CITY OF STATESVILLE
Public Works Department

The following standards are considered minimum acceptable standards for the construction of potable water lines as part of the City water distribution system. Where name brands are listed for specific components, these are acceptable in all cases. Equal brands can be used only upon specific approval in writing by the Director.

1/24/2020

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NOTE

The title, *ENGINEER,* used throughout these standards refers to the *DIRECTOR OF PUBLIC WORKS/CITY ENGINEER* for the City of Statesville.

SECTION 1.

GENERAL REQUIREMENTS - WATER

A. REQUIREMENTS:

1. All materials incorporated within the city's infrastructure shall be of domestic origin.

2. The contractor for this project shall furnish all labor, materials, tools, equipment and all else required for and to construct the water distribution system improvements complete, tested and placed into satisfactory operation, in accordance with the drawings, these Specifications, and the Engineers' requirements under them. The Contractor shall be responsible for furnishing details that are required, but not necessarily shown on the drawings, for the adequate and proper construction and operation of the piping work as required by the Engineers.

3. Every item mentioned, described, specified and/or referred to in these Specifications, and all items shown, indicated or implied by the construction of the piping work or the installation and operation of the equipment shall be furnished and installed complete in every respect; tested in all manners required and/or necessary; and made ready for complete and regular service, as intended. All materials and equipment of whatever nature shall be furnished by the Contractor in place in the project.

4. Insofar as possible, the existing water distribution system must be kept in operation at all times. The Contractor shall so organize and schedule his work as to cause the least inconvenience to the operation of the existing system. Should it become necessary to put any part of the existing distribution system out of operation, the Contractor, without cost to the City, shall make such temporary connections, alterations, etc., as may be required to keep the existing distribution system in operation.

5. Excavation through pavement shall be made using neat, uniform trench openings. The basis of payment for replacement of paving subbase and pavement shall be for a trench width not exceeding the trench width specified in the Detail Specifications for the pipe plus 2'.

B. PROJECT COMPLETION:

1. Upon completion of the construction work, the Contractor shall immediately remove all construction equipment, excess materials, tools, etc., from the site and leave same in a neat, orderly condition acceptable to the Engineers.

2. The Contractor shall perform tests on all parts of the project which he constructed and equipment which he furnished and/or installed, under the supervision of the Engineers to demonstrate that the pressure piping system and/or equipment performs in accordance with the requirements of the Specifications.

3. All equipment shall be drained and filled with new lubricants, and then thoroughly cleaned, removing all excess oil, grease, dirt, etc. All valves shall be cleaned and lubricated.

4. The Contractor shall be responsible for restoring all disturbed ground area and damaged crops, and replacing all disturbed property corners to the satisfaction of the Engineers.

END OF SECTION 1.

SECTION 3.

PRESSURE PIPING - GENERAL

A. EXTENT OF WORK:

1. The extent of the work shall be all pressure piping shown on the drawings, inside, outside and an integral part of structures, to the Contract limits including connecting to piping that may be existing at the time of construction.

2. The Contractor shall be responsible for furnishing details that are required, but not necessarily shown on the drawings, for the adequate and safe installation of the pressure piping work.

3. The Contractor shall strap all bends and other fittings subject to being blown off. The Contractor shall also form and pour concrete blocking as shown on the drawings or as directed by the Engineers.

4. All materials, equipment, apparatus, supplies, etc., used in this project, the methods of manufacture and/or construction and the methods of handling, placing, installing and/or erecting same shall conform to the following specifications. These material specifications apply to all items of the project wherein such materials are to be incorporated, unless otherwise specifically noted.

5. Special materials, special methods of manufacture and/or construction and special methods of handling, placing, installing, and/or erecting such special materials shall conform to the requirements noted in the detailed specifications applying to the various items of projects.

B. RIGHT-OF-WAY ON STATE CONTROLLED HIGHWAYS:

1. The right-of-way required by the Contractor for the actual work of excavation and/or trenching, the lineal distribution of pipe and the laying of pipe along the shoulder of State controlled highways will be the responsibility of the contractor. However, such arrangement as the Owner may make with the Department of Transportation, Division of Highways, for such right-of-way shall not relieve the Contractor for this Division of his responsibility for the safety of property and the public, nor from his liability for damage and/or injury thereto. The Contractor shall obtain all additional permits required and he shall maintain such day and night safety devices as may be required by either the State Department of Transportation, the City, or both, to insure adequate protection. The District Engineer shall be notified by letter when work on highway right-of-way is begun and a copy of same shall be provided to the Engineers. For purposes of final inspection, the District Engineer shall be notified in writing that all work on highway right-of-way has been completed. The Contractor must provide proof of acceptance by the Division of Highways before the project will receive final acceptance by the Engineers. However, the City to the extent possible, will obtain right-of-way encroachment permits from the North Carolina Department of Transportation, Division of Highways.

2. All work on or within street or highway right-of-ways, repairs to pavement, etc., shall be in accordance with the City of Statesville's requirements as well as the N.C. DOT

C. OTHER RIGHT-OF-WAY: Right-of-ways and easements outside of state controlled highways, required for the pipe lines and other structures incorporated in the work, will be furnished by the City. The Contractor shall confine his work to the limits of such right-of-way and shall take necessary precautions to protect property both within the right-of-way and adjacent thereto.

D. EXISTING UTILITY SERVICES:

1. Existing buried telephone cables and/or lines shall be field located prior to construction by the Contractor. The telephone company will assist the Contractor in such location work. The Contractor shall be responsible for repairing, or causing to be repaired, any overhead and/or buried telephone lines he might damage without additional cost to the City.

2. Existing gas mains and/or service lines shall be field located by the Contractor prior to construction. The gas company will assist the Contractor in such location work. The Contractor shall be responsible for repairing, or causing to be repaired, any gas main or service that he might damage, without additional cost to the City.

3. Existing water mains and/or service lines, sanitary sewer mains, manholes, storm sewers, etc., shall be field located by the Contractor prior to construction. The City will assist the Contractor in such location work. The Contractor shall be responsible for repairing or causing to be repaired, any water main or service that he might damage, without additional cost to the City.

4. Existing buried electricity transmission cables and/or lines shall be field located prior to construction by the Contractor. The electric utility company will assist the Contractor in such location work. The Contractor shall repair any overhead or buried electricity transmission lines that he might damage without additional cost to the City.

E. GROUTED RUBBLE RIP RAP: Grouted rubble rip rap shall be placed at the locations shown on the drawings and where directed by the Engineers to stabilize slopes and drainage ditches. The grouted rubble rip rap shall be installed according to the current standards and requirements of the North Carolina Department of Transportation, Division of Highways. The grouted rubble rip rap to be used with mortar shall be free from dirt, oil or other material that might prevent good adhesion with the mortar. At least 90% of the stone shall be not less than 8" wide by 12" long by 12" deep and shall be approximately rectangular in shape.

F. EXISTING RIGHT-OF-WAY MARKERS AND PROPERTY MARKERS: The Contractor shall employ a registered surveyor to relocate any right-of-way markers and/or property point or corner markers that may be disturbed during construction operations. The surveyor shall set reference points outside the construction limits before construction begins. Using these reference points, the surveyor shall relocate and reset the right-of-way markers and property markers at the completion of the project.

G. DETECTABLE TRACER TAPE: At all locations where nonmetallic piping is directly buried underground, the Contractor shall install a continuous 2" wide strip of detectable tracer tape above and parallel to the pipe. The tracer tape shall be made of tough inert plastic bonded to aluminum foil. Color shall be bright orange with 1 1/2" high black lettering repeated every 20 - 30". Lettering shall identify the pipe below with wording such as "Buried Water Line Below" or other wording as applicable and approved. Unless otherwise approved, the tape shall be laid to the extent possible, in continuous strips with minimum splices. The tape shall be buried approximately 8" below the finished grade level directly above the buried pipe. Installations of tracer tape shall be in strict conformance with the manufacturer's recommendations. The tracer tape shall be Alarmatape by Paul Potter Associates, Detectatape by Allen Systems, Inc., Terra Tape by Griffolyn Co., Inc., or equal.

H. CORPORATION STOPS: Water service corporation stops shall be constructed of bronze throughout, AWWA approved, Specifications C-800, latest edition. Corporation stops shall be manufactured by Hays Manufacturing Co., Mueller, Dresser Industries, or equal.

END OF SECTION 3.

SECTION 4.

CAST IRON AND DUCTILE IRON PIPE AND FITTINGS, MISCELLANEOUS PIPING:

A. MATERIALS: All pressure piping materials used on this project shall meet AWWA standards, section C, or be certified as meeting the North Carolina DEQ – Public Water Supply Section 15A; 18C .0400 specifications of ANSI/NSF Standard 61 Drinking Water System Components – Health Effects (including any subsequent amendments and additions). The pressure rating class of the pipe shall be in excess of the maximum design pressure within that section of the water distribution system. Pipe and fittings shall be slip joint, mechanical joint, or flanged joint as (1) called for in the proposal, or (2) as shown or called for in the drawing.

B. MECHANICAL JOINT CAST IRON PIPE:

1. Pipe shall be cast iron produced centrifugally in sand lined or metal molds, ANSI Standard Specification A21.6 or A21.8. Each pipe shall be provided with a mechanical joint socket on one end and the other end shall be plain. All joints shall be provided with rubber gaskets conforming to ANSI Standard Specification A21.11.

2. High strength cast iron tee head bolts and hex nuts shall be furnished in sufficient quantities to provide for each socket opening on pipe. These bolts shall have a minimum tensile strength of 50,000 pounds per square inch.

3. Cast iron glands shall be furnished in sufficient quantities to provide for each socket opening on pipe. These glands shall be made of high strength cast iron.

4. Mechanical joint pipe shall be cement lined and coated as specified hereinbefore for cast iron pipe.

C. DUCTILE CAST IRON PIPE:

1. Ductile cast iron pipe shall be manufactured in accordance with the latest revision of ANSI/AWWA C151/A21.51. Unless otherwise specified, thickness class shall conform to ANSI A21.50-1976.

2. Bells for push-on joints shall conform to the requirements of ANSI Standard A21.51, such as "Fastite", "Tyton", "Bell-Tite" or equal. Pipe shall be nominal 16', 18' or 20' lengths. Joint detail, including rubber gaskets shall conform to ANSI Standard Specification A21.11-17.

3. Pipe for direct burial shall be cement lines inside and bituminous coated inside and outside per ANSI/AWWA c104/A21.4. The exterior surface of unburied pipe shall receive one shop applied bituminous and two field coats of epoxy paint.

D. FITTINGS FOR CAST IRON AND DUCTILE IRON PIPE:

1. Unless otherwise approved by the Engineers or specified herein, all cast iron fittings for buried cast iron or ductile cast iron pipe shall be push-on joint type, class 250. Rubber gaskets and joint detail shall conform to ANSI Standard Specification A21.11-17.

2. The Contractor shall use Class 350 compact ductile iron fittings, mechanical joint. Mechanical joint shall conform to ANSI/AWWA A21.11/CIII. Wall and socket thicknesses shall be as specified in ANSI/AWWA A21.53/C153. Ductile iron shall be in accordance with ASTM A536 with minimum physical qualities of 70,000-psi tensile strength, 50,000-psi yield strength, and 5% elongation.

3. All cast iron or ductile cast iron fittings shall have cement mortar lining conforming to ANSI Standard A21.4, latest edition. Buried fittings shall be given a full coat inside and outside of a bituminous coating that conforms to ANSI 21.4, latest revision. Unburied fittings shall, in addition, be given two (2) coats of epoxy paint on the outside after installation. Where a unit price pay item for standard cast iron or standard ductile iron fittings is included in the Proposal, payment shall be based on fitting weights for standard length fittings of the type and class called for in the Proposal, as contained in ANSI A21.10.

E. MECHANICAL JOINTS: Mechanical jointing of cast iron and ductile iron pipe shall be used only at the specific locations indicated on the drawings or as approved by the Engineers. The mechanical joint shall consist of: (1) a bell cast integrally with the pipe or fitting and provided with an exterior flange having cored or drilled bolt holes and interior annular recesses for the sealing gasket and the spigot of the pipe or fitting; (2) a pipe or fitting spigot; (3) a sealing gasket; (4) a separate cast iron follower gland having cored or drilled bolt holes; and (5) cast iron tee head bolts and hexagon nuts. The joint shall be designed to permit normal expansion, contraction and deflection of the pipe or fitting while maintaining a leakproof joint connection. The mechanical joint shall conform to the requirements of ANSI Standard Specification A21.11, AWWA Specifications, latest revision.

F. FLANGED JOINTS: All flanged joints shall be firmly bolted with machine bolts; however, where valves or specials are attached to a flange pipe, stud or tap bolts may be used, providing the number used and diameter for each joint is the same for each respective size of pipe or special, or valve, as recommended by the latest AWWA Standard for flanged drilling. All bolts shall be of the best quality refined bar iron, of sufficient length to pass through two flanges and the nut threads shall be accurately cut, close fitting, and the prevailing standard. Bolt heads shall be cut square and nuts hexagonal in shape, both the heads and nuts being chamfered gaskets to be of a red rubber or equal as approved by the Engineers. Flanged joints shall not be used below ground in direct burial without specific approval of the Engineer. Flanges shall be Class 125, ANSI Standard A21.11.

G. TRANSITION JOINTS: Transition joints between pipes of different materials shall be made with standard transition adapters. Transition joints between pipes of different materials and diameters will be made as detailed on the drawings.

H. FLEXIBLE COUPLINGS: Flexible couplings shall be supplied and installed at the locations shown on the drawings. The couplings shall consist of one cylindrical middle ring, two follower rings, two resilient gaskets and a set of steel trackhead bolts. The middle ring shall have a conical flare at each end to receive the wedge portion of the gaskets, and the follower rings shall confine the outer ends of the gaskets. Tightening the bolts shall draw the follower rings toward each other, compressing the gaskets in the space formed by the follower rings, middle ring flares and pipe surface. This shall effect a flexible, leakproof seal and the entire coupling assembly shall be capable to withstanding the working and test pressures for the class pipe upon which it is installed. Such joints shall be harnessed in an approved manner to prevent expansion. The couplings shall be Dresser Style 38 for steel or concrete pipe and Dresser Style 53 for cast or ductile iron pipe. Alternate flexible couplings shall be Victaulic couplings Style 31 installed onto cast pipe grooved in accordance with Victaulic Specifications for "Flexible Cast Iron Radius Cut Grooved Pipe," and Victaulic Style 77 couplings installed onto steel pipe grooved in accordance with Victaulic specifications for "Standard Grooved Pipe" or equal.

I. RIGID COUPLINGS: Rigid couplings shall be used only at the specific locations indicated on the drawings or as approved by the Engineers. Where such couplings are used, the piping shall be adequately strapped or backed to eliminate spreading of the joint. The coupling housing shall be constructed of corrosion resistant malleable iron with positive locking, corrosion resistant hardened stainless steel pipe grips. The housing shall be of two-piece construction connected with plated, heat-treated oval neck track bolts. The coupling seal shall bridge the pipe ends, be constructed of neoprene and automatically seal for pressure or vacuum. The couplings shall be suitable for a working pressure of 250 psi, and a test pressure of 1,000 psi. The couplings shall be Style 90, "Plainlock" manufactured by the Victaulic Company of America, No. 100 Standard manufactured by the Gustin-Bacon Division of Certain-Teed Products Corp., or equal.

J. WALL SLEEVES: A cast iron sleeve shall be provided where piping passes through the walls and floors of structures. Sleeves shall be of heavy cast iron construction, of either bell of flanged pattern, as required, and each sleeve shall be provided with an integrally cast collar or waterstop. All underground piping passing through or entering walls, regardless of whether a wall sleeve is shown on the drawings or not, shall be installed with a joint outside of the wall, within 3' of the wall.

K. HOSE BIBBS: Hose bibb, chrome finish, integral vacuum breaker 3/4" inlet, 3/4" hose thread outlet, loose key handle, closing with water pressure, monel metal replaceable seats. Chicago Faucet Company, American Standard or equal.

L. FLOOR DRAINS: Typical floor drain to be case iron floor drain, with nickel-brass alloy adjustable strainer 4" diameter. Josm, Zurn, Wade or equal.

M. BRASS PIPE: Brass pipe shall conform to ASTM Specification B-43, current edition, and shall be of the type and strength required for the use intended.

N. COPPER PIPE: Copper pipe shall conform to the ASTM Specification B-42, current edition, and shall be of the type and strength required for the use intended.

0. POLYETHYLENE TUBING: Polyethylene tubing shall conform to the requirements of ASTM D2737. Polyethylene tubing shall be manufactured by Celanese Plastics, Phillips Products Co., Inc., or equal.

END OF SECTION 4.

SECTION 5.

VALVE OPERATION AND OPERATORS

A. VALVE OPERATION:

1. Buried valves shall have 2" square cast iron operating nuts and nut boxes.

2. Floor boxes shall be provided suitable for installation in concrete floors or slabs and shall be fitted with bronze bushings.

3. All exposed valves with stem extensions and nut boxes shall have a cover.

4. Exposed valves shall be handwheel operated unless otherwise indicated or specified.

5. Valves installed in overhead pipelines where the centerline of the pipe is 6' or more above the floor shall be provided complete with chain wheel operators. Chain guides shall be provided. Chains shall reach within 4' of the floor.

6. Valves shall be provided with extension stems and either cast iron floor boxes or floor stands as shown. Floor stands shall be cast iron, medium duty, with indicators. Extension stems shall be cold rolled steel complete with necessary steady bearings and couplings required to complete the installation indicated. Ratio of total stem length to radius shall not exceed 150. Where yard or line valves are buried beneath the finish grade surface such that the distance between the operating nut and final surface elevation of the nut box exceeds 42" the valve and nut box shall be furnished complete with an operating extension stem that shall terminate not more than 24" below the surface. The nut box shall terminate flush with the final surface elevation.

7. Stem guides shall be fully adjustable made of high strength cast iron and shall be bronze bushed as manufactured by Clow, Mueller or equal.

8. All operating nuts, handwheels and chain wheels shall have the direction of opening cast on them.

9. Insofar as possible, all large gate valves used in the work shall be by the same manufacturer. Gate valves adjacent to check valves shall be by the same manufacturer as check valves.

B. VALVE FLOOR STANDS: Manual valve operating floor stands shall be furnished in connection with the project. Floor stands shall be made of close grained, gray cast iron, with circular, flanged base; and the size of the stand of the operating wheel shall be appropriate for normal easy operation of the valve served by the floor stand. Floor stands shall be designed for neat appearance, with broken taper columns terminating in suitable collars at the top of the column and fitted with bronze valve stem bushing adapted to the type of valve served, i.e., inside screw valve, outside screw valve or plug valve. In this connection, it shall be the Contractor's responsibility to select the proper size of floor stand fitted with the proper operating housing for the valve the stand is intended to serve, bearing in mind the requirement that all valve stem thrusts be taken care of in the body or yoke of the valve itself rather than transmitted through the extension valve stem to the head of the valve stand.

C. ELECTRIC VALVE OPERATORS: Whenever indicated, combination electric and manual valve and sluice gate operators shall be furnished in connection with the project. When such indication is made, it shall be the Contractor's responsibility to select the proper size drive unit for the service intended based on the manufacturer's recommendations. The electric valve operators shall be Limitorque, as manufactured by the Philadelphia Gear Works, Rotork Valve Operators or equal.

D. HYDRAULIC VALVE CYLINDERS:

1. All hydraulically operated valves shall be equipped with operating cylinders which shall freely operate the valves when supplied with water at a pressure of 40 psig. Cylinders may be either centrifugally cast bronze tubes or cast iron lines with brass. In either case, the inside diameter of the cylinder shall be hones to at least a 15 rms finish. Tubes or linings shall be seamless and not less than 1/8" thick.

2. The hydraulic cylinder operators for the butterfly valves shall be bronze tube of the trunnion or swivel mounted type pivoted on two trunnions at the head of end of the cylinders. They shall be sized to transmit the numerical torque valves listed in Table 8 of AWWA Specifications C-504 to the valve shaft with a minimum cylinder operating pressure of 40 psig. Each operating cylinder shall have a manual adjustment to control the rate of closing, or opening, between 3 and 30 seconds.

3. Each hydraulically operated gate valve, sluice gate, mud valve and angle waste valve shall be equipped with cast iron bronze lined operating cylinders which will freely operate the valves when supplied with water at a pressure of 40 pounds per square inch. Equip each cylinder with telltale rod of noncorrosive material. Suitable packing rings or washers shall be provided for all cylinders to prevent leakage. Cylinders may be either brass tubes or cast iron, lined with brass. Tubes or linings shall be seamless brass not less than 1/8" thick. Cylinders shall be rigidly attached to valve bonnets, accurately aligned and tested at not less than 150 pounds per square inch water pressure. Each operating cylinder

shall have a manual adjustment to control the rate of closing, or opening between 3 and 30 seconds. Each valve shall be supplied with a valve position indicator compatible with the instrumentation as specified under the other sections of these Specifications.

E. MANUAL VALVE OPERATORS:

1. Manual valve and sluice gate operators shall be furnished in connection with the project whenever indicated on the Contract Drawings. An appropriately sized hand or chain wheel, varying according to valve size and dynamic conditions, actuates a worm gear device. The gear ratio and the wheel radius are sized to conform to the specification of a maximum 25-pound pull to attain required torque, in strict accordance with the numerical torque valves in Table 8, AWWA Specification C-504.

2. The gearing shall be housed in a dust-tight enclosure; the gearing shall operate in a bath of lubricating oil.

3. Adjustable, mechanical stops of high tensile steel shall be furnished to protect against disc overtravel.

4. A valve position dial shall be provided with each operator as well as a device to hold the valve in a fixed position for an extended period of time. Each operator shall be provided with a suitable mounting for changeover to electric motor operation.

END OF SECTION 5.

SECTION 6.

GATE VALVES;
TAPPING SLEEVE AND VALVES;
and AIR RELEASE VALVES

A. GATE VALVES:

1. All gate valves shall be of the double disc parallel seat type that fully comply with the requirements of the latest revision of AWWA Standard C-500. All gate valves shall open by turning in a clockwise direction. All operating nuts, handwheels and chainwheels shall have the direction of opening cast on them.

2. For valves up to and including 2" in size, use screw-end, bronze or brass body, bronze mounted gate valves designed for a working pressure of 150 pounds per square inch, and having removable seats, discs, stem stuffing box and gland.

3. Valves 2 1/2" and larger shall be iron body, bronze mounted, double disc parallel seat type gate valves with O-ring seals. All valves other than flanged end valves shall be of the nonrising stem type. All flanged gate valves for hand operation shall be of the OS&Y type with conventional packing for either wheel or chain operation. All gate valves shall be designed for a working pressure of 200 psi and shall be tested to a minimum pressure of 400 psi. All buried valves shall be provided with a 3-piece valve box.

4. Gate valves used in conjunction with fire hydrants shall be of the mechanical joint type. All other gate valves shall have either integrally cast mechanical joint ends, ends for asbestos cement pipe, Victaulic couplings, plain ends for Dresser couplings, hub end for slip joint pipe, or shall be flanged, whichever is specified by the City Engineer.

5. All gate valves 16" in diameter and larger shall be of the totally enclosed bevel geared type, installed in horizontal or vertical position, and shall be equipped with a bypass. The gear train shall be so mounted as to permit repacking the valve stem without disturbing the gears or gear housing. The gear case shall be leakproof and shall be packed with grease. The valve stem and packing glands shall be protected from dirt by means of suitable cast iron shield. Valve boxes shall be placed over main valve and bypass operating nuts.

6. Valves for use where pressure is less than 25 pounds per square inch shall be designed for working water pressure of not less than 35 pounds per square inch and shall be tested to 70 pounds per square inch. Buried valves 16" and larger shall be installed in horizontal position and shall be equipped with bevel gears, gear case, tracks and scrapers, and shall also be equipped with bypass.

7. All gate valves shall be manufactured by the American-Darling Co., Mueller Co., or Kennedy Valve Co.

B. TAPPING SLEEVE AND VALVE;

1. The tapping sleeve and valve shall be suitable for wet installation without interrupting water service in any manner.

2. The sleeve body shall be split type, cast iron construction, rated for a working pressure of 150 psi. The sleeve shall be installed on the main to be tapped using mechanical joint ends. The sleeve shall be suitable to fit the type and class of pipe being tapped. The mechanical joint shall have longitudinal compound rubber gaskets that fit against the rubber end gaskets effecting a totally enclosed rubber, watertight seal. Side and end bolts shall be hi-strength cast iron.

3. Tapping valves shall be "O" ring type with mechanical joint and conforming to AWWA C500-80 nonrising stem construction. Inlet flange end shall be Class 125 (ASA B16.1). The valves shall be as specified under Section 6. A. for gate valves.

4. The tapping sleeve and valve shall be installed in accordance with the manufacturer's recommendations.

C. AIR RELEASE VALVES;

1. Air release valves shall meet the requirements of ANSI/AWWA C512-07 (or latest version), Air Release, Air/Vacuum, and Combination Air Valves for Waterworks Services.

2. The City of Statesville requires a Crispin X Series, or a stainless steel equivalent, for air release valves.

END OF SECTION 6.

SECTION 7.

POST HYDRANTS & FIRE HYDRANTS

A. POST HYDRANTS: Post hydrants shall be cast iron nonfreeze type with aluminum housing, brass casing, brass valve housing, brass removable operating parts, neoprene washers, hand wheel with 1" hose connection, 1" IPS inlet, for 3' bury. The hydrant shall be No. 71700 manufactured by Josam Manufacturing Co., Figure M-200 manufactured by Murdock, Inc., or equal.

B. FIRE HYDRANTS: Fire hydrants shall be of the compression or gate type conforming to AWWA C-502 and shall be the Owner's standard which consists of a 5 ¼" valve opening, and open left (counter-clockwise), American Flow Control (American Darling) American Darling B84B or equal. All hydrants shall have a bronze to bronze main valve assembly. The hydrant shall have two 2 ½" hose nozzles with caps and one 4" pumper nozzle with cap. Threads on nozzles and caps and operating nuts shall conform to those adopted by the City as standard. Hydrants shall open by turning to the left (counterclockwise) and shall be so marked. The hydrant main valve shall meet or exceed the flow requirements of AWWA C-502 and shall be at least 5 ¼" in diameter and the hydrant elbow shall be a 6" MJ end. Fire Hydrant will have a Storz connection with 30° turn. The hydrant barrel shall be of such length to provide a minimum of 3'-6" (42") of bury. All hydrants shall be set so that the center of the pumper nozzle will be approximately 18" above the surface of the ground. Hydrants shall be designed for a 300-psi test pressure and a 150-psi working pressure. All hydrants shall be factory primed and finish painted. Paint shall be specifically suitable for the purpose intended and shall be as recommended by the manufacturer. Final color shall be as selected by the City after the manufacturer submits to the Engineers two (2) color charts listing available colors. Hydrant manufacturer shall furnish a sufficient quantity of touch-up paint to the Contractor. The Contractor shall be responsible for touching up any nicks, scratches, etc., that have occurred during shipment and handling or as otherwise directed by the Engineers.

END OF SECTION 7.

SECTION 8.

EXCAVATION; RATE OF PROGRESS; SHEETING AND BRACING TRENCHES; WATER IN TRENCHES; PIPE LAYING; PIPELINE SEPARATION; BACKFILLING; AND PAVEMENTS

A. GENERAL REQUIREMENTS:

1. Construction of the pressure piping shall be done in accordance with the drawings, these Specifications, and as directed by the Engineers. Should conditions be encountered in the work which are not covered by these Specifications or where it would not be practical or feasible to proceed with the work in strict accordance with the Specifications, then the Contractor shall notify the Engineers and await instructions from him before proceeding with the work.

2. All pipe lines shall be laid to such line and grade so as not to conflict with water, sewer, gas, storm sewer or other existing utility lines or services. All pipelines shall generally be laid to line and grade shown on the drawings. Drainage structures shall be built of the materials shown on the Drawings and in accordance with the Engineers' details and/or instructions. Install temporary air relief and blow-off connections and lines at the high and low points on the line. The temporary connections shall be removed in an approved manner after their service is no longer required.

B. EXCAVATION:

1. All excavation under this Section shall be "Unclassified" and shall include all materials of whatever nature encountered. No extra compensation will be allowed for excavating work.

2. When rock or noncushioning material is encountered in trench excavation, a cushion at least 8" thick shall be placed between the rock and the bottom of the pipe. An additional 1" depth of cushioning material will be required for each additional 2' of trench depths in excess of 16' up to a maximum of 12" of cushioning material. The cushioning material shall consist of #57 clean stone or other equivalent material approved by the Engineers.

3. When directed, unstable soil shall be removed for the full width of the trench and replaced with clean #57 crushed stone or other approved material. The Engineers shall determine the depth of removal of the unstable soil and the amount of backfill required. The backfill shall be thoroughly compacted and shaped to form the bed for the pipe.

4. Excavation shall be true to line and grade as directed by the Engineers. Depth of trench shall be generally such as to provide for a depth of cover over the pipe of 3.5'. Depth of trench shall, however, be sufficient to allow for proper burial of valves, crossing under obstructions, etc. It shall be the responsibility of the Contractor to provide adequate bearing of foundations for all pipe lines laid in uncertain soil conditions or where a fill is to be placed over the pipe line or lines, to prevent settlement, distortion, leakage or breakage. The amount of trench that may be opened in advance of pipe laying or in advance of pipe completed and tested, shall be determined by the Engineers.

5. The minimum width of the trench at the top of the pipe when placed shall be a width which will permit the proper construction of joints and compaction of backfill around the pipe, but shall be at least equal to the outside diameter of the pipe plus 6" on each side of the pipe. The sides of the trenches shall be vertical unless otherwise approved by the Engineers. The maximum allowable width of trench shall not exceed the pipe O.D. + 24" for pipe 14" and smaller, pipe O.E. + 36" for 14" to 36" and pipe O.E. + 48" for pipe larger than 36" in diameter.

6. Excavated material shall not be placed on grass plots unless there is no other suitable place to put it. Excavated material shall be placed on pavements or sidewalks only on the explicit approval of the Engineers.

7. Unsuitable and surplus excavated material not incorporated in the works shall be disposed of by the Contractor at his own expense.

8. If private land is used by the Contractor as a spoil site, the Contractor shall obtain written permission from the Owner or Agent of the land to be used for this purpose and provide the project Owner with a certified copy of such agreement.

C. RATE OF PROGRESS: Without permission from the Engineers, not more than 300' of trench shall be opened in advance of the completed work in any section and, in all cases, the work of excavating, pipe laying and backfilling must move forward at approximately equal rates of progress. Any exceptions to this requirement, in excess of 24 hours, must be with the consent of the Engineers.

D. SHEETING AND BRACING TRENCHES:

1. The Contractor will be required to keep the sides of the excavation vertical by sheeting or bracing. The Contractor shall prevent movement, slides or settling of the sides of the trench, which might injure or displace the pipe or any appurtenances thereof, or diminish the working space required on the sides of the pipe.

2. The Contractor shall leave in place along the trench such sheeting and bracing as the Engineers may direct. For the purpose of preventing injury to persons, corporations or property, whether public or private, the Contractor at his option

may also leave in place, to be covered and imbedded by the backfilling of the trench, any and all bracing, in addition to that directed by the Engineers to be left in place, provided that no sheeting or bracing shall extend closer than 2' to the finished street surface; and provided, further that no timbers shall be left in the trench so as to form pockets or cavities which cannot easily be filled during the filling and compaction of the trench.

E. RESPONSIBILITY OF THE CONTRACTOR: It is understood that the City is under no obligation to pay for sheeting left in place by the Contractor unless specific directions have been given to the Contractor by the Engineers. Failure to sheet and brace trenches or other excavations shall be at the Contractor's risk, and he will be responsible for the caving thereof and all damages resulting therefrom. If the Engineers are of the opinion that at any point, sufficient or proper supports have not been provided, he may order additional supports put in at the expense of the Contractor, but compliance with such orders shall not release the Contractor from responsibility for the sufficiency of such supports.

F. SUBGRADE: Whenever the nature of the ground will permit, the excavation at the bottom shall have the shape and dimensions of the outside lower quarter of the circumference of the pipe, care being taken to secure a firm bearing support uniformly throughout the lengths of the pipe. In lieu of bed shaping, the Contractor, at this own expense, may provide additional cushioning materials of clean sand or No. 5 crushed stone to attain the specified one-quarter depth of contract between the pipe and bedding. A space shall be excavated under and around each bell to sufficient depth to relieve it of any load and to allow ample space for finishing the joint. The pipe, when thus bedded firmly, shall be on the exact grade of the completed pressure piping. In case the bed trimmed in the bottom of the trench is too low, the pipe shall be completely removed from position and bedding material shall be thrown over the bottom and thoroughly tampered into place to prepare a new foundation for the pipe. In no case shall the pipe be brought to grade by blocking up under the bell or barrel of the pipe, but a new and uniform support must be given for the full length of the pipe. In case this foundation prepared for the pipe should not be firm enough to support the pipe and the superimposed loads, the Engineers may require the Contractor to consolidate the subgrade by tamping or by the addition of available material until the pipe has a satisfactory foundation.

G. WATER IN TRENCHES: Wherever ground water is encountered, the Contractor will be required to install such equipment and carry on the construction in such manner as to provide the best possible laying conditions. He shall remove all water that may accumulate or be found in the trenches or other excavations made under this Contract by pumping or bailing, and no pipe shall be laid until such water has been removed from the trench. The Contractor will not be permitted to drain water through the pipeline and the open end of pipe in the trench shall be kept closed with a tight fitting plug to prevent washing of dirt or debris into the pipeline. Water so removed from the trench must be disposed of in such manner as not to cause injury to the public health or to public or private property, nor to work completed or in progress, nor to the surface of the streets nor cause any interference with the use of the streets by the public.

H. TIMBER FOUNDATIONS: Whenever the bottom of the trench shall be of such nature as to provide an unsatisfactory foundation for the pipe line or other structure, the Engineers will require the pipe be laid on timber foundations or platform. Such foundation, whether of single plank, plank cradle supported on piles, shall be placed as directed by the Engineers. All timber and planking for foundation shall be of good quality sawed cypress or creosoted pine lumber, sound free from shakes, large, loose or decayed knots and other imperfections affecting its strength and durability. PVC pipe shall be placed in a steel carrier pipe to preclude contact with ribbing materials.

I. MAKING THE JOINT:

1. Inspect the bell interior, spigot and gasket to be sure they are clean. Observe particularly the recesses of the bell where dirt is likely to accumulate. Remove any foreign material present with a cloth or brush. Wash with water if necessary.

2. Insert the gasket in the bell with square end of gasket facing outward, begin insertion of gasket by placing one side in recess using the thumb. This begins alignment. Further push gasket into recess as far as possible. Holding the aligned portion of the gasket in the recess, place thumb on unaligned portion of the gasket. Fold unaligned portion of gasket over. Gasket will be set in position to fully seat. With the thumb, fully seat gasket. After the gasket is thus in place, the installer should insure that it is fully locked in by kneading with the fingers around the entire inner face.

3. Lubricate the exposed face of the gasket with joint lubricant. Do not use lubricant other than that furnished by pipe manufacturer with pipe and fittings.

4. The joint is assembled by hand. Align the spigot with the mating bell and force the spigot into the bell thereby compressing the gasket.

5. The spigot should be entered to a position where the seating stripe is flush with the face of the bell. The first stripe, if dual striping is used, is then inside the bell and is not visible. The spigot in this position is correctly spaced from the bottom of the bell to allow normal expansion and contraction of the pipe. If the spigot goes to the bottom of the bell on assembly, withdraw the spigot to a position where the seating stripe is flush with the face of the bell.

6. If pipe is cut in the field, the end of the spigot shall be beveled with a file and a stopmark made on the cut end at the following distances back from the end of the pipe: 1 1/2" pipe, 3 1/16"; 2" pipe, 3 1/16"; 2 1/2" pipe, 3 3/16"; 3" pipe, 3 3/8"; 4" pipe, 3 1/2". For larger pipe the stripe shall be placed at the same distance from the pipe being placed. In addition, both the spigot and gasket of cut pipe must be lubricated before placement.

J. LAYING THE PIPE:

1. No pipe shall be laid except in the presence of the Engineers, or their inspector. The Contractor shall be expected to cooperate fully with the Engineers in regard

to time and duration of pipe laying. Except in cases of emergency, where the ground is treacherous or in situations where suspension of the work would cause extra delay or damage to the pipe line, work required by the presence of the Engineers or Inspector shall be confined to the usual eight hours of the working day. In cases noted above, work may be extended for longer periods or made continuous, provided the permission of the Engineers is first obtained.

2. All pipe, prior to being lowered into the trench, shall be carefully inspected to see that each section or joint is clean, sound and free from defects. Pipe shall be removed at any time if broken, injured or displaced in the process of laying or backfilling the trench.

3. On the subgrade prepared as hereinbefore described, the pipe shall be laid to produce a straight line of pipe on a uniform grade, each pipe being laid to form a joint close with the preceding pipe, and so as to form a smooth inside flow line.

4. The pipe shall be assembled "in the trench" rather than on the side. Laying can be most easily accomplished by the following method:

   a. Lift the bell end of the pipe out of the trench and hold it there by resting it on a board placed across the trench.

   b. With the bell thus held out of the trench, join and position next length to it. (Refer to Section on "Making the Joint".)

   c. Lower joint into trench and, again, lift next bell end into position for joining.

   d. After lowering each joint, observe the last joint previously made to assure that positioning stripes continue to be in proper position. Before lifting next bell end, cover center portion of pipe length with dirt to aid in keeping last joint properly positioned.

K. PIPELINE SEPARATION:

1. Wherever pipelines designated to carry potable water supplies cross or are laid less than 10' horizontally from existing or proposed drain or sewer lines, special precautions shall be taken as specified herein.

2. Should conditions prevail which prevent a lateral separation of 10', the pipeline may be laid closer than 10' to a storm or sanitary sewer, provided the main is laid in a separate trench and at such an elevation that the bottom of the pipeline is at least 18" above the top of the sewer. This minimum vertical separation shall be maintained for that portion of the pipeline located within 10', horizontally, of any sewer or drain crossed, said 10' to be measured normal to the pipeline centerline to the drain or sewer.

3. If it is impossible to obtain a horizontal separation of at least 10', and a vertical separation of at least 18", as stipulated above, the Engineers may require the sewer to be constructed or reconstructed of mechanical joint, cast iron pipe, or concrete pressure pipes specified herein, and be pressure tested to assure watertightness.

4. When making crossings with less than 18" vertical separation, a full length of pipeline pipe shall be centered over the sewer to be crossed so that joints will be equidistant from the sewer and as remote therefrom as possible. The installation shall be as specified in *Rules Governing Public Water* Systems Rule .0906 (f). Also, per Rule .0904, crossings of a storm drain must have a minimum of 12-inches of vertical separation. If impractical to maintain separation per Rule .0904, justification of the deviation must be outlined in accordance with Rule .0904(c).

L. BACKFILLING:

1. The backfilling of the pipe trench shall be performed in a manner that will not shift or disturb the pipe in the pipe bed. Care shall be taken to thoroughly compact the backfill around and over the pipe without subjecting the pipe to impact or damage from compacting tools. This initial backfill material must be free of rocks and large clods. After backfilling and compaction in a careful manner is achieved to a minimum of one (1) foot above the pipe, backfill by normal spreading and compacting may proceed. Backfill material shall be free of large rocks. Complete the backfilling operation in 6" layers, each being thoroughly tamped and compacted, taking care to remove large rocks. In all cases where the pressure piping is laid in road right-of-ways the trench shall be compacted to 95% standard density as determined by AASHO T-99 for the entire depth of the trench. In all other areas the level of compaction of the backfill shall be not less than 90% as determined by AASHO T-99 for the entire depth of the trench. The final 2 feet of backfill below finish grade shall be free of any rock or rubble.

2. Backfill shall be made with suitable material and carefully tamped so as not to disturb pipe lines, etc. Backfilling against masonry structures shall not be done until the masonry has attained sufficient strength to withstand the load imposed without injury to the work.

3. Backfilling material shall be deposited and tamped to an elevation approximately 6" above the established streets, or road grade, to provide for settlement of material in the trench. After final settlement has taken place, all excess material shall be removed and the top trimmed even with the established grade. If, after final settlement has taken place, the material in the trench has settled below the established grade, the Contractor shall deposit, tamp and/or compact sufficient additional material to bring the fill to the required elevation.

M. OBSTRUCTIONS TO TRAFFIC: The excavated material shall be placed on one side of the trench in such manner as not to obstruct any drain or unnecessarily obstruct any passageway. All street hydrants, water valve boxes, fire alarm boxes and letterboxes shall be kept accessible for immediate use. At street crossings, the Contractor must, when necessary, provide a safe bridge with railings to allow pedestrians to cross the trench. The Contractor shall provide, without additional compensation, suitable temporary channels for the water that may flow along or across the site of the work.

N. EXISTING STRUCTURES: All existing gas pipes, water pipes, steam pipes, electric conduits, sewers, drains, cisterns and hydrants, railway tracks and other structures which do not, in the opinion of the Engineers, require a change in location, shall be carefully supported and protected from injury by the Contractor and in case of injury they shall be restored by him without additional compensation to as good condition as that in which they were found. Where pipes, conduits or sewers are removed from the trench leaving dead ends in the ground, such dead ends shall be carefully plugged or bulkheaded by the Contractor without extra compensation.

O. CHANGING STRUCTURES: Whenever it becomes necessary, in the opinion of the Engineers, to change the location of any pipe line, drain or other structure, the Contractor shall do the whole of the work of making such changes, or such portions of it as the Engineers may direct.

P. PAVEMENTS: Where it is necessary to remove existing pavements, prepared road surfaces, sidewalks or curbing, these surface structures must be replaced by the Contractor and left in as good condition as they were before being removed, to the complete satisfaction of the Engineers. Such repairing shall be done under the original specifications under which the same was done, and shall be subject to the approval of the Engineers. When pressure piping work is built in or across streets, alleys, driveways, or highways which have been macadamized or graveled, the Contractor must save the gravel or stone and refill the top of the trench with such materials to bring the streets, alleys, driveways, or highways to their original grade. Roadway base material, where required, is to be replaced with ABC (Old #7) aggregate to the depth of the existing base or to a minimum of 8", whichever is greater. Any Portland cement concrete pavement to be removed must be cut by sawing, not breaking.

Q. RAILROAD TRACKS: All railroad tracks and track structures crossing the line of the pressure piping shall be supported by the Contractor at his own expense during the construction under or near them and the work shall be so prosecuted as not to interrupt the use of the tracks nor endanger the traffic on them, and such tracks and track structures, culverts, etc., shall be fully restored to their original condition.

END OF SECTION 8.

SECTION 9.

VALVE BOXES;
CONCRETE STRUCTURES;
PIPE BLOCKING;

A. VALVE BOXES: With each valve buried in the ground, the Contractor shall furnish and set in place a cast iron adjustable valve box and cover of close grained gray cast iron in three pieces. The bottom piece shall be beveled at the lower end to fit around the stuffing box gland, and rest on the valve bonnet or gear case. The upper piece shall telescope over the lower part, and shall have socket at top to receive cover. The cover shall have cast on the upper surface, in raised letters, the word "WATER". Each bypass valve shall also have a valve box. All valve boxes shall have one coat of coal tar paint before shipment from factory.

B. CONCRETE STRUCTURES:

1. Build all concrete piers and other structures as may be required to complete the work under this Section.

2. All concrete used in structures shall conform to that specified herein under applicable Sections. All structures shall conform to the drawings and these Specifications. Unless otherwise shown on the drawings, all concrete shall be mixed in the proportions of one (1) part Portland cement, two (2) parts sand and three and one-half (3½) parts coarse aggregate.

C. BACKING FOR PIPE, SPECIALS, ETC.:

1. Whenever directed by the Engineers, the Contractor for this Division shall furnish all labor, materials, tools, etc., required for and shall place Class D concrete fill back of tees, bends or at such other critical points, and in such point(s) against pressures imposed during testing periods or after the system has been placed in operation.

2. Before placing such concrete, the side and/or bottom of the trench shall be trimmed to solid earth and normal to the line of pressure. All materials used shall conform to those specified under applicable Sections.

D. HYDRANTS, VALVES AND SPECIAL CASTINGS: Hydrants, valves and special castings shall be placed as shown on the drawings, or for exact location, as directed by the Engineers. An adjustable valve box shall be placed over each gate valve.

END OF SECTION 9.

SECTION 10.

STEEL PIPE ENCASEMENT - DRY BORE AND JACK

A. GENERAL REQUIREMENTS: Where the encasement of the pressure piping is required, the Contractor shall furnish and install encasement as approved by the Engineers. The encasement shall be installed in accordance with the requirements for same of the manufacturer of the encasing material. The encasement shall be smooth wall steel pipe of a thickness as specified in the Proposal. The Contractor shall submit to the Engineers a written certification from the encasement pipe manufacturer that the encasement pipe is the type of pipe specified herein and of the thickness specified in the Proposal. Encasement pipe shall not be installed until said certification is received and approved by the Engineers. Encasement pipe shall be installed by dry boring and jacking. As the dry bore operation progresses, each new section of the encasement pipe shall be butt welded to the section previously jacked into place. The boring auger shall not be of a greater diameter than the outside diameter of encasement and voids are to be filled with 1:3 Portland cement pressure grout at 50 psi to insure that there will be no settlement.

B. OBSTRUCTIONS: In the event that an obstruction is encountered during the dry boring operation, the auger is to be withdrawn, the excess pipe cut off and capped, and the void is to be completely filled with 1:3 Portland cement pressure grout at 50 psi before moving to another boring site.

C. BLOCKING UP: After completion of the boring and installation of the carrier pipe, the ends of the steel casing pipe are to be filled with crushed stone when encasement pipe runs under highways. Crushed stone shall be as required by State DOT having jurisdiction. The ends of the steel casing pipe are to be filled with masonry brick and mortar when encasement pipe runs under railroads.

END OF SECTION 10.

SECTION 11.
PIPE HANGERS; SUPPORTS;
CLAMPS; ANCHORAGE

A. GENERAL REQUIREMENTS:

1. All pipe installed shall be adequately secured against movement by the use of metal pipe supports, hangers, ties, brackets, clamps and/or concrete piers or anchorage blocking. It is the intention of this requirement that the Contractor provide, at his expense, all items necessary to secure the piping at the locations shown on the drawings and/or as required by the Engineers in order to provide a complete and working installation. Securing of piping shall, unless otherwise indicated or directed, be in general accordance with the following:

2. Interior flange joint or bell joint pressure piping shall be secured at each joint in the line by the use of hangers, supports, brackets, piers, or anchorage blocks as indicated or directed.

3. Flange spigot pieces connecting to wall sleeves shall be adequately tied with clamps and tie rods with the tie rods sufficiently embedded in the concrete walls. Tie rods shall be placed in the forms before the concrete is poured.

4. Bell-flange pieces used for make-up in flange piping shall be securely tied by the use of pipe clamps.

5. Interior piping shall be secured in a manner that will permit valves, equipment, and similar items to be removed from the piping without the necessity for temporary blocking to support the remaining piping.

6. Concrete piers and anchor blocks either shown on the drawings, or the location of which is known, before the concrete work is started shall have dowels extending into the adjacent walls or floor slabs. Unless otherwise indicated, concrete piers and anchor blocks shall have a minimum of four No. 5 bars embedded not less than 36" into the adjacent concrete construction and extending into the pier or blocking to approximately 3" from the surface contacting the supported pipe. Where concrete piers and anchor blocking must be installed after the adjacent concrete work has been completed, piers and anchor blocks shall conform to the above requirements as applicable and shall have expansion shields with adequately long bolts inserted into the adjacent concrete with the reinforcing of the piers or blocking tied to the bolts.

7. Buried pressure piping shall be adequately blocked with nonreinforced concrete anchor blocks in accordance with AWWA Standard Specification C-600.

8. Pipe hangers shall be of the type specified herein and of the size required to support the pipeline. The Contractor shall furnish and place all inserts required for pipe hangers or other anchorages. Inserts shall be accurately placed as shown on the drawings, shop drawings, or as directed by the Engineers and shall have their outside face flush with the concrete surface. Inserts shall be manufactured by Unistrut Products Company, Crawford, or equal.

END OF SECTION 11.

SECTION 12.

TESTING; STERILIZATION; CLEANING UP

A. TESTING:

1. All newly installed mains must be pressure and leakage tested before acceptance. AWWA C600 and AWWA C605 standards shall be used for ductile iron pipe and PVC pipe, respectively. Pressure and leakage testing for materials other than DIP and PVC will meet the current AWWA standard as applicable. When a segment of pressure piping and appurtenances has been completed and before it is covered, the Contractor shall furnish proper appliances and facilities for testing and draining the same, without injury to the work, or surrounding territory. He shall test by filling the pipe with clean water furnished by the Contractor at his expense. Air shall not be used for pressure testing. Unless otherwise stated in these Specifications, all pipe shall be subjected to the following hydrostatic tests. The Contractor will be required to set up a pump and test each section of pressure piping between valves to a water pressure test of fifty (50) pounds per square inch in excess of the normal operating pressure. If pipe line is a free discharge or no valves exist the pipe shall be plugged and tested. Unless otherwise directed by the Engineers, all piping shall be tested at 250 psi. The Contractor shall furnish at this own expense, all water required to perform the testing, flushing, sterilization, or other required tests or procedures, including any required retesting for any purpose if found necessary by the Engineers.

2. Water service pipe and fittings shall be subjected to a hydrostatic pressure of two hundred and fifty (250) pounds per square inch after the service is laid, and before any backfilling is done. Each service shall be required to sustain this pressure for a period of ten (10) minutes without leakage, before being acceptable.

3. Pipe lines shall be tested before backfilling at joints except where required by necessity or public convenience. Depending on traffic conditions, public hazard, or other reasons, the Engineers may direct when tests of completed sections of mains shall be made, and he may order tests to be made in relatively short sections in order that hazardous sections may be backfilled promptly.

4. Simultaneous or separate pressure and leakage tests may be performed.

   a. If separate tests are made, the pressure test shall be conducted prior to the leakage test.

   b. Working pressure is defined as the maximum sustained operating pressure.

   C. In no case shall the test procedure exceed the pressure rating for the pipe, valves, appurtenances, or thrust restraints.

Procedure	Test Pressure	Duration of Test
Simultaneous pressure & leakage test	150% of working pressure at point of test, but not less than 125% of normal working pressure at highest elevation	2 hours
Separate pressure test	150% of working pressure at point of test, but not less than 125% of normal working pressure at highest elevation	1 hour
Separate leakage test	150% of working pressure of segment tested	2 hours

5. Leakage is defined as the quantify of water that must be supplied into the main in order to maintain the water pressure within 5 psi of the specified test pressure after the pipe has been filled with water and air expelled. No installation will be acceptable if the leakage is greater than that determined by the following formula (for PVC or DIP pipe):

$$L = [S \times D \times \text{Sqrt}(P)]/148{,}000, \text{ where}$$

L = allowable leakage (gallons per hour)
S = length of pipe tested (feet)
D = nominal diameter of pipe (inches)
P = average test pressure during the leakage test (psi)

Notes:
a. When testing against closed metal seated valves allow an additional 0.0078 gal/hr/in of nominal valve size for each valve.
b. The allowable leakage for test sections with different diameters is the sum of the computed leakage for each pipe size.

TABLE 2 - ALLOWABLE LEAKAGE (gal/hr) FOR 1000 FT OF GASKETED PVC OR DIP PIPE

Nominal Pipe Size (in)	Average Test Pressure in Pipeline, psi													
	50	75	100	125	150	175	200	225	250	275	300	350	400	450
2	0.10	0.12	0.14	0.15	0.17	0.18	0.19	0.20	0.21	0.22	0.23	0.25	0.27	0.29
3	0.14	0.18	0.20	0.23	0.25	0.27	0.29	0.30	0.32	0.34	0.35	0.38	0.41	0.43
4	0.19	0.23	0.27	0.30	0.33	0.36	0.38	0.41	0.43	0.45	0.47	0.51	0.54	0.57
6	0.29	0.35	0.41	0.45	0.50	0.54	0.57	0.61	0.64	0.67	0.70	0.76	0.81	0.86
8	0.38	0.47	0.54	0.60	0.66	0.72	0.76	0.81	0.85	0.90	0.94	1.01	1.08	1.15
10	0.48	0.59	0.68	0.76	0.83	0.89	0.96	1.01	1.07	1.12	1.17	1.26	1.35	1.43
12	0.57	0.70	0.81	0.91	0.99	1.07	1.15	1.22	1.28	1.34	1.40	1.52	1.62	1.72
14	0.67	0.82	0.95	1.06	1.16	1.25	1.34	1.42	1.50	1.57	1.64	1.77	1.89	2.01
16	0.76	0.94	1.08	1.21	1.32	1.43	1.53	1.62	1.71	1.79	1.87	2.02	2.16	2.29
18	0.86	1.05	1.22	1.36	1.49	1.61	1.72	1.82	1.92	2.02	2.11	2.28	2.43	2.58
20	0.96	1.17	1.35	1.51	1.66	1.79	1.91	2.03	2.14	2.24	2.34	2.53	2.70	2.87
24	1.15	1.40	1.62	1.81	1.99	2.15	2.29	2.43	2.56	2.69	2.81	3.03	3.24	3.44
30	1.43	1.76	2.03	2.27	2.48	2.68	2.87	3.04	3.21	3.36	3.51	3.79	4.05	4.30
36	1.72	2.11	2.43	2.72	2.98	3.22	3.44	3.65	3.85	4.03	4.21	4.55	4.86	5.16
42	2.01	2.46	2.84	3.17	3.48	3.75	4.01	4.26	4.49	4.71	4.92	5.31	5.68	6.02
48	2.29	2.81	3.24	3.63	3.97	4.29	4.59	4.86	5.13	5.38	5.62	6.07	6.49	6.88
54	2.58	3.16	3.65	4.08	4.47	4.83	5.16	5.47	5.77	6.05	6.32	6.83	7.30	7.74
60	2.87	3.51	4.05	4.53	4.97	5.36	5.73	6.08	6.41	6.72	7.02	7.58	8.11	8.60
64	3.06	3.75	4.32	4.83	5.30	5.72	6.12	6.49	6.84	7.17	7.49	8.09	8.65	9.17

6. All pipe, fittings and other materials found defective under test shall be removed and replaced at the Contractor's expense.

7. Lines which fail to meet this test shall be repaired and retested as necessary until test requirements are complied with.

B. STABILIZATION:

1. GENERAL:

a. All piping used for finished water service shall be chlorinated in accordance with the requirements for the State of North Carolina, Department of Human Resources, Division of Health Services.

b. Pipe interiors, fittings, and valves shall be protected from contamination. pipe delivered for construction shall be strung so as to minimize entrance of foreign material. When pipelaying is not in progress for more than one hour, all openings in the pipeline shall be closed by water tight plugs. Joints of all pipe in the trench shall be completed before work is stopped. If water accumulates in the trench, the plugs shall remain in place until the trench is dry.

c. If dirt that, in the opinion of the Engineers will not be removed by the flushing operations, enters the pipe, the interior of the pipe shall be leaned and swabbed as necessary, with a 5% hypochlorite disinfecting solution.

d. Generally, sampling taps shall be provided on the water main every 500', in order to afford representative water testing and sample collection. When long transmissional mains are constructed, without side connections, the distance between each tap may, at the discretion of the Engineers, be increased.

2. PRELIMINARY FLUSHING: Each valve section of the completed main shall be flushed prior to sterilization as thoroughly as possible with water pressure and outlets available. If no hydrant is provided at the end of the main section, a tap shall be installed at the main section extremity, large enough to develop a velocity in the main of, at least, 2.5 fps. The flushing operation shall be done after the pressure test has been made. Each valved section of the newly laid pipe shall be flushed separately. Flushing sites shall have adequate drainage and shall be approved by the Engineers. Flushing outlets shall be comparable to those listed in the following table:

*REQUIRED OPENINGS TO FLUSH PIPELINES**

(40 psi Residual Pressure)

Pipe Size In.	Flow Required to Produce 2.5 FPSVelocity GPM	Orifice Size In.	Hydrant Outlet Nozzles	
			Number	In.
4	100	15/16	1	2 ½
6	220	1 3/8	1	2 ½
8	390	1 7/8	1	2 ½
10	610	2 5/16	1	2 ½
12	880	2 13/16	1	2 ½
14	1,200	3 1//4	2	2 ½
16	1,565	3 5/8	2	2 ½
18	1,980	4 3/16	2	2 ½

*With 40 psi residual pressure, a 2 1/2 inch hydrant outlet nozzle will discharge approximately 1,000 gpm and a 4 1/2 inch hydrant nozzle will discharge approximately 2,500 gpm.

3. DISINFECTING:

a. Before being placed in service, all new mains and existing piping disturbed in any manner by the work shall be disinfected. Draining the water from existing piping or even lowering the water pressure more than one-half will constitute disturbances of the piping.

b. The disinfection of water mains, valves, and other appurtenances incorporated into the main construction (including storage tanks), after flushing to remove sediment and other foreign matter, and after testing for leaks, shall be disinfected in accordance with ANSI/AWWA Standard C652-11; "Disinfection of Water Storage Facilities" or in accordance with ANSI/AWWA C651-14; "Disinfection of Water Mains."

c. Records demonstrating compliance with ANSI/AWWA Standards C652-11 or ANSI/AWWA Standard 651-14 shall be available for three years for inspection.

d. The point of chlorine application shall be at the beginning of the water main construction and/or any valve section thereof, through corporation cock installed close to and on the downstream side of the regulating gate valve controlling the flow of water into the main.

e. During the disinfecting operation, valves, hydrants and other mechanical devices controlling the flow of water shall be operated to permit full effectiveness of the chlorine. Valves shall be manipulated so that the strong solution within the main being sterilized will not flow back into the supply line nor flow into mains already in service. A chlorine concentration test shall be made, in turn, at each of the hydrants and/or taps provided for that purpose.

f. After the disinfecting operation has been completed and upon test, proved satisfactory, the heavily chlorinated water shall be retained in the main long enough to destroy all nonspore formatting bacteria. This period shall be at least twenty-four (24) hours. At the completion of the retention period, the chlorine concentration of the water within the main shall be at least twenty-five (25) parts per million (210 pounds per million gallons) of chlorine.

4. FINAL FLUSHING AND TESTS:

a. After the required period of retention has elapsed, the heavily chlorinated water shall be flushed out completely to waste by the Contractor until the replacement water throughout the length of the main shall, upon test, be proven comparable in quality to the water supply source.

b. When the water in the treated main shall have been proven comparable to that of the source, water samples shall be collected at each of the sampling taps and submitted to a laboratory on two (2) separate days. Under no circumstances shall such samples be collected from hydrants or unsterilized hose connections.

i. After disinfection the water supply shall not be placed into service until bacteriological test results of representative water samples are analyzed in a state approved, certified laboratory are found to be satisfactory.

ii. Should the initial disinfecting fail to pass, the disinfecting procedure shall be repeated until satisfactory results are obtained.

C. CLEANING UP:

1. While carrying out the work required under this Division, the Contractor shall remove all excess materials, earth, debris, etc., and shall clean up and leave all affected property, streets, roads and highways in a neat, clean and orderly condition. All clean-up work of any nature, including any required soil stabilization, debris removal, plantings and/or reseeding work, shall closely follow the actual pipe laying work. If so directed by the Engineers, the Contractor shall deposit all or part of the excess earth at such point or points as may be designated. Excess earth from trenches along State controlled highways or roads shall be disposed of in a manner satisfactory to the State Highway Department.

2. The Contractor shall be responsible for restoring all disturbed ground area and replacing all disturbed property corners to the satisfaction of the Engineers.

END OF SECTION 12.

SECTION 13

POLYETHYLENE PLASTIC POTABLE WATER PIPE

A. SCOPE: This Specification establishes the standards for high density polyethylene plastic potable water pipe, fittings, the material, joints and construction practices.

B. MATERIAL:

1. All material shall be manufactured from a PE 4710 resin. The resin material shall meet the specifications of ASTM D 3350 with a minimum cell classification of 445474C. HDPE pipe and fittings 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. HDPE products shall be homogeneous throughout and free of visible cracks, holes, foreign inclusions, voids, or other injurious defects.

2. The polyethylene compound shall be suitably protected against degradation by ultraviolet light by means of carbon black of not less than 2 percent.

3. The manufacture of the HDPE resin shall certify the cell classification indicated.

C. PIPE CLASSIFICATION AND DIMENSIONS:

1. Pipe shall meet AWWA C901 (1/2" to 3") or AWWA C906 (4" to 63") and shall be listed as meeting NSF-61.

2. Pipe sizes 3" and larger shall have a manufacturing standard of ASTM F 714, while pipe smaller than 3" shall be manufactured to the dimensional requirements listed in ASTM D 3035. Dimension Ratio (DR) and Outside Diameter (IPS/DIPS) shall be as specified on plans.

3. The color coding shall be permanently co-extruded stripes on the pipe outside surface as part of the pipe's manufacturing process (blue for water).

4. Minimum operating pressure shall be 150 psi.

D. WORKMANSHIP: Workmanship shall be of the highest quality and level compatible with current commercial practice. The PE pipe shall be homogeneous throughout and free of cracks, holes, foreign inclusions or other injurious defects. It shall be uniform in color, opacity, density and other physical properties.

E. MARKING: Marking on pipe shall include the following at intervals of not more than 5':

1. Nominal pipe size.
2. Type of plastic material.
3. The standard thermoplastic pipe pressure rating in psi for water at 73.4°F and 150 psi pipe.
4. Manufacturer's name or trademark and code.
5. National Sanitation Foundation markings.

F. FITTINGS: Fittings shall be molded or fabricated from high-density polyethylene. The polyethylene material used for fittings shall be the same as that used for the polyethylene pipe, as specified in Paragraph B. of this Specification. All fittings will meet similar specifications as the pipe and shall be manufactured to operate at the same operating pressure as the polyethylene pipe specified herein.

G. JOINTS: All pipe and fittings to be installed in trenches shall be joined to one another by the thermal butt fusion system. Polyethylene pipe lengths, fittings and flanged connections to be fused shall be of the same type, grade and class of polyethylene compound and supplied by the same raw material supplier. Fusion shall be perfectly accomplished such that no internal interface shall exist where the two pipe surfaces are united. The polyethylene pipe and fittings shall be a low flow, high viscosity material such that a substantial pressure shall be required to properly effect the interfacial fusion. Butt fusion shall be accomplished with the use of equipment specifically designed and designated by the pipe manufacturer for this purpose. The pipe manufacturer shall provide for the services of a trained technician for two (2) days to instruct the Contractor in the details of the butt fusion system and use of the fusion equipment.

H. HANDLING: The handling of the joined pipeline shall be in such a manner that the pipe is not damaged by dragging it over sharp and cutting objects. Sections of the pipes with deep cuts and gouges shall be cut out and the ends of the pipeline rejoined by the butt fusion system as noted above. Pipe shall be unloaded from the shipping trucks and stacked as required according to the manufacturer's recommendations.

I. INSTALLATION:

1. Underground installation shall be performed in accordance with the drawings and Section 8 of these Specifications.

END OF SECTION 13.

SECTION 14

POLYVINYL CHLORIDE PRESSURE PIPE FOR POTABLE WATER

A. GENERAL REQUIREMENTS: Polyvinyl chloride pressure pipe and fittings used for the conveyance of potable water, in nominal sizes of 3" and less, shall be American National Standards Institute/NSF (ANSI/NSF) International Standard 61 compliant (including subsequent amendments and editions). PVC pipe used for potable water in sizes 4" and larger shall be in strict conformance with the requirements of AWWA Standard C-900. PVC pipe used for all types of interior or exterior process piping shall be Class 12454 (Type 1, Grade 1) Schedule 80 PVC (ASTM D-1785) piping unless specifically designated as Schedule 40 on the drawings.

B. PHYSICAL PROPERTIES:

1. The PVC pipe of 3" nominal diameter and less shall conform to ASTM Specification D-2241, "Standard Specification for Polyvinyl Chloride (PVC) Plastic Pipe (SDR-PR)," as it applies to Class 12454 (A or B) polyvinyl chloride plastic pipe, SDR21 water pressure ratings of 200 psi at 23°C (73.4°F), with minimum physical requirements as listed in the following table.

NOMINAL SIZE INCHES	OUTSIDE DIAMETER NCHES	MIN. WALL THICKNESS INCHES	WEIGHT/ 100 FT. POUNDS	WORKING PRESSURE PSI
3/4	1.050	0.060	11.8	200
1	1.315	0.063	15.9	200
1 1/4	1.660	0.079	24.8	200
1 1/2	1.900	0.090	32.2	200
2	2.375	0.113	50.8	200
2 1/2	2.875	0.137	74.2	200
3	3.500	0.167	110.0	200

2. Pipe with nominal diameters of 4" and larger shall meet the physical requirements of AWWA Standard C-900. Physical dimensions and requirements of Table 2 of AWWA C-900 for 150-psi pressure class (DR18). Where PVC is shown on the drawings to be interconnected with steel piping, the dimensions of the PVC pipe shall conform to Table 1 of AWWA C-900 for 150 psi pressure class (DR18).

C. JOINTS: The joints shall be push-on type designed so that the pipe and fittings may be connected on the job without the use of solvent cement or any special equipment. The push-on joint is a single rubber gasket joint designed to be assembled by the positioning of a continuous, molded, rubber ring gasket in an annular recess in the pipe or fitting socket and the forcing of the plain end of the entering pipe into the socket, thereby compressing the gasket radially to the pipe to form a positive seal. The gasket and the annular recess shall be so designed and shaped that the gasket is locked in place against displacement as the joint is assembled. Details of the joint design and assembly shall be in accordance with the joint manufacturer's standard practice. The joints shall be designed so as to provide for the thermal expansion or contraction experienced with a total temperature change of at least 75°F in each joint per length of pipe.

D. LUBRICANT: Lubricant furnished for lubricating joints shall be nontoxic, shall not support the growth of bacteria, shall have no deteriorating effects on the gasket or pipe material and shall not impart color, taste or odor to water. The lubricant containers shall be labeled with the manufacturer's name.

E. GASKETS:

1. Gaskets shall meet all applicable requirements of ANSI/AWWA C111/A21.11-17..

2. Gasket dimensions shall be in accordance with the manufacturer's standard design dimensions and tolerances. The gasket shall be of such size and shape as to provide an adequate compressive force against the spigot and socket after assembly to effect a positive seal under all combinations of joint and gasket tolerances. The trade name or trademark, size, mold number, gasket manufacturer's make and year of manufacture shall be molded in the rubber on the back of the gaskets.

3. Gasket shall be vulcanized natural or vulcanized synthetic rubber. No reclaimed rubber shall be used. When two hardnesses of rubber are included in a gasket, the soft and hard portions shall be integrally molded and joined in a strong vulcanized bond. They shall be free of porous areas, foreign material and visible defects.

F. PIPE LENGTHS: The pipe shall be furnished in nominal lengths of 20'.

G. FITTINGS:

1. Fittings shall have joints as described above and shall be designed to withstand the same pressures as required for the pipe.

2. The supplier shall be capable of supplying fittings with combinations of spigot (plain) end and bell.

3. The double bell coupling shall be so designed that the pipe will slip completely through the coupling or available optionally with pipe stops therein.

H. MARKING REQUIREMENTS: All PVC pipe shall be marked and labeled in accordance with AWWA Standard C-900, Section 2.5. All PVC pipe in nominal sizes 3" and less shall bear the National Sanitation Foundation logos.

I. TESTING: All factory tests shall be performed in accordance with the requirements of AWWA Standard C-900. When the total quantity of pipe of all sizes exceeds 10,000 linear feet the manufacturer shall provide the Owner and Engineers with an affidavit certifying that all materials and tests required under this specification and AWWA Standard C-900 have been complied with.

J. CORPORATION STOPS: Corporation stops for use on PVC pipe shall consist of a corporation stop and a saddle. The saddle shall be specifically designed to prevent distortion of PVC pipe. The water service corporation stop and saddle shall be constructed of bronze throughout with silicon bronze stud bolts. The stop saddle shall be fitted with a rubber gasket. The outlet of the saddle shall be copper service AWWA Standard. The corporation stop shall be Duo-Stops as manufactured by Hays Manufacturing Co., Mueller, Co., Ford Meter Box Co., Dresser Industries, or equal. Corporation stops shall be suitable for use with any of the below listed service saddle manufactures. The service saddle shall be manufactured by Ford Meter Box Co., Mueller Co., Rockwell Industries, Dresser Industries, or equal.

END OF SECTION 14

SECTION 26
CONCRETE FORM WORK

PART I - GENERAL

26-1 REQUIREMENTS.

A. The Contractor shall provide all labor, materials, equipment and services necessary for the proper completion of all formwork for cast in place concrete work indicated on the drawings and specified herein.

B. The Contractor shall refer to the drawings for required size and location of cast in place concrete members.

26-2 REFERENCE SPECIFICATIONS.

Unless otherwise altered, amended, supplemented or deleted by "Part II, Products" and "Part III, Execution" which follow, all concrete formwork shall conform to the following:

A. American Concrete Institute Standard ACCI 347, "Recommended Practice for Concrete Formwork."

B. The American Concrete Institute "Specifications for Structural Concrete for Buildings," ACI 301-72. A copy of "Specifications for Structural Concrete for Buildings, ACI 301-72, With Selected ACI and ASTM References," ACI Publication SP-15, shall be purchased by the Contractor and shall be maintained in good condition at the job site at all times during construction. This reference may be purchased from the American Concrete Institute, P.O. Box 4754, Redford Station, Detroit, Michigan, 48219. This reference is referred to hereafter in these Specifications as the ACI Specifications.

C. The American Concrete Institute "Manual of Standard Practice for Detailing Reinforced Concrete Structures, "ACI 315-80, hereafter referred to as the ACI Detailing Manual.

D. The Concrete Reinforcing Steel Institute "Manual of Standard Practice," latest edition, hereafter referred to as the CRSI Manual.

26-3 SUBMITTALS.

A. Complete erection plans shall be prepared for removable forms in accordance with the ACI Detailing Manual, the CRSI Manual, and the Manual of Recommended Practice for Concrete Formwork.

B. The review of erection drawings will be for size and arrangement of the concrete members. The Contractor shall verify dimensions and any errors in dimensions shown on the erection drawings shall be the responsibility of the Contractor.

C. Review by the Engineers shall not be construed as a waiver of construction responsibilities unless the Contractor has requested a deviation from the Contract Documents in writing and the Engineers have granted such deviation in writing. Fabrication or delivery of materials prior to review of submittals shall be entirely at the risk of the Contractor.

PART II - PRODUCTS

26-4 MATERIALS.

A. Removable Metal Pan Forms: Unless otherwise noted, the metal pan joists shall be constructed in accordance with the "Code of Standard Practice for the Use of Removable Forms for Concrete Joist Floor and Roof Construction," of the CRSI Manual. It is essential to the load capacity of concrete joists that the dimensions for all standard and special filler forms be in accordance with the "Standard Dimensions of Forms for One-Way Joist Construction" of the U. S. Department of Commerce Simplified Practice Recommendation R87-32.

1. Longform Type - Where concrete joists will be permanently exposed to view (see drawings), the joist forms shall be of the "long form" type constructed to the full length of each segment of joists between distribution ribs or beams. End closures may be of the removable type or may be permanently attached to the forms.

2. Standard Type - Where concrete joists will be concealed by ceiling construction, and in mechanical equipment rooms, the joist forms shall be "standard" type. End closures and laps shall be sufficiently tight to prevent the leakage of concrete.

3. Removable metal pan forms shall be new, or practically so. Forms displaying excessive dents, holes or other signs of excessive use or abuse shall not be used. Forms shall be cleaned and properly oiled before each use.

4. Special width filler forms shall be used to fill in odd spaces. Openings and ends shall be properly headed.

5. Products of equivalent quality and dimensions constructed of molded fiber, reinforced fiberglass or plastic may be used in lieu of steel forms, at the option of the Contractor.

B. Forms for As-Cast Architectural Concrete: Concrete to be left permanently exposed to view shall be considered "As-Cast Architectural Finishes" and shall conform to the requirements of Chapter 13 of the ACI Specifications.

C. Forms for Pile Caps and Grade Beams: Earth cuts shall not be used to form vertical surfaces for pile caps, grade beams and other vertical concrete surfaces in contact with earth. These surfaces shall be formed with wood or metal forming materials to the required dimensions.

D. Forms for Footings: Earth cuts may be used for forms for vertical surfaces for footings where the workmanship and soil permit accurate excavation to size and shape shown on the drawings. Sloping sides, rounded corners and irregular bottoms will not be accepted. Where these requirements cannot be met, form the vertical surfaces with wood or metal forming materials to the required dimensions.

E. Grade Stakes: Where earth cuts are used for forms, the footing excavations shall be provided with grade stakes set to correct elevations prior to ordering concrete. Grade stakes shall be #3 or larger steel bars, may be new or scrap material and may remain in the concrete.

F. Wood Forms: Wood forming materials shall conform to the requirements of Chapter 4 of the ACI Specifications.

G. Corrugated Steel Sheet Forms: The Contractor shall furnish and install galvanized corrugated steel sheet forms for all concrete slabs over joist beams, as shown on the drawings and directed by the Engineers. The steel sheet forms shall be corrugated form low temper, low carbon, cold reduced steel with a minimum yield strength of 95,000 psi by 0.1% offset method to a nominal corrugation pattern of 2-3/8" x 9/16". Sheets shall be galvanized conforming to ASTM Specification A446-60T, Grade E steel, 1.25 oz. per square foot coating class. Minimum physical properties shall be as follows:

DESCRIPTION	CHARACTERISTICS
Weight-galvanized per cover width	0.88 lbs./sq. ft.
Moment of Inertia per foot width	0.010 inches 4
Section of modulus per foot width	0.036 inches 3
Corrugation (pitch x depth)	2-3/8" x 9/16"
Nominal cover width	24 inches
Nominal overall width	25-1/16 inches

26-5 DESIGN OF FORMS.

Forms shall conform to shapes, lines and dimensions of the members as called for on the drawings, and shall be sufficiently tight to prevent leakage of mortar. They shall be properly braced or tied together so as to maintain position and shape.

26-6 FORMS COATINGS.

Provide commercial formulation form coating compounds that will not bond with, stain nor adversely affect concrete surfaces, and will no impair subsequent treatment of concrete surfaces requiring bond or adhesion, not impede the wetting of surfaces to be cured with water or curing compounds.

26-7 TIGHTENING FORMS.

Immediately prior to the commencement of concrete placement all joints in the formwork shall be tightened to prevent the leakage of concrete.

26-8 ERECTION CORRUGATED STEEL SHEET FORMS.

A. The corrugated sheet steel forms shall be placed with corrugation edges up and with corrugations perpendicular to supports. Sheet shall be placed end-to-end along one side of the building. Adjacent rows will be placed in like manner, side lapping one corrugation with previously placed row. End laps shall always occur over supporting joists, beams or purlins and should be centered over the support. Minimum end lap is 2" for welded attachment shall not extend beyond edge of support flange. Sheets shall be attached to supports by plug welding through curbed washers to supporting top chords.

B. The welded attachments shall have the following minimum welding requirements:

1. End Laps - Weld top sheets in the valley of the side lap through four (4) sheet thicknesses and again at the middle of the sheet.

2. Intermediate Supports - Weld in X pattern; that is, weld in valley of side lap on every other joist and in the valley of the center corrugation of the remaining joist.

26-9 REMOVAL OF FORMS.

A. Formwork for joists, slabs, beams and other parts supporting the weight of concrete, shall remain in place until the concrete has reached its specified 28-day strength, but in no case less than 14 days. Other formwork may be removed in accordance with "Recommended Practice for Concrete Formwork," ACI 347-78, unless otherwise specified in these specifications.

B. Forms shall be removed in such a manner as to ensure the complete safety of the structure. Where the structure is supported on shores, the removable floor forms, beams and girder sides, and column and similar vertical forms may be removed after 48 hours, providing the concrete will not be injured.

26-10 REUSE OF FORMS.

Clean and repair surfaces of forms to be reused in the work. Split, frayed, delaminated or otherwise damaged form facing material will not be acceptable. Apply new form coating compound material to concrete contact surfaces as specified for new formwork.

When forms are extended for successive concrete placement, thoroughly clean surfaces, remove fins and laitance and tighten forms to close all joints. Align and secure joints to avoid offsets. Do not use "patched" forms for exposed concrete surfaces, except as acceptable to the Engineers.

END OF SECTION 26.

SECTION 27
CONCRETE REINFORCEMENT

PART I - GENERAL

27-1 REQUIREMENTS.

A. The Contractor shall provide all labor, materials, equipment and services necessary for the proper completion of all reinforcement for cast in place concrete work indicated on the drawings and specified herein.

B. The Contractor shall refer to the drawings for required size, type and location of concrete reinforcement.

27-2 REFERENCE SPECIFICATIONS.

A. Unless otherwise altered, amended, supplemented or deleted by Part II - Products and Part III - Execution, which follow, all reinforcement for concrete work shall conform to the following:

B. The American Concrete Institute "Specifications for Structural Concrete for Buildings," ACI 301-72. A copy of "Specifications for Structural Concrete for Buildings, ACI 301-72, with Selected ACI and ASTM References," ACI Publication SP-15, shall be purchased by the Contractor and shall be maintained in good condition at the job site at all times during construction. This reference may be purchased from the American Concrete Institute, P. O. Box 4754, Redford Station, Detroit, Michigan 48219. This reference is referred to hereafter in these Specifications as the ACI Specifications.

C. The American Concrete Institute "Manual of Standard Practice for Detailing Reinforced Concrete Structures," ACI 315-80, hereafter referred to as the ACI Detailing Manual.

D. The Concrete Reinforcing Steel Institute "Manual of Standard Practice," latest edition, hereafter referred to as the CRSI Manual.

27-3 QUALIFICATIONS.

A. Reinforcing Steel Fabricator:

1. The fabricator shall have not less than 5 years experience in the fabrication of reinforcing steel and shall have previously fabricated not less than 5 projects similar in scope to this project.

2. When directed by the Engineers, the fabricator shall submit a written description of fabrication ability including facilities, personnel and list of similar completed projects.

B. Reinforcing Steel Erector:

1. The erector shall have not less than 3 years experience in the erection of reinforcing steel and shall have previously erected not less than 3 projects similar in scope to this project.

2. When directed by the Engineers, the erector shall submit a written description of reinforcing steel erection ability including equipment, personnel and a list of similar completed projects.

27-4 SUBMITTALS.

A. Shop and Erection Drawings:

1. Complete shop and erection drawings shall be prepared for reinforcement in accordance with the ACI Detailing Manual and the CRSI Manual. Erection drawings shall show sufficient detail to illustrate the reinforcing steel erection procedure, including placement of accessories.

2. Preliminary and final erection drawings shall be submitted to the Engineers for their approval before any reinforcement may be placed.

3. The review of shop and erection drawings will be for size and arrangement of the reinforcement. The Contractor shall verify quantities and dimensions and any errors shown on the shop and erection drawings shall be the responsibility of the Contractor.

B. Certifications of Materials: Furnish to the Engineers for review the following:

1. Certified mill test reports of ladle analysis, tensile properties and bend tests of each grade of steel from which reinforcement is fabricated.

2. Certificates of conformance of stainless steel accessories.

C. Review: Review by the Engineers shall not be construed as a waiver of construction responsibilities unless the Contractor has requested a deviation from the specifications in writing and the Engineers have granted such deviation in writing. Fabrication or delivery of materials prior to the review of the shop and erection drawings shall be entirely at the risk of the Contractor.

27-5 PRODUCT HANDLING.

A. Reinforcement shall not be carelessly unloaded from delivery vehicles in such a manner as to alter the configuration of the individual pieces.

B. Reinforcement shall be stored in an orderly manner to avoid mixing bars of different marks.

C. Reinforcement and accessories which are stored at the project site shall be at least 2' above the ground on platforms, skids or other supports, and be covered to protect it from the weather. It shall be free from oil, mud, dirt or excessive corrosion when placed in the formwork.

D. Accessories and other packaged materials shall be stored in their original unbroken package until ready for use in the work.

PART II - PRODUCTS

27-6 MATERIALS.

A. Metal Reinforcement:

1. All reinforcing bars shall be deformed and shall conform to one of the following:

   a. Specifications for Billet-Steel Bars for Concrete Reinforcement, ASTM A615, Grade 40.

   b. Specifications for Deformed Billet-Steel Bars for Concrete Reinforcement, ASTM A615, Grade 60.

   c. Specifications for Deformed Billet-Steel Bars for Concrete Reinforcement, ASTM A615, Grade 75.

   d. Specifications for Minimum Requirements for Deformations of Deformed Steel Bars for Concrete Reinforcement (ASTM A408).

   e. Specifications for Special Large-Size Deformed Billet-Steel Bars for Concrete Reinforcement (ASTM A408).

   f. Bar and rod mats for concrete reinforcement shall conform to Specifications for Fabricated Steel Bar or Rod Mats for Concrete Reinforcement (ASTM A184).

   g. Wire for concrete reinforcement shall conform to Specifications for Cold-Drawn Steel Wire for Concrete Reinforcement (ASTM A82).

2. Welded wire fabric for concrete reinforcement shall conform to Specifications for Welded Steel Wire Fabric for Concrete Reinforcement (ASTM A185) except that the weld shear strength requirement shall be extended to include a wire size differential up to and including six gauges.

3. The clear distance between parallel bars shall be not less than the nominal diameter of the bar, 1 1/3 times the maximum size of the coarse aggregate, nor less than 1".

4. Structural steel shall conform to Specifications for the Design, Fabrication and Erection of Structural Steel for Buildings of the American Institute for Steel Construction adopted April 17, 1963, as amended to date.

5. Steel pipe for concrete-filled pipe columns shall conform to Grade B of Specifications for Welded and Seamless Steel Pipe (ASTM A53).

6. Cast iron pipe for composite columns shall conform to Specifications for Cast Iron Pressure Pipe (ASTM A377).

B. Metal Accessories:

1. High chairs with sand plates (HCP) shall be used to support reinforcing steel in footings and other members in contact with the earth. Wire shall not be less than #4 and plate shall not be less than 20 gauge. HCP shall be constructed with one, approximately square, sand plate.

2. CRSI "Class E, Special Stainless" bar supports shall be provided to support all reinforcing steel in members to be left permanently exposed to view. Such supports shall be constructed of stainless steel containing not less than 16% chromium.

3. CRSI "Class A, Bright Basic" bar supports shall be provided to support reinforcing steel for all other concrete members.

PART III - EXECUTION

27-7 PLACING REINFORCEMENT.

Metal reinforcement shall be accurately placed according to the drawings and adequately secured in position by concrete, metal or other approved chairs, spacers or ties.

27-8 CLEANING AND BENDING.

At the time concrete is placed, metal reinforcement shall be free from rust, scale or other coatings that will destroy or reduce the bond. All bars shall be bent cold, unless otherwise permitted by the Engineers. No bars partially embedded in concrete shall be field bent except as shown on drawings or as specifically permitted by the Engineers.

27-9 SPLICES IN REINFORCEMENT.

A. Welded wire fabric shall be considered as load carrying reinforcement and shall be lapped in accordance with 505(b) of the ACI Specifications, except at slabs on grade, which shall be considered as nonload carrying and shall be lapped in accordance with 505(c) of the ACI Specifications.

B. No splices of reinforcement shall be made except as shown on the drawings, as specified, or as authorized by the Engineers. All welding shall conform to the American Welding Society's Recommended Practices for Welding Reinforcing Steel, Metal Inserts and Connections in Reinforced Concrete Construction (AWS-D-12.1), unless otherwise authorized by the Engineers. Where lapped splices are used the minimum amount of lap shall be not less than 40 bar diameters.

END OF SECTION 27.

SECTION 28
CONCRETE - GENERAL

PART I - GENERAL

28-1 REQUIREMENTS.

A. The Contractor shall furnish all labor, materials, tools, equipment and all else required to construct the concrete work, test and place the structures into satisfactory operation as required by the drawings, these Specifications, and the Engineers' requirements under them.

B. All concrete shall be composed of Portland cement, fine and coarse aggregate and water proportionally mixed.

C. All concrete shall be mixed, tested, transported, formed, placed, vibrated, finished and cured as shown on the drawings and as hereinafter specified.

28-2 REFERENCE SPECIFICATIONS.

Unless otherwise altered, amended, supplemented or deleted by "Part II - Products," and "Part III - Execution," which follow, all concrete work shall conform to the American Concrete Institute "Specifications for Structural Concrete for Buildings," ACI 301-66. A copy of "Specifications for Structural Concrete for Buildings, ACI 301-66, with Selected ACI and ASTM References," ACI Publication SP-15, shall be purchased by the Contractor and shall be maintained in good condition at the job site at all times during construction. This reference may be purchased from the American Concrete Institute, P. O. Box 4754, Redford Station, Detroit, Michigan, 48219. This reference is referred to hereafter in these Specifications as the ACI Specifications.

28-3 TESTING.

The Contractor shall be responsible for all testing of concrete. He shall be responsible for preparing, transporting, storing, curing, testing and reporting test sample cylinders for compressive strength. He shall also perform slump tests when required by the Engineers. All tests and the manner in which they are conducted shall be satisfactory to the Engineers. The testing laboratory shall be satisfactory to the Engineers.

A. SLUMP TEST AND AIR ENTRAINMENT TEST OF PORTLAND CEMENT CONCRETE:

1. Test specimen shall be formed in a standard 16-gauge, galvanized metal slump cone 12" in height, as described by ASTM C143-52.

2. Air entrainment test shall conform to ASTM C-175 and C-595.

B. SAMPLING:

1. Samples of concrete for test specimens shall be taken at the mixer, or from the truck mixer in the case of ready-mixed and transit-mixed concrete, during discharge. Obtain such samples by passing a receptacle completely through the stream of concrete, at three or more regular intervals throughout the discharge of the entire batch except that samples shall not be taken at the beginning or end of discharge. The sample shall then be transported in a wheelbarrow or some other suitable conveyance to the place of molding.

2. Mix the specimen with a shovel until the specimen is uniform in appearance. Note location of batch from which the sample is taken for future reference.

C. MOLDING:

1. Dampen the cone and place it on a flat, moist, nonabsorbent surface. From the sample, immediately fill the cone in three layers, each approximately 1/3 of the volume of the cone. In placing, move the scoop around the top edge of the cone in order to insure symmetrical distribution of the concrete. Rod each layer with 25 strokes of a 5/8" standard rod. (See equipment list.)

2. Distribute the strokes across the cross section of the cone, penetrating the underlying layer. Rod the bottom layer throughout its depth. After the top layer has been rodded, strike off surface of the concrete with a trowel so that the cone is exactly filled. Remove the cone by raising it carefully in a vertical direction. The slump shall then be measured by determining the difference between the height of the cone and the height of the specimen.

D. PREPARATION OF STORAGE OF CONCRETE TEST CYLINDERS IN THE FIELD (Reference ASTM C31-57; ASTM C172-54):

1. Sampling:

a. The sampling shall be representative of the batch. (The word batch as here employed shall be understood to refer to one day's pour rather than the contents of one mixer load.) It shall consist of portions from different points in the batch. A sample shall be taken for each fifty (50) cubic yards or portion thereof of each pour.

b. When taken from truck mixers or agitators, the samples shall be taken in three or more regular increments throughout the discharge of the entire batch.

c. The composite sample shall be mixed with a shovel sufficiently to insure homogeneity & immediately molded into test specimens.

d. The place of molding shall be such that the cylinders will not have to be moved during the first 24 hours. Molding shall be done on a platform or some other firm, level base not subject to vibration.

2. Size of Specimens: Cylinders shall be 6" in diameter and 12" deep. The mold shall be metal or other nonabsorptive material such as paraffined cardboard. If a metal mold is used it must have a machined base which can be secured to the mold and be watertight.

3. Molding: Place the concrete into the mold in three layers of approximately equal volume. Move the scoop around the top edge in placing in order to achieve symmetrical distribution of the concrete. Distribute the concrete further by a circular motion of the tamping rod. Rod each layer with 25 strokes of a 5/8" diameter standard rod. (See equipment list.) Distribute strokes uniformly over the cross section of the mold, penetrating into the immediate underlying layer. Bottom layer shall be rodded throughout its depth. Where voids are left by the tamping rod, tap sides of the mold to close the voids. After the top layer has been rodded, strike off the surface of the concrete with a trowel and cover with a glass or metal plate to prevent evaporation. Mark number and date on top of cylinder with a nail or similar object.

4. Curing:

a. Test specimens shall be removed from the molds at the end of 24 hours and stored in a location such that they will be protected from damage. At the end of 48 hours they shall be moved to the laboratory where they shall be placed in a moist room or in a lime saturated water bath until time for testing. The temperature of the moist room or water bath must be controlled between the limits of 60° F. and 80° F. All other conditions of curing shall conform to Paragraph 7(c) ASTM C31-57. The test specimens cured as above specified shall be the ones used for the standard 7-day and 28-day reports.

b. Should the Contractor desire to remove shoring and forms before the time stipulated in the Specifications and to subject the concrete to loads of any kind, he will be required to provide an extra set of test cylinders for testing at an agreed upon time to determine whether the structure has actually acquired sufficient strength to carry the loads. These test cylinders shall receive, insofar as practicable, the same protection that they represent, and shall be stored on the site. They shall be moved to the laboratory not more than two days prior to the date of testing.

5. Shipping Instructions: When cylinders are moved to a laboratory they shall be packed in boxes having inside dimensions of 7" x 21" x 13" to contain three cylinders. The box shall be made of 1/2" plywood with a separation partition between the cylinders and equipped with a hinged lid, hasp and carrying handle. The cylinders shall be packed completely with excelsior, straw or sawdust and kept damp. In the top of the box, place a list showing the data listed in Paragraph 1 of "Data to be Reported." Fasten the lid securely and tag with a shipping ticket.

E. EQUIPMENT TO BE FURNISHED BY CONTRACTOR FOR CONCRETE TESTING:

1. Slump Cone.

2. Platform.

3. Concrete molds for cylinders, including machined base if metal molds are used.

4. 5/8" round smooth rod approximately 24" long, one end rounded to a hemispherical tip diameter that is 5/8".

5. Shovel and wheelbarrow for sampling and transporting of samples.

6. Metal or glass covers for protecting cylinders.

7. Small scoop for use in filling slump cone and cylinder molds.

F. DATA TO BE REPORTED:

1. The following data shall be reported by the Contractor to the testing laboratory for each group of cylinders.

   a. Mix, including amounts and brands of materials used.

   b. Specified 28-day compressive strength.

   c. Atmospheric temperature at time of pour.

   d. Slump.

   e. Type and amount of admixtures used.

   f. Location of concrete in the structure. (In sufficient detail to definitely identify the pour at any later date.)

2. The following data shall be reported by the laboratory to the Engineers and to the Contractor.

   a. Data listed in Paragraph 1, above.

   b. Unit weight of the cylinder (lbs./cubic foot).

   c. Type of break.

   d. Percentage of aggregate broken.

   e. Breaking load (lbs.).

   f. Breaking stress (lbs./square inch).

28-4 QUALIFICATIONS.

A. CONCRETE PRODUCER:

1. The concrete producer shall have not less than 5 years experience in the production of structural concrete and shall have previously supplied concrete for not less than 5 projects similar in scope to this project.

2. All concrete mixers, stationary or transit-mix, shall be equipped with revolution counters in proper working order.

3. When directed by the Engineers, the concrete producer shall submit a written description of production ability, including facilities, personnel and list of similar completed projects.

B. TESTING AGENCY: The testing agency shall provide evidence to the Engineers that an inspection of its facilities within the previous 24 months was made by the Cement and Concrete Reference Laboratory of the National Bureau of Standards and that any deficiencies noted in the report of that inspection have been corrected.

28-5 SUBMITTALS.

A. For review, the Contractor shall prepare and submit to the Engineers data for the following items specified in this Section:

B. Concrete mix designs.

C. Certificates of analysis for concrete aggregates.

D. Cement mill reports.

E. Proposed method of concrete curing and trade names of proposed curing methods.

F. Trade names of other proprietary items if different than those specified.

G. Trade name and physical data of proposed nonslip aggregate.

28-6 PRODUCT HANDLING.

A. Revolution counters shall be in operation for all concrete discharged for use on this project.

B. All concrete shall be discharged from the mixer within one hour after the introduction of water into the mix or before the drum has been revolved 300 revolutions, whichever comes first. To insure mixing at the job site, the drum must be revolved 20 revolutions at mixing speed just before pouring.

PART II - PRODUCTS

28-7 CLASS OF CONCRETE.

Unless otherwise provided herein, or noted on the drawings, all structural concrete used in this project shall be Class "D" concrete having a minimum compressive strength of not less than 3,000 pounds per square inch at 28 days and all plain concrete shall be Class "F" having a minimum compressive strength of not less than 2,500 pounds per square inch at 28 days.

28-8 MATERIALS.

Unless otherwise provided herein, noted on drawings or approved in writing by the Engineers, all material used in concrete work shall conform to the following specifications.

A. CEMENT:

1. Portland cement shall conform to Specifications for Portland Cement ASTM C-150 and shall be Type I.

2. When high early strength concrete is called for, use Type III.

B. ADMIXTURES:

1. Except as noted on the drawings, all structural and plain concrete to be used on this project shall contain an approved air entraining agent conforming to "Specifications for Air Entraining Admixtures for Concrete" (ASTM C-260). The admixture shall be used and dispensed according to the recommendations of the manufacturer.

2. Except as noted on the drawings, all structural and plain concrete to be used on this project shall contain an approved water-reducing admixture. The water-reducing admixture shall be composed essentially of water soluble reacting products of an amine and an organic acid or a hydroxylated polymer, and shall not contain lignosulfonic acid, its derivatives or calcium chloride. The admixture shall be supplied in liquid, ready-to-use form and shall be used and dispensed according to the recommendations of the manufacturer. The water reducing admixture shall meet the performance requirements of ASTM C-494, "Standard Specifications for Chemical Admixtures for Concrete."

3. Due to special construction conditions, the Contractor may request permission from the Engineers to use a retarding agent in his concrete. Such request shall be made in writing and approval received from the Engineers in writing before any retarding agents are used. Such approval shall not relieve the Contractor from any responsibility under the Contract. The retarding admixture shall be composed essentially of a complex amine salts of hydroxylated carboxylic acid or a hydroxylated polymer and shall not contain lignosulfonic acid, its derivatives or calcium chloride. The admixture shall be supplied in liquid, ready-to-use form and shall be used and dispensed according to the recommendations of the manufacturer.

4. Other admixtures, if approved by the Engineers, shall conform to appropriate ASTM Standards.

C. AGGREGATES:

1. Concrete aggregates shall conform to Specifications for Concrete Aggregates (ASTM C-33). Aggregates failing to meet these requirements but producing concrete of required quality as shown by special test or actual service may be used where authorized by the Engineers. (See Table 1, Grading of Fine and Coarse Aggregate for Concrete.)

2. The maximum size of the aggregate shall be not larger than 1/5 of the narrowest dimension between sides of the forms within which the concrete is to be cast nor larger than 3/4 of the minimum clear spacing between reinforcing bars, or between reinforcing bars and forms. For unreinforced slabs, the maximum size of aggregate shall not be larger than 1/3 of the slab thickness.

D. MIXING WATER: Preferably, water used in mixing concrete shall be fresh, clean and potable. Nonpotable water may be used if mortar cubes made with the water in question have 7 and 28-day strengths equal to those of companion specimens in which potable water was used.

28-9 CONCRETE QUALITY.

A. ALLOWABLE STRESSES: The allowable stresses for the design of the structures are based on the specified 28-day compressive strength of the concrete, or on the specified compressive strength at the earlier age on which the concrete may be expected to receive its full load. The strength of concrete, at 28 days, for which all parts of the structures were designed, unless shown otherwise on the drawings, is 3,000 psi.

B. WATER-CEMENT RATIO: The proportioning of materials shall be based on requirements for a plastic and workable mix. When no preliminary tests of the materials to be used are made, the water-cement ratio shall not exceed, nor shall the cement content be less than that given in Table 2 for the class of concrete specified. The water in the aggregate must be included in the quantity specified and subtracted from the amount added to the mixture. It shall be measured by methods satisfactory to the Engineers which will give results within one (1) pound for each one hundred (100) pounds of aggregate. Moisture determination shall be made on representative samples at least once each day and at such other times as the appearance of the aggregate of the mixed concrete indicates a change in moisture content.

C. PROPORTIONS FOR CONCRETE MIX: The determination of the proportions of cement, aggregate and water to attain the required strengths shall be made by one of the following methods:

1. Method 1 - Without Preliminary Tests: When no preliminary strength tests of the concrete to be used are made, the water cement ratio shall not exceed the values in Table 2.

2. Method 2 - With Preliminary Tests and/or Field Data: Water cement ratios other than those shown in Table 2 may be used when the strength of the concrete is to be established by tests. Test specimens shall be made before beginning operations, using the consistencies suitable for the work and in accordance with ASTM Method of Making and Curing Concrete Compression and Flexure Test Specimens in the Laboratory (ASTM C-192). Tests shall be conducted according to ASTM Method of Test for Compressive Strength of Molded Concrete Cylinders (ASTM C-39). A curve shall be established to represent the relationship between the water cement ratio and the minimum 28-day compressive strength or earlier strength at which the concrete is to receive its full working load. The range of values on the curve shall include all the compressive strengths called for on the drawings. The curve shall be established by at least three points, each point denoting average values from at least four test specimens. The water cement ratio shall correspond to a strength sufficiently high as to ensure that none of the strength tests shall have values less than the specified strength. Method 3-ACI 318-71 coefficient of variation report with appropriate over design.

D. CONCRETE CONSISTENCY: The proportions of the concrete shall produce a mixture that will work readily, with the placement method used, into the corners and angles of the forms and around reinforcement. Segregation of materials in the mixture shall not be permitted nor the collection of excess free water on the surface.

28-10 CONCRETE TOPPINGS.

A. FLOOR TOPPING: The floor topping indicated on the drawings shall be proportioned in accordance with Paragraph 1140 (f), "Two-Course Heavy-Duty Topping (deferred placement)" of the ACI Specifications.

B. ROOF TOPPING: The roof topping indicated on the drawings shall be proportioned to produce a minimum compressive strength of 3,000 psi at 28 days, and shall be of a consistency to permit placement to the slopes required for drainage of the roof.

28-11 EXPANSION JOINT FILLER FOR 1/2" EXPANSION JOINT W/O WATERSTOPS.

Use bituminous impregnated, preformed type conforming to ASTM D-994. Provide joint filler between all horizontal concrete surfaces and vertical surfaces, unless otherwise noted on the drawings. Joints shall be sealed with 3/4" depth of sealer acceptable to the Engineer.

28-12 DUSTPROOFING HARDENER.

A. For all interior concrete floor surfaces to be left permanently exposed to view, apply a two-coat treatment of "Clearbond" manufactured by Guardian Chemical Company, "Lapidolith" manufactured by A. C. Horn Co., or equal. Remove all foreign materials, including mortar, paint, etc., to prevent any foreign materials from showing through the finished surface.

B. One coat shall be applied upon completion of curing of the slab and one coat applied after final painting and other finishes are complete. The final result shall be a transparent appearance which, when subjected to an abrasion test made with a stiff wire brush, shall not dust but shall polish without showing abrasion.

28-13 CONCRETE CURING

Use Opeic Poly (5 mils thick or greater) or curing paper, as directed by the Engineer. Where curing paper is selected for final curing of flatwork, Sisalkraft "Orange Label," Ludlow Papers, Inc., "Scuf-Champ," "Glas-Kraft" Grade A, or equivalent concrete curing paper conforming to ASTM C-171, Type I, shall be used.

28-14 MEMBRANE-FORMING CURING COMPOUND.

Liquid membrane-forming curing compounds shall be wax free resin type capable of retaining 95% of the moisture for the specified curing period and shall conform to ASTM C-309, Type I, and shall contain a red fugitive dye. Curing compound applied to surfaces to be left permanently exposed to view shall not cause permanent discoloration or otherwise adversely affect the appearance of these surfaces. Curing compounds shall not be used on surfaces to receive hardeners or other finishes.

28-15 NONSHRINK GROUT.

A. All column base plates and all equipment base plates shall be grouted with nonshrink grout, whether called for or not on the drawings.

B. Nonshrink grout used for grouting column base plates and equipment base plates shall be non-catalyzed metallic aggregate grout capable of developing full strength without vertical confinement, and requiring no cutting or capping of shoulders. It also shall be used at a self-leveling (fluid) consistency.

C. If nonmetallic nonshrink grout is required by the Engineers for special applications, it must be capable of developing full strength without vertical confinement and require no cutting or capping of shoulders. It also shall be used at a self-leveling (fluid) consistency.

28-16 NONSLIP AGGREGATE:

Concrete surfaces to receive a "Nonslip Finish" shall receive a "dry shake" application of crushed ceramically bonded aluminum oxide abrasive particles. The material shall be pre-mixed by the manufacturer and applied as recommended by the manufacturer.

28-17 STONE FILL UNDER SLABS-ON-GRADE.

A minimum thickness of 4" of N.C. Department of Transportation, Division of Highways Standard Size No. 5 stone shall be provided under all slabs on grade within the building lines and at other locations noted on the drawings.

28-18 VAPOR BARRIER UNDER SLABS-ON-GRADE.

"Moistop," manufactured by American Sisalkraft Corporation, "Ply-Bar Plus" manufactured by Glas-Kraft, Inc., "Sealtight Premoulded Membrane" by W. R. Meadows, Inc., or equal conforming to the requirements of ASTM E-154, shall be provided under all slabs on grade within the building lines and at other locations noted on the drawings.

PART III - EXECUTION

28-19 PREPARATION OF EQUIPMENT.

A. Before placement, all equipment for mixing and transporting the concrete shall be cleaned and all debris and ice shall be removed from the places to be occupied by the concrete. Forms shall be thoroughly wetted (except in freezing weather) or oiled, and masonry filler units that will be in contact with concrete shall be well drenched (except in freezing weather). The reinforcement shall be thoroughly cleaned of ice, dirt, rust, scale or other coatings.

B. Water shall be removed from place of deposit before concrete is placed unless otherwise permitted by the Engineers. All laitance and other unsound material shall be removed from hardened concrete by sand blasting, chipping or wire brushing before additional concrete is added.

28-20 INSPECTION.

After the reinforcing steel is in place and all formwork completed, and at least 24 hours before placing concrete, the Contractor shall notify the Engineers that the work is ready for his inspection. The Engineers will then inspect the work. The Contractor shall have capable men on the job who shall assist the Engineers in inspecting the work and who shall make all changes in the work required by the Engineers prior to placing concrete. No concrete shall be placed except when the Engineers are on the job and have approved the work and authorized the placing of the concrete.

28-21 STORAGE OF MATERIALS.

Cement and aggregates shall be stored in such a manner as to prevent deterioration or intrusion of foreign matter. Liquid admixtures shall be protected from freezing and from settling out of solution. Any deteriorated or damaged material shall not be used for concrete.

28-22 MIXING.

A. Ready-mixed concrete shall be mixed and delivered in accordance with Specifications for Ready-Mixed Concrete (ASTM C-94).

B. For job-mixed concrete, the mixer shall be rotated at a speed recommended by the manufacturer. Each batch of one cubic year or less shall be mixed for at least one minute after all materials are in the mixer. The mixing time shall be increased 15 seconds for each additional cubic yard or fraction thereof. The entire batch shall be discharged before the mixer is recharged. If job-mixed concrete is used, all equipment and methods of mixing employed must be approved by the Engineers.

28-23 CONVEYING.

A. Concrete shall be conveyed from the mixer to the place of final deposit by methods that will prevent separation or loss of materials.

B. Equipment for chuting, pumping and pneumatically conveying concrete shall be of such size and design as to ensure a practically continuous flow of concrete at the delivery end without separation of materials.

28-24 PLACING.

A. Concrete shall be deposited as nearly as practicable in its final position to avoid segregation due to rehandling or flowing. Unless approval is granted by the Engineers, concrete shall not be dropped more than 3'. Chutes or "elephant trunks" shall be used to deposit concrete for drops greater than 3'. The placing of concrete shall be carried on at such a rate that concrete is at all times plastic and flows readily into the spaces between the bars. No concrete that has been contaminated by foreign material shall be used, nor shall retempered concrete be used unless approved in writing by the Engineers.

B. When placing is once started, it shall be carried on as a continuous operation until placement of the panel or section is completed. When construction joints are necessary, they shall be made in accordance with "Construction and Expansion Joints," as hereinafter specified.

C. All concrete shall be thoroughly consolidated by suitable means during placement. It shall be thoroughly worked around reinforcement and embedded fixtures and into the corners of the forms.

28-25 WATERTIGHT STRUCTURES.

All concrete structures shall be made watertight. The Contractor shall use all means necessary to produce structures that are absolutely watertight against hydraulic pressure both from inside and from outside. Concrete walls, etc. that show seepage or damp spots will not be accepted until this condition is corrected. No waterproofing ingredients shall be added to the concrete mix unless approved by the Engineers. Should contraction cracks occur in the concrete work, the Contractor shall make such repairs as necessary to produce a watertight structure. The Contractor shall lap all splice bars in temperature and structural reinforcement not less than 40 diameters.

28-26 COLD WEATHER REQUIREMENTS.

A. Adequate equipment shall be provided for heating concrete materials and protecting concrete during freezing or near freezing weather. No frozen materials or materials containing snow or ice shall be used.

B. All reinforcement, form, fillers and ground with which the concrete is to come in contact shall be free from snow and ice. Whenever the temperature of the surrounding air is below 40°F, all concrete placed in the forms shall have a temperature of 40°F or higher after placement. Adequate means shall be provided for maintaining this temperature for 4 days. When high early strength concrete is used, a temperature of at least 45°F shall be maintained for 3 days. In either case, any additional time necessary to ensure proper curing of the concrete shall be provided as directed by the Engineers. The housing, covering or other protection used in connection with curing shall remain in place and intact at least 24 hours after the artificial heating is discontinued. No salt or other devices shall be used for the prevention of freezing.

28-27 HOT WEATHER REQUIREMENTS.

A. In hot weather, suitable precautions shall be taken to avoid drying of the concrete prior to finishing operations. Use of windbreaks, sunshades, fog sprays or other devices shall be provided as directed by the Engineers.

B. Concrete deposited in hot weather shall not have a placing temperature that will cause difficulty from loss of slump, flash set, or cold joints. Concrete temperature shall be less than 90°F unless higher temperatures are permitted by the Engineers.

28-28 CONDUIT, PIPES, ETC., EMBEDDED IN CONCRETE.

A. Conduits, pipes, sleeves, etc., with the outside diameter not exceeding 1/3 the thickness of concrete and spaced not closer than 3 diameters on center may be placed in the center of slabs, walls, beams, columns, etc., unless approved by the Engineers. Concrete covering shall be not less than 1" and preferably 2".

B. Piping carrying liquid, air, gas, etc., shall be tested immediately prior to placing concrete and again after concrete has attained its designed strength.

28-29 CONCRETE PROTECTION FOR REINFORCEMENT.

A. The reinforcement shall be protected by the thickness of concrete indicated in the drawings. Where not otherwise shown, the thickness of concrete over the reinforcement shall be as follows:

1. Where concrete is deposited against the ground without the use of forms - not less than 3".

2. Where concrete is exposed to weather or to the ground but placed in forms - not less than 2".

3. In slabs and walls not exposed to the ground or to the weather - not less than 3/4".

4. In beams, girders and columns not exposed to the ground or to the weather - not less than 1 1/2".

5. In all cases - at least equal to the diameter of the bars.

B. Exposed reinforcing bars intended for bonding with future extensions shall be protected from corrosion by concrete or other adequate covering.

28-30 CONSOLIDATION.

A. All concrete shall be consolidated by the use of mechanical vibrators operated by experienced workmen under competent supervision. Supplement vibrating by spading and rodding. No forking or raking shall be permitted. Vibrators and consolidation shall conform to the requirements of ACI-609.

B. Where the drawings require concrete fill to be placed in concrete masonry units, cavity walls or other similar locations where proper placement and consolidation cannot be made, the concrete may be proportioned with 3/8" maximum aggregate size and the maximum slump increased to 8", provided the minimum strength requirements are maintained.

28-31 GROUTING.

A. In concrete columns, walls and where conditions impair consolidation of concrete, or where reinforcement is congested, the Contractor shall first deposit in the forms, batches of grout containing proportions of one part cement to two parts of concrete sand with sufficient water for workability to a depth of at least 3".

B. The Contractor shall provide nonshrink grout under all column bases and beam bearings on masonry or concrete, whether or not called for on the drawings.

28-32 SLABS-ON GRADE WITHIN BUILDING LINES.

A. Prior to placing reinforcement, the grade shall be prepared, the fill and stone base materials compacted and the vapor barrier, keyways, joint material and other imbedded items placed as required by the drawings and other Sections of the Specifications.

B. The vapor barrier shall be placed by lapping all edges a minimum of 4" and sealing continuously with an approved roofing mastic, waterproof tape or equivalent material. Seal around all piping and other openings through the vapor barrier and turn up edges 2" minimum at the walls and other vertical surfaces.

C. Screed chairs or other objects shall not be permitted to damage or penetrate the vapor barrier or waterproofing membrane. Buggy runways shall be used where concrete is required to be transported over the vapor barrier or waterproofing membrane. Screeds may be set in mounded concrete in lieu of screed chairs.

28-33 CONSTRUCTION JOINTS AND 1" EXPANSION JOINTS.

A. Joints not indicated on the drawings shall be so made and located as to impair least the strength of the structure. Where a joint is to be made, the surface of the concrete shall be thoroughly cleaned and all laitance removed by sweeping the top of the joint with a stiff broom just before the concrete becomes thoroughly hard. No such joints shall be made without first obtaining the permission of the Engineers in writing.

B. A delay until the concrete is no longer plastic in columns or walls (generally, at least 2 hours) must occur before concrete is placed in the beams, girders or slabs to be supported. Beams, girders, brackets, column capitals and haunches shall be considered as part of the floor system and shall be placed integrally with it.

C. Construction joints in floors shall be located near the middle of the spans of slabs, beams or girders. If a beam intersects a girder at this point, the joint in the girder shall be offset a distance equal to twice the beam width and adequate shear reinforcement provided.

D. Provision shall be made at expansion and construction joints to prevent water leakage. All construction joints shall have a minimum 1/8" by 8" wide steel plate waterstops continuous for the full length of the joint, embedded on each side of the joint as required by the drawings. When the waterstop exceeds 15" in width, it shall be 3/16" steel plate. A construction joint keyway shall have a width of at least 1/3 of the wall width. The ratio of depth to width of a construction joint keyway shall be at least 1/2. Joints at intersection and at ends of steps shall be welded to form continuous waterstop. Expansion joints shall have a continuous strip of 3/8" polyvinyl plastic or synthetic rubber (SBR), 9" wide, embedded 4" into the concrete on each side of the joint and having a 3/4" bulb to form a bellows in the center such as Type 7C as manufactured by Servicised Products Corporation, type SS.7 large "O" as manufactured by Saf-T-Grip Specialties or equal.

E. Each piece of waterstop shall be of maximum practicable length in order that the number of end joints will be held to a minimum.

F. Joints at intersections at ends of pieces shall be made in the manner most appropriate to the material being used. Joints shall develop effective watertightness fully equal to that of the continuous waterstop material and shall develop not less than 50% of the mechanical strength of the parent section.

G. In expansion joint construction, in connection with the waterstop, use an approved premolded expansion joint filler 1" thick conforming to ASTM D-1752-67, Type I. In expansion joint construction, the outermost 1/2" of the joint shall be filled with an approved two component polyurethane joint sealing compound for horizontal joints. Caulk vertical joints with an approved nonsag two component polysulfide that shall be suitable for use in potable water supplies with EPA and State approval. Expansion joints shall be provided as shown on the drawings and as approved by the Engineers.

28-34 PATCHING CONCRETE.

A. PATCHING:

1. If any concrete work is not formed as shown on the drawings or if, for any reason, is out of alignment or level or shows a defective surface, it shall be considered as not conforming with the intent of these Specifications and shall be removed from the job by the Contractor at his expense, unless the Engineers grant permission to patch the defective area. Permission to patch any such areas shall not be considered a waiver of the Engineers' right to require complete removal of the defective work if the patching does not, in their opinion, satisfactorily restore the quality and appearance of the surface.

2. Immediately after removing forms, all concrete surfaces shall be inspected and any poor joints, voids, stone pockets or other defective areas permitted by the Engineers to be patched and all the holes shall at once be patched before the concrete is thoroughly dry. Defective areas shall be chipped away to a depth of not less than 1" with the edges

   perpendicular to the surface. Such areas are to be patched and a space at least 6" wide entirely surrounding them shall be wetted to prevent absorption of water from the patching mortar. The defective areas shall be patched with a mortar containing a special bonding agent mixed and applied in accordance with the manufacturer's instructions. The mortar shall be made of the same material and of the same proportions as used for the concrete except that the coarse aggregate shall be omitted. The amount of water used in mixing the mortar shall be as little as consistent with the requirements of handling and placing.

3. The mortar shall be thoroughly compacted into place and screeded off so as to leave the patch slightly higher than the surrounding surface. It shall then be left undisturbed for a period of one to two hours to permit initial shrinkage before being finally finished. The patch shall be finished in such a manner as to match the adjoining surface.

28-35 PROPRIETARY PATCHES.

If approved or required, proprietary compounds for adhesion or as patching ingredients may be used in lieu of or in addition to the foregoing patching procedures. Such compounds shall be used in accordance with the manufacturer's recommendations.

28-36 FINISHES.

The finishing of concrete work shall be in accordance with Chapters 10 and 11 of the ACI Specifications.

A. At the completion of consolidation of the concrete, the tops of all footings, pile caps and grade beams shall be floated to a level and place surface with wood or metal floats.

B. Exterior formed surfaces to be left permanently exposed to view shall receive a "Smooth Rubbed Finish."

C. Exterior flatwork shall receive a "Broom Finish."

D. Exterior and interior concrete steps except those with abrasive nosing, exterior slabs, platforms and landings and interior and exterior ramps shall receive a "Nonslip Finish" of approved ceramically bonded aluminum oxide abrasive particles.

E. Interior flatwork to receive terrazzo, concrete topping or other cementitious finish applications shall receive a "Scratched Finish."

F. The floor topping indicated on the drawings shall be placed in accordance with Paragraph 1104(f), “Two Course Heavy Duty Topping (deferred placement)” of the ACI Specifications.

G. All other interior flatwork shall receive a "troweled finish."

28-37 CURING AND PROTECTION.

A. Provisions shall be made for maintaining concrete in a moist condition for a period of at least 7 days after placement. For high early strength concretes, however, moist curing shall be provided for at least the first 3 days when concrete and air temperatures are above 50°F; longer periods of curing shall be required when temperatures are below 50°F.

B. All concrete shall be cured by one or more methods specified in Chapter 12 of the ACI Specifications. Membrane forming curing compounds shall not be used on any surfaces against which additional concrete or other cementitious finishing materials are to be bonded.

C. Waterproof curing paper shall be used for final curing of flatwork only. When selected for final curing, the paper shall be placed as follows:

1. Unroll curing paper over the entire surface to be cured. Lap ends and edges a minimum of 4" and seal continuously with masking or pressure sensitive tape and provide sufficient weights over paper to prevent separation from concrete surface.

2. Curing paper shall be used for curing purposes only one time.

D. Additional care shall be exercised in protecting and curing the concrete topping to prevent rapid loss of moisture at any time during and immediately after the curing period.

28-38 FIELD QUALITY CONTROL.

A. TESTING:

1. Routine testing of materials and concrete for compliance with the Specifications shall be the responsibility of the Contractor. The Contractor shall be responsible for taking, handling, transporting and curing of concrete samples.

2. Six cylinders shall be molded from each sample of concrete for compressive strength tests. Two specimens shall be tested at 7 days and two specimens tested at 28 days, and two spares to be tested in case of low 28-day breaks.

B. FAILURE TO MEET STRENGTH REQUIREMENTS:

1. If strength tests fail to meet the minimum requirements of the Engineers, the concrete represented by such tests shall be considered questionable and shall be subject to further testing at the expense of the Contractor.

2. Additional tests of questionable concrete shall be conducted at the expense of the Contractor in accordance with "Methods of Securing, Preparing and Testing Specimens from Hardened Concrete for Compressive and Flexural Strengths" (ASTM C-42).

3. Additional tests of the hardened concrete may be required by the Engineers even though the requirements of the Specifications are met when, in their opinion, there is cause for concern over the adequacy of the structure.

4. If core tests fail to demonstrate strengths adequate for the intended purpose of the member of members in question, as determined by the Engineers, or if the failure to meet specified strength requirements occurred in members from which it is impracticable to secure test specimens by the method of ASTM C-42, load tests shall be conducted and their results evaluated in accordance with Chapter 2 of "Building Code Requirements for Reinforced Concrete" (ACI-318).

C. FIELD REVIEW BY THE ENGINEERS:

1. The Contractor shall give ample notice to the Engineers prior to placing concrete to permit field review of the general construction work as well as mechanical, electrical and other work to be incorporated in the concrete.

2. The Contractor shall afford the Engineers whatever casual labor, platforms, ladders or other access as may be required for proper field observation of the concrete work.

3. Field review of the work by the Engineers shall in no way relieve the Contractor of his responsibility to furnish materials and workmanship in full compliance with the drawings and Specifications.

END OF SECTION 28.

SECTION 36
AIR VALVES; SURGE RELIEF VALVES; CHECK VALVES

A. AIR VALVES:

1. Furnish and install air release, combination air release and vacuum, and/or air inlet valve assemblies including all piping, fittings, gate valves, etc., as shown on the drawings and as specified herein.

2. The air release valve shall automatically function to release to atmosphere entrained air that may accumulate in a pipeline, chamber or tank. Once the accumulated air is exhausted, the valve shall seat tightly to prevent water leakage. The valve body and cover shall be of semisteel; float of stainless steel (Grade 316); levers of bronze and with resilient seat.

3. Air release valves shall be manufactured by the Golden Anderson Co., Apco Valve Co., Standard Simplex Air Release Valve, Type AGFD, Val-Matic, or equal, equipped with vacuum holding attachment, designed for operation under working pressures of 150 pounds per square inch unless otherwise indicated on the drawings.

4. The air inlet valves shall be equal to the type VAC units as manufactured by the Simplex Valve and Meter Company, Golden Anderson Co., G-A Industries, Apco Valve Co., or equal. These valves shall be of the size or sizes, and shall be arranged, as shown on the drawings.

5. The combination air release and vacuum valve shall be furnished with both a large and small orifice. The valve shall automatically function to release to atmosphere both large and small amount of air that accumulate in a pipeline, tank or chamber. Once the air has been exhausted both the large and small valves shall seat tightly to prevent water leakage. The valve shall also function to admit air into a line, tank or chamber under emergency conditions or when it is being drained. The valve body and cover shall be of semisteel; floats of stainless steel; levers of bronze and resilient seats. The air and vacuum valve, shall be manufactured by Golden Anderson Co., Simplex Valve, G-A Industries, Apco Valve Co., or equal.

B. AIR VALVES (NONPOTABLE WATER):

1. When air release, air release and vacuum or combination air release and vacuum valves, are indicated for use with nonpotable water or sewage, a valve especially adapted for nonpotable water and sewage shall be required. The valve shall be of the long body design and constructed with cast iron body and covers, floats and levers of stainless steel, bronze mechanisms and seat.

The valve shall be equipped with inlet shutoff valve, bottom blow-off valve and two upper body quick disconnect couplings for flushing both the body and venting orifice. The body-flushing coupling shall be attached to an upper body shutoff valve. The valve shall be manufactured by Apco Valve Co., Golden Anderson, G-A Industries, or equal.

C. SURGE RELIEF VALVES:

1. Surge relief valves shall conform to AWWA C530 standards.

2. The pressure relief valve (2" and smaller) shall function to open on excessive line pressures and permit exhaust to atmosphere. It shall provide for adjustment of the pressure at which the valve is to open. It must be of heavy bronze body with cast bronze spring casing. The valve internal design shall be of the balanced type to permit maximum sensitivity. The stem shall be guided throughout its stroke. The diaphragm shall be composition with 1,200 psi bursting strength on a 2" circle. The connecting line ends shall be threaded. The stem shall be furnished with upper and lower "O" ring packing or leather cups to isolate pressures and prevent excessive leakage. The valve shall be manufactured by the Golden Anderson Valve Co., GA Industries, APCO Valve Co., Ross Valve Co., Clayton Valve Co., or equal.

3. The water pressure relief valve (2 1/2" and larger) shall function to open to atmosphere when the system pressure exceeds the intensity for which the pilot is set. It shall open rapidly, and close slowly at a predetermined rate of speed. Provision shall be made on the valve to regulate the closing speed of the valve.

4. The valve shall be of the angle body design with inlet pressure entering the valve under the piston. It shall be possible to install the valve in any position without impairing its functional value.

5. The valve shall be hydraulically operated, designed with a differential type piston such that the piston will expose a greater area to the closing force than to the opening force. A vent to atmosphere from the side of the valve body shall produce the differential piston area, and also serve to provide air cushion to prevent hammer and shock.

6. The body and lid of the valve shall be constructed of high-grade cast iron or semisteel comparable to that covered by the ASTM Specifications A-126, Class B. Interior parts of the valve, including the piston, liner and seat, shall be of bronze, conforming to ASTM Specification B-62. The liner and piston shall be equipped with renewable leather cups and the piston shall additionally have a leather or rubber seat ring. All wear on the valve shall be absorbed by the cups and seat ring and there shall be no metal-to-metal contacts within the main valve.

7. The pilot valve shall be of cast bronze conforming to ASTM Specification B-62. It shall be of the diaphragm operated, spring-loaded type, single seated, balanced design. Adjustment of the opening pressure of the main valve shall be accomplished by regulation of the handwheel on the pilot and shall provide for a range of 20 psi.

8. The valve shall provide full pipeline opening when opened its full stroke, and it shall be drop tight when closed. It shall be possible to open the relief valve at any time by exhausting the pressure from above the piston to atmosphere.

9. Workmanship and material shall be first grade throughout. The overall body test shall be made hydraulically at a pressure of no less than 50% above the maximum working pressure of the valve. The test for tight seating shall be conducted at a pressure equal to the maximum working pressure of the valve. The Owner reserves the right to witness all or any tests, and must be given free access to the place of manufacture at all times.

10. The valve shall be manufactured by Golden Anderson Valve Specialty Co., APCO Valve Co., Ross Valve Co., Clayton Valve Co., G-A Industries, or equal.

D. SURGE RELIEF VALVES (NONPOTABLE WATER):

1. All surge relief valves used on nonpotable water systems shall be constructed with heavy cast iron or cast steel body with a welded steel disc having rubber seating face, a noncorrosive shaft for attachment of counterweight arms and lever and complete noncorrosive cushion chamber.

2. It shall open immediately when the system pressure exceeds the load setting of the counterweights, and shall close slowly at an adjustable speed upon return of system pressure to normal.

3. The cushion chamber shall be attached to the side of the valve body externally and so constructed with a piston operating in a chamber that will effectively permit the valve to be operated without any hammering action. The cushioning shall be by oil stored in an oil reservoir attached by piping and fittings to the cushion chamber. The cushion chamber shall be so arranged that the closing speed will be adjustable to meet the service requirements.

4. All material and workmanship shall be first class throughout and the purchaser reserves the right to inspect this valve before shipment.

5. Each valve shall be supplied with Class 200 cast or ductile iron pipe discharge line from each relief valve to and connecting with discharge line to the free discharge outlet. All fittings required in the installation of the relief valves and discharge lines, and all else necessary to complete the installation shall be furnished and installed with the surge relief valves. The relief valves, fittings, etc., shall be designed for a water working pressure of 150 pounds per square inch. Flanged pipe and fittings shall be faced and drilled 125-pound standard.

6. The valve will be the Golden Anderson Valve Specialty Company, Inc. Fig. No. 525-RD, GA Industries, Fig. No. 525-RD, or equal.

E. CHECK VALVES:

1. Check valves shall conform to AWWA C508 standards.

2. All check valves used in the project, up to and including 2" in diameter, shall be all bronze, screw-end. All parts shall be machined to jigs, and they shall be interchangeable on check valves of the same make and size. All check valves shall be designed for minimum of 150 psi working pressure, and they shall be tested to 400 pounds hydrostatic pressure. Valves shall be RP&C Fig. 298, ITT Grinnell Fig. 3300, Jenkins Bros. Fig. 92A, or approved equal.

3. Check valves 2 1/2" to 3" in diameter shall be as above specified, except that they shall be flanged.

4. All check valves 3 1/2" in diameter and larger shall be flanged, lever operated or spring loaded, swing disc type iron body, fully bronze mounted except that stainless steel seal and seat ring shall be provided if anything other than potable water is being conveyed and designed and constructed with a minimum number of working parts. The shaft for outside attachment of lever operator shall be one piece stainless steel. Where indicated on the drawings the check valve shall be equipped as indicated with either an air or oil cushion cylinder assembly attached externally to the valve. Closing speed shall be adjustable after installation. The air cushion shall be rated at less than two seconds closure while the oil cushion shall be adjustable, two-stage and rated at two-second minimum closure and four second maximum closure. Check valves, unless otherwise provided herein shall be designed for a working pressure of not less than 175 pounds per square inch. Check valves shall be provided with a removable bonnet. Valves shall be manufactured by the Golden Anderson Valve Company, APCO Valve, American Darling, Clow, Mueller, Dresser, G-A Industries, or equal.

END OF SECTION 36.

SECTION 37
HORIZONTAL DIRECTIONAL DRILLING (HDD)

A. DEFINITIONS:

1. Annular Space: the space between the HDD final reamed bore diameter and the product pipe or cable.

2. Bent Sub: A section of drill pipe behind the cutting tools that is inclined at an angle at one to three degrees from the axis of the bore in the desired direction of steering. The bent sub allows steering while rotating the cutting tools.

3. Drilling Fluid/Mud: A mixture of water, bentonite, and/or polymers continuously pumped to the drilling tools to facilitate the removal of soil cuttings, and stabilization of the bore. These fluids also cool the cutting tools and lubricate the drill pipe and product pipe string.

4. Drill String: The total length of the drill pipe in the borehole.

5. Drilling Tool/Bit: Any tool or system of tools which excavates at the face of a bore.

6. Entry Pit: The location where the pilot bore initially penetrates the ground surface and where the HDD rig is positioned.

7. Exit pit: The location where the pilot bore exits the ground surface.

8. Horizontal Directional Drilling (HDD): A surface-launched, guided, steerable drilling system used for the trenchless installation of pipes, conduits, and cables. A pilot bore path is excavated in a shallow arc from a surface-launched drill rig. Excavation takes place with fluid assisted cutting from a drilling tool on the drill string. The pilot bore is directed by the positioning of a bent sub. Tracking of the drill string is achieved by using a downhole wireline survey tool which shall be augmented by using an energized wire grid at the surface. The bore is filled with drilling fluid/mud for stabilization, to cool the cutting tools, and to mix the cuttings into a slurry, which is circulated to the entry point where solids are removed before the drilling fluids are returned to the bore. The bore path is enlarged with subsequent reaming passes until the desired diameter is achieved. The product pipe, conduit, or cable is then pulled into the fluid-stabilized bore hole.

9. HDD Work Plan: Written descriptions, together with sketches, profile drawings, schedules, and other documents defining Contractor's plans and procedures for horizontal directional drilling. This HDD Work Plan also includes a detailed inadvertent return and subsidence analysis and any changes proposed to the boring lengths, depths, entry/exit pit locations or angles.

10. Inadvertent Return: Uncontrolled flow of drilling fluid/mud to the surface at a location other than the entry or exit pit.

11. Obstruction: Any hard object lying completely or partially within the design pathway of the bore and pipe that prevents further advancement of the drill pipe, pre-reamer, reamer, and/or pipe, after all reasonable Contractor attempts to advance past the object or re-drill around the object have failed.

12. Pilot Bore: The action of creating the first guided pass of the HDD process which is then reamed in one or more passes to the size required to allow pullback of the pipe.

13. Pullback: The part of a horizontal directional drilling process in which the drill pipe, swivel, and product pipe or cable is pulled back through the bore to the entry.

14. Pullback Loads: The loads (forces) applied to a drill string and product pipe during the pullback process. In addition to the tensile pullback loads, bending, buckling and combination loads must be considered in design.

15. Reamer: A cutting tool pushed or pulled through the borehole in order to enlarge the pilot bore hole to a diameter sufficient for the installation of the product pipe.

16. Tracer Wire: Wire used to track the drill string, achieved by using a downhole wireline survey tool. An energized wire grid at the surface augments the tracer wire.

17. Settlement Point: A point with elevation and spatial location established by survey prior to construction. The point is re-surveyed periodically to monitor ground movements. The point may be a nail, pin, subsurface settlement rod, borehole extensometer, or other device that can be readily located and surveyed.

B. REFERENCE STANDARDS:

1. Horizontal Directional Drilling Good Practices Guidelines, Latest Edition, HDD Industry Consortium, 300pp.

2. Pipeline Design for Installation by Horizontal Directional Drilling, ASCE Manuals and reports on Engineering Practice No. 108, 2005.

C. SUBMITTALS:

1. Submittals shall provide sufficient detail to allow the Engineer to judge whether or not the proposed equipment, materials, and procedures will meet the Contract requirements. The Engineer's review of submittal details and data will be based on considerations for the completed Work, utilities, and the possibility of necessary delays in the execution of the Work to be constructed under the Contract. Review and acceptance of the Contractor's submittals by the Engineer shall not be construed in any way as relieving the Contractor of its responsibilities under the Contract.

2. The following is the summary of information to be included in shop drawing submittals required for the HDD Work. All submittals shall be signed and sealed by a licensed Professional Engineer registered in the State of North Carolina.

a. Qualifications: The Contractor shall submit written documentation of HDD superintendent and key personnel experience.

b. Schedule: No later than fifteen (15) working days prior to mobilization for HDD operations, the Contractor shall submit a detailed schedule for the HDD installation showing all major construction activities and durations, with beginning and completion dates shown. The schedule shall be updated at least every and shall include:

   i. Utility locate requests and visual confirmation of all crossing utilities and all parallel utilities within the vicinity of the bore centerline.

   ii. Risk Mitigation Meeting.

   iii. Rig mobilization and setup.

   iv. Pilot bore drilling.

   v. Pre-reaming and reaming.

   vi. Layout and fusing/welding/assembly of pipe.

   vii. Final reaming and pullback of pipe.

   viii. Pressure testing of pipe after installation.

   ix. Mandrel/pig test to confirm deformations of pipe are within allowable tolerances.

   x. Cleanup, surface restoration, and demobilization.

c. Safety Plan: The Contractor shall submit a Safety Plan, including the name of the Contractor's Site Safety Representative, emergency telephone numbers for medical facilities, and precautions for handling and disposal of any hazardous or flammable materials. The Safety Plan shall include a code of safe practices and an emergency plan in accordance with OSHA requirements.

d. Methods, Equipment, and Materials Description Plan: The Contractor shall submit detailed description of methods, equipment, and materials to be used for the pipeline installation. Descriptions of drilling fluid additives shall be accompanied by Materials Safety Data Sheets (MSDS) and Manufacturers' descriptions and warranties. Descriptions of equipment shall include Manufacturers' specifications, calibrations, appropriate drawing, photographs, and descriptions of any modifications since manufacture.

e. Surveying Equipment and Procedures: The Contractor shall submit records of equipment calibrations and certifications for all equipment used for downhole surveys and tracking of the drill head. Procedures for operating the downhole survey tools shall be described, including measures to verify the accuracy of the equipment readings.

f. Protection of Adjacent Structures and Facilities Plan: The Contractor shall submit a plan that provides details on measures to be taken to monitor and protect adjacent utilities, structures, roadways and sidewalks, and provide details on monitoring equipment and provisions, including the layout of all settlement points and other monitoring points. Provide two (2) copies of preconstruction survey of adjacent structures and photographs with captions to document preconstruction conditions prior to beginning HDD construction.

g. Contingency Plan for Remediation of Potential Problems: The Contractor shall submit a Contingency Plan for Remediation of Potential Problems that may be encountered during the drilling operations. The contingency plans shall address the observations that would lead to the discovery of the problem and the methods that would be used to mitigate the problem. Items to be discussed in the plan include, but is not limited to, the following:

   i. Loss of returns/loss of circulation of drilling fluids.

   ii. Inadvertent returns/hydrofracture or surface spills resulting in drilling fluids entering surface waters or reaching the ground surface.

   iii. Encountering obstruction during pilot bore or reaming/pullback.

iv. Drill pipe or product pipe cannot be advanced.

v. Deviations from design line and grade exceed allowable tolerances.

vi. Drill pipe or product pipe broken off in borehole.

vii. Product pipe collapse or excessive deformation.

viii. Utility strike.

ix. Deviation from planned bore path.

x. Hydrolock occurs or is suspected.

xi. Excessive ground settlement or heave.

h. Disposal of Spoils and Drilling Fluids Plan: The Contractor shall submit plans for disposal of waste materials resulting from the pipeline construction, including drilling fluids, cuttings, waste oil, fuel, discharge water, etc. Identify the disposal site(s) and submit a letter indicating willingness and legal authority to accept the described and anticipated waste products.

i. Equipment Layout Plan: The Contractor shall submit a plan which provides sketches depicting the layout and locations of equipment within the rig side work area and pipe side work area, including any proposed drilling fluid containment and recirculation pits. The Contractor shall confirm that all operations shall be completely contained within the permanent and temporary construction easements shown on the Contract Documents.

j. Inadvertent Return and Surface Spill Contingency Plan: An Inadvertent Return and Surface Spill Contingency Plan shall be prepared and the Contractor shall be capable of implementing the plan immediately should an Inadvertent Return or Surface Spill occur during the HDD work. The Contractor shall submit letter signed by an authorized representative of the Contractor confirming that the Plan will be followed. If required by permit conditions, the Contractor shall revise the Plan as necessary to satisfy the associated regulatory agency.

k. Horizontal Directional Drilling Work Plan: The Contractor shall submit a HDD Work Plan complete with drawings and written description identifying details of the proposed method of construction and the sequence of operations to be performed during construction including placement and method of attachment. The plan shall include:

i. A detailed plan and profile of the bore, showing utilities and structures and plotted at a scale no smaller than one inch equals 40 feet horizontal and one inch equals four feet vertical. Proposed deviations from the Contract Documents shall be shown; and,

ii. Details of the planned bore path and the method for monitoring and controlling the speed, line, grade and rate of fluids delivery. Include the sequence, size, and description of each reamer and capabilities of each through anticipated geologic formation. Include details on the swabbing of the borehole prior to pullback of the pipe.

l. Soil Separation Plan: The Contractor shall submit details on the pump and soil separation plan. Include dimensions, manufacturer's specifications, pump capacity, etc. on the system.

i. Pump capacity shall be specified for water at sea level elevation and adjusted for actual elevation and fluid viscosity.
ii. Provide details on the generator, including dimensions, noise ratings at 25 feet, etc. Confirm that the generator meets any applicable regulatory requirements.

m. Maximum Allowable Drilling Fluid Pressure Calculations: The Contractor shall submit calculations identifying the critical downhole pressure that would cause hydrofracture or inadvertent return of drilling fluid. The calculations shall identify the critical points in the alignment and near the exit point where the soil cover above the bore is low. The calculations shall identify all parameters used and state all assumptions made in the calculations. The calculations shall be signed and sealed a licensed Professional Engineer registered in the State of North Carolina.

n. Pipe Filling Methods and Testing: Submit methods and procedures for filling the pipe with water during pull back and testing.

o. Pipe Stress Calculations: Submit calculations for pipe stresses expected to result from the pullback, bending, buckling loads, earth loads, groundwater loads, and other installation and service loads expected to be exerted on the pipe. The calculations shall identify parameters and state the assumptions made in the calculations including: the radius of curvature; assumed drilling fluid weights; whether or not the pipe is assumed to be filled or empty during pullback; and temperature. The calculations shall be signed and sealed by a licensed Professional Engineer registered in the State of North Carolina.

p. Pullback Calculations: The Contractor shall submit calculations for pullback loads for the conditions and operating practices anticipated. In addition to the tensile pullback loads, bending, buckling and combination loads must be considered in design. The calculations shall identify all parameters used and the state all assumptions made in the calculations. The calculations shall be signed and sealed by a licensed Professional Engineer registered in the State of North Carolina.

q. Radius of Curvature Confirmation: Confirm that the bore can be completed using the radius of curvature and geometry shown on the Contract Drawings along with the calculations showing that installation stresses do not exceed allowable pipe stresses.

r. Rig Capacity Plan: Submit a plan which provides details on the capacity of the drill rig verifying that the pullback capacity is greater than the calculated required pullback.

s. Contact Grouting Plan: The Contractor shall submit descriptions of methods, equipment, and materials to be used for contact grouting any areas where over-excavation, aborted bores, voids, or cavities are created or encountered during construction.

3. Construction Records: The following shall be submitted as construction progresses and at the completion of construction.

   a. Daily Logs and Records: The Contractor shall submit complete, legible, written daily logs and records by noon of the following day to which the records correspond.

   b. Drilling and Reaming Rates: The Contractor shall submit maximum drilling speeds and reaming rates for pilot bore and each reaming pass and confirm that the pump capacity is adequate for these anticipated drilling rates for the mud and/or drilling fluid weights and viscosities anticipated. These shall be submitted to the Engineer on a daily basis.

   c. Drilling Fluid Viscosity and Density (Mud Weight): The Contractor shall submit measured mud and/or drilling fluid weights used during pilot boring and reaming of the bore measured at a minimum of three times per shift or at least once per 200 feet of drilled or reamed length, whichever is more frequent, with at least two (2) hours between readings.

   d. Pilot Bore As-Built Profile: The Contractor shall submit an as-built profile of the pilot bore within 24 hours of completion of the pilot bore.

   e. Pressure Test Records: The Contractor shall submit all pressure test records for post installation tests. These shall be submitted within 24 hours of completion of such tests.

   f. Variations in Plan and Profile: The Contractor shall document any variations between the actual Contract Drawings and profile of the bore path and the location shown on the Contract Drawings. The Contractor shall notify in writing and by telephone the Engineer immediately upon discovery of any deviations.

4. Risk Mitigation Meetings: At least 15 working days prior to the specified HDD segment of the work, the Contractor and HDD superintendent shall attend a risk mitigation meeting (or conference call) with representatives of the Engineer and Owner for the HDD crossing to discuss major operations milestones. Specific risk mitigation meetings shall be held and include a discussion of the following as a minimum:

   a. Drilling of pilot-hole.

b. Pre-reaming and reaming.

c. Layout of pipe.

d. Pressure testing of pipe prior to pullback.

e. Final reaming and pullback of pipe.

f. Pressure testing of pipe after installation.

g. Pig test.

h. Protection and monitoring of adjacent and/or overlying structures, roadways, sidewalks and utilities.

D. PERFORMANCE REQUIREMENTS:

1. The Contractor shall provide all equipment, materials, and personnel necessary for completing the installation as shown on the Contract Drawing and specified herein. The equipment and materials shall include but are not limited to:

   a. Directional drilling rig with all ancillary equipment, including drill pipe, drilling fluid, cutting tools, reaming bits, swivels, expanders, motors, pumps, hoses, mixing equipment, drilling fluid processing equipment (cuttings separation equipment), downhole survey equipment, energized surface grid tracking system, fluid pressure and flow rate monitoring equipment, spare parts, pipe handling equipment (cranes, backhoes, rollers, side boom tractors) control equipment, and office equipment.

   b. Drilling fluids, water, fuel, lubricant, polymers, or other additives. Any other expendable or reusable materials, supplies, and equipment needed for the installation.

2. The drilling equipment shall be capable of advancing through the geologic conditions to be encountered at the site, as encountered in the applicable test boring logs.

3. The drilling fluid shall be designed for the geologic conditions to be encountered at the site, as described in the test borings and as anticipated by the Contractor.

4. The drilling system shall include a fluid pump and separation plant that can achieve the rates of drilling fluid pumping, spoil separation, and slurry cleaning required by the Contractor to achieve planned production rates for the soils as anticipated by the Contractor. Shaker screens and hydrocyclones may be required for efficient separation of spoils.

5. All spoil and slurry must be contained in trucks, tanks, approved recirculation pits, or other containers at all times. Dumping of spoil or slurry on the ground, discharge into sewers, or discharge into the water bodies will not be permitted. All spoils will be transported and disposed of off-site at an approved disposal facility that meets all State of North Carolina and local requirements.

6. Perform all Work within Work areas shown on the Contract Drawings or in areas obtained by the Contractor with written approval from the affected property owner.

7. The pipeline shall be installed using the radii of curvatures and entry and exit angles as specified herein, or as shown otherwise on the Contract Drawings, unless deviations are approved in writing by the Engineer.

8. For sections of pipe that are to be fused/welded, pipe rollers and lifters will be required to help the transition of the carrier pipe into the bore and to minimize the pull force. The number of pipe rollers and lifters shall be determined by the Contractor in accordance with the pipe supplier's recommendations. Location and spacing of the rollers and lifters will be done in accordance with the pipe manufacturer's recommendations based on bend radius and to protect pipe during pullback over hard or sharp surfaces. All pipe rollers and lifters will be in a condition so as not to damage the pipe during construction activities.

9. It shall be the Contractor's sole responsibility that all Work is done in conformance with all applicable federal, state, and local safety requirements. Required safety equipment and procedures shall be employed by the Contractor at all times.

10. The Contractor shall allow access to the Owner and/or Engineer and shall furnish necessary assistance and cooperation to aid the Engineer in observations and data and sample collection, including, but not limited to the following:

a. The Owner and/or Engineer shall have full access to the operator control container prior to, during, and following all HDD operations. This shall include, but not be limited to, providing visual access to real-time operator control screens, gauges, and indicators.

b. The Owner and/or Engineer shall have full access to the slurry separation plant prior to, during, and following all HDD operations. This shall include, but not be limited to, full access to shaker screens, hydrocyclones, conveyor belts, and slurry and spoil holding tanks. The Engineer shall be allowed to collect soil samples from the shaker screens and/or spoil holding tanks on the slurry separation plant a minimum of once per installed pipe section, and whenever changes in conditions are observed or suspected. If requested, the Contractor shall assist in the collection of these samples as directed by the Engineer.

11. Contractor shall comply with all local noise ordinances. Sound levels in excess of these values are sufficient cause to have the Work halted until equipment can be quieted to these levels. Work stoppage for excessive noise shall not relieve the Contractor of the portions of this Specification including, but not limited to completion of all Work within specified Contract Time and Contract Price. The Contractor shall submit a Plan prior to construction identifying all noise reduction/abatement procedures. The Plan will be reviewed by the Engineer prior to construction. If mufflers cannot achieve the necessary noise reduction, noise abatement shall be accomplished by the Contractor's installation of baffles (or other acceptable means) positioned to break line-of-sight from the noise source to affected residences and/or commercial structures. Minimum noise abatement measures shall consist of equipping all engines with hospital grade mufflers or silencers.

E. QUALITY ASSURANCE:

1. Contractor Qualifications and Experience: The Contractor shall meet the following minimum qualifications:

a. Contractor must be licensed in the State of North Carolina as an underground utility Contractor for a minimum of five (5) years.

b. The Contractor shall have at least five (5) years of demonstrated successful experience installing pipelines by the means of HDD.

c. The Contractor must have successfully completed three (3) water projects where the carrier pipe was installed with HDD techniques.

d. Contractor shall provide the following for each project:

- Project Description
- Pipe Size, Length, Material, DR
- Bore Length
- Soil Types
- Owners' contact information
- Engineer's contact information
- Change Orders
- Scheduled Completion Date and Actual Completion Date

2. The Contractor will be required to employ skilled, experienced superintendent(s), equipment operator(s) and personnel throughout the project. The superintendent shall have at least five (5) years of successful experience using the HDD process.

3. The HDD equipment operator for this project shall have at least three (3) years of successful experience using the HDD process.

4. The Contractor shall furnish resumes of the superintendent(s) and key personnel. Personnel experience records should include project names, locations, project description, project owner, Engineer, and references with names, addresses, and telephone numbers.

5. The superintendent listed in the submittal shall be on site during all construction related activities required for the HDD installation for this project.

6. The Contractor shall not be allowed to alter their personnel assigned to the project without prior written approval from the Engineer and owner.

7. Daily Logs and Records: Daily logs and records shall be maintained by the Contractor and shall include the following:

   a. Drilling lengths.
   b. Location of drill head.
   c. Drilling fluid pressures and flow rates.
   d. Drilling fluid losses.
   e. Inadvertent returns.
   f. Drilling times required for each pipe joint.
   g. Any instances of retraction and re-drilling of the pilot bore or segments thereof
   h. Any other relevant observations, including any observed settlement, heave, frac-outs, or surface spills.
   i. The downhole annular drilling fluid pressures shall be measured and recorded throughout the pilot hole drilling. These records shall be maintained and provided daily to the Engineer. The position of the drill head shall be continuously tracked and recorded. A plot of actual locations of the bore path shall be maintained and updated daily.

8. Advance Notices and Inspections: The Contractor shall provide at least 72 hours advance written notice to the Engineer of the major drilling activities, including pilot bore launch, pre-reaming, reaming, and pipe pullback. The Contractor shall immediately notify the Engineer, in writing, when any significant problems are encountered or if ground conditions are considered by the Contractor to be materially and significantly different than those represented within the test boring logs. All Work by the Contractor shall be performed in the presence of the Engineer, unless Engineer grants prior written approval to perform such Work in Engineer's absence.

9. Surveying Equipment and Procedures: All surveying equipment used for downhole surveying and tracking of the bore path and drill head shall be inspected and calibrated by the equipment manufacturer prior to use. Proof of this inspection and calibration shall be provided to the Engineer prior to commencement of drilling operations.

F. PRODUCTS:

1. Drilling fluids: The Contractor shall select drilling fluid mixture proportions to ensure continuous circulation, bore stability, reduce drag on the pipe, and completely fill the annular space between the bore and the pipe to control settlement. Management and disposal of drilling fluids shall be the Contractor's responsibility. Drilling fluids shall not be disposed of on-site or discharged to sanitary or storm sewers, or the waterways or adjacent wetlands.

2. Drill pipe: The Contractor shall provide high quality drill pipes that have been inspected and determined to be adequate for the project requirements. Bent, racked, or fatigued drill pipes shall not be used. Threads must be in good condition. The length of each drill pipe shall be measured and recorded.

3. Carrier pipe: The Contractor shall pipe which conforms to the most conservative design with respect to design calculations for the critical combination of internal and external pressure, pullback and bending.

4. Water: The Contractor shall secure a suitable source of water, and shall be responsible for transporting, storing and disposing of water required.

5. Cement grout: Cement grout shall consist of one part cement to six parts sand. The quantity of cement may be increased or decreased as necessary and as permitted by the Engineer to provide good flowing characteristics.

G. EXECUTION:

1. General:

a. The Contractor shall provide adequate control of surface water and drilling fluids drainage and runoff, and provide silt fences, hay bales, and wattles to prevent surface water or drilling fluids from being transported off-site.
b. The Contractor shall not initiate HDD until all submittals are received, reviewed, and approved by the Engineer.
c. The Contractor shall not initiate HDD until all required permits are obtained. Copies of all permits shall be provided to the Engineer prior to construction.
d. It is the Contractor's responsibility to provide barricades, fencing, or other safety measures to prevent public access into Work and staging areas.

2. Protection of underground utilities:

a. The Contract Drawings show existing buried utilities that are believed to be near the directional drill alignment. There is no guarantee that these utilities are located as shown or that other utilities are not present. It will be the Contractor's responsibility to field locate all nearby utilities or other potential subsurface obstructions that may interfere with the Work.

b. The Contractor shall notify the "North Carolina 811 System" to request marking of utilities that subscribe to the System, and shall individually notify all other known or suspected utilities to request marking of these utilities. The Contractor shall confirm that all requested locates are made prior to commencing drilling operations. Contractor shall make all diligent efforts to locate any unmarked or abandoned utilities using all available information, maps, and drawings. The Contractor shall visually confirm and stake all existing lines, cables, or other underground facilities including exposing all crossing utilities and utilities within twenty (20) feet laterally of the centerline of designed drilled path.

3. Work staging area:

a. Barricades, Warning Signs, and Lights: The Contractor shall, in accordance with approved Traffic and Safety Plans, erect appropriate barriers, warning lights, and signs, painted with approved colors, warnings, and graphics to ensure adequate warnings to personnel and the public.

b. Combustible Materials: Combustible materials (fuel, oil, lubricants, etc.) shall be stored off-site or in a well-ventilated storage facility removed from the immediate vicinity of the drilling area by at least twenty (20) feet.

c. Construction Impacts: The Contractor shall maintain the Work area in a manner that shall minimize adverse impacts on other public use activities. The Contractor shall proceed with Work in a safe, orderly manner, while maintaining the Work site free of debris and unnecessary equipment and materials.

d. Control of Drilling Fluids: The Contractor shall follow all requirements of the Inadvertent Return and Surface Spill Contingency Plan as submitted and approved and shall control operational pressures, drilling mud weights, drilling speeds, and any other operational factors required to avoid hydrofracture fluid losses to formations, and control drilling fluid spillage. This includes any spillages or returns at entry and exit locations or at any intermediate point. All inadvertent returns or spills shall be promptly contained and cleaned up by the Contractor.

The Contractor shall maintain on-site mobile spoil removal equipment during all drilling, pre-reaming, reaming, and pullback operations and shall be capable of quickly removing spoils. The Contractor shall immediately notify Engineer of any inadvertent returns or spills and immediately contain and clean up the return or spill.

e. Removal of Temporary Facilities: At the completion of construction, the Contractor shall remove all temporary facilities installed by the Contractor. Unused soil, aggregate, and other materials shall be removed and disposed of at approved sites in accordance with Federal, State, and Local regulations. Any damage to streets, lawns, common areas, and sidewalks shall be restored to original or better conditions at no additional cost to the Owner. All disturbed areas shall be revegetated.

f. Site Security: The Contractor shall install an enclosure fence around the Work area. The enclosure fence shall be adequate to prevent entry of unauthorized persons. The Contractor is completely responsible for their own site security throughout the entire duration of construction.

g. Temporary Lighting: The Contractor shall procure and maintain all temporary lighting needed for Contractor's operations, safety, testing, and inspection. Temporary lighting shall be removed immediately after completion of construction.

h. Work Staging: The Contractor shall be responsible for obtaining staging areas and all necessary approvals and permits for storage of equipment and materials, parking, drilling and other Work.

i. Pipe Layout Staging Areas: The Contractor shall:

    i. Obtain a pipe layout area if not otherwise provided by the owner as part of project easements, etc. shown on the contract drawings;

    ii. Limit the pipe layout to the pipe staging area;

    iii. Visit the proposed areas prior to submitting a bid for this work;

    iv. Not conduct excavation or earthwork activities in the pipe staging area without prior acceptance by the Engineer; and

    v. Be responsible for securing necessary permits and approvals for the use of the temporary staging area layout of the pipe.

H. MOBILIZATION:

1. The Contractor shall mobilize all equipment, materials, and personnel necessary to construct the carrier pipeline using the HDD process at the locations shown in the Contract Drawings.

   a. Entry Area: The Contractor shall set up temporary workspace within the areas delineated on the Contract Drawings. Appropriate precautions and measures shall be employed by the Contractor to prevent erosion, surface drainage, and spillage of drilling fluids or other materials that could adversely impact the environmental quality of the site. Silt fences, hay wattles, and hay bales shall be used to line the Work area to minimize erosion and contain any spillage or runoff. Shovels, brooms, buckets, and barrels shall be kept on-site to facilitate containment and cleanup. A vacuum truck or trailer unit will be on standby and capable of responding within one hour to any spill or inadvertent return incident.

   b. Exit Area: the exit area shall have appropriate precautions and measures for containing drilling fluids and cuttings. The Contractor shall use appropriate methods to minimize erosion and runoff. Containment and cleanup equipment shall be available to contain and clean up any surface spills and inadvertent returns.

   c. Pipe Layout Area: Layout area shall be free of stones, wood, debris, and obstructions. Pipe rollers shall be provided by the Contractor during the assembly process to facilitate pipe joining and pullback. Pipe rollers and all pipe handling shall be non-abrasive and cushioned using special devices and methods to prevent damage. Pipe rollers that are uncushioned, unsteady or in any way pose a possibility of damaging or scratching the pipe shall not be used. The pipe layout area may not allow the entire length to be joined in a single length before start of pull-in. Contractor will plan work accordingly. The Contractor shall maintain access to all properties unless written permission has been granted by the individual property owners.

I. HORIZONTAL DIRECTIONAL DRILLING:

1. Drill Rig Capacity: The capacity of the directional drilling system used by the Contractor shall be adequate to install the specified pipeline.

2. Pump Capacity: The pumps used by the Contractor shall be adequate to supply the required flow rate and pressures at the anticipated drilling fluid viscosity at all times. Drilling speeds shall not exceed pump capacity. Drilling speeds shall be monitored continuously during HDD operations.

3. Bore Tracking and Monitoring: At all times during the pilot bore the Contractor shall provide and maintain a bore tracking system that is capable of accurately locating the position of the drill head in the x, y, and z axes. The Contractor shall record these data at least once per drill pipe length or every twenty (20) feet, whichever is less.

   i. Tracking System: Monitor and record the x, y, and z coordinates relative to an established surface survey benchmark. Where the pilot hole is greater than 10 feet from the surface, a downhole wire line tracking locator system shall be installed between the entry point and the exit point. The coordinates of the surface wire grid system shall be surveyed and recorded. The grids shall be surveyed to establish horizontal and vertical position to 0.1 foot accuracy.

   ii. Deviations between the recorded and design bore path shall be calculated and reported on the daily log. If the deviations exceed tolerances specified, such occurrences shall be reported immediately to the Engineer. The Contractor shall undertake all necessary measures to correct deviations and return to design line and grade.

   iii. Drilling Fluid Pressures and Flow Rates: Drilling fluid pressures and flow rates shall be continuously monitored and recorded by the Contractor. The pressure shall be monitored at the pump. These measurements shall be made during pilot bore drilling, reaming, and pullback operations.

   iv. Drilling Speeds: Maximum allowable drilling speeds shall be calculated by the Contractor for pilot boring and each reaming pass and shall not be exceeded for pilot boring or reaming passes. Measurements shall be taken every twenty (20) feet or thirty (30) minutes, whichever is more frequent.

   v. Drilling Fluid Viscosity and Density (Mud Weight): The Contractor shall measure and record drilling fluid viscosity and density at least three (3) times per shift or at least once per 200 feet of drilled and reamed length, whichever is more frequent with at least two (2) hours between readings, using calibrated Marsh funnel and mud balance. These measurements shall be included in daily logs submitted to the Engineer.

The Contractor shall document modifications to the drilling fluids, by noting the types and quantities of drilling fluid additives and the dates and times when introduced. The reason for the addition of drilling fluid additives or other modifications shall be documented and reported.

4. Location of Entry and Exit Points: Entry and exit points shall be as shown on the Contract Drawings, unless otherwise approved in writing by the Engineer. The Contractor shall employ experienced licensed surveyors registered in the State of North Carolina to locate the entry and exit points, and to establish horizontal and vertical datum for the bore and the pipe layout and fabrication areas.

5. Entry and Exit Angles: Drill entrance and exit angles shall be as shown on the Contract Drawings or unless otherwise approved in writing by the Engineer.

6. Pilot Bore: The pilot bore shall follow the design path of the bore shown on the Contract Drawings.

    a. Horizontal and Vertical Tolerances: Horizontal and vertical deviations shall be less than plus or minus two (2) feet from the design path centerline. The Contractor shall continuously monitor horizontal and vertical position and record the position at least once per drill pipe length, or every twenty (20) feet, whichever is less.
    b. Radius of Curvature: The radius of curvature shall not be less than that shown on the Contract Drawings.
    c. Entry and Exit Tolerances: The location of the entry and exit points shall be in accordance with the approved HDD Work Plan. The Contractor shall be solely responsible for all Work necessary to correct excessive deviations from line and grade, including redrilling, redesigning connections, and acquiring additional easement, at no additional cost to the Owner and without schedule extension.

7. Pre-reaming and Reaming: The pilot bore shall be pre-reamed and reamed using equipment and methods submitted by the Contractor. The Contractor shall completely pre-ream the bore to the final diameter prior to pullback.

8. Pipe Pullback:

    a. A final swabbing of the bore path prior to pullback of the carrier pipe is required.
    b. The pipe shall be installed by pulling it into the reamed bore path in a continuous operation, behind a final reaming tool selected by the Contractor. Consideration shall be given that the carrier pipe may not be able to be pulled into the bore path in a continuous operation and that pulling may need to be temporarily suspended during intermediate fusing/welding of the carrier pipe.

c. The pipes shall be isolated from excessive torsional and axial stresses by a swivel device.
d. All measurements shall be made, recorded, and submitted on the daily logs during final reaming and pipe pullback.
e. Pulling Loads: The maximum pull (axial tension force) exerted on the carrier pipeline shall be measured continuously and limited to the maximum allowed by the pipe Manufacturer so that the pipe or joints are not overstressed. A factor of safety over the maximum allowable is not required.
f. Pipeline Support: The pipelines shall be adequately supported during installation so as to prevent overstressing or buckling. The Contractor shall provide adequate support/rollers along the stringing area to support the required length of the carrier pipe for each bore. Such support/rollers shall be spaced according to the pipe supplier, and the rollers shall be comprised of a non-abrasive material arranged in a manner to provide support to the bottom and bottom quarter points of the pipeline allowing for free movement of the pipeline during pullback. The pipe layout area shall be cleared of all large stones, construction debris, or other foreign objects that could damage the piping during pullback.
h. The leading end of the pipe shall be closed during the pullback operation, in accordance with the pipe supplier's recommendations. A pulling head shall be used that is rated at the allowable pull force capability of the pipe section being installed, in accordance with the pipe supplier's recommendations.
i. Each length of pipe shall be inspected and cleaned as necessary to be free of debris immediately before joining.

9. The Contractor shall at all times handle the carrier pipe in a manner that does not overstress or otherwise damage the pipe. Vertical and horizontal curves shall be limited to manufacturer's recommended bend radius so that wall stresses do not exceed the allowable bending radius as recommended by the pipe supplier. If the pipe is buckled or otherwise damaged due to Contractor's acts or omissions, the damaged section shall be removed and replaced by the Contractor at his expense. The Contractor shall take appropriate steps during pullback to ensure that the carrier pipe and tracer wires will be installed without damage.

10. If the pull has mid-welds, the Contractor shall engage the pipe Manufacturer to provide a Welding Technician to ensure Quality Assurance and Quality Control (QA/QC) of the midwelds during the Pullback operation.

11. The Contractor shall monitor and inspect pipe rollers and method for suspending pipe at entry during the pullback operation to avoid damage to the pipe.

12. The Contractor shall cease operations if the carrier pipe is damaged and shall remove the pipe from the bore and repair the pipe using the Manufacturer's recommended procedure or replace the damaged pipe before resuming installation.

13. Damage to the pipe resulting from installation or contact grouting is the responsibility of the Contractor, including costs for replacement and labor and materials at no cost to the Owner.

14. After the carrier pipe is completely installed, a sufficient period as recommended by the pipe Manufacturer shall be provided before the final pipe tie-in.

15. Upon completion of pullback and grouting, perform the following cleaning on the completed pipeline.

    a. After the installation of the carrier pipe, swab inside of pipe with a flexible polyurethane foam swab complete with rear polyurethane drive seal.
    b. In tandem, swap with a one to two pounds per cubic foot pig for proving, sweeping and sealing and a five to seven pounds per cubic foot pig for wiping.
    c. The tandem swabs shall make a minimum of two passes through the entire pipeline.
    d. Cleaning and flushing shall be accomplished by propelling the swab down the pipeline to the exit point with potable water. Flushing shall continue until the water is complete clear.

16. Final Hydrostatic Test: The Contractor shall conduct a final hydrostatic test of the installed pipeline. The Contractor shall repair any defects discovered during the test, and repeat until the pipe passes the test.

17. Flushing: The Contractor shall be responsible for flushing prior to startup.

J. ANNULAR SPACE AND CONTACT GROUTING:

1. The Contractor shall be prepared to grout the annular space between the bore and the outer diameter of the carrier pipe prior to the mandrel or pig test.

2. Grouting shall be completed within 48 hours of completion of the final hydrostatic test. Grouting procedures shall be in accordance with approved submittals. The grouting operations shall ensure that the both annulus are filled with grout for at least 100 feet from entry point and the last 100 feet before exit point. Grouting may be accomplished using one or more of the methods described below, or an alternative submitted by the Contractor, subject to Engineer's approval. The Contractor shall ensure that the annulus does not provide a preferential pathway for seepage regardless of the method(s) used and shall ensure that settlements shall not cause damage to existing utilities, roadways or structures.

3. Tremie pipe: Tremie pipes shall be inserted into the borehole, for at least 100 feet from both entry and exit ends after the carrier pipe pullback is completed to grout the annular space between borehole and carrier pipe, or any other voids created or encountered above the borehole. Tremie grout pipes shall be not less than 1-1/4 inch, Schedule 40 PVC, and shall be inserted at the crown and at two locations 60 degrees from the crown. Grout will be injected in sufficient volume to completely fill the annulus as the tremie pipes are withdrawn. Grouting pressures shall be carefully controlled and monitored to avoid applying excessive pressure to the pipe and to avoid heave or hydrofracture. The pipes shall be filled with water during grouting to counterbalance grouting pressures and to avoid excessive heat of hydration as the grout sets that could damage the pipes. Mix grout into drilling fluids and inject with drilling fluid as pipe is pulled back 100 feet to grout annulus at entry side. Grout shall be mixed into drilling fluid recirculation/distribution system and shall be injected as drilling fluid as the tremie pipe is pulled back. The grout mixture shall satisfy performance requirements of drilling fluid before set and requirements of annulus grout after set. Retarding agents may be incorporated into grout mixture to allow sufficient time to complete pipe pullback before initial grout set. The exit side annulus shall be grouted by inserting a tremie pipe(s) into the bore annulus and pipe annulus for at least 100 feet from the exit end as described in 1 above. Grout/drilling fluid injection pressures shall be less than pressures that could result in collapse of the pipe or hydrofracture of the surrounding soil.

K. OBSTRUCTIONS:

1. The Contractor shall notify the Engineer immediately in the event that any obstruction is encountered that prevents further advancement of the drill pipe, or pullback of the pre-reamer, reamer, and/or pipe.

2. The Contractor shall make all diligent and reasonable efforts to advance past the object by drilling slowly through the object, pulling back, and drilling along a new bore path that avoids the object, or excavating and exposing and removing the object, and all other reasonable attempts to continue the bore.

3. The Contractor shall notify the Engineer of proposed measures to attempt to advance past the object, prior to initiating the attempt. If the Contractor attempts to pullback and re-drill, the Contractor shall adhere to line and grade tolerances established in this Specification section, unless the Engineer approves variance, in writing, prior to the Contractor's attempt to re-drill.

4. The Contractor and Engineer shall investigate the cause and together determine an appropriate response. Appropriate response may include revisions to equipment or methods, retraction and re-drilling of a portion of the bore, or abandonment of the hole.

5. If abandonment is deemed necessary, the Contractor shall recover, to the extent practicable, any drill pipe, product pipe, and tools in the bore, and properly abandon the bore by contact grouting unless otherwise directed in writing by the Engineer. If the bore is abandoned, the Contractor shall be allowed to begin a second attempt to install the pipeline at an alternate location subject to approval, in writing, by the Engineer. The Contractor shall take all reasonable actions to complete the installation with minimal delays.

L. SITE RESTORATION AND DEMOBILIZATION:

1. The Contractor shall remove all equipment, materials, drilling fluids, muck, waste, and debris from the site and restore the site to its original condition upon completion of the installation. Restoration and demobilization shall be completed by the Contractor within seven (7) calendar days of the completion of the pipeline installation.

2. Settlement Monitoring: The Contractor shall visually monitor for settlement or heave before and during drilling and grouting operation at the locations shown on the plans and/or as determined during the pre-construction survey. The settlement monitoring locations shall be surveyed to the nearest 0.01 foot and recorded prior to drilling operations and each day drilling operations are ongoing. A final record of spot elevations shall be recorded two weeks after pipe installation is complete and presented with the record drawings. Areas found to have significantly settled or heaved will require restoration. The Engineer will determine what constitutes significant settlement or heave. The Contractor will restore these areas at no cost to the Owner.

END OF SECTION 37.