

I N D E X

DIVISION G

WATER MAIN CONSTRUCTION SPECIFICATIONS

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DIVISION G

WATER MAIN CONSTRUCTION SPECIFICATIONS

1. GENERAL:

These specifications form a part of the Contract Documents and shall govern the handling and installation of water mains with all their appurtenances.

2. MATERIALS:

All materials necessary for the completion of the Contract shall be furnished by the Contractor unless otherwise specified.

Aggregates	Division E	Section 3.0
Block (Concrete)	Division E	Section 4.0
Brick	Division E	Section 5.0
Cement	Division E	Section 6.0
Concrete	Division E	Section 7.0
Concrete Reinforcement	Division E	Section 7.5
Mortar	Division E	Section 8.0
Manholes, Catch Basins & Inlets	Division E	Section 9.0
Asbestos-Cement Water Pipe	Division E	Section 11.1
Polyvinyl Chloride (PVC) Pressure Pipe	Division E	Section 11.3
Ductile Iron Water Pipe	Division E	Section 11.4
Prestressed Concrete Water Pipe	Division E	Section 11.5
Detectable Tracer Tape	Division E	Section 11.6
Dry-Barrel Fire Hydrants	Division E	Section 11.7
Gate Valves	Division E	Section 11.8
Butterfly Valves	Division E	Section 11.9
Hydrant Valves	Division E	Section 11.10
Valve Boxes	Division E	Section 11.11
Fittings	Division E	Section 11.12
Manhole Steps	Division E	Section 12.0
Manhole Frames and Covers	Division E	Section 13.0
Structural Steel	Division E	Section 14.0
Landscaping	Division E	Section 15.0
Water	Division E	Section 16.0
Casing Pipe	Division E	Section 17.0

3. RESPONSIBILITY FOR MATERIALS:

3.1 Responsibility for Material Furnished by Contractor: The Contractor shall be responsible for all material furnished by him and he shall replace at his own expense all such material that is found to be defective in manufacture or that has become damaged in handling after delivery by the manufacturer.

3.2 Responsibility for Safe Storage: The Contractor shall be responsible for the safe storage of material accepted by him, and intended for the work, until it has been incorporated in the completed project.

4. HANDLING PIPE AND ACCESSORIES:

4.1 Care: Ductile cast iron or other pipe, fittings, valves, hydrants and other accessories shall, unless otherwise directed, be unloaded at the point of delivery hauled to and distributed at the site by the Contractor; they shall at all times be handled with care to avoid damage. In loading and unloading, they shall be lifted by hoists or skid, or rolled on skidways in such manner as to avoid shock. Under no circumstances shall they be dropped. Pipe handled on skidways must not be skidded or rolled against pipe already on the ground.

4.2 At Site of Work: In distributing the material at the site of the work, each piece shall be unloaded opposite or near the place where it is to be laid in the trench.

4.3 Care of Pipe Coating: Pipe shall be handled in such manner that a minimum amount of damage to the coating will result. Damaged coating shall be repaired in a manner satisfactory to the Engineer.

4.4 Pipe Kept Clean: The interior of all pipe, fittings, and other accessories shall be kept free from dirt and foreign matter at all times.

4.5 Frost Protection: Valves and hydrants before installation shall be drained and stored in a manner that will protect them from damage by freezing.

5. ALIGNMENT AND GRADE:

5.1 General: All pipe shall be laid and maintained to the required lines and grades; with fittings, valves and hydrants at the required locations; and with joints centered and spigots home; and with all valve and hydrant stems plumb.

5.1.1 Protecting Underground and Surface Structures: Temporary support, adequate protection and maintenance of all underground and surface utility structures, drains, sewers and other obstructions encountered in the progress of the work shall be furnished by the Contractor at his own expense under the direction of the Engineer.

5.1.2 Deviations Occasioned by Other Utility Structures: Wherever existing utility structures or branch connections leading to main sewers or to main drains, or other conduits, ducts, pipes or structures present obstructions to the grade and alignment of the pipe, they shall be permanently supported, removed, relocated, or reconstructed by the Contractor through cooperation with the owner of the utility, structure or obstruction involved. In those instances where their relocation or reconstruction is impracticable, a deviation from line and grade will be ordered and the change shall be made in the manner directed, and with extra compensation allowed therefore.

5.1.3 Deviation with Engineer's Consent: No deviation shall be made from the required line or grade except with the written change order of the Engineer.

- 5.2 Subsurface Exploration: Underground structures which may be encountered or which may effect the progress of the work have been determined from careful field survey and are shown on the plans in as much detail and with such accuracy as is practicable. The City does not guarantee the location shown to be absolutely correct. Any inconsistencies or inaccuracies in the location of structures revealed during the progress of construction does not relieve the Contractor from responsibility for damage to same nor in any way entitle him to extra compensation under the terms of this Contract. House connections to sewers, water and gas services are not shown, but shall be anticipated in construction and the Contract shall use due and proper precautions to protect same from injury.
- 5.3 Depth of Pipe Cover: All pipe shall be laid to have a depth of cover of five (5) feet when in earth excavation and four and one-half (4-1/2) feet of cover when rock is encountered, measured from the established street grade or the surface of the permanent improvement to the top of the barrels of the pipe or depths of cover otherwise indicated on the contract drawings or as required in Supplementary Specifications.

6. PROTECTION OF EXISTING UTILITIES AND STRUCTURES:

- 6.1 Prior to commencing excavation, the Contractor shall be required to adhere to the provisions of Act 53 of Public Acts of 1974.
- 6.2 Existing Sewers, Drains Utilities: Unless otherwise directed, the Contractor shall protect and not damage any existing utility. If damage is done, the Contractor shall repair such damage and leave such utility in as good condition as when first encountered. Water mains, sewers and drains, before backfilling, shall be provided with structural steel or other Engineer approved supports across the trench, and this expense shall be incidental to the item of "Excavation".

Whenever existing water, gas or other utility services, pipe or structures are encountered in the construction, they shall be protected by the Contractor. Any damage to them by the Contractor shall be reimbursed to the utility involved. If not paid before Contract completion, the City shall deduct such expenses from the final Contract payment.

Services, pipes or structures needing supports across or in the trench shall be properly supported with structural steel or other suitable material by the Contractor in coordination with the owner of the utilities before any backfilling is attempted. Provision for the cutting of any utility services, which crosses the trench, shall be made by the Contractor with the utilities, and such expense of cutting and reconnecting shall be borne by the Contractor. Any expense incurred by the Contractor because of interference of utility services, pipe or structures with the excavation shall be regarded as incidental to the item of "Excavation".

- 6.3 Crossing Under Existing Railroad Tracks: In laying the water main under railroad tracks, special care must be taken to properly shore up and protect the tracks and maintain traffic over them. This work shall be done in such a manner as will meet with the approval of the railroad companies involved; and the Contractor shall save the City harmless from any damage or injury resulting to such companies or individuals by reason of this work.

The Contractor shall encase the main that is laid under railroad tracks or in railroad rights-of-way with concrete as indicated on plans.

The expense involved for the protection of tracks by the use of track supports or any other expenses involved in such crossing shall be borne by the Contractor.

7. EXCAVATION AND PREPARATION OF TRENCH:

7.1 Description: The trench shall be dug to the alignment and depth required and only so far in advance of pipe laying as the Engineer shall permit. The trench shall be so braced and drained in accordance with the requirements as established by MIOSHA. It is essential that the discharge from pumps be led to natural drainage channels, to drains, or to storm sewers.

7.1.1 Width: The trench width may vary with and depend upon the depth of trench and the nature of the excavated material encountered; but in any case, shall be of ample width to permit the pipe to be laid and jointed properly and the backfill to be placed and compacted properly. The width of trench from a point two feet above the top of the pipe to the bottom of the trench shall be 24" excavation for all sizes up to and including 12" pipe, and for all larger sizes it shall be 12" wider than the nominal diameter of the pipe plus 9" on each side for that portion excavated in earth only.

7.2 Pipe Foundation: The trench shall have a flat bottom conforming to the grade to which the pipe is to be laid. The pipe shall be laid upon a 3" stone cradle carried up to a point equal to 1/2 the diameter of the pipe. The barrel of the pipe shall have an even bearing for its full length.

7.2.1 Correcting Faulty Grade: Any part of the trench excavated below grade shall be corrected with the approved bedding material, thoroughly compacted.

7.2.2 Pipe Foundation in Poor Soil: When the bottom uncovered at subgrade is soft and, in the opinion of the Engineer, cannot support the pipe, a further depth and/or width shall be excavated and refilled to pipe foundation grade as required, or other approved means shall be adopted to assure a firm foundation for the pipe.

7.3 Pipe Clearance in Rock: Ledge rock, boulders, and large stones shall be removed to provide a clearance of at least 6" below all parts of the pipe, valves, or fittings, and to a clear width of 6" on each side of all pipe and appurtenances for pipes 16" or less in diameter; for pipes larger than 16", a clearance of 9" below and a clear width of 9" on each side of pipe shall be provided. Adequate clearance for properly jointing pipe laid in rock trenches shall be provided at bell holes.

7.3.1 Subgrade in Rock Trench: Excavations below subgrade in rock or in boulders shall be refilled to subgrade with approved material and thoroughly compacted.

- 7.3.2 Rock Excavation Defined: Rock shall be boulders over one-third (1/3) cubic yard in size within the area of the trench, or it shall be hard, durable ledge rock that cannot be easily removed by use of pick and shovel or by means of a power driven mechanical shovel.

When blasting is done it shall be by permission of the Engineer, and the Contractor shall assume all risks for damage incurred by any property, structures, persons, etc.

- 7.3.3 Blasting Procedure: Blasting for excavation will be permitted only after securing the approval of the Engineer and only when proper precautions are taken for the protection of persons or property. The hours of blasting will be fixed by the Engineer. Any damage caused by blasting shall be repaired by the Contractor at his expense. The Contractor's methods or procedure, relative to blasting, shall conform to local, state laws and municipal ordinances.

- 7.3.4 When pre-blasting is used (fracturing of rock with explosives prior to actual trench excavation) the Contractor, if required by the Engineer, shall first verify that the rock cannot be removed by pick and shovel or by power driven mechanical shovel. Cost of such verification shall be at the Contractor's expense.

- 7.4 Bell Holes Required: Bell holes of ample dimensions shall be dug in earth trenches at each point to permit the jointing to be made properly.

- 7.5 Braced and Sheeted Trenches: Wherever necessary to prevent caving, excavations in sand, gravel, sandy soil or other unstable material shall be adequately sheeted and braced. Where sheeting and bracing are used, the trench width shall be increased accordingly. Trench sheeting shall remain in place until the pipe has been laid, tested for defects and repaired, if necessary, and the earth around it compacted to a depth of two (2) feet over the top of the pipe.

- 7.6 Care of Surface Material for Reuse: If local conditions permit their reuse, all surface material suitable for reuse in restoring the surface shall be kept separate from the general excavation material.

- 7.6.1 Manner of Piling Excavated Material: All excavated material shall be piled in a manner that will not endanger the work and that will avoid obstructing sidewalks and driveways. Gutters shall be kept clear or other satisfactory provisions made for street drainage.

- 7.7 Trenching by Machine or by Hand: The use of trench-digging machinery will be permitted except in places where operation of same will cause damage to trees, buildings, or existing structures, above or below grade, in which case hand methods shall be employed.

- 7.8 Barricades, Guards and Safety Provisions: To protect persons from injury and to avoid property damage; adequate barricades, construction signs, torches, red lanterns and guards, as required, shall be placed and maintained during the progress of the construction work and until it is safe for traffic to use the trenched highway. Whenever required, flagmen shall be provided to prevent accidents.

Rules and regulations of the local authorities respecting safety provisions shall be observed.

7.9 Traffic and Utility Controls: Excavations for pipe laying operations shall be conducted in a manner to cause the least interruption to traffic. Where traffic must cross open trenches, the Contractor shall provide suitable bridges at street intersections and driveways. Hydrants under pressure, valve pit covers, valve boxes, curb stop boxes, fire or police call boxes, or other utility controls shall be left unobstructed and accessible during the construction period.

7.9.1 Flow of Drains and Sewers Maintained: Adequate provision shall be made for the flow of sewers, drains and water courses encountered during construction, and the structures which may have been disturbed shall be satisfactorily restored upon completion of the work.

7.9.2 Property Protection: Trees, fences, poles, and all other property shall be protected unless their removal is authorized; and any property damaged shall be satisfactorily restored by the Contractor and shall be incidental to pipe installation.

7.9.3 Interruption of Water Service: No valve or other control on the existing system shall be operated for any purpose by the Contractor without approval of the Engineer, and all consumers affected by such operation shall be notified by the Contractor at least one hour before the operation and advised of the probable time when the service will be restored.

8. PLACES OF DISPOSAL:

All excavated material not required or allowed for refilling or in embankments shall be removed and deposited at such locations as are specified, or, if no such locations are specified, the Contractor shall find suitable dumping places for all such material. No material shall be deposited on private property until written consent of the owner or owners thereof has been filed with the Engineer. All costs of disposal of surplus excavated material shall be included in the prices bid for excavation or items requiring excavation.

8.1 Excavated material shall be disposed of, all dumps shall be leveled by the Contractor in the following order of preference:

- a. Along the site of the work to fill requirements of the work, material for this purpose shall be of the same type or better than the existing material where fill is required or where necessary to replace as backfill.
- b. On private property facing the site of the project.
- d. On any City-owned property in or outside of the City's limits.
- d. Adjacent to the work upon the request of property owners upon property within two (2) miles haul and as directed by the Engineer.
- e. Nonadjacent to the work beyond two (2) miles haul and as directed by the Engineer.

- f. Any balance remaining after the above requirements are filled shall be disposed of by the Contractor to his best advantage with no overhaul compensation.

The Contractor shall be entitled to "Overhaul" under the terms of this Contract for his compensation for hauling beyond the two (2) mile limit upon orders of the Engineer. All free haul and "Overhaul" shall be made by written orders of the Engineer on order blanks having a number sequence.

- 8.2 Salvage: In the case of structures, the service of which is permanently abandoned, the Engineer will designate which of the materials are to be salvaged and which are to be abandoned. The Contractor shall remove and deliver to a designated point of storage, materials ordered to be salvaged, and unless otherwise specified, no additional compensation will be allowed for this removal and hauling. He shall allow owners of privately-owned structures reasonable facilities for salvaging their property. Structures designed as abandoned and not mentioned in plans or specifications to be salvaged shall become the property of the Contractor, and shall be removed from the work without additional compensation. The Contractor shall not move nor disturb the structures in any way without the approval of the Engineer.

9. PIPE LAYING:

- 9.1 Manner of Handling Pipe and Accessories into Trench: Proper implements, tools, and facilities satisfactory to the Engineer shall be provided and shall be used by the Contractor for the safe and convenient prosecution of the work. All pipe, fittings, valves and hydrants shall be carefully lowered into the trench piece by piece by means of derrick, ropes, or other suitable tools or equipment in such a manner as to prevent damage to pipe or coating, on fittings or pipe. Under no circumstances shall pipe or accessories be dropped into the trench.
- 9.2 Pipe Kept Clean: All foreign matter or dirt shall be removed from the pipe before it is lowered into its position in the trench, and it shall be kept clean by approved means during and after laying.
- 9.3 Joints: The Contractor shall keep the trench free from water, and the assembly of pipe and couplings shall be made with dry and clean materials wherever possible. Joints for cement asbestos pipe shall be Ring-tite couplings or equal.

Couplings shall be assembled in such a manner that the couplings and rubber rings are placed concentrically over the ends of adjacent pipe in accordance with the manufacturer's instructions. After assembly of couplings, the ends of the pipe within the coupling shall be separated a minimum of 3/8" to allow for the expansion and contraction of the pipe.

Joints made between asbestos cement pipe and cast iron pipe or fittings shall be made by entering the asbestos cement pipe into standard or special bells on the cast iron pipe or fittings. In those cases where special bells are required but are not available, adapters with standard spigots and special bells shall be provided. The space between the asbestos cement pipe and the bell of the cast iron pipe or fitting shall be not less than 1/4" and shall be free from oil.

Whenever a joint lubricant is required for joining pipe sections together, the lubricant shall be supplied by the pipe manufacturer.

- 9.4 Cutting of Pipe: Whenever it is necessary to cut pipe, it shall be done with a sharp saw in such a manner as to make a clean, even cut.
- 9.5 Connections: Service connections shall be made by inserting a corporation stop into the barrel of the asbestos cement pipe. The insertion shall be made with a standard drilling and tapping machine under the direction of the City of Monroe Water Department.
- 9.6 Protecting Pipe: During the progress of the work, the Contractor shall take all precautions necessary to protect the pipe from injury. All damaged pipe shall be removed and replaced at the Contractor's expense.
- 9.7 Backfill: Backfill along side and to a depth of one foot over the top of the pipe shall be selected material from the site, if possible. Only loose dirt or sand, free from stones, shall be used and shall be uniformly tamped in place along the full length of the pipe. Tamping should be done in layers not exceeding four (4) inches thick. The remaining selected backfill need not be tamped. The balance of the backfill may be placed in the trench by hand or mechanical means.

The Contractor shall provide MDOT Spec. 23A stone aggregate backfill and power tamp such backfill in 12" layers up to plan grade at all locations where excavation occurs under existing roadways, driveways or sidewalks, or where the trench edge is within five (5) feet of pavement.

- 9.8 Steel Casings and Borings: Where shown on the plans and where indicated, the Contractor shall install steel casing pipe by the combined boring-jacking operation method. The pipe shall be new and unused mill primed welded steel pipe conforming to ASTM-A-252 Grade 2 or better specifications.

The casing pipe shall have a cutting edge and the boring head shall be contained within the casing, with the casing leading the boring head. The casing shall be installed concurrently and ahead of the face of the excavation. In no case shall water be used in conjunction with the boring operation.

The Contractor shall bulkhead the ends of the casing and/or fill the casing with sand or other materials around the pipe as demanded by State or other authorities.

Also, where indicated on the plans or if ordered by the Engineer, the Contractor shall bore under trees, without a casing, and such work shall be a part of the unit price for water mains installed in place.

10. SETTING VALVES, VALVE BOXES, FITTINGS, AND BLOW-OFFS:

- 10.1 Jointing to Asbestos Cement Pipe: Each cast iron valve or fitting, when connected to asbestos cement pipe, shall have a bell with an inside profile such that a seal can be made between the machined pipe end and the bell with a rubber ring, or shall be equipped with a bell having an inside diameter sufficient

to receive the pipe and provide a caulking width between the pipe and bell of at least 1/4" for the full circumference of the pipe.

- 10.2 Support of Fittings: Each valve shall be permanently supported independently of the pipe in accordance with the details shown on the plan sheet entitled "Water Detail Standards".
- 10.3 Preparation of Bell and Spigot Ends: Before laying valves or fittings; all lumps, blisters and excess coating shall be removed from the bell. The inside of the bell shall then be wire-brushed and both the inside of the bell and the spigot end of the pipe wiped clean and dry. When sulphur base joint compound is used, oil and grease also shall be removed. All surfaces to be joined shall be kept clean until joints are made.
- 10.4 Valve Boxes: Cast iron valve boxes shall be firmly supported and maintained centered and plumb over the wrench nut of the gate valve, with box cover flush with the surface of the finished pavement or at such other level as may be directed.
- 10.5 Reaction or Thrust Blocks: Reaction or thrust blocks shall be applied at bends, tees, plugs and where changes in pipe diameter occur at reducers or in fittings. The design of concrete thrust blocks shall be as specified on the plan sheet entitled "Water Detail Standards".
- 10.6 Back-siphonage to be Prevented: Drainage branches or blow-offs shall not be connected to any sewer or submerged in any stream or be installed in any other manner that will permit back-siphonage into the distribution system.

11. USE OF MAIN:

The owner shall have the progressive use of the water mains after they are tested and chlorinated between valved sections.

12. HYDRANTS:

- 12.1 General Location: Hydrants shall be located in a manner to provide complete accessibility, and in such manner that the possibility of damage from vehicles or pedestrians will be minimized. Unless otherwise directed, the setting of any hydrant shall conform to the following:
 - 12.1.1 Location Regarding Curb Lines: When placed behind the curb, the hydrant barrel shall be set so that no portion of the pumper or hose nozzle cap will be closer than 3 feet from the curb face or less than 20 feet from the curb line intersection of any street; if set between streets, the hydrant shall be placed in the manner designated by the Engineer.
 - 12.1.2 Location Regarding Sidewalk: When set in the lawn space between the curb and the sidewalk, or between the sidewalk and the property line, no portion of the hydrant or nozzle cap shall be within 6" of the sidewalk.
- 12.2 Position of Nozzles: All hydrants shall stand plumb, and shall have their nozzles parallel with or at right angles to the curb, with the pumper nozzle pointing normal to the curb, except hydrants having hose nozzles at an angle of 45° shall be set

normal to the curb. They shall conform to the established grade, with nozzles at least 12" above the ground.

- 12.3 Connection to Main: Each hydrant shall be connected to the main pipe with a 6" cast-iron branch controlled by independent 6" gate valve, except as otherwise directed.
- 12.4 Drainage of Hydrant: All hydrants shall be furnished and installed with the drainage hole factory plugged.
- 12.5 Anchorage for Hydrant: The bowl of each hydrant shall be well braced against unexcavated earth at the end of the trench with concrete thrust block or it shall be tied to the pipe with suitable rods or clamps. Hydrants shall be firmly braced until the backfill is firmly tamped around them.
- 12.6 Cleaning: Hydrants shall be thoroughly cleaned of dirt or foreign matter before setting.

13. PLUGGING DEAD ENDS:

Standard plugs shall be inserted into the bells of all dead ends of pipes, tees or crosses, and spigot ends shall be capped. Plugs or caps shall be jointed to the pipe or fitting in the manner specified.

14. HYDROSTATIC TESTS:

After any section of pipe is laid between valves, the pipe shall be filled with water and subjected to a hydrostatic pressure of 150 lbs per square inch for a period of two hours in accordance with AWWA C605 for both ductile iron pipe and PVC pipe. Allowable leakage will be based on 10.5 gallons/inch/mile/24 hours. Tests shall be performed by the Contractor and witnessed by the Engineer. The actual cost of the test shall be borne by the Contractor. All mains to be tested with hydrants in place and with hydrant connection valves open.

- 14.1 Procedure: Each section of pipe line shall be slowly filled with water and the specific test pressure, measured at the point of lowest elevation shall be applied by means of a pump connected to the pipe, in a manner satisfactory to the Engineer. The pump, pipe connection and all necessary apparatus, except gauges and meters, shall be furnished by the Contractor. The owner will furnish gauges and measuring devices for the test. When required, all material and labor necessary to make taps into the pipe shall be furnished by the Contractor at no cost to the City.
- 14.2 Expelling Air Before Test: Before applying the specified test pressure, all air shall be expelled from the pipe. To accomplish this, taps shall be made, if necessary, at points of highest elevation and afterward tightly plugged.
- 14.3 Connection to Existing Mains: When the pipe is to be connected to an existing valve or main, the Contractor shall make the connection only after the new water main pipe has been pressure tested and chlorinated. The Contractor may elect to connect the new water main to the existing pipe or valve prior to pressure testing; however, if such is done, the Contractor shall first verify to his satisfaction

and shall be responsible for insuring that the existing pipe or valve is capable of meeting the pressure test requirements.

15. AIR TEST:

Prior to tapping an existing main for a new main extension, the Contractor shall install the tapping saddle and apply a 90 pound air test for 5 minutes with no loss to insure against leakage of the saddle during the tapping operation.

16. DISINFECTION OF COMPLETED PIPE LINE:

Before being placed in service and before certification of completion by the Engineer, all new water systems, or extensions to existing systems or valved section of such extension, or any replacement in the existing water system, or any exposed section of the existing system shall be flushed and disinfected in accordance with the current State of Michigan procedures and or AWWA C651. Water mains shall be thoroughly flushed prior to disinfection at a velocity of not less than 2.5 feet per second.

16.1 Chlorination: The Contractor will perform all necessary work to chlorinate the water mains and its appurtenances. A chlorine solution (Chlorine used shall conform to the NSF Standard 60 or 61) shall be injected into the water main of sufficient strength to create a minimum 50 ppm chlorine solution (maximum 500 ppm) in the main. The type of chlorine used, mixing rates and application rate shall be approved by the Engineer. The strong chlorine solution shall remain in the water main at least 24 hours and maximum of 72 hours prior to flushing. Immediately at the time of flushing the chlorinated water from the main, a water sample for testing the strong chlorine solution shall be taken by the City Water Department. After the main has been thoroughly flushed at a velocity of not less than 2.5 feet per second, another sample shall be taken to test for residual chlorine. Sufficient notification shall be given to the City Water Department by the Contractor as to the date and time such samples are to be taken. The Contractor shall re-chlorinate the water main if test conducted on the samples taken do not meet current City Water Department standards. At the time of chlorination, all hydrant valves and intermediate main line valves shall be operated. All cost of chlorination, installation of corporations and related materials and labor shall be at the Contractor's expense.

16.2 Chemical and Bacteriological Test: Immediately following chlorination, all treated water shall be thoroughly flushed from the main at a velocity of not less than 2.5 feet per second until the replacement water through its length shall, upon test by the City Water Department, both chemically and bacteriologically, be proven equal in quality to the water in the source supply system.

17. STRUCTURES:

17.1 New Structures shall be constructed as indicated on the plans and of the materials specified. In general, structures will be indicated in the Proposal as a unit and this work shall include necessary excavation of earth and rock, furnishing of materials, labor, clean-up, etc., incidental for the completion of the whole unit of construction.

17.2 Existing Structures encountered in the work which necessitates some alteration or demolishing will be indicated on the plans and, if not, any work necessary to the progress of the project shall be ordered by the Engineer.

17.3 Alteration or Demolishing of any Structure, etc. will be indicated in the Proposal. In general, when this work is not included in the Proposal, it shall be regarded as incidental to item of Excavation with no additional payment.

18. VALVE MANHOLES:

18.1 Manholes shall be built according to the details of the plans and at locations shown. They shall be built of precast concrete or block laid radially with each seventh course as stretchers with one-quarter inch mortar joints.

18.2 The upper three feet of manholes shall be eccentric dome, drawing in on all sides to fit the ring. The ring shall be set in a bed of mortar and carefully adjusted to the grade set by the Engineer. Cast iron ring and cover shall be as specified on the plans.

18.3 Manholes shall be thoroughly bonded to the barrel of the water main and all connections to pipes made without projections or voids. Interior and exterior of block shall be plastered with one-half inch cement mortar.

18.4 Casting Grade Adjustments: Adjustments to meet the final design grade shall be set with precast reinforced concrete adjusting rings as detailed on the plans. The maximum allowed depth of adjusting rings shall be twelve (12) inches.

18.5 Earth Excavation: The excavating for manholes shall be vertical or slanting with no overhang over the work. It shall be to the same depth as the bottom of the stone bedding for the manhole base and shall have diameter not less than three (3) feet greater than the outside diameter of round manholes or three (3) feet greater than any side dimension of square or rectangular manholes.

18.6 Rock Excavation: Where rock is encountered, the excavation shall be vertical and to the same depth as for earth excavation. It shall be of the same diameter or side dimension as for earth when manholes are of brick, but can be of the same diameter or side dimension as the outside of the manhole when it is built of concrete.

18.7 Steps: Manhole steps shall be of the material, size, length and shape as shown on the plans. They shall be firmly built into the walls not more than sixteen (16) inches apart.

18.8 Frames and Covers: Manhole frames and covers shall be as specified on the plans.

19. CONCRETE STRUCTURES:

19.1 Concrete: Concrete shall consist of a mixture of Portland cement, aggregates and water, proportioned in accordance with the requirements of this specification. Admixtures shall be included with these primary ingredients when specified.

19.2 Handling and Placing: No concrete shall be used which does not reach its final position in the forms within one (1) hour after water is first added to the mix, except when the concrete is continually agitated when the time may be extended to one and one-half (1-1/2) hours.

- 19.3 Depositing Concrete Under Water: Concrete, until it has set, shall not be exposed to the water by which it is surrounded, it shall not be deposited in water except with the approval of the Engineer and under his immediate supervision; and in the case the method of placing shall be as hereinafter designated.

Concrete deposited in water shall be Class 1 with ten (10) percent excess cement. To prevent segregation, it shall be carefully placed in a compact mass, in its final position, by means of a tremie, a bottom dump bucket or other approved method, and shall not be disturbed after being deposited. Still water shall be maintained at the point of deposit and the forms under water shall be watertight.

For parts of structures under water, when possible, concrete seals shall be placed continuously from start to finish, the surface of the concrete shall be kept as nearly horizontal as practicable at all times. To insure thorough binding, each succeeding layer of a seal shall be placed before the preceding layer has taken initial set. All laitance or other foreign matter shall be removed from the top surface before any concrete is placed upon it in the dry.

A tremie shall consist of a tube having a diameter of not less than ten (10) inches, constructed in sections having flanged couplings fitted with gaskets. The tremies shall be supported so as to permit free movement of the discharge and over the entire top surface of the work and so as to permit rapid lowering when necessary to retard or stop the flow of concrete. The discharge end shall be plugged at the start of work so as to prevent water entering the tube and shall be entirely sealed at all times; the tremie tube shall be kept full to the bottom of the hopper. When a batch is dumped into the hopper, the flow of concrete shall be induced by slightly raising the discharge end, always keeping it in the deposited concrete. The flow shall be continuous until the work is complete.

- 19.4 Spudding and Vibration:

19.4.1 Spudding shall be used in all work if deemed necessary by the Engineer. The spuds shall be of such lengths that they will reach the bottom of the concrete poured. Care should be taken to spud the concrete in and around the reinforcing and at the form faces so that the entrapped air will be brought to the surface.

19.4.2 Vibration: All Class 1, 2, and 3 concrete, except that in pipe cradles, immediately after having been placed in the forms, shall be subjected to high frequency vibration by means of a vibrating tool arranged to be inserted within the mass of the concrete from above, the tool being so arranged that, due to its own weight, it will embed itself in the concrete to the full depth of the concrete just placed. The tool shall be of such diameter that it will not disturb or wedge the reinforcement from its specified position. The tool shall impart sufficient energy to the concrete to make it plastic and flowing so that when the forms are removed, there will be no stony pockets or segregation. The tool shall operate at frequencies in excess of five thousand (5,000) impulses per minute and shall be allowed to remain in the concrete long enough to puddle the concrete thoroughly but no longer.

In the placement of concrete in roof slabs, the vibrating tool shall be provided with a short handle so constructed that vibration of the tool will not be transmitted to the operator and permitting the operator to control the position of the tool with ease. As the concrete is deposited in the forms the vibrating tool shall be inserted at close intervals and to a depth which will permit the tool to vibrate concrete through the lateral motion of the tool and at the same time permit the tool to transmit vibrations to the supporting forms. The tool shall be reinserted under the flanges of girder beams, re-entrant angles in the forms and wherever it is necessary to force the concrete to flow into proper position. The tool shall be inserted at locations close enough together to insure that the whole mass of concrete being treated shall have been subjected to adequate vibration. If it is evident after the tool has operated for a reasonable length of time that stony pockets still remain due to a deficiency of mortar, such stony pockets shall be removed, fresh concrete substituted and vibration repeated until the condition of segregation disappears.

The Contractor shall have a sufficient number of vibrating tools available to accomplish the results desired.

- 19.5 Construction Joints: Concrete shall be deposited continuously and as rapidly as possible until the unit of operation, as approved by the Engineer, is completed. Construction joints at points not provided for in the plans shall be subject to the approval of the Engineer.
- 19.6 Curing: All exposed surfaces of finished and unfinished work shall be kept constantly moist by sprinkling with water at short intervals, or by such means as the Engineer shall direct, and this moistening shall be continued until, in the opinion of the Engineer, the concrete has sufficiently hardened.
- 19.7 Protection of Surfaces: Sufficient tarpaulin or other covering shall be provided to protect freshly laid work from the action of the elements.
- 19.7.1 No wheeling, working or walking on finished surfaces will be allowed for twenty-four (24) hours after the concrete is deposited.
- 19.7.2 Temperatures: When the air temperature falls to 40° F. or less, no concrete shall be deposited unless the aggregate and water have first been heated so that the mixture shall have a temperature on leaving the mixer between 70° F. and 100° F. When the temperature falls to 20° F. or less, concrete pouring shall be stopped and shall not be resumed until the temperature has risen about 20° F.
- 19.7.3 Frozen Base: No concrete shall be poured on a frozen, dry or uncompacted subgrade.
- 19.7.4 Hot Weather Curing: All exposed surfaces of concrete shall be protected from the sun and the wind and kept wet in dry weather for fourteen (14) days after placing.

- 19.8 General Concrete Finish: Unless otherwise specified, concrete surfaces shall be finished as follows:

Immediately after the face forms are removed, the surface shall be freed from inequalities and projections by scraping. All voids shall be filled by floating with cement mortar, and the entire surface shall be brushed or broomed with a thin wash, composed of equal parts of cement and fine, sharp sand in as many successive coats as may be required to produce an even surface in finish and color.

- 19.9 Reinforcement: All reinforcement bars shall have the dimensions and shall be placed as shown on the plans and details. The bars shall be supported at intervals of not more than three (3) feet by bent steel or molded concrete chairs of approved pattern, to maintain them in position with respect to the forms, and they shall be wired together at all intersections with two turns of No. 12 wire.

All bars shall be protected from exposure to the weather until used, and immediately before placing them in the concrete they shall be thoroughly cleaned of scale and any rust, grease or dirt that may have accumulated on them.

Exposed reinforcement intended for bonding with future extensions shall be protected from corrosion.

The reinforcement shall be bent to shapes shown on the plans. The radii of bends shall be equal to or greater than twice the diameter of the bar, measured from the inside of the curved bar, except for stirrups in which the bends shall be equal to or less than the diameter of the bar. When bars are heated for bending, they shall not be heated to a higher temperature than that producing a dark cherry red color. Only competent persons shall be employed for cutting and bending and proper appliances shall be provided for the work.

All reinforcement shall be furnished in the full lengths indicated upon the plans. No splicing of bars, except where shown on the plans, will be permitted without the written approval of the Engineer. Splices which are permitted shall have a length of not less than forty (40) times the nominal diameter of the bars, and shall be well distributed or else located at points of low tensile stress. No splices will be permitted at points where the section is not sufficient to provide a minimum distance of two (2) inches between the splice and nearest adjacent bar or the surface of the concrete. The bars shall be rigidly clamped or wired at all splices in manner approved by the Engineer.

- 19.10 Forms: All centers of forms shall be collapsible, of ample strength, rigidly braced, with smooth surfaces against the concrete. Ribs and bracing may be constructed of either wood or steel, and must be of adequate strength to prevent deviation in the line. Ribs shall be cut or fabricated to exact dimensions, and all ribs shall be matched before the sheathing is fastened to them. Unless otherwise specified on the plans, sheathing over ribs shall be constructed of plywood, cut plywood to exact size and curvature before assembling. Plywood used for this purpose shall be securely fastened to the ribs, and shall be of such size as to reduce the number of joints to a minimum.

All joints shall be butt joints, and shall fit together in such a manner as to leave no large marks on the finished concrete surfaces. Sections of forms shall be

constructed with all ends exact duplicates, so that when the form is moved ahead, after pouring, the rear end of the section will fit exactly into the front end. Any section in which the space at any point as outlined above, if more than one-eighth (1/8) of an inch, shall not be used on the work; this restriction to apply to each movement of the section. All forms shall be maintained in first class condition during the entire period of their use, and any repairs ordered repaired may again be used in the work.

In the determination of the time for removal of false work and forms, consideration shall be given to the location and character of the structure, the weather and other conditions influencing the setting of the concrete, and the materials used in the mix. Methods of form removal likely to cause overstressing of the concrete shall not be used. Forms and their supports shall not be removed in such a manner as to permit the concrete to uniformly and gradually take the stresses due to its own weight.

If form removal is not controlled by tests for compressive strength, the following periods, exclusive of days when the temperature is below forty (40) degrees F., may be used as a guide for form removal:

for arches..... 14 to 21 days
for reinforced slabs..... 14 to 21 days
for walls..... 7 days

Should the Contractor desire to remove the forms in a shorter time than designated above, the removal must be controlled by tests for the strength of the concrete, and the forms shall not be slackened until the concrete has attained a compressive strength of at least fifteen hundred (1500) pounds per square inch. This compressive strength shall be determined by the testing laboratory designated by the municipality from specimens cast at the time of pouring of the concrete. The specimens shall be stored and cured under conditions similar to the concrete structure. The cost of these tests shall be borne by the Contractor. The Contractor shall be responsible for all damage caused by the premature removal of forms.

20. PAVEMENT, CURB AND WALK RESTORATION:

20.1 General: The Contractor shall replace all pavement, sidewalk and curb and gutter that is broken or removed during the water main construction.

All such replacement shall be done in accordance with the City's specifications for each type of work.

All materials and workmanship shall be subject to inspection by the Engineer.

20.2 Work Included: Under the heading Pavement, Curb and Walk Restoration is included the work of tearing up such areas of pavement other than macadam or telford, as may be required for the construction of water main appurtenances therein; of removing and disposing of all materials torn up; of placing a temporary pavement to carry traffic until such time as the backfill has settled and the permanent pavement may be laid; of subgrading for the permanent pavement, including the accurate removal and the disposal of all materials for the width of the proposed pavement, below the existing surface to a depth not exceeding that

of the pavement and foundation to be laid; of compacting or rolling of subgrade as specified or directed by the Engineer; and of permanently repaving these areas.

20.3 Temporary Pavement: In placing the temporary pavement, the backfill shall be compacted or puddled as described under "Backfilling" up to the level of the pavement subgrade, after which the pavement, as shown on the plans, shall be placed and compacted as far as possible without requiring the use of a roller. This temporary pavement may be crowned at the discretion of the Engineer, but in no case shall this crown be more than three-quarters (3/4) of an inch in height for each foot of width of repavement. The Contractor shall maintain this temporary pavement in condition adequate for its usual traffic, until such time as it is replaced by the permanent pavement, and shall be liable for any claims or damages arising from his neglect to maintain the temporary pavement.

20.4 Permanent Pavement: The permanent pavement shall be laid at such time as the Engineer may permit, but in no case in less than two weeks after the trench was backfilled, except as specified below, nor more than one (1) year after the temporary pavement was laid. The Contractor shall replace the permanent pavement during the above stated period upon receipt of notice from the Engineer. Such replacement must be under local inspection and in accordance with the local standard specifications for the kind of pavement to be laid.

When specified on the plans or in the proposal, and permitted under local laws, regulations and ordinances; permanent paving over trenches may be laid immediately after the water main structure is completed and the trench backfilled and properly compacted to subgrade elevation. In this case, the permanent surface course shall be supported on a concrete or reinforced concrete base having the thickness and reinforcement shown or specified on the plans. This base shall have a satisfactory bearing at least one (1) foot each side of the trench, and shall be designed to support the maximum allowable surface loads over the trench.

The Contractor shall guarantee all permanent pavement for the period specified in the Contract. If, within the period of guarantee, any of the work shall prove to be defective either in materials or workmanship, or if damage occurs by settlement of the backfill, the Contractor shall immediately upon demand of the Engineer (whose decision as to such defectiveness shall be binding and conclusive upon the parties hereto) repair and replace the same at the Contractor's own cost and expense. All repairs and replacements shall be done to the satisfaction of the Engineer and subject to his approval. Concrete pavements shall be replaced with Class 1 concrete.

20.5 Walks and Curbs: Walks and curbs shall be of Class 1 concrete laid to proper lines and grades after proper settlement of the trench backfill. Under walks the trench backfill shall be thoroughly tamped or flushed or both as necessary with the top one (1) foot to be of approved crushed stone well tamped.

21. RESTORATION OF CONDITIONS:

All rubbish or refuse and all unused materials and tools shall be removed promptly from the premises, and as the work progresses it shall be carefully cleaned and kept clean from such rubbish and refuse. Before the work will be considered as having been

completed, the sites and places affected by the work shall be thoroughly cleared and left clean; free from debris, construction plant, buildings, and materials; fit for travel and other proper use; and in as good condition as existed before the work was begun. Grass plots disturbed shall be resodded or planted anew. The restoration work shall be governed by a record of existing conditions made and filed in the office of the Engineer previous to the commencement of the work.

22. LANDSCAPING RESTORATION:

Work included shall be grading, the replacement of trees, shrubs and topsoil, and placement of topsoil, fertilizer, seed and mulch, or fertilizer, seed and mulch. Sod shall be placed if specified in the proposal.

22.1 Materials:

Topsoil	Division E	Section 15.1
Sod	Division E	Section 15.2
Seed	Division E	Section 15.3
Fertilizer	Division E	Section 15.4
Trees	Division E	Section 15.5
Mulch	Division E	Section 15.6
Latex Base Adhesive	Division E	Section 15.7

22.2 Time of Placement:

Seed: April 15 to May 15; August 15 to October 1
 Sod: April 15 to June 15; August 15 to November 1
 Trees: (Bare-Root) April 1 to May 15; September 15 to October 1
 Trees: (Balled) March 1 to June 1; September 1 to November 1

22.3 Placement:

Topsoil, Fertilizer, Seed and Mulch: Four inches (4") of topsoil shall be placed on the subbase and fertilizer applied at a rate not less than 20 lbs. per 1000 sq. ft. Class A seed shall be sown in an amount not less than 5 lbs. per 1000 sq. ft. After sowing, the surface shall be lightly raked, mulch applied, rolled with a light lawn roller and thoroughly wetted.

23. BASIS OF PAYMENT:

Unless otherwise noted, the compensation to the Contractor for the water main installation of the diameter specified will be paid for at the Contract price per lineal foot, measured in place along the center line of pipe, which price shall be payment in full for all necessary excavation, sheeting or bracing, draining, laying, jointing, bedding, testing, backfilling, disposal of surplus excavated materials, restoration of trees, fences, shrubs, lawns, special backfill, replacement of roadway, driveway, sidewalk, and final clean-up.

Measurements will be based on actual pipe installed. Valves, hydrants, tee and fittings will be paid for at the unit price bid.