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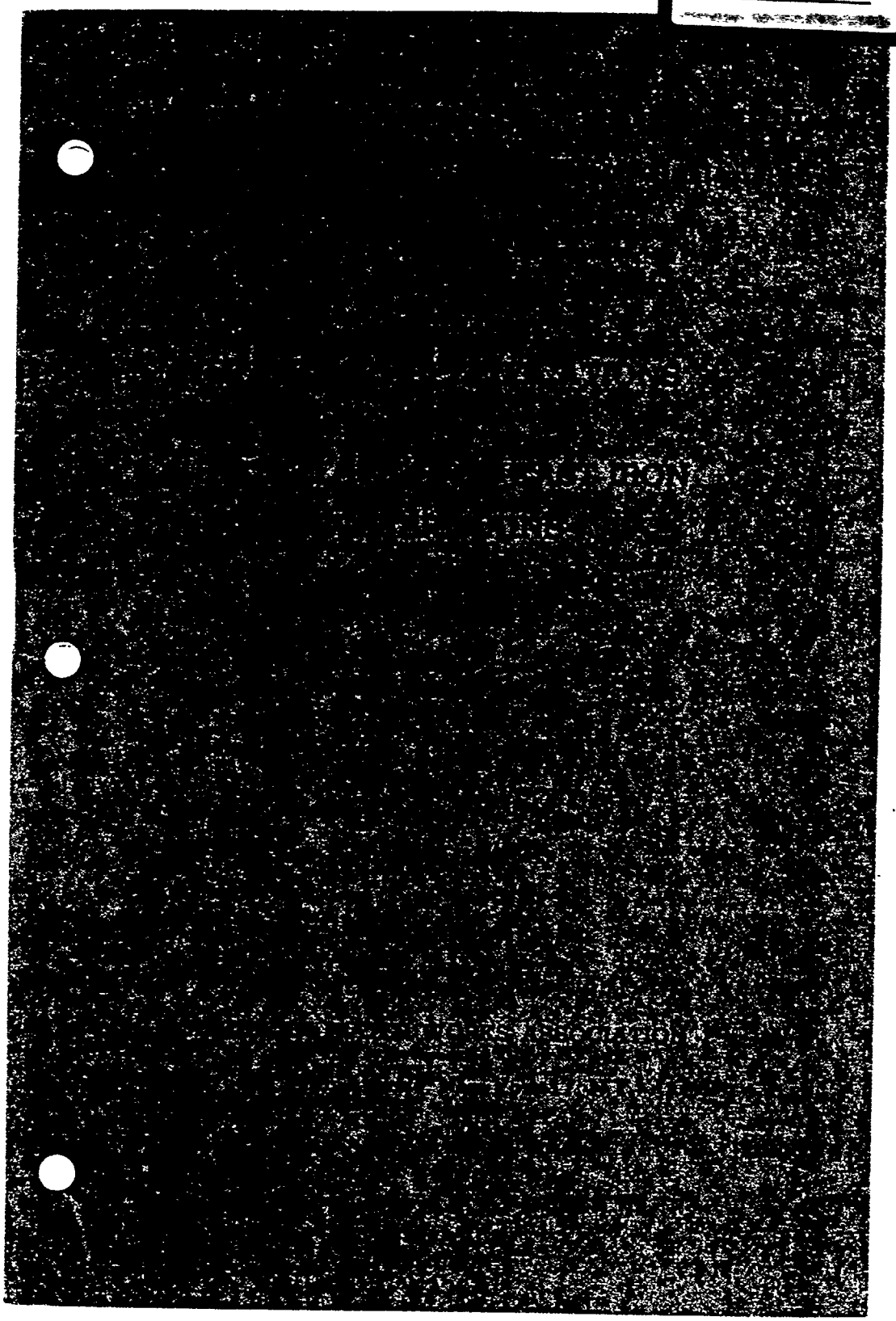

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1949

American Water Works Association

Tentative

Standard Specifications

for

INSTALLATION OF CAST-IRON WATER MAINS

These "Tentative Standard Specifications for Installation of Cast-Iron Water Mains" are based upon the best known experience and are intended for use under normal conditions. They are not designed for unqualified use under all conditions and must be reviewed by the engineer responsible for the construction and modified as necessary to meet specific conditions pertaining to each individual installation.

Approved as Tentative by the Board of Directors of the A.W.W.A., June 3, 1949
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Introduction

General

Standard specifications governing the construction of new water mains and the extension of existing mains must of necessity differ from specifications prepared for any particular project. Although both should include subject matter pertaining to the required work, materials and methods of construction, the latter can be made complete for any particular project by including therein a detailed description of the specific work, materials and methods applicable to that project. However, standard specifications, to be complete and serve their purpose, should include a detailed description of the several acceptable materials and methods of construction recognized as standard. Consequently, although the specifications for a particular project can be used without further supplementation, standard specifications must be accompanied by an appendix or addendum.

Standard Specifications and Addendum

The A.W.W.A. Specifications for Installation of Cast-Iron Water Mains can be made applicable to all water main construction projects by being supplemented with an adequate addendum for each project. The specifications presented herein include the various materials and methods of construction recognized as standard. The addendum, which must be prepared by the engineer, designates which of these various materials and methods of construction are to apply to a particular project. The addendum can also be expanded to cover work and materials not included in the specifications themselves.

Outline of Addendum

The "Outline of Addendum" included herein (p. 25) is intended to guide and aid the engineer in the preparation of the addendum to accompany the A.W.W.A. Specifications for the Installation of Cast-Iron Water Mains.

Limits of A.W.W.A. Specifications

These specifications cover several procedures for laying and testing a system of water mains and for the furnishing of sheeting, blocking and joint materials incidental thereto. They do not cover the furnishing and delivery of pipes, castings, fittings, valves and hydrants by manufacturers, or the laying and jointing of any pipe other than cast iron.

These specifications do not include the detailed procedure for the disinfection of water mains following their construction. However, reference is made to a separate document prepared and approved by the A.W.W.A., entitled "A Procedure for Disinfecting Water Mains—7D.2–1947."

Use of A.W.W.A. Specifications

It is contemplated that the A.W.W.A. Specifications for Installation of Cast-Iron Water Mains may be of service in their published form as a part of the specifications to be incorporated in the contract documents. If it is decided to so use them, a statement having the following import should be made under the title "Specifications":

The water mains shall be laid and the work incidental thereto performed in accordance with the Specifications for Installation of Cast-Iron Water Mains adopted by the American Water Works Association on June 3, 1949, and the Addendum attached hereto.

General Requirements

Since the contract documents for the construction of any project include among them the "General Requirements," it is recommended that the definitions, notices and permits, regulations, schedule of minimum wages, means of measurement and payment for work on unit basis and as extra work, and similar items not covered by these specifications be included therein.

Tentative Standard Specifications for

Installation of Cast-Iron Water Mains

Section 1—Scope

Sec. 1.1—General

These specifications and the addenda attached hereto form a part of the contract documents.

Sec. 1.2—Work Included

The contractor shall, unless specified otherwise, furnish all material, equipment, tools and labor necessary to do the work required under this contract and unload, haul and distribute all pipe, castings, fittings, valves, hydrants and accessories. The contractor shall also remove the pavement as stipulated; excavate the trenches and pits to the required dimensions; excavate the bell holes; construct and maintain all bridges for traffic control; sheet, brace and support the adjoining ground or structures where necessary; handle all drainage or ground water; provide barricades, guards and warning lights; lay and test the pipe, castings, fittings, valves, hydrants and accessories; backfill and consolidate the trenches and pits; restore the roadway surface unless otherwise stipulated; remove surplus excavated material; clean the site of the work; and maintain the street or other surface over the trenches as specified.

The contractor shall also furnish all equipment, tools, labor and materials required to rearrange branch connections to main sewers, or to rearrange sewers, conduits, ducts, pipes or other structures in accordance with the contract drawings and stipulations included herein.

Sec. 1.3—General Description of Work to Be Done

See Addendum Sec. 1.3.

Sec. 1.4—Schedule of Progress and Completion

See Addendum Sec. 1.4.

Sec. 1.5—List of Contract Drawings

See Addendum Sec. 1.5.

Sec. 1.6—Special Work to Be Performed

See Addendum Sec. 1.6.

Sec. 1.7—Materials to Be Furnished by Owner

See Addendum Sec. 1.7.

Sec. 1.8—Materials to Be Furnished by Contractor

See Addendum Sec. 1.8.

Sec. 1.9—Water Used

See Addendum Sec. 1.9.

Section 2—Inspection

Sec. 2.1—Shop Inspection

All materials furnished by the contractor are subject, at the discretion of the owner, to inspection and approval at the plant of the manufacturer. *See* Addendum Sec. 2.1.

Sec. 2.2—Field Inspection

All pipe and accessories shall be laid, jointed and tested under pressure for defects and leakage in the manner specified and in the presence of and as approved by the engineer.

Sec. 2.3—Disposition of Defective Material

All material found during the progress of the work to have cracks, flaws or other defects will be rejected by the engineer. All defective materials furnished by the contractor shall be promptly removed by him from the site. Any material furnished by the owner and found defective shall be set aside and removed from the site of the work by the owner.

Section 3—Responsibility for Material

Sec. 3.1—Responsibility for Material Furnished by Contractor

The contractor shall be responsible for all material furnished by him and shall replace at his own expense all such material found defective in manufacture or damaged in handling after delivery by the manufacturer. This shall include the furnishing of all material and labor required for the replacement of installed material discovered defective prior to the final acceptance of the work.

Sec. 3.2—Responsibility for Material Furnished by Owner

The contractor's responsibility for material furnished by the owner shall begin at the point of delivery thereof to said contractor. Materials already on the site shall become the contractor's responsibility on the day of the award of the contract. The contractor shall examine all material furnished by the owner at the time and place of delivery to him and shall reject all defective material. Any material furnished by the owner and installed by the contractor without discovery of such defects will, if found defective prior to final acceptance of the work, be replaced with sound material by the owner. The contractor, however, shall, at his own expense, furnish all supplies, labor and facilities necessary to remove said defective material and install the sound material in a manner satisfactory to the engineer.

Sec. 3.3—Responsibility for Safe Storage

The contractor shall be responsible for the safe storage of material furnished by or to him, and accepted by him, and intended for the work, until it has been incorporated in the completed project. The interior of all pipe, fittings and other accessories shall be kept free from dirt and foreign matter at all times. Valves and hydrants shall be drained and stored in a manner that will protect them from damage by freezing.

Sec. 3.4—Replacement of Damaged Material

Any material furnished by the owner that becomes damaged after acceptance by the contractor shall be replaced by the contractor at his own expense.

Section 4—Handling of Material

Sec. 4.1—Hauling

All materials furnished by the contractor shall be delivered and distributed at the site by the contractor. Materials furnished by the owner shall be picked up by the contractor at points designated in Addendum Sec. 4.1 and hauled to and distributed at the site.

Cast-iron pipe, fittings, valves, hydrants and accessories shall be loaded and unloaded by lifting with hoists or skidding so as to avoid shock or damage. Under no circumstances shall such materials be dropped. Pipe handled on skidways shall not be skidded or rolled against pipe already on the ground.

Sec. 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.

Sec. 4.3—Care of Pipe Coating and Lining

Pipe shall be so handled that the coating and lining will not be damaged. If, however, any part of the coating or lining is damaged, the repair shall be made by the contractor at his expense in a manner satisfactory to the engineer.

Section 5—Alignment and Grade

Sec. 5.1—General

The water main shall be laid and maintained to the required lines and grades with fittings, valves and hydrants at the required locations; spigots centered in bells; and all valves and hydrant stems plumb.

Sec. 5.2—Deviations Occasioned by Other Structures

Wherever obstructions not shown on the plans are encountered during the progress of the work and interfere to such an extent that an alteration in the plan is required, the engineer shall have the authority to change the plans and order a deviation from the line and grade or arrange with the owners of the structures for the removal, relocation or reconstruction of the obstructions. If the change in plans results in a change in the amount of work by the contractor, such altered work shall be done on the basis of payment to the contractor for extra work or credit to the owner for less work. (*See* Note 5.2.)

Sec. 5.3—Caution in Excavation

The contractor shall proceed with caution in the excavation and preparation of the trench so that the exact location of underground structures, both known and unknown, may be determined, and he shall be held responsible for the repair of such structures when broken or otherwise damaged because of carelessness on his part.

Sec. 5.4—Subsurface Explorations

Whenever, in the opinion of the engineer, it is necessary to explore and excavate to determine the location of existing underground structures, the contractor shall make explorations and excavations for such purposes. If the contractor is required to perform additional work in making the explorations and excavations, extra compensation will be allowed for such additional work.

Sec. 5.5—Depth of Pipe

All pipe shall be laid to the depth shown on the contract drawings or as

required in Addendum Sec. 5.5. Any variation therefrom shall be made only at the order of the engineer. (*See* Note 5.5.)

Section 6—Excavation and Preparation of Trench

Sec. 6.1—Description

The trench shall be dug so that the pipe can be laid to the alignment and depth required, and it shall be excavated only so far in advance of pipelaying as specified in Addendum Sec. 6.1 or permitted by the engineer. The trench shall be so braced (Sec. 6.13 (p. 6)) and drained that the workmen may work therein safely and efficiently. It is essential that the discharge of the trench dewatering pumps be conducted to natural drainage channels, drains or sewers.

Sec. 6.2—Width of Trench

The width of the trench shall be ample to permit the pipe to be laid and jointed properly, and the backfill to be placed and compacted as specified. Trenches shall be of such extra width, when required, as will permit the convenient placing of timber supports, sheeting and bracing, and handling of specials. *See* Addendum Sec. 6.2 *and* Note 6.2.

Sec. 6.3—Bell Holes

Bell holes shall be provided at each joint to permit the jointing to be made properly.

Sec. 6.4—Pipe Clearance in Rocks

Ledge rock, boulders and large stones shall be removed to provide a clearance of at least 6 in. below and on each side of all pipe, valves and fittings for pipes 24 in. in diameter or less, and 9 in. for pipes larger than 24 in. in diameter.

The specified minimum clearances are the minimum clear distances which will be permitted between any part of the pipe and appurtenances being laid and any part, projection or point of such rock, boulder or stone.

Sec. 6.5—Excavation to Grade

The trench shall be excavated to the depth required so as to provide a uniform and continuous bearing and support for the pipe on solid and undisturbed ground at every point between bell holes, except that it will be permissible to disturb and otherwise damage the finished surface over a maximum length of 18 in. near the middle of each length of pipe by the withdrawal of pipe slings or other lifting tackle. Any part of the bottom of the trench excavated below the specified grade shall be corrected with approved material, thoroughly compacted as directed by the engineer. The finished subgrade shall be prepared accurately by means of hand tools.

The subgrade beneath the centerline of the pipe shall be finished to within 0.03 ft. of a straight line between pipe joints or batter boards, and all tolerances shall be above the specified grade.

If, in the opinion of the engineer, soil conditions are encountered at subgrade which require all or part of the work to be done in accordance with Sec. 6.6, the engineer shall have the authority to order the work to be so done, and the contractor will be allowed extra compensation for the additional work. *See* Sec. 6.10 (p. 6) *and* Addendum Sec. 6.5; *see also* Note 6.5 (a) *and* Note 6.5 (b).

Sec. 6.6—Excavation Below Grade

The trench shall be excavated to at least 3 in. and not more than 6 in. below the specified grade. Before the pipe is laid, the subgrade shall be made by backfilling with an approved material in 3-in. uncompacted layers. The layers shall be thoroughly tamped as directed by the engineer so as to provide a uniform and continuous bearing and support for the pipe at every point between bell holes, except that it will be permissible to disturb and otherwise damage the finished surface over a maximum length of 18 in. near the middle of each length of pipe by the withdrawal of pipe slings or other lifting tackle. The finished subgrade shall be prepared accurately by means of hand tools.

The subgrade beneath the centerline of the pipe shall be finished to within 0.03 ft. of a straight line between pipe joints or batter boards, and all tolerances shall be above the specified grade. *See* Sec. 6.10 (p. 6) *and* Addendum Sec. 6.6; *see also* Note 6.5 (a) *and* Note 6.6.

Sec. 6.7—Excavation in Poor Soil and Refilling to Grade

Where the bottom of the trench at subgrade is found to be unstable or to include ashes, cinders, all types of refuse, vegetable or other organic material, or large pieces or fragments of inorganic material which in the judgment of the engineer should be removed, the contractor shall excavate and remove such unsuitable material to the width and depth ordered by the engineer. Before the pipe is laid, the subgrade shall be made by backfilling with an approved material in 3-in. uncompacted layers. The layers shall be thoroughly tamped as directed by the engineer so as to provide a uniform and continuous bearing and support for the pipe at every point between bell holes, except that it will be permissible to disturb and otherwise damage the finished surface over a maximum length of 18 in. near the middle of each length of pipe by the withdrawal of pipe slings or other lifting tackle. The finished subgrade shall be prepared accurately by means of hand tools.

The subgrade beneath the centerline of the pipe shall be finished to within 0.03 ft. of a straight line between pipe joints or batter boards, and all tolerances shall be above the specified grade.

The contractor will be allowed extra compensation for the additional work. *See* Sec. 6.10 *and* Note 6.5 (a).

Sec. 6.8—Special Foundation in Poor Soil

Where the bottom of the trench at subgrade is found to consist of material which is unstable to such a degree that, in the opinion of the engineer, it cannot be removed and replaced with an approved material thoroughly compacted in place to support the pipe properly, the contractor shall construct a foundation for the pipe, consisting of piling, timbers or other materials, in accordance with plans prepared by the engineer. Extra compensation will be allowed for the additional work.

Sec. 6.9—Subgrade in Rock Trenches

Where excavation is made in rock or boulders and the clearance specified in Sec. 6.4 is provided, the subgrade shall be made by backfilling with an approved material in 3-in. uncompacted layers. The layers shall be thoroughly tamped as directed by the engineer so as to provide a uniform and continuous bearing and support for the pipe at every point between bell holes, except that it will be permissible to disturb and otherwise damage the finished surface over a maximum length of 18 in. near the middle of each pipe length by the withdrawal of

pipe slings or other lifting tackle. The finished subgrade shall be prepared accurately with hand tools.

The subgrade beneath the centerline of the pipe shall be finished to within 0.03 ft. of a straight line between pipe joints or batter boards, and all tolerances shall be above the specified grade. *See* Sec. 6.10.

Sec. 6.10—Subgrade for Blocking

Where blocking is ordered in accordance with Sec. 8 (p. 9), the trench shall be excavated to at least 2 in. and not more than 4 in. below the specified grade and the blocking laid as specified.*

Where, in the opinion of the engineer, the bottom of the trench at subgrade is found to be unsuitable for blocking, the engineer shall have the authority to order additional excavation and backfilling with an approved material, which shall be placed in 3-in. uncompacted layers and thoroughly tamped to an elevation of 2 in. below the specified grade so as to support the blocking properly.

The contractor will be allowed extra compensation for the additional work. *See* Addendum Sec. 6.10 *and* Note 6.5 (a).

Sec. 6.11—Rock Excavation

The word "rock," wherever used as the name of an excavated material, shall mean boulders and pieces of concrete or masonry exceeding 250 lb. in weight, or solid ledge rock and masonry which, in the opinion of the engineer, requires for its removal drilling and blasting, wedging, sledging or barring, or breaking up with a power-operated hand tool. No soft or disintegrated rock which can be removed with a hand pick or power-operated excavator or shovel; no loose, shaken or previously blasted rock or broken stone in rock fillings or elsewhere; and no rock exterior to the minimum limits of measurement allowed, which may fall into the excavation, will be measured or allowed.

* Blocking is not recommended. See p. 9.

Sec. 6.12—Blasting

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 of procedure in blasting shall conform to state laws and municipal ordinances.

Sec. 6.13—Braced and Sheeted Trenches

Open-cut trenches shall be sheeted and braced as required by any governing state laws and municipal ordinances, and as may be necessary to protect life, property or the work. When close sheeting is required, it shall be so driven as to prevent adjacent soil from entering the trench either below or through such sheeting. Where sheeting and bracing are used, the trench width shall be increased accordingly.

The engineer reserves the right to order the sheeting driven to the full depth of the trench or to such additional depths as may be required for the protection of the work. Where the soil in the lower limits of a trench has the necessary stability, the engineer, at his discretion, may permit the contractor to stop the driving of sheeting at some designated elevation above the trench bottom. The granting of permission by the engineer, however, shall not relieve the contractor in any degree from his full responsibility under the contract.

Sheeting and bracing which have been ordered left in place must be removed for a distance of 3 ft. below the established street grade or the existing surface of the street, whichever is lower. Trench bracing, except that which must be left in place, may be removed when the backfilling has reached the respective levels of such bracing. Sheeting, except that which has been left in place, may be removed after the backfilling has been completed or has been brought up to such an elevation as to permit its safe removal. Sheeting and bracing may be removed before flushing the trench, but only in such manner as will insure the adequate protection of the completed water structures and adjacent underground or surface structures, and prevent the disturbance of adjacent ground.

The cost of furnishing, placing and removing the sheeting and bracing and the leaving in place of sheeting and bracing indicated on the plans shall be included in the price bid for the work. When sheeting and bracing have been ordered by the engineer, or when such sheeting and bracing have been ordered left in place by the engineer, the payment for same shall be as an extra. When sheeting and bracing have been ordered left in place, payment for same shall include the upper 3 ft. or "cut-off" section of the sheeting.

Sec. 6.14—Care of Surface Material for Reuse

All surface materials which, in the opinion of the engineer, are suitable for reuse in restoring the surface shall be kept separate from the general excavation material, as directed by the engineer.

Sec. 6.15—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. Hydrants under pressure, valve pit covers, valve boxes, curb stop boxes, fire and police call boxes, or other utility controls shall be left unobstructed and accessible until the work is completed. Gutters shall be kept clear or other satisfactory provisions made for street drainage, and natural watercourses shall not be obstructed.

Sec. 6.16—Trenching by Hand or Machine

Hand methods for excavation shall be employed in locations shown on the drawings. In other locations the contractor may use trench-digging machinery or employ hand methods.

Sec. 6.17—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 highway. All material piles, equipment and pipe which may serve as obstructions to traffic shall be enclosed by fences or barricades and shall be protected by proper lights when the visibility is poor. The rules and regulations of the local authorities respecting safety provisions shall be observed.

Sec. 6.18—Maintenance of Traffic and Closing of Streets

The contractor shall carry on the work in a manner which will cause the least interruption to traffic, and may

close to through travel not more than two consecutive blocks, including the cross street intersected. Where traffic must cross open trenches, the contractor shall provide suitable bridges at street intersections and driveways.

The contractor shall post, where directed by the engineer, suitable signs indicating that a street is closed and necessary detour signs for the proper maintenance of traffic.

Sec. 6.19—Structure Protection

Temporary support, adequate protection and maintenance of all underground and surface structures, drains, sewers and other obstructions encountered in the progress of the work shall be furnished by the contractor at his expense and under the direction of the engineer. The structures which may have been disturbed shall be restored upon completion of the work.

Sec. 6.20—Protection of Property and Surface Structures

Trees, shrubbery, fences, poles and all other property and surface structures shall be protected unless their removal is shown on the drawings or authorized by the engineer. When it is necessary to cut roots and tree branches, such cutting shall be done under the supervision and direction of the engineer. *See* Sec. 15.3 (p. 20).

Sec. 6.21—Interruption of Service

No valve or other control on the existing system shall be operated for any purpose by the contractor. The owner will operate all valves, hydrants, blow-offs and curb stops.

Section 7—Laying

Sec. 7.1—Handling of Water Main Material Into Trench

Proper implements, tools and facilities satisfactory to the engineer shall be provided and 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 a derrick, ropes or other suitable tools or equipment, in such a manner as to prevent damage to water main materials and protective coatings and linings. Under no circumstances shall water main materials be dropped or dumped into the trench.

Sec. 7.2—Hammer Test

The pipe and fittings shall be inspected for defects and, while suspended above grade, be rung with a light hammer to detect cracks.

Sec. 7.3—Cleaning Pipe and Fittings

All lumps, blisters and excess coal-tar coating shall be removed from the bell-and-spigot end of each pipe, and the outside of the spigot and the inside of the bell shall be wire-brushed and wiped clean and dry and free from oil and grease before the pipe is laid.

Sec. 7.4—Laying Pipe

Every precaution shall be taken to prevent foreign material from entering the pipe while it is being placed in the line. If the pipe-laying crew cannot put the pipe into the trench and in place without getting earth into it, the engineer may require that before lowering the pipe into the trench, a heavy, tightly woven canvas bag of suitable size shall be placed over each end and left there until the connection is to be made to the adjacent pipe. During laying operations, no debris, tools, clothing or other materials shall be placed in the pipe.

After placing a length of pipe in the trench, the spigot end shall be centered in the bell and the pipe forced home and brought to correct line and grade. The pipe shall be secured in place with approved backfill material tamped under it except at the bells. Pipe and fittings which do not allow a sufficient and uniform space for joints shall be removed and replaced with pipe and fittings of proper dimensions to insure such uniform space. Precautions shall be taken to prevent dirt from entering the joint space.

At times when pipe laying is not in progress, the open ends of pipe shall be closed by a watertight plug or other means approved by the engineer. Joints of pipe in the trench which cannot be poured (*see* Sec. 7.5) shall be calked with packing to make them as watertight as possible. This provision shall apply during the noon hour as well as overnight. If water is in the trench, the seal shall remain in place until the trench is pumped completely dry.

Sec. 7.5—Number of Pipes Laid Before Jointing

Wherever the jointing material specified is cement, six or more lengths of pipe shall be in place ahead of each joint before such joint is finished.

Sec. 7.6—Cutting Pipe

The cutting of pipe for inserting valves, fittings or closure pieces shall be done in a neat and workmanlike manner without damage to the pipe or cement lining and so as to leave a smooth end at right angles to the axis of the pipe.

When machine cutting is not available for cutting pipe 20 in. in diameter or larger, the electric-arc cutting method will be permitted using a carbon or steel rod. Only qualified and experienced workmen shall be used on this work.

The flame cutting of pipe by means of an oxyacetylene torch shall not be allowed.

Sec. 7.7—Bell Ends to Face Direction of Laying

Pipe shall be laid with bell ends facing in the direction of laying, unless directed otherwise by the engineer.

Sec. 7.8—Permissible Deflection at Joints

Wherever it is necessary to deflect pipe from a straight line, either in the vertical or horizontal plane, to avoid obstructions or plumb stems, or where long-radius curves are permitted, the amount of deflection allowed shall not exceed that required for satisfactory calking of the joint, and shall be approved by the engineer. *See* Addendum Sec. 7.8 *and* Note 7.8.

Sec. 7.9—Railroad and Street Railway Crossings

See Addendum Sec. 7.9.

Sec. 7.10—Unsuitable Conditions for Laying Pipe

No pipe shall be laid in water or when, in the opinion of the engineer, trench conditions are unsuitable.

Section 8—Blocking

Blocking of cast-iron pipe is not recommended and is not ordinarily used in modern practice. When special conditions indicate the desirability of the use of blocking, the following statements are indicative of an accept-

able method. These comments also govern the application of Sec. 6.10 and Note 8.3.

Sec. 8.1—Support Required

See Sec. 6.10 *and* Addendum Sec. 8.1.

Sec. 8.2—General

Pipe shall be laid on wood blocking and held in position by wood wedges. Blocking and wedges shall be cut from sound lumber.

Sec. 8.3—Dimensions

The number and size of blocks shall be as specified in Addendum Sec. 8.3. (*See* Note 8.3.)

Sec. 8.4—Spacing of Blocks

Blocks shall be placed 3 ft. from the joint where only one block is used per length of pipe, 4 ft. from the joint where two blocks are used for pipes 16 ft. long, and 5 ft. from the joint where two blocks are used for pipes 18 ft. and 20 ft. long.

Sec. 8.5—Placing of Wood Blocking

Blocks shall be bedded firmly with uniform bearing and with the long side tangent and crosswise to the outside of the pipe barrel. Blocks shall not be embedded in any manhole or buttress or act as a support for such structures.

Section 9—Jointing

Sec. 9.1—Yarning or Packing Material

Yarning or packing material shall consist of one of the following: [1] molded or tubular rubber rings, [2] asbestos rope or [3] treated paper rope. All of the above materials shall be handled with care in order to prevent contamination and shall be dry when put into place in the joint. The material used shall be free of oil, tar or greasy substances. In cement joints, the yarning material may be omitted if so specified. *See* Addendum Sec. 9.1.

Sec. 9.2—Placing of Yarning Material

The yarning material shall be placed around the spigot of the pipe and shall be of proper dimensions to center the spigot in the bell. When the spigot is shoved home, the yarning material shall be driven tightly against the inside base or hub of the bell with suitable yarning tools.

When a single strand of yarning material is used, it shall have an overlap at the top of not more than 2 in. When more than a single strand is required for a joint, each strand shall be cut to sufficient length so that the ends will meet without causing overlap. The ends of the strands shall meet on opposite sides of the pipe and not on the top or at the bottom. Successive strands of yarning material shall be driven home separately.

Sec. 9.3—Depth of Jointing Material

For lead joints a space not less than 2¼ in. in depth shall be left in the bell in pipe having a nominal diameter of 20 in. or less; 2½ in. in 24-, 30- and 36-in. pipe; and 3 in. in pipe larger than 36 in.

When cement is specified, a space not less than 3 in. in depth shall be left in the bell unless it is specified that the yarning material or packing shall be omitted. *See* Addendum Sec. 9.1.

Sec. 9.4—Lead Joints

See Addendum Sec. 9.4.

Sec. 9.5—Lead

Lead for calking purposes shall contain not less than 99.73 per cent pure lead. Impurities shall not exceed the following limits:

	per cent
Arsenic, antimony & tin together	0.015
Copper	0.08
Zinc	0.002
Iron	0.002
Bismuth	0.25
Silver	0.02

The producer's name or the mark of Lead Industries shall be clearly cast or stamped upon each piece of lead.

Sec. 9.6—Heating and Pouring of Lead

Lead shall be heated in a melting pot kept in easy reach of the joint to be poured—so that the molten metal will not be chilled in being carried from the melting pot to the joint—and shall be brought to a proper temperature so that when stirred it will show a rapid change of color. Before pouring, all scum shall be removed. Each joint shall be made with one continuous pour filling the entire joint space with solid lead. Spongy or imperfectly filled joints shall be burned out and repoured.

Sec. 9.7—Position of Joint Runner

The joint runner shall fit snugly against the face of the bell and the outside of the pipe and shall be dammed with clay to form a pouring lip to provide for filling the joint flush with the face and to the top of the bell.

Sec. 9.8—Calking Lead Joints

After the lead has cooled to the temperature of the pipe, lead joints shall be calked with pneumatic or hand tools operated by competent workmen, until such joints are thoroughly compacted and watertight. The finished joint shall show a hard and even hammered surface overall. Care should be taken not to overstrain the bells during calking.

Sec. 9.9—Cement Joints

See Addendum Sec. 9.9 *and* Note 9.9.

Sec. 9.10—Cement

All cement shall be of an approved brand acceptable to the engineer and shall comply with the current specifications of the American Society for Testing Materials.

Sec. 9.11—Proportions of Cement and Water

One quart of cement shall be thoroughly mixed with about ¼ pint of water. The mixture shall be such that when it is tightly compressed by hand into a ball and the ball is broken into two pieces, the break shall be clean. If the hand is water-stained, the mixture is too wet. If there is evidence of crumbling in the break, the mixture is too dry. The cement mixture shall ring with a metallic sound while being calked.

Sec. 9.12—Cause for Rejection

No cement shall be used after having been wet more than one hour or after its initial set.

Sec. 9.13—Calking Cement Joints

Starting at the bottom, the joint space shall be filled with the cement mixture and the mixture calked. The remaining joint space shall then be

refilled and calked until the joint is practically flush with the face of the bell. The mixture shall be thoroughly compacted to make a watertight joint without overstraining the bell.

Sec. 9.14—Trench Water and Initial Set

No water shall be allowed to touch the joint until the initial set has taken place.

Sec. 9.15—Joints Kept Moist Until Set

Cement joints shall be covered immediately with damp burlap, or other material approved by the engineer, for the proper time to insure complete hydration. In cold weather, care shall be taken to prevent freezing of the cement mixture before and after the joint is made.

Sec. 9.16—Time Interval Before Filling Pipe

Pipe laid with cement joints shall not be filled with water until a lapse of twelve hours after the last joint in any valved section has been made, and pressure shall not be permitted in the pipe until all joints have aged as provided in Sec. 13.10 (p. 17).

NOTE: *Certain materials are omitted from the preceding list, pending the completion of investigations now in progress.* See *Note 9 (p. 23)*.

NOTE: *Although mechanical joints are being used in water works pipe-laying practice, no specification for their use is included herein, pending the study of mechanical joints and the completion of a specification therefor under the direction of a recently authorized committee established for that purpose by the Association.*

Section 10—Setting Valves and Fittings

Sec. 10.1—General

Valves, fittings, plugs and caps shall be set and jointed to pipe in the manner heretofore specified for cleaning, laying and jointing pipe.

Sec. 10.2—Location of Valves

Valves in water mains shall, where possible, be located on the street property lines extended unless shown otherwise on the plans.

Sec. 10.3—Valve Boxes and Valve Pits

A valve box or a masonry pit shall be provided for every valve.

A valve box shall be provided for every valve which has no gearing or operating mechanism or in which the gearing or operating mechanism is fully protected with a cast-iron grease case. The valve box shall not transmit shock or stress to the valve and shall be centered and plumb over the wrench nut of the valve, with the box cover flush with the surface of the finished pavement or such other level as may be directed.

A masonry valve pit shall be provided for every valve which has exposed gearing or operating mechanisms. The valve nut shall be readily accessible for operation through the opening in the manhole, which shall be set flush with the surface of the finished pavement or such other level as may be specified. Pits shall be so constructed as to permit minor valve repairs and afford protection to the valve and pipe from impact where they pass through the pit walls.

Sec. 10.4—Drainage of Mains

Mains shall be drained through drainage branches or blowoffs to dry wells from which the water can be pumped. Drainage branches, blowoffs, air vents and appurtenances shall be provided with gate valves and shall be located and installed as shown on the plans.

Drainage branches or blowoffs shall not be connected to any sewer, submerged in any stream or be installed in any other manner that will permit back siphonage into the distribution system.

Sec. 10.5—Dead Ends

All dead ends on new mains shall be closed with cast-iron plugs or caps, with or without a blowoff cock, as shown on the drawings.

Section 11—Setting Hydrants

Sec. 11.1—Location

Hydrants shall be located as shown or as directed and in a manner to provide complete accessibility, and also in such a manner that the possibility of damage from vehicles or injury to pedestrians will be minimized.

When placed behind the curb, the hydrant barrel shall be set so that no portion of the pumper or hose nozzle cap will be less than 6 in. nor more than 12 in. from the gutter face of the curb.

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 in. of the sidewalk.

Sec. 11.2—Position

All hydrants shall stand plumb and shall have their nozzles parallel with or at right angles to the curb, with the pumper nozzle facing the curb, except that hydrants having two hose nozzles 90 deg. apart shall be set with each nozzle facing the curb at an angle of 45 deg. Hydrants shall be set to the established grade, with nozzles at least 12 in. above the ground, as shown or as directed by the engineer.

Sec. 11.3—Connection to Main

Each hydrant shall be connected to the main with a 6-in. cast-iron branch controlled by an independent 6-in. gate valve, except as otherwise directed.

Sec. 11.4—Hydrant Drainage in Pervious Soil

Wherever a hydrant is set in soil that is pervious, drainage shall be provided at the base of the hydrant by placing coarse gravel or crushed stone mixed with coarse sand, from the bottom of the trench to at least 6 in. above the waste opening in the hydrant and to a distance of 1 ft. around the elbow. No drainage system shall be connected to a sewer. *See* Note 11.4 *and* Addendum Sec. 11.4.

Sec. 11.5—Hydrant Drainage in Impervious Soil

Wherever a hydrant is set in clay or other impervious soil, a drainage pit 2 ft. in diameter and 3 ft. deep shall be excavated below each hydrant and filled compactly with coarse gravel or crushed stone mixed with coarse sand, under and around the elbow of the hydrant and to a level of 6 in. above the waste opening. No drainage pit shall be connected to a sewer. *See* Addendum Sec. 11.5.

Section 12—Anchorage

Sec. 12.1—Anchorage for Hydrants

The bowl of each hydrant shall be well braced against unexcavated earth at the end of the trench with stone slabs or concrete backing, or it shall be tied to the pipe with suitable metal tie rods or clamps, as shown or directed by the engineer. *See* Addendum Sec. 12.1.

Sec. 12.2—Anchorage for Plugs, Caps, Tees and Bends

All plugs, caps, tees and bends deflecting 22½ deg. or more on mains 8 in. in diameter or larger shall be provided with a reaction backing, or movement shall be prevented by attaching suitable metal rods or clamps as shown or specified.* *See* Note 12.2.

Sec. 12.3—Reaction Backing

Reaction backing shall be concrete of a mix not leaner than 1 cement: 2½ sand: 5 stone, and having a compressive strength of not less than 2,000 psi. at 28 days. Backing shall be placed between solid ground and the fitting to be anchored; the area of bearing on the pipe and on the ground in each instance shall be that shown or directed by the engineer. The backing shall, unless otherwise shown or directed, be so placed that the pipe and fitting joints will be accessible for repair. *See* Addendum Sec. 12.3.

Sec. 12.4—Metal Harness

Metal harness of tie rods or clamps of adequate strength to prevent movement may be used instead of concrete backing, as directed by the engineer. Steel rods or clamps shall be galvanized or otherwise rustproof treated, or shall be painted as shown or directed by the engineer. *See* Addendum Sec. 12.4.

Section 13—Hydrostatic Tests

Sec. 13.1—Hydrostatic Tests Required

See Addendum Sec. 13.1.

Sec. 13.2—Pressure Test

After the pipe has been laid and partially backfilled as specified in Sec. 14.5, all newly laid pipe, or any valved section thereof, shall be subjected to the hydrostatic pressure stated in Addendum Sec. 13.2. If specified in Addendum Sec. 13.11, or if directed by the engineer, the contractor shall backfill the trench in accordance with Sec. 14.7 before making the pressure test. *See* Sec. 13.11.

Sec. 13.3—Duration of Pressure Test

The duration of each pressure test shall be at least one hour.

Sec. 13.4—Procedure

Each valved section of pipe shall be slowly filled with water and the specified test pressure, based on the elevation of the lowest point of the line or section under test and corrected to the elevation of the test gage, 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 gages shall be furnished by the contractor. The owner will furnish the gages for the test and will make all taps into the pipe, but the contractor shall furnish all necessary assistance for conducting the tests.

* Note: Consideration is being given by the committee to the rewording of Sec. 12.2 as follows: "All plugs, caps, tees and bends deflecting 22½ deg. or more on mains 8 in. in diameter or larger shall, unless otherwise indicated, be anchored to prevent movement by providing suitable reaction backing or metal harness therefor, as shown on the plans or specified herein."

Sec. 13.5—Expelling Air Before Test

Before applying the specified test pressure, all air shall be expelled from the pipe. If hydrants or blowoffs are not available at high places, the owner shall make the necessary taps at points of highest elevation before the test is made and insert the plugs after the test has been completed.

Sec. 13.6—Examination Under Pressure

All exposed pipes, fittings, valves, hydrants and joints will be carefully examined during the open-trench test. When the joints are made with lead, all such joints showing visible leaks shall be recalked until tight. When the joints are made with cement and show seepage or slight leakage, such joints as may be defective shall be cut out and replaced by the contractor as directed by the engineer. Any cracked or defective pipes, fittings, valves or hydrants discovered in consequence of this pressure test shall be removed and replaced by the contractor with sound material in the manner provided under Sec. 3, and the test shall be repeated until satisfactory to the engineer.

Sec. 13.7—Leakage Test

A leakage test shall be conducted after the pressure test has been satisfactorily completed. The owner will furnish the gage and measuring device for the leakage test. The contractor shall furnish the pump, pipe, connections and all other necessary apparatus, and shall furnish all necessary assistance to conduct the test. The duration of each leakage test shall be two hours, and during the test the main shall be subjected to the pressure stated in Addendum Sec. 13.7.

Leakage is defined as the quantity of water to be supplied into the newly laid pipe, or any valved section thereof, necessary to maintain the specified leakage test pressure after the pipe has been filled with water and the air expelled.

No pipe installation will be accepted until the leakage is less than the number of gallons per hour as determined by the formula:

$$L = \frac{ND\sqrt{P}}{1{,}850}$$

in which L equals the allowable leakage, in gallons per hour; N is the number of joints in the length of pipeline tested; D is the nominal diameter of the pipe, in inches; and P is the average test pressure during the leakage test, in pounds per square inch gage. (The allowable leakage according to the formula is equivalent to 70 U.S. gal. per 24 hours per mile of pipe per inch nominal diameter, for pipe in 12-ft. lengths evaluated on a pressure basis of 150 psi.)

The allowable leakage at various pressures for pipe of various diameters is shown in Table 1.

Sec. 13.8—Variation From Permissible Leakage

Should any test of pipe laid disclose leakage greater than that specified in Section 13.7, the contractor shall at his own expense locate and repair the defective joints until the leakage is within the specified allowance.

Sec. 13.9—Time for Making Test of Lead-jointed Pipe

Lead-jointed pipe may be subjected to hydrostatic pressure and inspected

TABLE 1

Allowable Leakage for Various Pressures and Pipe Diameters

Ave. Test Pressure psi.	Allowable Leakage per 100 Joints—gph. (U.S.)* Pipe Diameter—in.																							
	2	3	4	6	8	10	12	14	16	18	20	24	30	36	42	48	54	60
150	1.33	1.99	2.65	3.97	5.30	6.62	7.94	9.27	10.59	11.92	13.24	15.89	19.86	23.83	27.81	31.78	35.75	39.72
145	1.30	1.95	2.60	3.91	5.21	6.51	7.81	9.11	10.41	11.72	13.02	15.62	19.53	23.43	27.34	31.24	35.15	39.05
140	1.28	1.92	2.56	3.84	5.12	6.40	7.68	8.95	10.23	11.51	12.79	15.35	19.19	23.03	26.86	30.70	34.54	38.38
135	1.25	1.88	2.51	3.77	5.02	6.28	7.54	8.79	10.05	11.30	12.56	15.07	18.84	22.61	26.38	30.15	33.92	37.68
130	1.25	1.85	2.47	3.70	4.93	6.16	7.40	8.63	9.86	11.09	12.33	14.79	18.49	22.19	25.89	29.58	33.28	36.98
125	1.21	1.81	2.42	3.63	4.84	6.04	7.25	8.46	9.67	10.88	12.09	14.50	18.13	21.76	25.38	29.01	32.64	36.26
120	1.18	1.78	2.37	3.55	4.74	5.92	7.11	8.29	9.47	10.66	11.84	14.21	17.76	21.32	24.87	28.42	31.97	35.53
115	1.16	1.74	2.32	3.48	4.64	5.80	6.96	8.12	9.28	10.43	11.59	13.91	17.39	20.87	24.35	27.82	31.30	34.78
110	1.13	1.70	2.27	3.40	4.54	5.67	6.80	7.94	9.07	10.20	11.34	13.61	17.01	20.41	23.81	27.21	30.61	34.02
105	1.11	1.66	2.22	3.32	4.43	5.54	6.65	7.75	8.86	9.97	11.08	13.29	16.62	19.94	23.26	26.59	29.91	33.23
100	1.08	1.62	2.16	3.24	4.32	5.41	6.49	7.57	8.65	9.73	10.81	12.97	16.22	19.46	22.70	25.95	29.19	32.43
95	1.05	1.58	2.11	3.16	4.22	5.27	6.32	7.38	8.43	9.48	10.54	12.64	15.81	18.97	22.13	25.29	28.45	31.61
90	1.02	1.54	2.05	3.08	4.10	5.13	6.15	7.18	8.21	9.23	10.26	12.31	15.38	18.46	21.54	24.61	27.69	30.77
85	0.99	1.50	1.99	2.99	3.99	4.98	5.98	6.98	7.97	8.97	9.97	11.96	14.95	17.94	20.93	23.92	26.91	29.90
80	0.96	1.45	1.93	2.90	3.87	4.84	5.80	6.77	7.74	8.70	9.67	11.60	14.50	17.41	20.31	23.21	26.11	29.01
75	0.93	1.40	1.87	2.81	3.75	4.68	5.62	6.55	7.49	8.43	9.36	11.24	14.04	16.85	19.66	22.47	25.28	28.09
70	0.90	1.36	1.81	2.71	3.62	4.52	5.43	6.33	7.24	8.14	9.05	10.85	13.57	16.28	18.99	21.71	24.42	27.14
65	0.87	1.31	1.74	2.61	3.49	4.36	5.23	6.10	6.97	7.84	8.72	10.46	13.07	15.69	18.30	20.92	23.53	26.15
60	0.83	1.26	1.67	2.51	3.35	4.19	5.02	5.86	6.70	7.54	8.37	10.05	12.56	15.07	17.59	20.10	22.61	25.12
55	0.80	1.20	1.60	2.41	3.21	4.01	4.83	5.61	6.41	7.22	8.02	9.62	12.03	14.43	16.84	19.24	21.65	24.05
50	0.76	1.15	1.53	2.29	3.06	3.82	4.59	5.35	6.12	6.88	7.64	9.17	11.47	13.76	16.05	18.35	20.64	22.93
45	0.72	1.09	1.45	2.18	2.90	3.63	4.35	5.08	5.80	6.53	7.25	8.70	10.88	13.05	15.23	17.41	19.58	21.76

* If the Imperial gallon is used the figures must be reduced one-sixth.

The allowable leakage for a pipeline is calculated by multiplying the leakage per hour per 100 joints at the average test pressure and for the diameter of pipe tested as obtained from the above table, by the duration of the test in hours and the total number of joints in the line divided by 100. If the section under test contains joints of various diameters, the allowable leakage will be the sum of the computed leakage for each size of joint.

and tested for leakage at any convenient time after the trench has been partially backfilled except at the joints in accordance with Sec. 14.6, or backfilled in accordance with Sec. 14.7, if specified or directed by the engineer (*see* Sec. 13.11). The leakage allowance shall be that specified in Sec. 13.7.

Where any section of a main is provided with concrete reaction backing, the hydrostatic pressure test shall not be made until at least five days have elapsed after the concrete reaction backing was installed. If high early-strength cement is used in the concrete reaction backing, the hydrostatic pressure test shall not be made until at least two days have elapsed.

Sec. 13.10—Time for Making Test of Cement-jointed Pipe

Pipes jointed with cement shall not be subjected to hydrostatic pressure and inspected and tested for leakage until at least 36 hours have elapsed after the main was filled with water as specified in Sec. 9.16. Pipelines shall remain full of water until all tests have been made. The pressure test, inspection and leakage test shall be made after the trench has been partially backfilled except at the joints in accordance with Sec. 14.6, or backfilled in accordance with Sec. 14.7, if specified or directed by the engineer (*see* Sec. 13.11). The leakage allowance shall be that specified in Sec. 13.7.

Where any section of a main is provided with concrete reaction backing, the hydrostatic pressure test shall not be made until at least five days have elapsed.

Sec. 13.11—Pressure and Leakage Tests After Backfilling

After the trench has been backfilled in accordance with Sec. 14.7, the test connections made and the main filled with water, the test sections shall be subjected to water pressure normal to the area. After examination of exposed parts of the system, the test pressure will be increased to the hydrostatic pressure specified in Addendum Sec. 13.2 and exposed parts again examined. If defects are found, the contractor shall immediately make the necessary repairs at his own expense. The engineer will then repeat the pressure test until no defects are found. The duration of the final pressure test shall be at least one hour.

The leakage test shall be conducted after satisfactory completion of the pressure test, in accordance with Sec. 13.7. Should any test section fail to meet the leakage test, the contractor shall make the necessary repairs at his own expense. *See* Addendum Sec. 13.11.

Section 14—Backfilling

Sec. 14.1—Backfill Material

All backfill material shall be free from cinders, ashes, refuse, vegetable or organic material, boulders, rocks or stones, or other material which in the opinion of the engineer is unsuitable. However, from 1 ft. above the top of the pipe to the subgrade of the pavement, material containing stones up to 8 in. in their greatest dimension may be used, unless specified otherwise herein.

Sec. 14.2—Use of Excavated Material as Backfill

When the type of backfill material is not indicated on the drawings or specified, the contractor may backfill with the excavated material, provided that such material consists of loam clay, sand, gravel or other materials which, in the opinion of the engineer, are suitable for backfilling. Where excavated material is indicated on the drawings or specified for backfill and there is a deficiency due to a rejection of part thereof, the contractor shall furnish the required amount of sand, gravel or other approved material as an extra.

Sec. 14.3—Sand or Gravel Backfill

Where sand or gravel backfill is not indicated on the drawings or specified herein, and in the opinion of the engineer should be used in any part of the work, the contractor shall furnish and backfill with sand or gravel as directed as an extra.

Sec. 14.4—Limestone Screenings Backfill

Where shown on the drawings or specified in the Addendum, or where directed by the engineer, the contractor shall completely encase the pipe, fittings and appurtenances in limestone screenings 1 ft. thick and complete the backfilling of the trench as shown or directed by the engineer. The limestone screenings shall be placed in layers 3 in. thick and compacted by tamping to the bottom of the trench at subgrade as required in Sec. 6.7 if blocking is not used, and to about 1 in. below the subgrade as required in Sec. 6.10 if blocking is used. Above these elevations the limestone screenings shall be placed in layers 3 in. thick and compacted by tamping under the pipe, fittings and appurtenances to the centerline, as required in Sec. 14.5. From the centerline to 1 ft. above the pipe, fittings and appurtenances, the limestone screenings shall be placed as specified in Addendum Sec. 14.4. The contractor shall be allowed extra compensation for excavating, furnishing and placing the limestone screenings where such work is not shown on the drawings or specified. *See* Note 14.4 *and* Addendum Sec. 14.4.

Sec. 14.5—Backfilling Under Pipe

All trenches—whether the pipe, fittings and appurtenances are laid on a flat bottom at subgrade in accordance with Sec. 6.5 or laid on blocking in accordance with Sec. 6.10—shall be backfilled by hand, from the bottom of the trench to the centerline of the pipe, with sand, gravel or other approved material placed in layers of 3 in. and compacted by tamping. Backfilling material shall be deposited in the trench for its full width on each side of the pipe, fittings and appurtenances simultaneously.

Sec. 14.6—Backfilling Over Pipe

From the centerline of the pipe, fittings and appurtenances to a depth of 1 ft. above the top of the pipe, the trench shall be backfilled by hand or by approved mechanical methods. The contractor shall use special care in placing this portion of the backfill so as to avoid injuring or moving the pipe. See Addendum Sec. 14.6 for the type of backfill material required and the method of placing and consolidating.

Sec. 14.7—Backfilling to Grade

From 1 ft. above the pipe to the grade shown on the drawings or specified herein, the trench shall be backfilled by hand or by approved mechanical methods. See Addendum Sec. 14.7 for the type of backfill required and the method of placing and consolidating.

Sec. 14.8—Backfill Under Permanent Pavement

Where the excavation is made through permanent pavements, curbs, driveways or sidewalks or where such structures are undercut by the excavation, the entire backfill to the subgrade of the structures shall be made with sand. Walks and driveways consisting of broken stone, gravel, slag or cinders shall not be considered as being of a permanent construction. See Addendum Sec. 14.8 for the method of placing and consolidating the backfill material.

Sec. 14.9—Backfilling Where Settlement Unimportant

Where shown on the drawings or specified, the contractor may backfill the trench from 1 ft. above the pipe to the top of the trench with the excavated material, and the backfill shall be neatly rounded over the trench to a sufficient height to allow for settlement to grade after consolidation. See Addendum Sec. 14.9.

Sec. 14.10—Backfilling in Freezing Weather

Backfilling shall not be done in freezing weather except by permission of the engineer, and it shall not be made with frozen material. No fill shall be made where the material already in the trench is frozen.

Sec. 14.11—Backfill Sand

All sand used for backfill shall be a natural bank sand, graded from fine to coarse, not lumpy or frozen, and free from slag, cinders, ashes, rubbish or other material which, in the opinion of the engineer, is objectionable or deleterious. It shall not contain a total of more than 10 per cent by weight of loam and clay, and all material must be capable of being passed through a $\frac{3}{4}$-in. sieve. Not more than 5 per cent shall remain on a No. 4 sieve.

Sec. 14.12—Backfill Gravel

Gravel used for backfill shall consist of natural bank gravel having durable particles graded from fine to coarse in a reasonably uniform combination with no boulders or stones larger than 2 in. in size. It shall be free from slag, cinders, ashes, refuse or other deleterious or objectionable materials. It shall not contain excessive amounts of loam and clay and shall not be lumpy or frozen. No more than 15 per cent shall be finer than No. 200 sieve.

Sec. 14.13—Backfill Limestone Screenings

Screenings shall consist of the product obtained from crushing sound limestone or dolomite ledge rock and shall be free from shale, dust, excessive amounts of clay and other undesirable materials. All materials shall pass a $\frac{1}{2}$-in. sieve and no more than 25 per cent shall be finer than a No. 100 sieve.

Section 15—Removal, Restoration and Maintenance of Surface

Sec. 15.1—Allowable Removal of Pavement

The contractor shall remove pavement and road surfaces as a part of the trench excavation, and the amount removed shall depend upon the width of trench specified for the installation of the pipe and the width and length of the pavement area required to be removed for the installation of gate valves, specials, manholes or other

structures. The width of pavement removed along the normal trench for the installation of the pipe shall not exceed the width of the trench specified by more than 6 in. on each side of the trench. The width and lengths of the area of pavement removed for the installation of gate valves, specials, manholes or other structures shall not exceed the maximum linear dimensions of such structures by more than 6 in. on each side. Wherever, in the opinion of the engineer, existing conditions make it necessary or advisable to remove additional pavement, the contractor shall remove it as directed by the engineer and shall receive extra compensation therefor, provided such additional work is not shown in the drawings or specified. The contractor shall use such methods, either drilling or chipping, as will assure the breaking of the pavement along straight lines. The face of the remaining pavement shall be approximately vertical. *See* Addendum Sec. 15.1.

If the contractor removes or damages pavement or surfaces beyond the limits specified above, such pavement and surfaces shall be replaced or repaired at the expense of the contractor as specified in Sec. 15.2.

Sec. 15.2—Restoration of Damaged Surfaces and Property

Where any pavement, trees, shrubbery, fences, poles or other property and surface structures have been damaged, removed or disturbed by the contractor, whether deliberately or through failure to carry out the requirements of the contract documents, state laws, municipal ordinances or the specific direction of the engineer, or through failure to employ usual and reasonable safeguards, such property and surface structures shall be replaced or repaired at the expense of the contractor. If Addendum Sec. 15.3 specifies that the replacements or repairs shall be made by the contractor, he shall replace or repair and restore said structures to a condition equal to that before the work began, furnishing all labor and materials incidental thereto. If Addendum Sec. 15.4 specifies that the replacement or repairs will be made by the owner, the cost of the replacements or repairs will be deducted from monies due the contractor. Costs shall be determined by the engineer from measurements and the cost of replacement or repairs, or from a schedule of fixed charges previously prepared by the owner and furnished the contractor. *See* Addendum Sec. 15.2.

Sec. 15.3—Replacement of Pavement and Structures by Contractor

The contractor shall restore (unless otherwise stipulated) all pavement, sidewalks, curbing, gutters, shrubbery, fences, poles, sod or other property and surface structures removed or disturbed as a part of the work to a condition equal to that before the work began, furnishing all labor and materials incidental thereto. In restoring the pavement, sound granite blocks, sound brick or asphalt paving blocks may be reused. No permanent pavement shall be restored unless and until, in the opinion of the engineer, the condition of the backfill is such as to properly support the pavement. *See* Addendum Sec. 15.3.

Sec. 15.4—Replacement of Pavement and Structures by Owner

The owner will restore (unless otherwise stipulated) all pavements, sidewalks, curbing, gutter, shrubbery, fences, poles, sod or other property and surface structures removed or disturbed as a part of the work. *See* Addendum Sec. 15.4.

Sec. 15.5—Cleaning up

All surplus water main materials furnished by the contractor and all tools and temporary structures shall be removed from the site by the contractor. All dirt, rubbish and excess earth from the excavation shall be hauled to a dump provided by the contractor and the construction site left clean to the satisfaction of the engineer. All surplus water main materials furnished by the owner and delivered to the site by the contractor shall be removed and delivered by the contractor to a location designated by the owner. All surplus water main material furnished and delivered by the owner shall be removed by the owner.

Sec. 15.6—Maintenance of Surface

See Addendum Sec. 15.6.

NOTES

The boldface numerals at the beginning of each note refer to the section of the specification to which the note relates.

5.2. In a specification of this kind it is not possible to set forth the rights and responsibilities of the owner and of the utilities and others owning structures that may have to be removed, relocated or reconstructed, because such rights and responsibilities vary in different localities. Then, too, the owners of certain structures may insist on doing all or part of the work involved at the expense of the owner installing the water main. It is recommended that an investigation be made when the plans are prepared and the rights and responsibilities of all parties involved be considered in allocating the work to be done. When obstructions not shown on the plans are encountered during the progress of the work, the rights and responsibilities of the parties involved will also determine the allocation of the work and costs.

5.5. The minimum depth of cover over water pipe should be determined by: [1] the maximum depth of frost penetration in the locality where the pipe is to be laid and [2] the direct effect of loaded trucks.

The depth of cover and the nature of the trench bottom are two primary factors in the determination of metal thicknesses. Metal thicknesses, as developed from calculations by the American Standards Assn. Committee A21, take into account four distinct trench conditions and two types of backfill and varying depth of cover. A cover of about 4 ft. with a flat-bottom trench and tamped backfill usually results in the most favorable combination of earth and truck hazard.

Where failures in cast-iron pipelines occur, they usually result from settlement, careless laying, flat-slope trenching, bedding on rock, improper backfilling procedure, impact from loaded trucks or rupture from freezing because of shallow cover. These and other external and internal hazards should be carefully considered before the line is laid.

For full details of the design of cast-iron pipe for various pressures and trench conditions, refer to findings of American Standards Assn. Committee A21 on Specifications for Cast-Iron Pipe.

6.2. The width of trench will depend upon and vary with the size of the pipe, the depth of the trench and the nature of the excavated material encountered. However, it should pro-

vide for the minimum removal and replacement of pavement consistent with the requirements of Sec. 6.2.

The minimum widths shown in Table 2 represent the best judgment obtainable thereon for use where the soil is fairly stable and for depths of trench varying from about 6 to 12 ft. For each size of pipe, the minimum widths of earth shown provide a clearance of about 4 in. on each side of the bell of the pipe.

TABLE 2

Minimum Trench Widths

Nom. Pipe Diam. *in.*	Minimum in Earth *in.*	Minimum in Rock *in.*
2	18	24
3	18	24
4	18	24
6	21	24
8	24	24
10	26	26
12	28	28
18	31	31
20	33	33
24	36	36
30	40	40
36	47	47
42	54	54
48	61	61
54	68	68
60	75	75

Where shallow trenches are used, the widths may be less than those shown in the table.

6.5(a). The type of pipe foundation described in Sec. 6.5 is preferable to the alternative specified under Sec. 8—Blocking. Experiments indicate that the walls of the pipe supported by blocks must be thicker than one laid in a flat-bottom trench, in order to stand the same internal pressure and external loads. There appears to be no doubt that the bearing strength of pipe laid in a flat-bottom trench, well tamped or puddled, is considerably greater than if the pipe is laid and continues to bear on blocking. Consideration must be given to the type of trench, method of backfilling and use of blocks, if any, when specifying the metal thickness of pipe required in any particular installation.

Other factors affecting pipe thickness—such as water hammer, excessive earth loads, truck loads, foundry tolerance and corrosion—should also be considered. For full details of the design of cast-iron pipe for various pressures and trench conditions, refer to findings of American Standards Assn. Committee A21 on Specifications for Cast-Iron Pipe. From these findings, blocking, if used, should be recognized as a temporary expedient and the load should be transferred to the soil tamped under the pipe as soon as possible.

6.5(b). Excavating to the grade line is recommended when the soil at subgrade is uniformly good, and stones, dry clay, hard pan, shale or cemented gravel are not exposed.

6.6. Excavating below the grade line and backfilling is recommended when the soil at subgrade is not uniformly good, and stones, dry clay, hard pan, shale or cemented gravel are exposed. In some localities, this procedure is followed even when the soil at subgrade is uniformly good, in order to eliminate the final trimming of the trench bottom by hand, improve drainage conditions and obtain more rapid progress.

7.8. The deflection of a pipeline may be obtained by opening the joints, thereby permitting one side of the spigot end of the pipe to be away from home when the other side is touching the hub of the bell. However, an adequate depth of jointing material should always be provided on the side where the spigot is away from home, and an adequate width of calking space on the opposite side of the pipe at the face of the bell.

The maximum deflections shown in Table 3 recognize the limitations which should be observed when deflecting cast-iron bell-and-spigot pipe.

8.3. The number and size of blocks for various sizes and lengths of pipe shown in Table 4 represent a practice used satisfactorily in some localities.

9. Other materials have been extensively used in the jointing of cast-iron pipe. Pending the completion of an investigation of the performance of sulfur jointing compounds, these materials are not included in the specifications. Directions covering their use are herewith included, for the guidance of those who may employ these materials. These directions are reprinted from the 1938 Specifications for Laying Cast-Iron Pipe, prepared and published by the A.W.W.A.:

Sec. 10.5—Sulfur Compound Joints: Compound for pipe joints shall be of approved make and of established reputation. It shall have a sulfur base and other ingredients properly proportioned to produce a workable compound, and tight and permanent joints.

10.51 *Manufacturer's Instructions to Be Followed:* The compound shall be heated in a melting furnace suitable for the use of sulfur compound and manipulated in accordance with the instructions of the manufacturer of the compound.

10.52 *Proper Condition for Pouring:* It shall be stirred thoroughly and continuously while melting, and until used. When poured it must be very liquid, free from froth or bubbles or any foreign matter and shall show a mirror-like surface.

10.53 *Making the Joint:* Suitable funnel-shaped metal pouring gates extending not less than 8 in. above the bell shall be adequately clayed to the joint runner. The joint space and gate shall be filled with one continuous pour while the compound is at the proper temperature. The solidified compound in the pouring gate shall be cut off flush with the top of the bell or broken off flush with the top of the joint.

10.54 *Replacing Defective Joints:* If a joint is defective, it shall be cut out and entirely replaced as directed by the engineer.

10.55 *Burned Compound Rejected:* Any compound burned in the melting pot shall be dumped out and not reused.

9.9. It is the practice in certain localities where cement joints are used to install some lead joints in the main to relieve possible strains on fittings or valves that might result from the extreme rigidity of a cement-jointed pipeline and also to speed up the completion of the final connections of a line in order to get it into service. One lead joint is poured at every gate valve, at every fire hydrant lateral and at intervals of about 500 ft. in a long line without valves or fittings. Sometimes two or three lead joints are poured for speed in completing the final connections. A lead joint at a fire hydrant may permit a twisting or deflecting of the connection when the hydrant is struck by an automobile instead of resulting in a broken hydrant.

11.4. Proper drainage of waste water from a hydrant is very important where there is a possibility of the water freezing in the barrel of the hydrant, and where this may occur a drainage system that will dispose of the waste water rapidly should be used. Where ground water may enter the hydrant through the waste openings and contaminate the water supply, it is recommended that the waste openings be plugged and the waste water removed from the barrel immediately after the hydrant has been used.

12.2. Section 12.2 does not apply to

TABLE 3—*Maximum Deflections of Cast-Iron Bell-and-Spigot Pipe**

Nom. Pipe Diam.	Joint Opening	Max. Deflection With Pipe Length of:				Approx. Radius of Curve Produced by Succession of Joints With Pipe Lengths of:			
		12 ft.	16 ft.	18 ft.	20 ft.	12 ft.	16 ft.	18 ft.	20 ft.
	in.					*ft.*			
2	0.41	23.6	31.5	35.4	39.4	73	98	110	122
3	0.43	14.8	19.7	22.2	24.7	112	149	168	186
4	0.41	11.1	14.8	16.7	18.5	156	208	234	260
6	0.58	11.1	14.8	16.7	18.5	156	208	234	260
8	0.65	9.7	12.9	14.6	16.2	178	238	268	297
10	0.75	9.3	12.4	14.0	15.5	186	248	279	310
12	0.75	7.9	10.5	11.9	13.2	218	292	327	363
14	0.75	6.7	8.9	10.1	11.2	258	345	387	430
16	0.75	5.9	7.9	8.8	9.7	293	390	440	488
18	0.75	5.3	7.1	8.0	8.8	326	434	489	543
20	0.75	4.8	6.4	7.2	8.0	360	480	540	600
24	0.75	4.0	5.3	6.0	6.7	432	577	648	720
30	0.75	3.3	4.4	5.0	5.5	524	699	786	873
36	0.75	2.8	3.7	4.2	4.7	617	824	926	1,028
42	0.75	2.4	3.2	3.6	4.0	720	960	1,080	1,200
48	0.75	2.1	2.8	3.2	3.5	823	1,097	1,234	1,371
54	0.75	1.9	2.5	2.9	3.2	909	1,211	1,364	1,515
60	0.75	1.7	2.3	2.6	2.8	1,016	1,355	1,524	1,695

* Limiting factors: [1] joint opening not to exceed 0.75 in.; [2] caulking space at face of bell to be not less than 0.25 in. in width.

TABLE 4—*Number and Size of Blocks*

Pipe Id. *in.*	No. of Blocks Required		Block Dimensions*—*in.*		
	12-ft. Length or Less	Over 12-ft. Length	Thickness	Width	Length
2	1	2	2	6	8
3	1	2	2	6	9
4	1	2	2	6	10
6	1	2	2	6	12
8	1	2	2	6	14
10	1	2	2	6	16
12	1	2	2	6	18
16	1	2	4	6	22
18	2	2	4	6	24
20	2	2	4	6	26
24	2	2	4	6	30
30	2	2	4	6	36
36	2	2	6	6	42
42	2	2	6	6	48
48	2	2	6	8	54
54	2	2	6	8	60
60	2	2	6	8	66

* Wedges should be 2 × 2 × 6 in. long. Larger-sized blocks should be used where necessary to support valves and fittings.

suction pipelines or, at the discretion of the engineer, to low-pressure pipelines less than 12 in. in diameter.

14.4. It is considered good practice to encase the pipe, fittings and appurtenances in limestone screenings when muck, ash, refuse, cinders or acid soil is encountered in the excavation.

SPECIAL NOTE

Disinfection of Water Mains

The disinfection of newly laid water mains is not included in these specifications because usually the owner is better equipped to do the work and because the amount of the work involved cannot be estimated.

It is recommended that upon completion of a newly laid main or when repairs to an existing line are made, the main be disinfected according to "A Procedure For Disinfecting Water Mains—7D.2–1947," prepared and approved by the A.W.W.A. on September 30, 1947.

OUTLINE OF ADDENDUM

If the Specifications in their published form are to be used, the engineer should prepare and include as a part of the Specifications an addendum, entitled "Addendum to the Specifications for Installation of Cast-Iron Water Mains." Since the specifications include the various standard materials that may be used and the several standard methods that may be followed, the engineer should select the materials and methods that apply to the project and, by reference to the sections in the Specifications, indicate in the addendum those which do or do not apply.

The engineer should include in the addendum information pertaining to subject matter referred to in certain sections of the Specifications which cannot therein be completely covered and made applicable to all projects. The engineer may also include in the addendum information to cover work and materials not included in the Specifications.

The following is a guide to aid the engineer in preparing the addendum. (The section and paragraph numbers below correspond to the related sections of the Specifications.)

Sec. 1—Scope

1.3—General Description of Work to Be Done. The work to be done under these specifications consists of laying approximately ..... linear feet of .....-inch water main in ..... Street from ..... Street to ..... Street.

NOTE: The engineer should include a general description of the work to be done and the location of the work. A suitable breakdown of the work to be done is desirable.

1.4—Schedule of Progress and Completion. The work in ..... Street shall be started by ....., 19..... and shall be completed by ....., 19.....

NOTE: If various parts of the work are to be started and completed at different times, the engineer should include a suitable breakdown.

1.5—List of Contract Drawings. The contract drawings which apply to these Specifications and Addendum are listed below:

Drawing No.	Title	File No.
.....	.....	.....
.....	.....	.....

1.6—Special Work to Be Performed.

NOTE: The engineer should specify any special work required which is not covered by the Specifications for Installation of Cast-Iron Water Mains. It may include a section of pipe other than cast-iron and laid under another A.W.W.A. specification, or other structures covered by specifications

prepared by the engineer. If no special work is required, it should be so stated.

1.7—Materials to Be Furnished by Owner. The owner will furnish the following materials:

No. of Pieces	Class	Description	Approx. Weight	Delivery Point
.....	.....	.....	.....	.....
.....	.....	.....	.....	.....

NOTE: The engineer should also specify what materials, if any, are to be unloaded by the contractor from railroad cars. If no materials are to be furnished by the owner, the engineer should so specify.

1.8—Materials to Be Furnished by Contractor. The following is a partial estimate of materials to be furnished and delivered by the contractor:

No. of Pieces	Class	Description	Approx. Weight
.....	.....	.....	.....
.....	.....	.....	.....

NOTE: The engineer should include all materials required and not furnished by the owner.

1.9—Water Used. Water for testing mains, puddling trenches and drinking purposes will be made available to the contractor at the existing facilities of the owner at a charge of ..... The contractor shall furnish all necessary pipe or hose extensions or transportation to the point of use. The contractor shall exercise care in the use of the water.

NOTE: If the water is to be furnished by the owner without charge, or if the contractor is to furnish the water at his expense, it should be so stated in lieu of the above requirement.

Sec. 2—Inspection

2.1—Shop Inspection. The inspection at the plant of the manufacturer of materials furnished by the contractor shall be made at the expense of the owner or contractor.

NOTE: The engineer should include a list of the materials furnished by the contractor and subject to inspection at the plant of the manufacturer and state whether the inspection shall be made at the expense of the owner or contractor.

Sec. 4—Handling of Material

4.1—Hauling. The contractor shall pick up the materials furnished by the owner, as set forth in Sec. 1.7 of the Addendum, at the delivery points specified, haul the materials to and distribute them at the site.

NOTE: If the materials furnished by the owner are not to be picked up, hauled to and distributed at the site by the contractor, this should be stated. If part of the material furnished by the owner is to be handled by the contractor, the engineer should here list these materials in a table similar to the one included in Sec. 1.7 of the Addendum.

Sec. 5—Alignment and Grade

5.5—Depth of Pipe. The centerline of all pipe shall be laid to a minimum depth of ..... feet ..... inches below established grade.

NOTE: The above specification should only be included if the contract drawings do not show the grade line.

Sec. 6—Excavation and Preparation of Trench

6.1—Description. Not more than ..... linear feet of trench shall be dug in advance of the completed pipe-laying operation.

6.2—Width of Trench. The width of trench for the various sizes of pipe and locations shown shall be as follows:

NOTE: The engineer should here include a table showing the size of pipe and width of trench for various locations.

6.5—Excavation to Grade. The trench shall be excavated in accordance with Sec. 6.5. Sections 6.6 and 6.10 shall not apply, *or*

6.6—Excavation Below Grade. The trench shall be excavated in accordance with Section 6.6. Sections 6.5 and 6.10 shall not apply, *or*

6.10—Subgrade for Blocking. The trench shall be excavated in accordance with Sec. 6.10. Sections 6.5 and 6.6 shall not apply.

NOTE: The engineer should here include one of the above requirements.

Sec. 7—Laying

7.8—Permissible Deflection at Joints. Whenever it is necessary to deflect pipe from a straight line, the deflection shall not exceed the following amounts:

NOTE: The engineer should here include a table showing the maximum permissible deflections.

7.9—Railroad and Street Railway Crossings.

NOTE: The engineer is advised to consult with the railroad or street railway company before preparing plans and specifications for this part of the work. The company may require the work to be done according to a certain procedure and during certain hours. It may insist also upon doing some of the work itself and make charges for labor, material, supplies, supervision and inspection. Furthermore, the company may insist on dealing with the owner. However, whatever, the arrangements may be, they should be agreed upon prior to bidding so that there will be an understanding on how and when the work is to be done, the apportionment of the work and the disposition of the cost and any charges made by the company.

The engineer should here include a specification for the installation of the mains under railroad and street railway crossings in accordance with the plans and procedure agreed upon.

The engineer should also here specify that "Where a main is laid under a single track, it shall be constructed so that the center point of a full length of pipe lies midway between the rails of such single track. Where the main is laid under multiple tracks, it shall be constructed so that the joints lie midway between the tracks."

Sec. 8—Blocking

8.1—Support Required. Blocking as specified in Sec. 8 shall be provided, *or*

Blocking as specified in Sec. 8 shall not be provided.

NOTE: The engineer should here include one of the above requirements.

8.3—Dimensions. The number and size of blocks specified in Sec. 8.3 shall be used.

NOTE: If Sec. 8.3 does not apply, the engineer should here so state and include the number and sizes of blocks that shall be used.

Sec. 9—Jointing

9.1—Yarning or Packing Material. The yarning or packing material shall be .....

NOTE: The engineer should here state which material shall be used. If cement joints are used and the yarning or packing material is to be omitted, the engineer should here so specify. If some lead joints are to be used with the cement joints, the engineer should here specify the yarning or packing material that should be used with the lead joints.

9.4—Lead Joints. All sections pertaining to lead joints shall apply and all sections pertaining to cement joints shall not apply, *or*

9.9—Cement Joints. All sections pertaining to cement joints shall apply and all sections pertaining to lead joints shall not apply.

NOTE: The engineer should here include one of the above requirements.

Sec. 11—Setting Hydrants

11.4—Hydrant Drainage in Pervious Soil. This section shall apply and Sec. 11.5 shall not apply, *or*

11.5—Hydrant Drainage in Impervious Soil. This section shall apply and Sec. 11.4 shall not apply.

NOTE: The engineer should here specify one of the above requirements. If the soil conditions are not known, the engineer should specify that the type of hydrant drainage will be selected after the excavation of the trench.

Sec. 12—Anchorage

12.1—Anchorage for Hydrants. The anchorage for hydrants shall consist of stone slabs or concrete backing, *or*

The anchorage for hydrants shall consist of metal rods or clamps.

NOTE: The engineer should here specify one of the above requirements.

12.3—Reaction Backing. This section shall apply and Sec. 12.4 shall not apply, *or*

12.4—Metal Harness. This section shall apply and Sec. 12.3 shall not apply.

NOTE: The engineer should here include one of the above requirements.

Sec. 13—Hydrostatic Tests

13.1—Hydrostatic Tests Required. Hydrostatic tests as specified in Sec. 13.2–13.9 inclusive shall apply for lead joints and Sec. 13.10 shall not apply, *or*

Hydrostatic tests as specified in Sec. 13.2–13.8 inclusive and Sec. 13.10 shall apply for cement joints and Sec. 13.9 shall not apply.

NOTE: The engineer should here include one of the above requirements.

13.2—Pressure Test. The hydrostatic pressure shall be ..... pounds per square inch, based on the elevation of the lowest point in the line or section under test and corrected to the elevation of the test gage.

NOTE: A test pressure 50 per cent above normal operating pressure is considered conservative practice.

13.7—Leakage Test. The hydrostatic pressure shall be ..... pounds per equare inch, based on the elevation of the lowest point in the line or section under test and corrected to the elevation of the test gage.

NOTE: The pressure for the leakage test is usually set at the maximum operating pressure for the locality.

13.11—Pressure and Leakage Tests After Backfilling. The contractor shall backfill the trench before making the pressure and leakage tests.

NOTE: The engineer should here include the above requirement if the trench is to be backfilled before the tests are made.

Sec. 14—Backfilling

14.4—Limestone Screenings Backfill. This section shall (*or* shall not) apply.

NOTE: If the drawings show all the locations where limestone screening backfill shall be placed, the engineer should state that this section shall apply. If the drawings do not show all or any of the locations, the engineer should state that this section shall apply and here specify the additional locations or all of the locations. If this section shall not apply, the engineer should so specify.

14.6—Backfilling Over Pipe. The backfill material from the centerline of the pipe to 1 ft. above the pipe shall consist of:

1. Sand which shall be puddled with hose and long pipe nozzle after the trench is backfilled, *or*
2. Gravel which shall be puddled with hose and long pipe nozzle after the trench is backfilled, *or*
3. Approved excavated material which shall be puddled with hose and long pipe nozzle after the trench is backfilled, *or*
4. Approved excavated material which shall be placed in 3-in. layers and compacted by tamping.

NOTE: The engineer should here include one of the above requirements or any other requirement which is to be followed. The type of backfill material and the method of placing and compacting depends upon the importance of settlement. It also depends upon the type of pavement or surface. Puddling should not be done until the trench is backfilled. If more than one type of material and method of backfilling is required, the drawings or the Addendum should indicate the limits of each.

14.7—Backfilling to Grade. The backfill material from 1.0 ft. above the pipe to the street grade (or subgrade of pavement) shall consist of:

1. Sand which shall be puddled with hose and long pipe nozzle after the trench is backfilled, *or*
2. Gravel which shall be puddled with hose and long pipe nozzle after the trench is backfilled, *or*
3. Approved excavated material which shall be puddled with hose and long pipe nozzle after the trench is backfilled, *or*
4. Approved excavated material which shall be placed in 3-in. layers and compacted by tamping.

NOTE: The engineer should here include one of the above requirements or any other requirement which is to be followed. The type of backfill material and the method of placing and compacting depends upon the importance of settlement. It also depends upon the type of pavement or surface. Puddling should not be done until the trench is backfilled. If more than one type of material and method of backfilling is required, the drawings or the Addendum should indicate the limits of each.

14.8—Backfill Under Permanent Pavement. This section shall (*or* shall not) apply.

NOTE: If this section applies, the engineer should here include the method of placing and consolidating.

14.9—Backfilling Where Settlement Unimportant. This section shall (*or* shall not) apply.

NOTE: If this section applies, the engineer should show on the drawings or here include the limits.

Sec. 15—Removal, Restoration and Maintenance of Surface

15.1—Allowable Removal of Pavement.

NOTE: If the requirements of Sec. 15.1 are not applicable, the engineer should so state and prepare requirements that do apply.

15.2—Restoration of Damaged Surfaces and Property. This section shall apply and the cost of the replacement or repairs will be determined by the engineer from measurements and the costs incurred (or from a schedule of fixed charges, or from a combination of both).

NOTE: The engineer should here include a statement showing how the costs will be determined. Some cities do the repaving and restoration of sidewalk, curb, gutter and driveways with their own forces and furnish the bidders with a schedule of fixed unit prices.

15.3—Replacement of Pavement and Structures by Contractor. This section shall (*or* shall not) apply.

NOTE: If the drawings do not show the type of replacement, the engineer should here specify the materials to be used.

15.4—Replacement of Pavement and Structures by Owner. This section shall (*or* shall not) apply.

15.6—Maintenance of Surface. Following the certification of completion by the engineer, the contractor shall maintain the surface of the unpaved trenches, curbs, sidewalks, gutters, shrubbery, fences, sod and other surfaces disturbed for a period of three months thereafter; and shall maintain the repaved areas (if paved by the contractor) and curbs, gutters and sidewalks for one year after said certification.

All material and labor required for the maintenance of the trenches and adjacent structures shall be supplied by the contractor and the work shall be done in a manner satisfactory to the engineer.

NOTE: If the above paragraph does not apply in its entirety, the engineer should prepare a suitable paragraph.

Special Note—Extra Work

The Specifications for Installation of Cast-Iron Water Mains include provisions for payment for extra work in Sec. 5.2, 5.4, 6.5, 6.7, 6.8, 6.10, 6.13, 14.2 and 14.4, and the engineer should include means of measurement and payment for such extra work elsewhere in the contract documents.

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NOTES