of the tile. [[Lay perforated clay pipe] [and] [perforated concrete pipe] without filling the pipe joints, but with positive provision for centering each section of pipe in the bell [or groove] of the placed section.] [[Perforated corrugated aluminum pipe] [and] [perforated corrugated steel pipe] shall have joints made with standard coupling bands in a manner approved by the Owners Representative.] Provide vertical pipe at the high points in each drain run, for testing purposes. Connect the vertical pipe sections into the drains by means of tees, and extend to the height indicated. Fit the upper hub ends with screwed plugs. Make joints in cast-iron sections with fiber gaskets.

3.5 DRAINAGE STRUCTURES

- A. Manholes: See Related Section in Specifications
- B. Walls and Headwalls: Construction shall be as indicated on the drawings.
- C. Metal Work: Perform metal work so that workmanship and finish will be equal to the best practice in modern structural shops and foundries. Form iron [and steel] to shape and size with sharp lines and angles. Do shearing and punching so that clean true lines and surfaces are produced. Make castings sound and free from warp, cold shuts, and blow holes that may impair their strength or appearance. Give exposed surfaces a smooth finish with sharp well-defined

lines and arises. Provide rabbets, lugs, and brackets wherever necessary for fitting and support.

1. Apply zinc coating to steel gratings after fabrication in accordance with ASTM A 653. Clean surfaces of steel frames and covers to bare metal. For surfaces contaminated with rust, dirt, oil, grease, or other contaminants, wash with solvents until thoroughly clean. Immediately after cleaning, coat surfaces with a coat of pretreatment coating, applied to a dry film thickness of 0.3 to 0.5 mil (0.008 to 0.013 mm); or apply a crystalline phosphate coating. If primed surfaces are damaged before removal from the shop, retouch with primer.
2. Field Painting: After installation, clean cast-iron frames, covers, gratings, and steps not buried in masonry or concrete to bare metal of mortar, rust, grease, dirt, and other deleterious materials and apply a coat of bituminous paint. After installation, clean steel covers and steel or concrete frames not buried in masonry or concrete to bare metal of mortar, dirt, grease, and other deleterious materials. Do not paint surfaces subject to abrasion.

3.6 BACKFILLING

- A. Backfilling Pipe in Trenches: After the pipe has been properly bedded, selected material from excavation or borrow, at a moisture content that will facilitate compaction, shall be placed along both sides of pipe in layers not exceeding 6 inches (150 mm) in compacted depth. The backfill shall be brought up evenly on both sides of pipe for the full length of pipe. Care shall be taken to ensure thorough compaction of the fill under the haunches of the pipe. Each layer shall be thoroughly compacted with mechanical tampers or rammers. This method of filling and compacting shall continue until the fill has reached an elevation of at least 12 inches (300 mm) above the top of the pipe. The remainder of the trench shall be backfilled and compacted by spreading and rolling or compacted by mechanical rammers or tampers in layers not exceeding 8 inches (millimeters). Tests for density will be made as necessary to ensure conformance to the compaction requirements specified elsewhere in this paragraph. Where it is necessary in the opinion of the Owners Representative, any sheeting or portions of bracing used shall be left in place and the contract will be adjusted accordingly. Untreated sheeting shall not be left in place beneath structures or pavements.
- B. Backfilling Pipe in Fill Sections: For pipe placed in fill sections, backfill material and the placement and compaction procedures shall be as specified elsewhere in this paragraph. The fill material shall be uniformly spread in layers longitudinally on both sides of the pipe, not exceeding 8 inches (150 mm) in compacted depth, and shall be compacted by rolling parallel with pipe or by mechanical tamping or ramming. Prior to commencing normal filling operations, the crown width of the fill at a height of 12 inches (300 mm) above the top of the pipe shall extend a distance of not less than twice the outside pipe diameter on each side of the pipe or 12 feet, (4 m), whichever is less. After the backfill has reached at least 12 inches (300 mm) above the top of the pipe, the remainder of the fill shall be placed and thoroughly compacted in layers not exceeding 8 inches (mm).
- C. Movement of Construction Machinery: In compacting by rolling or operating heavy equipment parallel with the pipe, displacement of or injury to the pipe shall be avoided. Movement of construction machinery over a culvert or storm drain at any stage of construction shall be at the Contractor's risk. Any damaged pipe shall be repaired or replaced.
- D. Compaction: Cohesionless materials include gravels, gravel-sand mixtures, sands, and gravelly sands. Cohesive materials include clayey and silty gravels, gravel-silt mixtures, clayey and silty sands, sand-clay mixtures, clays, silts, and very fine sands.
 1. Minimum Density: Backfill over and around the pipe and backfill around and adjacent to drainage structures shall be compacted at the approved moisture content to the following applicable minimum density (densities) which will be determined as specified in this paragraph.
 - a. Under paved roads, streets, parking areas, and similar-use pavements including adjacent shoulder areas, the density shall be not less than 90 percent of maximum density for cohesive material and 95 percent of maximum density for cohesionless

material, up to the elevation where requirements for pavement subgrade materials and compaction shall control.

- b. Under unpaved or turfed traffic areas, density shall not be less than 90 percent of maximum density for cohesive material and 95 percent of maximum density for cohesionless material.
 - c. Under nontraffic areas, density shall be not less than that of the surrounding material.
- E. Determination of Density: Testing shall be the responsibility of the Contractor and performed at no additional cost to the Owner. Testing shall be performed by an approved commercial testing laboratory or by the Contractor subject to approval. Tests shall be performed in sufficient number to ensure that specified density is being obtained. Laboratory tests for moisture-density relations shall be made in accordance with ASTM D 1557 except that mechanical tampers may be used provided the results are correlated with those obtained with the specified hand tamper. Field density tests shall be determined in accordance with ASTM D 2167 or ASTM D 2922. When ASTM D 2922 is used, the calibration curves shall be checked and adjusted, if necessary, using the sand cone method as described in paragraph Calibration of the referenced publications. ASTM D 2922 results in a wet unit weight of soil and when using this method ASTM D 3017 shall be used to determine the moisture content of the soil. The calibration curves furnished with the moisture gauges shall be checked along with density calibration checks as described in ASTM D 3017 or ASTM D 2922. Test results shall be furnished the Owners Representative. The calibration checks of both the density and moisture gauges shall be made at the beginning of a job on each different type of material encountered and at intervals as directed.

3.7 FIELD TESTING

- A. Field Tests and Inspections: Contractor shall provide labor, equipment, and incidentals required for testing or engage the services of a firm to provide the necessary testing. The Owners Representative will conduct field inspections and witness field tests specified in this section. The Contractor shall be able to produce evidence, when required, that each item of work has been constructed properly in accordance with the drawings and specifications. Storm sewer system shall be cleaned of debris, soil, concrete, trash, etc. Examine structures and pipe for damage, displacement, shoving or misalignment, voids, proper gasket placement, embedments and visible infiltration. If, after visible inspection of the system, a suspected joint tightness problem, excessive deflection or infiltration, leakage/tightness and/or deflection testing may be required.
- B. Leakage Tests: Test lines for leakage by either infiltration tests or exfiltration tests. Prior to testing for leakage, backfill trench up to at least the lower half of pipe. When necessary to prevent pipeline movement during testing, place additional backfill around pipe sufficient to prevent movement, but leaving joints uncovered to permit inspection. When leakage exceeds the amount specified below, make satisfactory correction and retest pipeline section in the same manner. Correct visible leaks regardless of leakage test results. Amount of leakage, as measured by either infiltration or exfiltration test shall not exceed:
- 1. 250 gallons per inch diameter per mile of pipeline per day ([23.5 liters per mm diameter per kilometer of pipeline per day])
 - 2. 0.2 gallons per inch diameter per 100 feet of pipeline per hour ([0.03 liters per mm diameter per 30 m of pipeline per hour])
 - 3. 500 gallons per inch of diameter per day per mile of pipeline. ([47] liters per millimeter of diameter per day per kilometer)
 - 4. Infiltration and exfiltration tests for installed concrete pipe shall be performed in accordance with ASTM C 969.
- C. Hydrostatic Test on Watertight Joints: Cement or corrugated-metal pipes joined straight shall withstand 10 psi (69 kilopascal) for 24 hours without failure. When test is completed test sections shall be angled and retested at 10 psi (69 kilopascal) for an additional 24 hours.
- 1. Test results for concrete pipe shall conform to ASTM C 443 AASHTO M 198.
 - 2. Test results for clay pipe shall conform to ASTM C 425.

- D. Low Pressure Air Test of Conduit: Acceptance tests for installed ferrous and plastic piping shall be in accordance with ASTM F 1417.
- E. Deflection Testing: Perform a deflection test on entire length of installed plastic pipeline on completion of work adjacent to and over the pipeline, including leakage tests, backfilling, placement of fill, grading, paving, concreting, and any other superimposed loads. Deflection of pipe in the installed pipeline under external loads shall not exceed 4.5 percent of the average inside diameter of pipe. Determine whether the allowable deflection has been exceeded by use of a pull-through device or a deflection measuring device.
 - a. Pull-through device: Pass the pull-through device through each run of pipe, either by pulling it through or flushing it through with water. If the device fails to pass freely through a pipe run, replace pipe which has the excessive deflection and completely retest in same manner and under same conditions as specified.
 - b. Deflection measuring device procedure: Measure deflections through each run of installed pipe. If deflection readings in excess of 4.5 percent of average inside diameter of pipe are obtained, retest pipe by a run from the opposite direction. If retest continues to show a deflection in excess of 4.5 percent of average inside diameter of pipe, remove pipe which has excessive deflection, replace with new pipe, and completely retest in same manner and under same conditions.
 - c. Any pipe showing deflections in excess of 5 percent at the end of one year following installation and acceptance shall be replaced at no cost to the Owner.
- F. Field Tests for Concrete: See Field testing requirements covered in Section 03 30 53 - Structural Concrete.

END OF SECTION