SECTION 33 05 05
PIPELAYING

PART 1 GENERAL

1.1 SCOPE

A. Section includes the Work necessary to install water, sewer, and storm drainage piping and appurtenances.

1.2 RELATED WORK

A. Section 31 23 33 – Excavation, Backfilling, & Compacting for Utilities.

1.3 QUALITY ASSURANCE

A. Provide workmen with skill to ensure embedment of pipe.
B. Methods of Testing
   1. The moisture density relations of materials shall be determined in the laboratory in accordance with AASHTO T-99 or T-180, as specified.
   2. Field density of backfill shall be determined in accordance with ASTM D2922.

1.4 PUBLIC WORK

A. Comply with the City of Bentonville – Water Utilities Department Specifications 2021. If conflict should be found between this section and city standards, city standards shall be the priority. It shall be the Contractor's responsibility to obtain city standard water and sewer specifications and comply with the minimum requirements.

PART 2 PRODUCTS

2.1 EMBEDMENT

A. Class I material consists of manufactured angular, granular material, 1/4 to 1-1/2 inches (6 to 40 mm) in size.
B. Class II material consists of coarse sands and gravel with maximum particle size of 1-1/2 inches (40 mm), including variously graded sands and gravels containing small percentage of fines, generally granular and non-cohesive, either wet or dry. Soil types GW, GP, SW, and SP are included in this class.
   GW-Well graded gravels and gravel-sand mixtures, little or no fines, 50 percent or more retained on a No.4 sieve, more than 95 percent retained on a No. 200 sieve.
   GP-Poorly graded gravels and gravel-sand mixtures, little or no fines. 50 percent or more retained on a No. 4 sieve. More than 95 percent retained on a No. 200 sieve. Clean.
   SW-Well-graded sands and gravelly sands, little or no fines. More than 50 percent passes a No.4 sieve. More than 95 percent retained on a No. 200 sieve. Clean.
   SP-Poorly graded sands and gravelly sands, little or no fines. More than 50 percent passes a No.4 sieve. More than 95 percent retained on a No.4 sieve. Clean.

2.2 BACKFILL

A. Select materials are defined as good earth, sand, or gravel and shall be free from rocks larger than 1-1/2 inches in diameter or hard lumpy materials. Select materials require hand placement and consolidation.
B. Protection cover shall be defined as backfill from the top of the pipe to a point 12 inches above the top of the pipe and shall consist of select material as defined in paragraph 2.1A.
C. Backfill over the protection cover shall be free from cinders, ashes, refuse, vegetable, or organic material, boulders, rocks or stones having dimension greater than 6 inches, frozen soil, or other material that in the opinion of the Engineer is unsuitable.

PART 3 EXECUTION

A. Examine the pipe and appurtenances for compliance with specifications.
B. Reject pipe and appurtenances not in compliance with specifications.
C. Remove foreign matter from pipe and appurtenances before lowering into excavated area.
D. Pipe bedding
    1. For PVC pipe and fittings, place 6-inch minimum of Class I or Class II material between excavated trench bottom or stabilized trench bottom and bottom of pipe or fitting as embedment. Embedment material shall be tamped by hand or approved mechanical methods so as to provide a uniform and continuous bearing support for the pipe at every point along the pipe barrel. Class I material shall be used for haunching to the spring line of the pipe, and to 6 inches over the top of the pipe. Embedment shall be compacted to a standard proctor density of 85 percent as defined in AASHTO T-99.
    2. For iron pipe and appurtenances, place 4 inch minimum of Class I or Class II material between excavated trench bottom or stabilized trench bottom and bottom of pipe or appurtenance. Embedment material shall be tamped by hand or approved mechanical methods so as to provide a uniform and continuous bearing support for the pipe at every point along the pipe barrel. Class I material shall be used for haunching to the spring line of the pipe, and to 6 inches over the top of the pipe. Embedment shall be compacted to a standard proctor density of 85 percent as defined in AASHTO T-99.
E. Place pipe and appurtenance to planned line and elevation.
    1. Place gravity waste water pipe from low end to high end with pipe bells facing upstream.
    2. Place potable water pipe with bells facing the direction of laying.
    3. Cover open end of laid pipe to prevent rodents and debris from entering pipe.
F. For iron pipe, place Class I material 6 inch maximum layers, compacted to 85 percent maximum density standard proctor, to top of pipe. Ensure that Class I material is compacted against haunch area of pipe.
G. Pipe Covering: Place protection material to a minimum 12 inch depth over top of pipe and fittings. Place in 6 inch maximum layers, compacted to 85 percent standard proctor density.

H. See Section 31 23 33 for remainder of backfill requirements.
I. Existing Utility Crossing: Expose all utilities located between two manholes a minimum of 24 hours before the downstream manhole is constructed. Wherever possible, sewer will be adjusted to provide necessary clearance.

END OF SECTION

SECTION 33 05 31

POLYVINYL CHLORIDE (PVC) PIPE AND FITTINGS - WATER

PART 1. GENERAL

1.1 SUMMARY
A. Provide polyvinyl chloride (PVC) pipe and fittings.

1.2 RELATED SECTIONS
A. Section 33 05 05 – Pipe Laying
B. Section 33 14 00 – Water Distribution Systems

1.3 PUBLIC WORK
A. Comply with the City of Bentonville – Water Utilities Department Specifications 2021. If conflict should be found between this section and city standards, city standards shall be the priority. It shall be the Contractor's responsibility to obtain city standard water and sewer specifications and comply with the minimum requirements.

1.3 REFERENCES
A. Arkansas Department of Health.
   1. ADHHS: "Rules and Regulations Pertaining to Public Water Systems, latest Edition."

B. ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA, 19428-2959.
   1. ASTM D1784 - Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
   2. ASTM D2241 - Specifications for Poly (Vinyl Chloride) (PVC) Pressure - Rated Pipe (SDR Series).
   3. ASTM D3139 - Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.
   4. ASTM F477 - Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

C. American Water Works Association, 6666 West Quincy Avenue, Denver, Colorado 80235.
   1. AWWA C110/A21.10-03 - American National Standard for Ductile-Iron and Gray-Iron Fittings, 3 In. Through 48 In. For Water and Other Liquids.
   2. AWWA C605-05 - Underground installation of Polyvinyl choride (PVC) Pressure Pipe and Fittings for Water.
   3. AWWA: "The Ten States Standards for Water, 2007 Edition or latest version."

PART 2. PRODUCTS

2.1 PIPE

A. PVC pressure pipe, Class 200, SDR-21 in compliance with ASTM D1784 and manufactured from virgin PVC compound with a cell classification of 12454-B with gasket joints and integral bell for buried water piping.

B. Pipe and fittings shall be manufactured in the United States. Foreign made products shall be unacceptable.

C. Pipe shall be permanently marked at 5-foot intervals with the following information:
   1. Nominal size.
   2. Material code designation.
   3. Manufacturer's name or trademark and production record code.
   4. ASTM or AWWA certification.
   5. SDR designation.

D. Warranty:
   1. Manufacturer of the pipe shall warrant product for a period of not less than one (1) year.
   2. Forward copies of warranty to the Owner.
   3. Replace defective materials at no extra cost to the Owner.

2.2 JOINTS

A. Buried Pipe: Gasketed slip joint.

B. Comply with ASTM D3139.

2.3 FITTINGS

A. Fittings 4 Inches and Larger: Ductile iron, 350 psi pressure class, cement-lined and seal-coated. Where taps are shown on fittings, tapping bosses shall be provided.
   1. Flanged Joint: ANSI/AWWA C110/A21.10-03 and ANSI B16.1, faced and drilled 125-pound ANSI standard.
   2. Mechanical Joint: ANSI/AWWA C110/A21.10-03 and ANSI/AWWA C110/A21.11-07.
   3. Flexible Joint: American Flex-Lox pipe or equal.

B. Cement Linings: In accordance with ANSI A21.4.

C. Fittings shall receive an exterior coating of 1 mil thick bituminous material in accordance with ANSI A21.4.

D. Fittings shall have distinctly cast on them the manufacturer's identification, pressure rating, nominal diameter of openings, and the number of degrees or fraction of the circle on bends.

E. Fittings Smaller Than 4 Inches: PVC.

2.4 GASKETS

A. As recommended by pipe manufacturer to conform to pipe.

B. Comply with ASTM F477.

2.5 MARKING TAPE

A. Install on pressure systems.
B. Terra Tape "Extra Stretch."
C. Or equal.

PART 3. EXECUTION

3.1 GENERAL

A. Any connection to water main for the purpose of connecting any water line to the water main, shall use a minimum of Schedule 40, Polyvinyl chloride (PVC) pipe.
B. Rigid PVC pipe shall be cut, made up, and installed in accordance with the pipe manufacturer's recommendations.
C. Offset shall be as recommended by the manufacturer for the maximum temperature variation between time of installation and final use.

3.2 TRACE WIRE

A. Furnish and install a 14-gage insulated copper trace wire with PVC pressure pipe.
B. Run wire continuous from valve box to valve box, meter box, air release vault, cleanout, or other access points.
C. Bring wire up inside boxes and vaults in an accessible method.
D. Bring wire around or tape wire to each pipe section.
E. Pipe testing shall include following trace wire.
F. Wire breaks shall be repaired at no additional expense to the Owner.

3.3 MARKING TAPE

A. On pressure installations of non-metallic pipe, metallic marking tape, Terra Tape Extra Stretch or equal shall be installed 6 to 12 inches above the top of pipe or service line.
B. The tape shall be in addition to the trace wire specified.

3.4 THRUST BLOCKS

A. Install 2,500 psi concrete thrust blocks at bends, wyes, or other thrust points on pressure piping.
B. Block to bear against undisturbed soil and shall be of size and with bearing area as shown on Drawings.

3.5 TESTING

A. Pressure lines shall be hydrostatically tested at the pressures listed in Section 02512.
B. Use pipe-locating equipment to test continuity of trace wire.
C. Engineer shall observe and document trace wire test.

END OF SECTION

SECTION 33 14 00
WATER DISTRIBUTION SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Site water piping and fittings including domestic waterline and fire sprinkler system waterline including valves, fire hydrants and appurtanences.
B. Connection of site water system to municipal water systems and testing.
C. Utility line Detection tape.
D. Tracer Wire.

1.2 RELATED SECTIONS

A. Section 31 23 33 - Excavation, Backfill, and Compaction for Utilities.

1.3 PUBLIC WORK

A. Comply with all requirements and specifications of the City of Bentonville -Water Utilities Department Specifications 2021.
B. Comply with the requirements of the Arkansas Department of Health.
C. Comply with all other applicable local, state and federal rules and regulations.

1.4 REFERENCE STANDARDS

A. American Society of Mechanical Engineers (ASME) latest edition
   B 16.22 Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
B. American Society for Testing and Materials (ASTM) latest edition
   B 88 Seamless Copper Water Tube
   D 1784 Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
   D 2241 Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR-Series)
   D 2564 Poly(Vinyl Chloride) (PVC) Solvent Cement
   D 2672 Poly(Vinyl Chloride) (PVC) Integrally Molded Bell Ends for Solvent-Cemented Pipe Joints
   D 2855 Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings
   D 3139 Joints for Plastic Pressure Pipes using Flexible Elastomeric Seals
   F 477 Elastomeric gaskets and lubricant
   F 656 Poly(Vinyl Chloride) (PVC) Cement Primer
C. American National Standards Institute (ANSI) latest edition
   A21.8
D. American Water Works Association (AWWA) latest edition
   C104 Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
   C105 Polyethylene Encasement for Ductile-Iron Piping for Water and Other Liquids

C110/C153	Ductile-Iron Fittings, 3 In. Through 48 In., for Water and Other Liquids
C111	Rubber-Gasket Joints for Ductile Iron Pressure Pipe and Fittings
C151	Ductile-Iron Pipe, Centrifugally Cast, for Water or Other Liquids
C500	Gate Valves for Water and Sewage Systems
C502	Dry-Barrel Fire Hydrants
C504	Rubber-Seated Butterfly Valves
C508	Swing-Check Valves for Waterworks Service, 2 In. Through 24 In. NPS
C509	Resilient-Seated Gate Valves for Water and Sewage Systems
C600	Installation of Ductile-Iron Water Mains and Appurtenances
C606	Grooved and Shouldered Joints
C651	Disinfecting Water Mains
C900	Polyvinyl Chloride (PVC) Pressure Pipe, 4 In. Through 12 In., for Water Distribution

E. Underwriters Laboratories (UL) latest edition

246	Hydrants for Fire Protection Service

F. Arkansas Department of Health codes and requirements.

1.5 QUALITY ASSURANCE

A. Perform installation in accordance with requirments and specifications of the City of Bentonville – Water Utilities Department Specifications 2021.
B. Valves: Manufacturer's name and pressure rating marked on valve body.
C. Compaction testing of trench backfill shall be performed in accordance with Section 31 23 33.
D. Water distribution system pipe installed below grade and outside building shall be tested in accordance with the following procedures:
   1. Perform testing of pipe materials, joints, and other materials incorporated into construction of water mains and force mains to determine leakage and watertightness. Pressure pipeline shall be tested in accordance with City of Bentonville – Water Utilities Department Specifications 2021.

1.6 SUBMITTALS

A. Product Data: Provide submittal data on pipe materials, pipe fittings, hydrants, valves, and accessories.
B. Manufacturer's Certificate: Certify that products meet or exceed state or local requirements.
C. Furnish digital copy and one (1) hard copy of all test results to the Engineer, Owner and City.
D. Disinfection report; accurately record:
   1. Type and quantity of disinfectant used.
   2. Date and time of start and completion of disinfectant injection.
   3. Test locations.

4. Initial, 24-hour, and 48-hour disinfectant residuals (quantity in treated water) in ppm for each outlet tested.
5. Date and time of start and completion of flushing.
6. Disinfectant residual after flushing in ppm for each outlet tested.
7. Bacteriological report; accurately record:
8. Date issued, project name, and testing laboratory name, address, and telephone number.
9. Time and date of water sample collection.
10. Name of person collecting samples.
11. Test locations.
12. Initial and 24 hour disinfectant residuals in ppm for each outlet tested.
13. Coliform bacteria test results for each outlet tested.
14. Certification that water conforms, or fails to conform, to bacterial standards of the Arkansas Department of Health.
15. Bacteriologist's signature.

1.7 PROJECT RECORD DOCUMENTS

A. Accurately record actual locations of piping mains, valves, connections, and top of pipe elevations.
B. Identify and describe unexpected variations to subsoil conditions and location of uncharted utilities.

PART 2 PRODUCTS

2.0 GENERAL

A. All materials shall conform to the requirements of the City of Bentonville – Water Utilities Department Specifications 2021.

2.1 PIPE

A. Polyvinyl Chloride (PVC) Pipe for Waterlines
    a. PVC pipe shall be blue.
    b. PVC pipe shall be manufactured in accordance wit AWWA C900, latest revision, and shall be DR 14.
    c. Joints for PVC pipe shall conform to ASTM D-3139, latest revision.
B. Ductile Iron Pipe for Waterline
    a. Ductile Iron Pipe shall conform to the requirements of "Ductile-Iron Pipe, Centrifugally Cast" AWWA Standard C151/A21.51, latest revision.
    b. Ductile Iron Pipe shall be designed in accordance with the requirements of "Thickness Design of Ductile-Iron Pipe", ANSI/AWWA C150/A21.50, latest revision.
    c. Minimum pressure class shall be 250 psi.
    d. Cement-mortor lined interior
    e. Asphaltic exterior coated

2.2 FITTINGS & ACCESSORIES

A. Fittings and accessory materials shall conform to the requirements of the City of Bentonville – Water Utilities Department Specifications 2021.

2.3 TRACE WIRE

A. Trace wire shall be 12-guage solid coated copper
B. Jacket color shall be blue
C. Connectors shall be used for all splices and repairs

2.8 VALVES

A. Valves, valve boxes and accessory materials shall conform to the requirements of the City of Bentonville – Water Utilities Department Specifications 2021.

2.16 TAPPING SLEEVES AND VALVES

A. Tapping sleeves shall be stainless steel.

2.17 BACKFLOW PREVENTORS

A. Comply with applicable local code and/or NFPA 24

2.18 FIRE HYDRANTS

A. Fire Hydrants: As required by City of Bentonville Utility Division and as shown on Construction Drawings.
B. Hydrant Extensions: Fabricate in multiples of 6-in. with rod and coupling to increase barrel length.
C. Hose and Steamer Connections: Match size and thread as required by applicable utility company, with two hose nozzles and one pumper nozzle.
D. Finish: Apply primer and 2 coats of enamel or special coating of color as required by applicable utility company.

2.19 DETECTION TAPE

A. Detectable tape shall be "Detect Tape" as manufactured by Allen Systems, Inc. or approved equal, and shall consist of a minimum thickness of 0.35 mils solid aluminum foil encased in a protective inert jacket that is impervious to all known alkalis, acids, chemical reagents and solvents found in the soil. The minimum overall thickness of the tape shall be 5.5 mils and the width shall not be less than 2 inches with a medium unit weight of 2 ½ pounds / 1 inch x 1000 feet.

The tape shall be color coded and imprinted with message as follows:

Type of Utility	Color Code	Legend
Water	Safety Precaution Blue	Caution, Buried Water Line Below

2.20 DISINFECTION & TESTING

A. Test and disinfect water systems in accordance with the requirments of the City of Bentonville – Water Utilities Department Specifications 2021.

2.21 ACCESSORIES

A. Thrust Blocking: Place min. 2,500 psi concrete to provide sufficient bearing area to transmit unbalanced thrust from bends, tees, caps, or plugs to undisturbed soil. Refer to applicable detail on construction drawings for requirements.
B. Locked or restrained joint fittings shall be provided in addition to thrust blocking requirements at vertical and horizontal changes in direction, as required.

PART 3 EXECUTION

3.1 GENERAL

A. Construct all waterline in accordance with the requirement of the City of Bentonville – Water Utilities Department Specifications 2021.

3.2 PREPARATION

A. Ream pipe ends and remove burrs prior to assembly.
B. Remove scale and dirt, on inside and outside, prior to assembly.
C. Prepare and properly align pipe for connections to equipment.
D. Protect benchmarks, property corners, and other survey monuments from damage or displacement. If marker needs to be removed it shall be referenced by licensed land surveyor and replaced, as necessary, by same.

3.3 BEDDING

A. Excavate pipe trench and place bedding material in accordance with Section 31 23 33.

3.4 INSTALLATION - PIPE AND FITTINGS

A. Maintain separation of water main from sanitary and storm sewer piping in accordance with state or local codes.
B. Install pipe and fittings in accordance with AWWA C600.
C. Install pipe to allow for expansion and contraction without stressing pipe or joints as specified by pipe manufacturer.
D. Install access fittings in accordance with local codes to permit disinfection of water system performed under this Section.
E. Connections with Existing Pipelines: Where connections are made between new work and existing piping, make connection using suitable fittings for conditions encountered. Make each connection with existing pipe at time and under conditions that cause the least interference with the operation of existing pipeline and in compliance with local utility company requirements.

F. Form and place concrete for thrust blocks or other specified methods of retainage at each change of direction or end of pipe main.
G. Establish elevations of buried piping in accordance with Section 31 23 33.
H. Backfill trench in accordance with Section 31 23 33

3.5 INSTALLATION - VALVES AND HYDRANTS

A. Install gate valves as indicated on Construction Drawings and supported on concrete pads with valve stem vertical and plumb. Install valve boxes in manner that will not transmit loads, stress, or shock to valve body. Center valve box over operating nut of valve vertical and plumb. Securely fit valve box together leaving cover flush with finished surface.
B. Install fire hydrant assemblies where and as indicated on Construction Drawings in vertical and plumb position with steamer/pumper nozzle pointed perpendicular to traffic where hydrant is adjacent to street, roadway, or parking lot drive or toward protected building unless otherwise directed by local authorities. Support hydrant assembly on concrete pad and firmly brace on side opposite inlet pipe against undisturbed soil and concrete thrust blocking. Place a minimum of 6 cu. ft of crushed stone or gravel around hydrant base and barrel after thrust blocking has cured at least 24 hours. Exercise care when backfilling and compacting so proper vertical position will not be altered.

3.6 HYDROSTATIC AND LEAK TESTING OF PRESSURE LINES

A. Upon completion of installation, thoroughly clean new pipe:
    1. Flush with water to remove dirt, stones, pieces of wood, or other obstructions that may have entered pipe during construction.
    2. Flush pipelines at a minimum rate of 2.5 feet per second for a duration suitable to Engineer.
B. Upon completion of installation, pressure test water pipelines in presence of Engineer and Municipalities Representative.
C. Provide water into pipeline for testing and flushing, including necessary:
    1. Pumps, gages (increment at 10 psi or less), and meters.
    2. Plugs and caps.
    3. Temporary blowoff piping to discharge water.
    4. Reaction blocking to prevent pipe movement during testing.
D. Water source for the pump suction shall be potable water from the distribution system; vessel used shall be approved by the Engineer.
E. Prevent contamination of the water distribution system.
F. After pipelines or isolated sections of pipelines have been filled with water, increase the pressure to test pressure by means of a pump.
G. Test pressure shall be 125 psi or 50 percent above normal operating pressure, whichever is greater.
H. Duration of hydrostatic leakage test shall be 2 hours, or as specified by Engineer.
I. Open interior valves, including fire hydrants and other appurtenances, open during tests.

J. After the specified test pressure has been applied, the entire pipeline shall be checked in the presence of the Engineer giving particular attention to parts of the pipeline and the appurtenances that are exposed.
K. If leaks are apparent, perform corrective work and replace material that is required to remedy the defect and stop the leaks at no extra cost to the Owner.
L. If no leaks were apparent or after corrective work has been completed, the pipelines shall be subjected to a leakage test at the pressure specified with a meter inserted in the test pump discharge line.
B. The maximum allowable leakage per hour shall be as defined by the City of Bentonville – Water Utilities Department Specifications 2021.
N. If test of pipe laid discloses leakage greater than the allowable leakage as calculated from the above formula, locate the leak or leaks and perform corrective work and replace material that is required in order to remedy the defect and stop the leak.
O. Corrective work shall be approved by the Engineer.

3.7 DISINFECTION OF WATER PIPING SYSTEM

A. PREPARATION
1. Verify that piping system has been cleaned, inspected, and pressure tested.
2. Perform scheduling and disinfection activity with startup, testing, adjusting, and balancing, and demonstration procedures, including coordination with related systems.

B. EXECUTION
1. Provide and attach equipment required to execute Work of this Section.
2. Utilize fire hydrants as blow-off points when possible.
3. Fire hydrants shall not be used for sample points.
4. Sample points constructed shall be a 3/4-inch or 1 inch copper riser pipe that shall extend adequately above the ground surface.
5. During application of chlorine solution, prevent solution from flowing back into the distribution system.
6. Disinfect piping system by one of the three following methods:
   A. Tablet method:
      i. Use this method only if water line can be kept clean and dry during installation.
      ii. Place calcium hypochlorite tablets in water line during installation to provide a chlorine dose of 25 mg/l.
      iii. Fill water line with potable water after completion of installation at a rate so that water within the water line will flow at a velocity no greater than 1 ft./sec.
      iv. Allow water to remain in pipe for a minimum of 24 hours for water temperature above 40 degrees F., and 48 hours for water temperature below 41 degrees F.

B. Continuous Feed Method:

i. Calcium hypochlorite granules may be placed in the water line during installation as option to the tablet method. Provide a chlorine dosage of 25 mg/l.

ii. After installation flush water line to remove particulates. Velocity in the water line shall not be less than 2.5 ft./sec.

iii. Fill water line with water dosed with chlorine. Chlorine concentration shall not be less than 25 mg/l free chlorine.

iv. Retain chlorinated water in water line for 24 hours. Operate valves and hydrants during this time to disinfect.

Chlorine residual in water shall not be less than 10 mg/l at the end of the 24-hour period.

7. Slug Method:

A. Place calcium hypochlorite granules in the water line during installation. Provide a chlorine dosage of 25 mg/l.

B. After flushing water line to remove particulates, slowly fill water line with water dosed with a 100 mg/l concentration of chlorine.

C. Retain chlorinated water in water line for 3 hours.

D. Measure the free chlorine residual in the water line as it is filled. If dosage drops below 50 mg/l during this time, stop flow and relocate chlorination equipment to the reduced level of where chlorine was detected. As flow is resumed, apply chlorine to restore the free chlorine in the water to not less than 100 mg/l.

E. Operate valves and hydrants during this time to disinfect

8. Final Flushing:

A. Flush water from water line until chlorine measurements are not higher than the chlorine residual that are found in the existing distribution system.

B. Inspect environment where the chlorinated water is to be discharged. Add a neutralizing chemical as the chlorinated water is being discharged if area is in threat of environmental damage from the chlorinated water.

9. Bacteriological Tests:

A. After final flushing and prior to the new water line be connected to the existing distribution system, two consecutive sets of acceptable water samples collected from the new water line and taken at least 24 hours apart shall be submitted to the bacteriological laboratory at the Arkansas Department of Health in Little Rock, Arkansas.

B. Samples shall be tested for bacteriological quality in accordance with Standard Methods for the Examination of Water and Wastewater per the American Public Health Association, AWWA, and Water Environment Association (latest edition) and shall show the absence of coliform organisms.

C. If samples collected are positive, the disinfecting procedures and samples shall be repeated until two consecutive day samples are tested safe.

3.8 SERVICE CONNECTIONS

A. Provide water service connection in compliance with utility company requirements including reduced pressure backflow preventor if required and water meter with by-pass valves and sand strainer.

3.9 TRACE WIRE

A. Run trace wire continuous from valve box to valve box, meter box and other access points. Bring wire up inside boxes in an accessible fashion. Wrap wire around, or tape wire to each pipe section. Join wire segments by soldering or by using approved wire nuts. Pipe testing shall include following trace wire. Any wire breaks or incomplete splices shall be repaired by the Contractor at no additional expense. Include trace wire in the price for pipe.

END SECTION

SECTION 33 31 13
SANITARY SEWER SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Sanitary sewer drainage piping, fittings, accessories, cleanouts, and bedding.
B. Connection of site and/or building sanitary sewer system to municipal sanitary sewer systems.

1.2 RELATED REQUIREMENTS

A. Section 31 23 33 - Excavation, Backfill, and Compaction for Utilities
B. Local governing authority and code requirements

1.3 PUBLIC WORK

A. Comply with the City of Bentonville – Water Utilities Department Specifications 2021. If conflict should be found between this section and city standards for Public Utilities, city standards shall be the priority. It shall be the Contractor's responsibility to obtain city standard water and sewer specifications and comply with the minimum requirements.

1.4 REFERENCE STANDARDS

A. American Society for Testing and Materials (ASTM) latest edition

A 74	Cast Iron Soil Pipe and Fittings
A 746	Ductile Iron Gravity Sewer Pipe
C 12	Practice for Installing Vitrified Clay Pipe Lines
C 14	Concrete Sewer, Storm Drain, and Culvert Pipe
C 76	Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
C 425	Compression Joints for Vitrified Clay Pipe and Fittings
C 443	Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets
C 564	Rubber Gaskets for Cast Iron Soil Pipe and Fittings
C 700	Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated
D 1785	Polyvinyl Chloride (PVC) Plastic Pipe, Schedules 40, 80, and 120
D 2321	Underground Installation of Flexible Thermoplastic Sewer Pipe
D 3034	Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
F 477	Elastomeric Seals (Gaskets) for Joining Plastic Pipe
F 949	Polyvinyl Chloride (PVC) Pipe and Fittings

B. American Association of State Highway and Transportation Officials (AASHTO) latest edition

M 252	Corrugated Polyethylene Drainage Tubing
M 294	Polyvinyl Chloride (PVC) Pipe and Fittings

C. American Water Works Association (AWWA) latest edition

C111	Rubber-Gasket Joints for Ductile Iron Pressure Pipe and Fittings

1.5 QUALITY ASSURANCE

A. Compaction testing will be performed in accordance Section 31 23 33

B. Test sanitary sewer pipe system installed below grade and outside building in accordance with the following procedures:

1. Perform testing of manhole construction, pipe materials, joints, or other materials incorporated into construction of sanitary sewer system to determine leakage and watertightness. In event state or local code requires more stringent test, the more stringent shall apply.
2. Flexible Pipe Deflection Testing:

2.1 Allowable Deflection:
Maximum allowable pipe deflection shall not exceed 5 percent of nominal inside diameter.

2.2 Mandrel:
Mandrel, go/no-go, device shall be cylindrical in shape and constructed with either 9 or 16 evenly spaced arms or prongs. Mandrels with less arms will be rejected as not sufficiently accurate. Contact length of mandrel's arms shall equal or exceed nominal inside diameter of sewer to be inspected. Critical mandrel dimensions shall carry tolerance of 0.01-in. maximum. Mandrel and necessary equipment for mandrel test shall be provided by Contractor.

2.3 Procedure:
Mandrel shall be hand-pulled through flexible pipe sewer lines no earlier than 30 days after trench has been completely backfilled and compacted. Sections of sewer not passing mandrel shall be uncovered and rebedded, rerounded, or replaced to satisfaction of the Owner or his designated representative or Governing Agency. Repaired section shall be retested.

2.4 Mandrel O.D. (outside diameter):
Outside diameter of mandrel shall be set according to the following table:

Nominal Diameter, in.	Mandrel O.D., in.
4	3.60
6	5.40
8	7.12
10	8.80
12	10.44
15	12.90
18	15.30

2.5 Contractor's Warranty:
The Owner or his designated representative or Governing Agency reserves the right to mandrel test flexible pipe sewer line before acceptance, and also prior to expiration of first year of operation. If previously accepted line fails mandrel test performed during first year of operation, defects must be corrected at Contractor's expense.

C. Air Testing of Gravity Sewers:

1. Procedure:

4.1.1 Plug pipe outlets with suitable test plugs and brace each plug securely.

4.1.2 Pipe air supply to pipeline to be tested in such manner that air supply may be shut off, pressure observed, and air pressure released from pipe without workmen entering manhole.

4.1.3 Add air slowly to portion of pipe under test until internal pressure of line is raised to approximately 4 psig, but less than 5 psig.

4.1.4 Shut air supply off and allow at least 2 minutes for air pressure to stabilize.

4.1.5 When pressure has stabilized and is at or above starting test pressure of 3.5 psi, start test.

4.1.6 Determine time in seconds with stopwatch for pressure to fall 0.5 psig so that pressure at end of time is at or above 3.0 psig.

4.1.7 Compare observed time with minimum allowable times in chart on following page for pass/fail determination.

1 Nominal Pipe Diameter (inches)	2 Minimum Time (min:sec.)	3 Length for Minimum Time (feet)	4 Time for Longer Length (sec.)	SPECIFICATION TIME FOR LENGTH (L) SHOWN (MIN:SEC)							
				100 ft	150 ft	200 ft	250 ft	300 ft	350 ft	400 ft	450 ft
4	1:53	597	.190L	1:53	1:53	1:53	1:53	1:53	1:53	1:53	1:53
6	2:50	398	.427L	2:50	2:50	2:50	2:50	2:50	2:50	2:51	3:12
8	3:47	298	.760L	3:47	3:47	3:47	3:47	3:48	4:26	5:04	5:42
10	4:43	239	1.187L	4:43	4:43	4:43	4:57	5:56	6:55	7:54	8:54
12	5:40	199	1.709L	5:40	5:40	5:42	7:08	8:33	9:58	11:24	12:50
15	7:05	159	2.671L	7:05	7:05	8:54	11:08	13:21	15:35	17:48	20:02
18	8:30	133	3.846L	8:30	9:37	12:49	16:01	19:14	22:26	25:38	28:51
21	9:55	114	5.235L	9:55	13:05	17:27	21:49	26:11	30:32	34:54	39:16
24	11:20	99	6.837L	11:24	17:57	22:48	28:30	34:11	39:53	45:35	51:17
27	12:45	88	8.653L	14:25	21:38	28:51	36:04	43:16	50:30	57:42	46:54
30	14:10	80	10.683L	17:48	26:43	35:37	44:31	53:25	62:19	71:13	80:07
33	15:35	72	12.926L	21:33	32:19	43:56	53:52	64:38	75:24	86:10	96:57
36	17:00	66	15.384L	25:39	38:28	51:17	64:06	76:55	89:44	102:34	115:23

4.2 Safety Precautions:

Low pressure air test may be dangerous to personnel if, through lack of understanding or carelessness, line is overpressurized or plugs are installed improperly. It is extremely important that various plugs be installed so as to prevent the sudden expulsion of poorly inflated plug. As example of hazard, force of 250-lb is exerted on 8-in. plug by internal pressure of 5 psi. Observe following safety precautions:

4.2.1 No person shall be allowed in manholes during test or when plugged pipe is under pressure.

4.2.2 Gauges, air piping manifolds, and valves shall be located at top of ground.

4.2.3 Install and brace plugs securely.

4.2.4 Do not overpressurize lines.

4.3 Groundwater Elevation:

If pipeline to be tested is below groundwater level, starting test pressure shall be increased by 0.433 psi for each foot groundwater level is above invert of sewer pipe. In no case shall starting test pressure exceed 9.0 psig.

4.4 Acceptance of Installation:
No gravity sewer or manhole will be accepted that does not comply with minimum requirements of tests described in herein.

4.5 Test Equipment:
Necessary equipment to perform air test in accordance with Specifications shall be provided by Contractor. Test gauge shall preferably have incremental division of 0.10 psi and have accuracy of at least 0.04 psi. In no case shall test gauge be used which has incremental divisions of greater than 0.25 psi. Gauge shall be of sufficient size in order to determine this accuracy.

4.6 Furnish 1 copy of gravity sewer and manhole test results to the Owner or his designated representative and Governing Agency upon completion of gravity sewer system backfilling operations.

1.5 SUBMITTALS

A. Product Data: Provide data of pipe materials, pipe fittings, and accessories. Each submittal shall reference the applicable City of Bentonville specification section number.

B. Manufacturer's Certificate: Certify that products meet or exceed specified local requirements.

1.6 PROJECT RECORD DOCUMENTS

A. Accurately record actual locations of pipe runs, connections, cleanouts, and invert elevations.

B. Identify and describe unexpected variations to subsoil conditions and location of uncharted utilities.

1.7 PROJECT CONDITIONS

A. Coordinate work with sanitary sewer connections to structures and to municipal sewer system.

PART 2 PRODUCTS

2.1 SEWER PIPE MATERIALS

A. Sanitary sewer piping, buried **beyond 5 feet** of building
   1. PVC Pipe: ASTM D 2665 or ASTM D 3034
      a. Pipe: PVC SDR 26

2.2 PIPE ACCESSORIES

A. Pipe Joints: Mechanical clamp ring type, stainless steel expanding and contracting sleeve, neoprene ribbed gasket for positive seal.

B. Fittings: Same material as pipe molded or formed to suit pipe size and end design, in required tee, bends, elbows, cleanouts, reducers, traps, etc.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify items specified in other sections are properly sized and located.
B. Verify that trench cut and excavation is ready to receive work and excavations, dimensions, and elevations are as indicated on Construction Drawings.

3.2 PREPARATION

A. Hand trim excavations to required elevations. Correct overexcavation with bedding material.
B. Remove large stones or other hard matter which could damage pipe or impede consistent backfilling or compaction.

3.3 BEDDING

A. Excavate trench and place bedding material in accordance with Section 31 23 33.

3.4 INSTALLATION – PIPE

A. Install pipe, fittings, and accessories in accordance with ASTM C 12, ASTM C 14, ASTM D 2321, or manufacturer's instructions and local requirements.
B. Lay pipe to slope gradients noted on Construction Drawings.
C. Install pipe on bedding in accordance with Section 31 23 33.
D. Refer to Section 31 23 33 for trenching requirements. Do not displace or damage pipe when backfilling and compacting.
E. Refer to Section 33 39 00 for manhole requirements.
F. Connect to building sanitary sewer outlet and municipal sewer system as indicated on Construction Drawings.

END OF SECTION

SECTION 33 41 00
STORM SEWER SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Site storm sewer drainage piping, fittings, accessories, and bedding.
B. Connection of site and/or building storm water drainage system to municipal storm sewers.

1.2 RELATED REQUIREMENTS

A. Section 31 23 33 - Excavation, Backfill, and Compaction for Utilities
B. Section 33 43 00 - Corrugated High Density Polyethylene (HDPE) Pipe

1.3 PUBLIC WORK

A. Comply with the City of Bentonville – Stormwater Management and Drainage Manual 2008.. If conflict should be found between this section and city standards for public utilities, city standards shall be the priority. It shall be the Contractor's responsibility to obtain city standard water and sewer specifications and comply with the minimum requirements.

1.4 REFERENCE STANDARDS

A. American Association of State Highway and Transportation Officials (AASHTO) latest edition
   - M 198 Joints for Circular Concrete Sewer and Culvert Pipe Using Flexible Watertight Gaskets
   - M 252 Corrugated Polyethylene Pipe, 3" inch to 10" inch Diameter
   - M 294 Corrugated Polyethylene Pipe, 12' inch to 60" inch Diameter
B. American Society for Testing and Materials (ASTM) latest edition
   - C 14 Nonreinforced Concrete Sewer, Storm Drain, and Culvert Pipe
   - C 76 Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
   - C 443 Joints for Circular Concrete Pipe and Manholes, Using Rubber Gaskets
   - C 990 Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants
   - F 794 Polyvinyl Chloride (PVC) Pipe and Fittings

1.5 SUBMITTALS

A. Product Data: Provide data on pipe materials, pipe fittings, and accessories.
B. Manufacturer's Certificate: Certify that products meet or exceed specified local requirements.

1.6 PROJECT RECORD DOCUMENTS

A. Accurately record actual locations of pipe runs, connections, catch basins, cleanouts, and invert elevations.
B. Identify and describe unexpected variations to subsoil conditions and location of uncharted utilities.
C. City-specific closeout requirements.

1.7 PROJECT CONDITIONS

A. Coordinate work with storm sewer connections to structures and to municipal storm sewer system.

PART 2 PRODUCTS

2.1 SEWER PIPE MATERIALS AND ACCESSORIES

A. Reinforced Concrete Pipe: Comply with requirements of ASTM C 76, Class III unless another class type is indicated on Construction Drawings, installed with flexible plastic, bitumen gaskets at joints. Gaskets shall comply with ASTM C 990-09, and shall be installed in strict accordance with pipe manufacturer's recommendations.
B. Corrugated High Density Polyehtlylene (HDPE) Pipe as specified in Section 33 43 00.
C. Corrugated High Performance Polypropylene (PP) as specified in Section 33 43 02

2.2 INLETS, CATCH BASINS AND JUNCTION BOXES

A. Lid and frame per details shown on Construction Drawings.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify items specified in other sections are properly sized and located.
B. Verify that trench cut and excavation is ready to receive work and excavations, dimensions, and elevations are as indicated on Construction Drawings.

3.2 PREPARATION

A. Hand trim excavations to required elevations. Correct over excavation with bedding material.
B. Remove large stones or other hard matter which could damage piping or impede consistent backfilling or compaction.
C. Protect benchmarks, property corners, and other survey monuments from damage or displacement. If marker needs to be removed it shall be referenced by licensed land surveyor and replaced, as necessary, by same.

3.3 BEDDING

A. Excavate pipe trench and place bedding material in accordance with Section 31 23 33.

3.4 INSTALLATION - PIPE

A. Install pipe, fittings, and accessories in accordance with ASTM C 14, ASTM D 2321, or manufacturer's instructions and state or local requirements.
B. Install pipe on bedding in accordance with Section 31 23 33.
C. Lay pipe to slope gradients noted on Construction Drawings.
D. Refer to Section 31 23 33 for trenching requirements. Do not displace or damage pipe when backfilling and compacting.

3.5 INSTALLATION - CATCH BASINS, INLETS, AND JUNCTION BOXES

A. Form bottom of excavation clean and smooth to correct elevation.
B. Form and place cast-in-place concrete base pad in accordance with section 03 30 00, with provision for storm sewer pipe to be placed at proper elevation.
C. Form and place cast-in-place concrete walls, sleeved at proper elevation to receive storm sewer pipe in accordance with details shown on Construction Drawings.
D. Form and place cast-in-place top of structure in accordance with details shown on Construction Drawings.

END OF SECTION

SECTION 33 43 00
CORRUGATED HIGH DENSITY POLYETHYLENE (HDPE) PIPE

PART 1. GENERAL

1.01 SUMMARY

A. Provide smooth interior Corrugated High Density Polyethylene (HDPE) Pipe with silt tight and leak resistant joint.

1.02 RELATED SECTIONS

A. Section 31 23 33 – Excavation, Backfilling, & Compacting for Utilities

1.03 REFERENCES

A. American Association of State Highway and Transportation Officials, 444 North Capitol Street, N.W., Suite 225, Washington, DC 20001.
   1. AASHTO M252 - Standard Specification for Corrugated Polyethylene Pipe, 4-inch to 10" diameter.
   2. AASHTO M294 - Standard Specification for Corrugated Polyethylene Pipe, 12-inch to 48-inch diameter.
   3. AASHTO MP7-97 - Standard Specification for Corrugated Polyethylene Pipe, 54-inch to 60-inch diameter.

B. American Society for Testing and Materials, 1961 Race Street, Philadelphia, Pennsylvania 19103.
   1. ASTM D2321 - Recommended Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.
   2. ASTM D3350 - Standard Specification for Polyethylene Pipe and Fittings Materials.
   3. ASTM F477 - Standard Specifications for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

1.04 SUBMITTALS

A. Submit in accordance with General Conditions.

B. Submit manufacturers certificate of compliance.

PART 2. PRODUCTS

2.01 PIPE MATERIAL

A. Pipe and fitting material shall be high-density polyethylene meeting ASTM D3350 minimum cell classification 324420C for 4-inch to 10-inch diameters, or 335420C for 12-inch through 60-inch diameters.

2.02 PIPE REQUIREMENTS

A. Pipe manufactured for this specification shall comply with the requirements for test methods, dimension, and markings found in AASHTO M252, AASHTO M294 and/or AASHTO MP7-97. The prescribed sizes of pipe are nominal inside diameters. Pipe sizes shall be no less than 99% of nominal inside diameter and have a nominal length of 20.0 feet.

B. For 4-inch to 10-inch diameters, the pipe supplied shall be smooth Interior and Annular Exterior Corrugated High Density Polyethylene (HDPE) Pipe meeting the requirements of AASHTO M252, Type S.
C. For 12-inch to 42-inch diameters, the pipe supplied shall be smooth Interior and Corrugated High Density Polyethylene (HDPE) Pipe meeting the requirements of AASHTO M294, Type S or D.
D. For 48-inch to 60-inch diameters, the pipe supplied shall be smooth Interior and Corrugated High Density Polyethylene (HDPE) Pipe meeting the requirements of AASHTO MP7-97, Type S or D.
E. Manning's "n" value for use in design shall not be less than 0.012.

2.03 FITTINGS

A. Fittings shall conform to AASHTO M252, M294 or MP7-97. Fabricated fittings shall be welded on the interior and exterior at all junctions.

2.04 JOINT PERFORMANCE

A. Pipe shall be joined with bell-and-spigot joints meeting ASHTO M252, M294 or MP7-97. Joints shall provide a silt-tight and leak resistant joint.
B. Pipe joints shall incorporate a gasket meeting the requirements of ASTM F477 to form a silt tight and leak resistant connection. Joints shall exceed the soil tight joint performance criteria of AASHTO Standard Specifications for Highway Bridges, Division II, Section 26.
C. Gaskets shall be installed by the pipe manufacturer and covered with a removable wrap to ensure the gasket is free from debris.
D. A joint lubricant supplied by the manufacturer shall be used on the gasket and bell during assembly.

2.05 ACCEPTABLE MANUFACTURERS

A. Smooth Interior and Corrugated HDPE Pipe shall be as manufactured by:
   1. Hancor, Inc.
   2. Advanced Drainage Systems, Inc.
   3. Engineer approved equal.

PART 3. EXECUTION

3.01 INSTALLATION

A. Installation shall be in accordance with ASTM D2321 with the exception that minimum cover in trafficked areas shall be one foot for 4-inch to 48-inch pipe and 24-inches for 54-inch and 60-inch pipe.
B. Backfill the pipe with material meeting the requirements of ASTM D2321 Class I, II or III subject to approval of the Engineer. Backfill shall be placed in six to12 inch lifts compacted to a minimum 90% standard proctor or as designated by the Engineer.
C. Trench width should be wide enough to place and compact backfill around the entire pipe. The trench width shall be outside diameter +24-inches for pipe sizes 12-inch to 30-inch, and outside diameter +36-inches for pipe sizes 36-inches to 60-inches.

END OF SECTION

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. All of the Contract Documents, including General and Supplementary Conditions and Division 1 General Requirements, apply to the work of this Section and are hereby made a part of this Section.

B. Examine all Drawings and other Sections of the Specifications for requirements therein affecting the work of this trade.

1.2 SCOPE OF WORK

A. The work of this section includes, but is not limited to, the following:

1. Providing and installing landscape subdrainage system.
2. Providing and installing site wall drainage.
3. Protecting and maintaining the drainage system and completed work.
4. Warranty and Maintenance.
5. Coordination with other Trades.
6. Clean up.

1.3 RELATED WORK UNDER OTHER SECTIONS

A. Carefully examine all of the Contract Documents for requirements that affect the work of this section. Other specifications sections which directly relate to the work of this section include, but are not limited to, the following:

1. Section 31 20 00 – Earthwork
2. Section 32 84 00 – Irrigation
3. Section 32 91 00 – Planting Soils System
4. Section 32 93 00 – Planting and Fine Grading

B. Contract work subject to Specifications not in Project Manual:

1. Standard Specifications of the State of Arkansas Department of Transportation (Latest Edition).
2. City of Bentonville Standard Specifications (Latest Edition).

1.4 REFERENCES

A. General: Refer to Division 1 References Section.

B. AASHTO: American Association of State Highway and Transportation Officials.

1. AASHTO M 252 Corrugated Polyethylene Drainage Tubing

2. AASHTO M 288 Standard Specification for Geotextiles

C. ASTM: American Society of Testing Materials.

1. ASTM C 33 Concrete Aggregates
2. ASTM C 117 Test Method for Material Finer than 0.075mm (No. 200) Sieve in Mineral Aggregates by Washing
3. ASTM C 136 Method for Sieve Analysis of Fine and Coarse Aggregates
4. ASTM C 150 Portland Cement
5. ASTM C 822 Terminology Relating to Concrete Pipe and Related Products
6. ASTM D 2321 Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity Flow Applications
7. ASTM F 412 Definition of Terms Relating to Plastic Piping Systems
8. ASTM D 3212 Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
9. ASTM F 477 Elastomeric Seals (Gaskets) for Joining Plastic Pipe

1.5 SUBMITTALS

A. Submittals shall conform to Section 01 33 00 – Submittal Procedures.

B. Submit certificates from manufacturers of the following items certifying that the following materials comply with the requirements specified in this Section:

1. Perforated HDPE Underdrain Pipe
2. Panel Pipe
3. Aggregate Drainage System
4. Geotextile Filter Fabric

C. Submit, for testing, to a certified testing laboratory, one quart representative sample of each porous granular material proposed as backfill around the subdrains

1. Submit the sample in a clean, sturdy sealed container or bag that shall not permit loss or contamination of any kind of the material.
2. Clearly label the container or bag of the sample with: Contract location, title and number; the name of the material supplied; and location of the source.
3. The Landscape Architect will approve or disapprove the proposed material within 21 days after receipt of the laboratory certification.
4. Do not deliver material to the construction site from any source until the Landscape Architect has approved the material from that source.

D. Shop Drawings: Submit shop drawings showing layout, inverts, and product components, including accessories for drainage piping and all drainage connections to composites.

E. Submit catalog cuts of pipes and geotextile for the Landscape Architect’s approval.

F. Submit for Landscape Architect's approval methods for prevention of accumulation of groundwater and alternate methods of line and grade control where applicable.

G. Submit "As-built" drawings in accordance with Section 01 77 00 – Contract Closeout.

1.6 QUALITY ASSURANCE

A. Qualifications:

1. Installer Qualifications: Installer experienced to perform work of this type, who has specialized in the installation of work similar to that required for this project who can comply with manufacturer's warranty requirements, and who is an authorized applicator as determined by drainage manufacturer.

2. Manufacturer Qualifications: Manufacturer with a minimum of 10 years experience in underdrainage systems, capable of providing technical support in the application of the drainage system.

B. Pre-Installation Meetings: Conduct pre-installation meeting to verify project requirements, substrate conditions, manufacturer's installation instructions and manufacturer's warranty requirements.

C. The Landscape Architect will visually inspect pipe when delivered to the construction site. Damaged material or material not meeting the requirements of this Section shall be removed from the construction site and replaced at no cost to the Owner.

D. The Landscape Architect may inspect pipe at the place of manufacture.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Packing, Shipping, Handling and Unloading: Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact. Schedule deliveries to avoid construction delays but minimize jobsite storage.

B. Comply with the manufacturer's instructions for unloading, storing and moving all materials.

C. Care shall be taken when storing pipe and appurtenances so as not to damage any public or private property. Any property so damaged shall be repaired at the Contractor's expense and at the approval of the Landscape Architect and Construction Manager.

D. Store Aggregate Drainage System Pipe sections under tarp to protect from sunlight, when time from delivery to installation exceeds one week.

1.8 PROJECT CONDITIONS/ SITE CONDITIONS

A. When the pipe is bedded in a drainage layer the pipe shall be installed at the same time as the drainage layer.

1.9 WARRANTY

A. Manufacturer's Warranty: Submit manufacturer's standard warranty document executed by authorized company official.

1. Manufacturer's Warranty:
   (a) Extended 15 year Drainage Warranty.

1.10 PERMITS

A. The Contractor shall be responsible for obtaining all required permits for the work in this Section.

PART 2 PRODUCTS

2.1 UNDERDRAIN PIPE

A. Provide corrugated single wall heavy duty polyethylene (HDPE) (100% post-consumer recycled) resins pipe, conforming to ASTM F405 and F667.

1. NPS 6 and Smaller: ASTM F 405 or AASHTO M 252, Type CP; corrugated, for coupled joints.
2. Size as shown on Contract Drawings.
3. Perforations shall occur only on the underside of the pipe.
4. Provide perforated pipe under planted areas and non-perforated pipe under pavements and at connections into drainage structures.
5. Pipe Accessories: Couplings, end caps, tees, wyes, end plugs shall be heavy duty polyethylene resins, conforming to ASTM F405 and F667
6. Perforated High Density Polyethylene (HDPE) Pipe shall be from one of the following manufacturers or an approved equivalent:
   (a) Advanced Drainage Systems, Inc.
   4640 Trueman Blvd.
   Hilliard, OH 43026
   Phone: 800-821-6710
   (b) JM Eagle, Inc.
   5200 West Century Boulevard
   Los Angeles, CA 90045
   Phone: 800-621-4404
   (c) Crumpler Plastic Pipe, Inc.
   PO Box 2068, Highway 24 West;
   Roseboro, NC 28382
   Phone: 800-334-5071
   (d) or approved equal.

2.2 FILTER FABRIC

A. Landscape Drainage Filter Fabric:

1. A drainage-type non-woven geotextile fabric shall be used as a separation layer to prevent the surrounding in-situ subgrade soil from migrating into the underdrainage system. The geotextile is used to line the entire trench excavation prior to placement of any crushed stone and underdrainage piping. The permeability of the drainage fabric shall be a minimum of 120 gal/min/sq.ft.

2. Drainage filter fabric shall meet the following Minimum Average Roll Value (MARV) specifications across the weave:

Property	Requirement	Requirement
Grab Tensite Strength	ASTM D4632	90 lbs. min.
Grab Tensite Elongation	ASTM D4632	25% max.
Trapezoidal Tear Strength	ASTM D4533	40 lb. min
Mullen Burst Strength	ASTM D3786	130 psi. min.
Puncture Strength	ASTM D4833	60 lbs. min.
UV Resistance	ASTM D-4335	70% at 500 hrs min.
Apparent Opening	ASTM-D-4751	40-80 US Sieve
Permeability	ASTM D-4491	120 gal/min/ft.2 min.

3. Acceptable manufacturers include but are not limited to:
   (a) TenCate, Inc.
   365 South Holland Drive
   Pendergrass, GA 30567
   Phone: 706-693-2226
   Phone: 888-795-0808
   (b) Carthage Mills
   4243 Hunt Road
   Cincinnati, OH 45242
   Phone: 513-794-1600
   Phone: 800-543-4430
   (c) Or Approved Equal.

2.3 PANEL PIPE

A. Panel Pipe shall be as manufactured by:

1. "AdvanEDGE", ADS, Inc.
   4640 Trueman Blvd.
   Hillard, OH 43206

Phone: 800.821.6710

2. "FibarDrain", by The Fibar Group LLC
   80 Business Park Drive, Suite 300
   Armonk, NY 10504-1705
   Phone: 800.342.2721
   Fax: 914.273.8659
3. Approved equivalent:

B. Minimum Flow Rate: 10 gpm/ft

C. Pipe shall be furnished with filter fabric sock for standard drainage applications.

D. Size shall be as shown on the Drawings.

E. Provide all miscellaneous fittings, couplers, and fastenings to deliver a complete operational system.

2.4 AGGREGATE DRAINAGE SYSTEM

A. Aggregate Drainage System shall be as manufactured by the following, or approved equal:

1. "EZ-flow", NDS, Inc.
   21820 Burbank Blvd, Suite 200
   Woodland Hills, CA 91367
   800.726.1998

B. Pipe: High Density Polyethylene (HDPE),corrugated and perforated.

C. Aggregate: Expanded Polystyrene aggregate made from 100% recycled Polyethylene. Aggregate shall have a measured void space of 57%

D. Size: 7" diameter

E. Flow Rate: 80.8 gpm/ft

F. Provide all miscellaneous fittings, couplers, and fastenings to deliver0 a complete operational system.

2.5 SAND BLANKET

A. Sand Blanket shall be Coarse Sand per Section 32 91 13.19 – Planting Soil System Procurement.

2.6 DRAINAGE GRAVEL

A. Underdrainage Pipe Filtration Gravel:

1. Washed aggregate for use as backfill with Perforated HDPE shall be as shown on the Contract Drawings and in accordance with Section 312000 – Earthwork.

2. The perforated underdrainage pipes shall require a minimum 6 inch gravel filtration encasement to protect the pipe from siltation.

3. In order to best match the sand particle size and allow for laminar inflow of water, an AASHTO gravel size of #7 or #78 is required.

PART 3 EXECUTION

3.1 EXAMINATION

A. Site Verification of Conditions: Verify that the substrate conditions are acceptable for product installation in accordance with manufacturer's instructions and in compliance with the Drawings. Do not proceed with drainage installation until substrate conditions are acceptable for compliance with manufacturer's warranty requirements.

B. Notify Construction Manager and Landscape Architect if unacceptable conditions are present and wait to proceed with work until the condition has been corrected. Do not proceed in uncertainty.

3.2 PREPARATION

A. Adjacent Surfaces Protection: Protect adjacent work areas and finish surfaces from damage during installation operations.

B. Substrate Cleaning: Clean substrate that is to receive drainage. Remove loose debris and other harmful contaminants that will affect performance of drainage composite.

3.3 UNDERDRAINAGE SYSTEM INSTALLATION

A. Excavation

1. Coordinate construction of landscape subdrainage system with installation of Planting Soil layers. See Section 32 91 19.13. When the pipe is bedded in a Planting Soil layer the pipe shall be installed at the same time as the Planting Soil layer. Otherwise, excavate pipe trench in accordance with Section 31 20 00 – Earthwork in the location and to the depth shown on the Contract Drawings.

2. If ground water is encountered, prevent accumulation of water in trench by methods approved by the Civil Engineer.

B. Pipe Installation - General

1. Prior to the start of construction, the method for control of alignment and grade shall be submitted for approval. The method shall be a laser system or grade board setup, to establish a reference grade and alignment control directly above or within the pipe. Use of other equipment may be substituted if in the opinion of the Landscape Architect, the alternate system produces equivalent accuracy. Pipe invert elevations shall be checked at intervals no greater than 25 feet and shall be constructed to the lines and grades as shown on the Drawings.

(a) Also refer to Section 01 71 23 –Field Engineering.

2. Coordinate Installation of solid pipe under pavements that may need to be in place before the planting soils and under drainage system are installed.

3. All lines shall be positively pitched. Take extreme care to eliminate sags or drops in pipeline that would obstruct or slow down the flow of water.

4. Connect under drainage system to storm drainage structures. Pipe connection shall be fully embedded into the drainage structure and shall be sealed with a non-shrink grout. Coordinate connections to not delay work.

   (a) Use manufacturer's connection system for connecting different drainage pipe/systems to each other.

5. Use fittings for branch connections and bends. Use proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.

6. Inspect each pipe and fitting before and after installation; remove those found defective from site and replace with new. Provide proper facilities for lowering sections of pipe into trenches.

7. For plastic pipe installations, remove all rocks or other hard objects larger than 1 1/2 inches in size from the area within 12 inches of the pipe.

8. For plastic pipe installations, do not use blocking or mounding to bring the pipe to grade. Conform to the applicable requirements of ASTM D 2321.

9. Pipe beds in bedding material shall be rounded to accommodate the bottom quadrant of the pipe and to provide full support and uniform bearing for the entire length of the pipe barrel.

10. Take precautions to ensure that the interior of the pipeline remains clean during pipe jointing.

11. Make up the pipe joints in accordance with the manufacturer's instructions.

12. Care shall be taken not to damage or displace installed pipes during construction.

13. Where pipe is damaged or displaced, take remedial measures as directed by the Landscape Architect, at no additional cost to the Owner.

14. Close all opening in the pipeline temporarily with watertight wood blocks or bulkheads when pipelaying is stopped at the conclusion of the work period or interrupted for any reason.

15. Do not cover pipe until the Landscape Architect has approved the installation.

16. Coordinate connection of discharge with the site utility contractor.

17. HDPE Pipe shall be used at the base of planted areas, bio-swales, and as shown on the drawings. Provide vertical clean out pipes for all systems at a minimum of 250' o.c. Review locations of clean out with Landscape Architect as work proceeds.

C. Panel Pipe Installation

1. Install panel pipe and planting soils simultaneously.

2. After acceptance of subgrade, lay panel pipe on top of subgrade in accordance with the Drawings. Review layout with Landscape Architect.

3. Backfill to a depth of 6” above the top of the panel pipe with coarse sand. See Section 02950 for gradation requirements.

4. Joints shall be made by manufacturer supplied couplers. Use two coupling pins on each coupler. Couplers shall be placed under the filter fabric to prevent backfill infiltration. Secure the fabric with tape.

5. Outlets shall be placed as needed where Panel Pipe connects to round pipe.

6. End caps shall be used at all termination points to prevent soil infiltration into the system.

7. Positive pitch shall be maintained on all main lines and lateral lines.

8. Panel size shall be used on the benched planted slopes and anywhere else shown on the Drawings.

D. Aggregate Drainage System Installation

1. Install beginning at the outlet point and work upstream.

2. Use internal couplings provided by the manufacturer to connect pipe sections together.

3. To cut pipe to lengths other than ten-foot intervals, mark the mesh where cut needs to be made and carefully make a cross-sectional cut in the mesh to access Polystyrene Aggregate. Remove and set aside sufficient aggregate to expose the pipe and to re-connect the mesh to the pipe. Using an appropriate connector such as a nylon wire tie, reattach the mesh to the pipe, making sure remaining aggregate is properly contained. Cut the exposed polyethylene pipe to the measured length. Dispose of remaining aggregate properly.

4. At the end of the work day all upstream open ends of pipe shall be covered or plugged to prevent intrusion of dirt, debris and foreign objects.

5. Aggregate Drainage System shall be used on all site walls and as shown on the Drawings.

3.4 CLEANING AND PROTECTION

A. Cleaning: Remove temporary coverings and protection of adjacent work areas. Repair or replace damaged installed products. Clean installed products in accordance with manufacturer's instructions before owner's acceptance. Remove construction debris from project site and legally dispose of debris.

B. Take extreme care to protect planting soils installed by others.

C. Protection: Protect installed products finished surfaces from damage during construction.

END OF SECTION

SECTION 33 46 16
SUB-DRAINAGE SYSTEMS
(DOWNSPOUTS)

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Sub-drainage system for roof drains and downspouts.

1.2 REFERENCES

A. American Society for Testing & Materials (ASTM):
   1. ASTM D2729 - Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
   2. ASTM D3350 - Standard Specification for Polyethylene Plastics Pipe and Fitting Materials.
   3. ASTM F405 - Standard Specification for Corrugated Polyethylene Tubing and Fittings.

PART 2 PRODUCTS

2.1 PIPE MATERIALS

A. Polyvinyl Chloride Pipe: Schedule 40, ASTM D2729; with required fittings.
B. Corrugated Polyethylene Drainage Pipe: ASTM D3350, non-perforated, with required fittings.

2.2 FILL MATERIAL

A. Type specified for remainder of building pad.

2.3 ACCESSORIES

A. Pipe transitions and pipe sleeves as required for installation.

PART 3: EXECUTION

3.1 EXAMINATION

A. Verify that excavation base is ready to receive work, and excavations, dimensions, and elevations are as indicated on Drawings.
B. Beginning of installation means acceptance of existing conditions.

3.2 PREPARATION

A. Hand trim excavations to required elevations. Correct over excavation with fill material of coarse aggregate.
B. Remove large stones or other hard matter which could damage drainage tile or impede consistent backfilling or compaction.

3.3 INSTALLATION

A. Install and join pipe and pipe fittings.
   1. Place pipe at elevations shown on drawings
   2. Install coarse aggregate bed and surrounding cover as indicated on Drawings, minimum 12-inch depth.
   3. Join pipe ends mechanically.
B. Do not disturb drainage system in subsequent backfilling compaction operations.
C. See Civil Drawings for pipe sizes and routing of sub-drainage system.

3.4 PROTECTION

A. Protect pipe from damage or displacement until backfilling operation begins.

END OF SECTION