

APPENDIX A

**CONSTRUCTION SPECIFICATIONS
FOR
WEST MILFORD MUNICIPAL UTILITIES
AUTHORITY
WATER AND SEWER SYSTEMS**

NOVEMBER 2016

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APPENDIX A

CONSTRUCTION SPECIFICATIONS FOR THE WMMUA WATER AND SEWER SYSTEM(S)

- 1.1 **General Guidelines Applicable to Water and Sewer Systems:** NOTE: Any inconsistencies between the General Guidelines and the Details attached hereto shall be resolved in favor of the Details prepared by Alaimo Group Consulting Engineers.

1.2 Excavations

(A) *Test Holes:*

The Contractor shall make such test holes and borings along the line and site of the work as he may deem necessary to satisfy himself regarding the character of the various strata of subsurface materials, the presence and amount of ground water that may be encountered, and for accurate locations of utilities all of which may be encountered within the course of construction. Additional test holes required by the Engineer shall also be performed by the Contractor.

(B) *Method of Excavation:*

(1) *Avoid Damage to Underground Facilities:* The Contractor shall perform all excavation of whatever unclassified material encountered to the depths shown on the drawings. Care shall be taken not to injure any transmission, drainage or utility lines or other structures encountered on the lines of work. In case of damage to any structures, the Contractor shall notify the owner of the structure immediately so that proper steps may be taken to repair any and all damage at the expense of the Contractor.

(2) *Limit Damage Due to Excavation:* The Contractor shall limit and contain his excavation so that the streets and adjoining lands will not be unnecessarily disturbed, damaged or destroyed beyond reasonable limits. Trenches shall not be opened more than three hundred feet (300'), or such lesser length as the Engineer may direct, in advance of laid main pipe, without written consent of the Engineer. The Contractor shall be held liable for any damage or injury occurring by virtue of his not exercising sufficient precaution to keep his excavation within reasonable bounds.

(3) *Removal of Extraneous Materials:* Where necessary, the Contractor, in the course of excavation, shall remove all paving, brush, trees, weeds, stumps, fencing, sidewalks, driveways, and other materials or obstructions within the limits of the work and dispose of same in an approved manner. Rocks and boulders, present in excavations, shall be removed within six inches (6") of the pipe. Banks of excavation, unless otherwise indicated and approved, shall be nearly vertical. All excavation within the line of work shall be considered unclassified.

inch (6") minimum layer of clean, virgin crushed stone upon which the pipe shall rest, or other appropriate procedure as directed by the WMMUA Engineer (See detail - Plate No. 3).

h) When wet or unsatisfactory conditions are encountered, three-quarter inch (3/4"), clean, washed, stone shall be placed under the pipe at a minimum depth of one-fourth (1/4) the diameter or six inches (6"), whichever is greater, and up to the top of the pipe unless specified otherwise in these specifications. Stone shall be clean stone passing the 3/4" and retained on the #4 sieve.

i) When stone is used as pipe bedding under sewer mains or to alleviate wet conditions, geotextile fabric shall be placed under all stone at a width equal to the prevailing trench width at the time of placement. Pipe bedding requirements are described elsewhere in these specifications and are shown on Plate No. 3 of the construction details.

j) When job conditions require, the installation of sewer and water lines may require special construction. In the event of a stream crossing, the pipes shall be encased in concrete as per bedding class A-1 (Refer to Plate No. 3, Trench - Pipe Bedding Classification), and the encasement shall be provided with a 1/4 inch steel cover plate. Under special conditions, some crossings may require that the pipes be jacked. Installation requirements shall be as per Plate No. 19, Casing and Carrier Pipe Detail, and meet current NJDOT requirements.

(C) **Handling and Protection**

(1) **Handling:** During loading, transportation and unloading, care shall be taken to prevent damage to the pipes, fittings and appurtenances. Loading and unloading shall be done slowly with each item under control at all times. Under no circumstances shall a pipe be dropped. Suitable skids or blocks shall be placed under each pipe on the site of the work and the pipe shall be securely wedged during transportation to insure against any damage to the pipe.

(2) **Protection:** All piping and appurtenances shall be protected at all times, before, during and after installation, until the completion, inspection and acceptance of the work. Any piping not so protected and found not to pass inspections or tests, shall be rejected by the WMMUA Engineer.

In stockpiling or storing pipe and appurtenances, the Contractor shall take proper precautions to prevent any injuries to workmen or the public and likewise prevent any tampering or vandalism by properly screening, fencing or otherwise securing the stored material.

(D) **Backfill and Compaction**

(1) **Backfill Material:** Trenches and pits shall be backfilled with material obtained in excavation, except where such materials are found to be unsuitable and except where select backfill is deemed necessary by the WMMUA Engineer. Select backfill shall be dense graded aggregate conforming to the requirements of the New Jersey State Department of Transportation specification. Backfilling shall include removal of any unsuitable material, as determined by the WMMUA Engineer.

(2) *Method of Backfilling:*

(a) After the structure has been completed, inspected and approved or in the case of pipe after each joint has been made, inspected and approved, backfilling shall proceed immediately.

(i) In backfilling trenches for:

Three-quarter inch (3/4") clean stone shall be used to bed and cover the pipe to a point a minimum of one (1) foot above the top of the pipe. Geotextile fabric shall be placed under and over all stone backfill at a width equal to the prevailing trench width at the time of placement. Special care must be taken when backfilling plastic or PVC pipe to preserve the integrity and diameter of the pipe. Backfilling requirements are shown on Plate No. 3 of the construction details.

In lieu of 3/4" clean stone and filter fabric, choked stone may be used. Choked stone shall be 3/4" clean stone with a fine aggregate filler that conforms to NJDOT specifications for fine aggregates (Section 901.13) or ASTM C33. The percentage of fine aggregate shall not exceed the percent voids in the 3/4" clean stone (roughly 20 percent). The percent voids shall be determined for the specific material being provided and the percentage of fine aggregate adjusted accordingly. Choked stone shall be blended at the supply source facility. At the discretion of the WMMUA, field production of choked stone may be permitted subject to the contractor demonstrating that the fine aggregate meets the consistency of the above specifications and that quality control of the finished product can be maintained.

(ii) The remainder of the trench shall be backfilled with the material described in 1.1 (D)(1) in twelve inch (12") layers, loose measure, each layer then thoroughly tamped.

(b) At the direction of the WMMUA Engineer, clay dams shall be placed every two-hundred (200) feet and shall be a minimum of one (1) foot thick extending the width of the trench from the trench bottom to a point two (2) feet above the top of the pipe to control the flow of ground water in the trench and pipe bedding. Special care should be taken in the compaction of all clay dams around plastic or PVC pipe to preserve the integrity and diameter of the pipe.

(c) Shoring, sheeting and bracing of any kind shall be withdrawn as the backfilling proceeds except that the WMMUA Engineer may require such bracing to be left in place if it has been placed below the bottom of any structure or pipe or if he deems it necessary in order to protect adjacent structures, utilities or property.

(d) Sufficient backfill shall be placed to avoid the formation of depressions in the finished surface. The surface, including any special sub-base or base

material shall be restored in kind or in such other manner as may be satisfactory to the WMMUA Engineer.

(e) No backfill shall be placed while the material is frozen, thawing or during unfavorable weather conditions.

(f) The clay material to be used in forming clay dams shall conform to the following properties:

- | | |
|--------------------------------|--------------------|
| (1) Passing the 1.5 inch sieve | 100 percent |
| (2) Passing the 200 sieve | 50 percent minimum |
| (3) Soil classification | CH-CL |

Other materials can be used upon the approval of the WMMUA Engineer provided that such material will have similar properties to those listed above and will maintain a minimal hydraulic conductivity when placed.

(g) The geotextile fabric shall be needle punched non-woven. The apparent opening size shall be between U.S. Standard Sieve sizes 60 - 80. The water flow rate shall be a minimum of 100 gallons per minute per square foot. The grab tensile strength shall be a minimum of 100 pounds and the grab tensile elongation shall be a minimum of 40 percent. The fabric shall be resistant to rot, mildew, aging, rodents and insects. The fabric shall withstand the abuses of placement by men and equipment without tearing or being punctured. The fabric shall be inert to acids and alkalis within a pH range of 3 to 11.

(3) **Compaction:**

(a) **Soil Limitations:** Soils satisfactory for compaction must be worked at a moisture content which is within plus (+) or minus (-) 2% of optimum moisture content. The WMMUA Engineer may, at his discretion, make moisture content tests to determine compliance. If the soil is found to have a moisture content below specifications, the Contractor shall wet and thoroughly mix backfill materials prior to compaction. Should moisture content be above the stipulated tolerance, the material shall be manually and mechanically aerated until dry to within specification limitations. Care must be taken to prevent rain from soaking into backfill materials during trench construction since drying out to specification moisture content is a difficult and time consuming process.

(b) **Compaction Density Requirements:** Fill material shall be placed in layers in accordance with specifications previously recited herein. The layers shall be individually compacted to a minimum of ninety-five percent (95%) of maximum density as defined and measured in AASHTO TESTS T-180 (ASTM D 1557-66T) Method A. Compaction shall be made by manual, mechanical or combination of methods. Specifically, compaction equipment shall be demonstrated by the Contractor at his expense, and shall be subject to approval by the WMMUA Engineer as being capable of achieving the specification density.

(c) **Field Density Testing:** Field density tests shall be required. All field density testing and soil analyses shall be performed by the Contractor at his expense and subject to acceptance by the WMMUA Engineer. Areas found not conforming to the specifications will be corrected by the Contractor with no additional compensation.

(d) **Undisturbed Soils:** Where pipe is constructed above original ground, all gravel or stone bedding under such pipe shall be placed and compacted to a minimum of ninety-five percent (95%) of maximum density as defined above. Gravel shall be composed of screened material and stones not larger than three quarter inch (3/4") diameter.

(4) **Temporary Trench Finish:** In areas to be paved, the Contractor, upon completion of the earth backfill, shall immediately cover the surface of the excavated area with 6" of hot-mix asphalt base course, to be flush with adjacent grade on a daily basis. The material shall be carefully placed to conform to the adjacent finished surfaces, allowing however, a slight crown over the trench area to allow for settlement but not sufficient to prevent the use of streets by traffic across the trench area. As settlement occurs, the Contractor shall refill and regrade the temporary trench finish with suitable material and continue to maintain the surface until such time as permanent repaving shall be allowed by the WMMUA Engineer.

(5) **Permanent Repaving of Trenches:** Upon authorization from the WMMUA Engineer, the Contractor shall install the trench permanent pavement. He shall remove the temporary pavement to a minimum depth of 2" to allow the installation of the final surface course of pavement, and adjacent existing pavement to a width 6" beyond the edge of the trench on both sides of the trench, and regrade the sub-base for installation of permanent pavement. The permanent pavement shall consist of hot-mix asphalt surface course pavement, conform to the requirements of the Township, County and/or State highway departments having jurisdiction. Detailed specifications regarding pavement shall be as required by the Township, County or State highway departments, depending upon road jurisdiction. Both temporary and permanent pavement shall be placed in strict conformance with highway department requirements.

(6) **Excess Material:** The Contractor shall not, without permission from the WMMUA Engineer, remove from the line of work any sand, gravel, pipe or earth excavated therefrom. Generally, all materials excavated shall be considered the property of the Owner and all excess materials shall be disposed of at a site to receive such materials.

(E) **Permits and Notifications:**

The Contractor shall be responsible for obtaining all necessary permits, including the posting of bonds or other guarantees, arranging for and paying for any inspection services that are required by the State, County, Municipal Law, ordinance, code or regulation.

No construction may take place without the knowledge of the WMMUA Engineer and notification forty-eight (48) hours in advance of the construction shall be given by the Contractor.

(F) ***As-Built Plans:***

The Contractor or owner shall prepare and submit to the WMMUA Engineer and to the WMMUA, "as-built" plans within three (3) weeks after completion of the construction. Such plans shall show field locations, horizontally and vertically, of all completed improvements, including fittings, special appurtenances and unusual conditions found during construction.

They shall show, to the satisfaction of the WMMUA, the size, location, depth, and slope of mains, laterals and service lines and related appurtenances, manhole rim and invert elevations, distances of water/sewer lines from other underground utilities, (i.e., stormsewers, gas, telephone, electric, cable TV, etc. and others), and distances of valve boxes, curb boxes, sewer clean outs, etc., to the nearest permanent points of reference (i.e., utility poles, house corners, and so on) using the minimum of two swing ties.

The as-built plan shall be prepared by a New Jersey Licensed Professional Engineer, and shall be submitted in paper and digital format. Digital formats shall be in both CAD and PDF and shall be submitted via compact disc. Three (3) signed and sealed paper copies of the as-built on 24" x 36" sheets shall be submitted to the WMMUA.

2.1 **Detailed Specifications - Water System(s)**

2.2 ***Materials***

- (A) ***Cement Mortar Lined Ductile Iron Pipe:*** Ductile iron pipe shall be manufactured in accordance with ANSI standard A21.11 (AWWA C111), ANSI standard A21.51 (AWWA C151), federal specification WW-P421c. The minimum pipe size for water distribution piping shall be six (6) inches. Cement mortar linings shall conform to current ASA specification A21.4-1964, 1/8" thick. Cement mortar lined ductile iron pipe shall be furnished with push-on joints, Tyton joint type, or approved equal, or in certain cases mechanical or restrained joints when specifically required and approved by the WMMUA Engineer. Pipe shall be ductile iron Thickness Class 53 unless otherwise specified. In the event corrosive soil is encountered, an eight (8) mil thick polyethylene tube or sheet enclosure will be used (Refer to ANSI/AWWA C105/A21.5-82 for corrosivity standards). This protection shall include all valves, fittings, piping, etc.
- (B) ***Valves:*** Gate valves shall conform to the latest AWWA specifications and shall be cast iron body, fully bronze mounted, resilient wedge, non-rising stem, inside screw type. Gate valves shall incorporate "O" ring type stuffing boxes. Operating nut of valves shall be two inch (2") square cast iron and shall open in a counter clockwise direction. Valve stems shall be bronze or equal non-corrosive metal. Valve ends generally shall be of the mechanical joint type and size necessary to accomplish approved joint assembly. Valve size shall be as shown on the plans. Valves shall be suitable for minimum 150 psi working pressure. All iron and ferrous parts of the valves shall be cleaned and coated with nominal ten (10) mils of epoxy both inside and outside. Epoxy coating shall meet or exceed all applicable requirements of ANSI/AWWA C550 and be certified to ANSI/NSF61. Gate valves shall be as

approved by the WMMUA, shall be American made and match the existing style of valve throughout the existing distribution system.

- (C) **Valve Boxes:** Valve boxes shall be cast iron and shall be of ample strength to fully sustain the shocks of heavy vehicular traffic. The covers shall be not less than six inches (6") in diameter and the shafts shall be five and one-quarter inches (5 1/4"). Covers shall have the word "WATER" and an arrow cast on the top surface to indicate the direction for opening the valve. The boxes shall be of a telescopic pattern and adjustable to such height and length as required. Valve boxes shall be coated both inside and outside with tar or asphalt compounds. They shall be Slip-Type as approved by the WMMUA, shall be American made and match the existing style of valve box throughout the existing distribution system.
- (D) **Cement Mortar Lined Ductile Iron Pipe Fittings:** Cement mortar lined ductile iron pipe fittings will be mechanical joint with retainer glands and shall conform to the latest ASA specifications A21.11-1953. Cement mortar lining shall conform to ASA specifications A21.4-1964 or latest revision. A torque wrench is to be used on all mechanical joint pipe and fittings and all fittings shall be installed in strict conformance with manufacturer requirements.
- (E) **Flushing Hydrants:** Hydrants shall be provided for flushing of the water system and not for fire protection. Flushing hydrants shall be Model A-411 Post Type Fire Hydrant as manufactured by Mueller Company or approved equivalent. Color shall be as selected by the WMMUA to match standard color throughout distribution system. Flushing hydrant shall be provided with manufacturer's operating wrench, seat wrench, nozzle wrench and nozzle lock installation tool.
- (F) **Fire Hydrants:**

If required for fire protection, fire hydrants shall be cast iron, bronze mounted, compression type with five and one-quarter inch (5 1/4") valve opening. Fire hydrants shall be supplied with six inch (6") mechanical joint inlet connections with strapping lug, two (2) each of two and one-half inch (2 1/2") hose nozzle outlets (national standard), and one (1) four and one-half inch (4 1/2") pumper nozzle outlet (Storz quick connection). (See detail - Plate No. 1) Specific requirements for fire hydrants:

1. The hydrant shall open to the left (counter clockwise) by operation of a one and one-half inch (1 1/2") pentagon operating nut.
2. The hydrant stuffing box shall incorporate "O" ring seals.
3. Coatings shall be factory applied on interior surfaces and exterior below ground surfaces. Above ground exterior paint shall be a minimum two (2) factory applied coats of primer and finish paint in fire hydrant red standard.
4. All hydrants shall be supplied with caps and cap chains.
5. Cover or bury shall be four feet (4') unless otherwise specified on the approved plans.

6. Hydrants shall be rated at 150 psi working pressure and tested to 300 psi.
7. Hydrants shall be model A-423 Super Centurion as manufactured by Mueller Company or an approved equal.

(G) **Plugs:** The exposed end of all uncompleted lines shall be closed with plugs at all times when pipe laying is not actually in progress. When necessary to put completed mains into service, a cast iron plug or cap shall be installed at the end of the pipe and securely braced to prevent blowing out.

Dead end mains, 6" and larger, shall be fitted with a fire hydrant blow off to facilitate maintenance of the system. (Refer to Plate No. 1, Fire Hydrant, for detail specifications.)

(H) **House Service Lines:** Service lines shall be copper tubing type "K", soft tempered, and shall conform to the latest AWWA specifications concerning said copper tubing, minimum of one inch (1"). Service lines from the curb stop to the building(s) shall conform to specifications of State and local plumbing codes and ordinances. (See detail - Plate No. 2) service line and curb stop requirements include:

1. Corporation stops for use with ductile iron mains shall be Mueller Company type H-15000 or approved equal with Mueller inlet thread.
2. Curb stops shall be Mueller Company type H-15204 Mark II Oriseal or approved equal.
3. Curb boxes shall be cast iron and of the telescopic type with lid. Inside diameter of the upper section shall be at least one and one-quarter inch (1 1/4"). Curb stop boxes shall be coated inside and out with a tar or asphalt compound and shall be of a sufficient length to properly envelop the curb stop key and meet surface grade with reasonable adjustable allowance for future raising or lowering of grade. Curb stop boxes shall be Mueller Company type H-10386 Oriseal with foot piece or approved equal.
4. Separate curb stop box may be omitted if installed in a curb meter pit or box, where applicable, and approved by the WMMUA Engineer and/or WMMUA representative.
5. Curb stops shall not be installed in driveways and sidewalks, nor shall they be obstructed by the placement of materials that may hinder access, operation, or repair (ie., mailbox, trees and shrubs, fencing and so on).
6. Entire length of service line including gooseneck shall be installed with a minimum cover of four (4) feet.

(I) **Air Release Valves:** Air release valves shall be of the compound-level type as manufactured by APCO, Val-Matic Valve Manufacturing Corp., or other approved manufacturer. Valve shall be approved by the WMMUA Engineer. The air release valve shall be installed with all proper valves and release piping in a masonry pit. (Refer to Plate No. 16, Water Main Air Relief Valve for detail specifications.)

(J) **Backflow Preventors:**

1. Backflow preventors shall be used on the potable water lines servicing a structure when those lines are used to provide fire suppression or are used to supplement an on-site unapproved water system. The main assembly shall be of cast iron or ductile iron construction with corrosion resistant internal parts. Gate valves shall carry any UL listing and FM approvals required by the users insurance company. Units shall be as manufactured by Febco, Watts or equal.
2. Backflow preventors for line sizes three (3) inch and under shall be provided with a double check valve assembly and a meter. The double check backflow prevention assembly shall consist of two independently operating check valves, inlet and outlet isolation valves and four (4) test cocks. The check valves shall be spring loaded to the closed position and shall hold a minimum of 1 psi in the flow direction. The assembly shall be a bronze body with all internal parts of corrosion resistant materials. Assemblies shall be as manufactured by Febco, Watts, or equal. The meter shall be an undilating disc type with remote reader as manufactured by Badger Meter Company.
3. Backflow preventors for line sizes four (4) inch and up shall be of the double check detector assembly type. The units shall consist of two independently operating check valves, inlet and outlet OS&Y gate valves, four (4) test cocks and a by-pass assembly. The by-pass assembly shall consist of its own double check valve assembly and a water meter of the undilating disc type. The meter shall be provided with a remote reading device, and shall be similar to that manufactured by Badger Meter Company.

(K) **Meter Box Installation:** It is standard practice of the WMMUA to have water meters installed inside the structure being serviced. Where this is not practicable, the WMMUA may, on a case-by-case basis, approve the use of an outside meter box installation. The following specifications for buried meter boxes shall be followed.

1. **Residential Water Meters to 2-inch Size:**

- (a) Meter boxes shall be PVC or HDPE with the following minimum inside diameter according to meter size:

<u>Meter Size (in.)</u>	<u>Enclosure Diameter (in.)</u>
up to 5/8	18
3/4 to 1	21
1-1/2	24
2	27

- (b) Depth of meter boxes shall be as required to straddle the supply pipe and establish a cast cover at finished grade. Boxes shall be open bottom, installed on an 8-inch bed of 3/4-inch clean stone.
- (c) PVC meter boxes shall be white ASTM D2241 Grade 1120 SDR 51 PVC. Minimum wall thickness shall be 0.3-inch for meter boxes up to 18-inch diameter, and 0.5-inch for meter boxes up to 24-inch diameter.

- (d) Molded HDPE meter boxes shall be white interior, black exterior, minimum wall thickness of 0.4-inch. Strength and density shall be in conformance with ASTM D638 and ASTM D1505.
- (e) Covers shall be cast iron in conformance with ASTM A48, free from scale, lumps or blisters. Meter boxes shall be flanged to support covers, if cover design dictates, or cover shall be shouldered or grooved to center the cover on the box. Covers shall have the words "WATER METER" cast into the top. Covers shall be flat lid with standard waterworks pentagon nut lock. Cover opening shall be 15-inch for meter boxes with up to 21-inch diameter, 18-inch for 24-inch and 27-inch boxes. Covers shall be installed flush with finished grade.
- (f) Piping in meter pit shall be installed such that the meter face is 15-inches below grade. Vertical piping to and from the meter shall be supported to provide and maintain a distance between meter inlet and outlet couplings, and to prevent translation of piping. Piping shall be rigid copper, fittings shall be brass. Meter shall be preceded by a meter stop angle valve. Piping and fittings shall be wrapped with 1-inch insulation tape; the meter shall be provided with a meter jacket.
- (g) Meter boxes shall be as manufactured by Ford Meter Box Co., Mueller Co., Mid-States Plastics Inc., or equal.

2. ***Commercial/Industrial Water Meters 3-inch and Larger:***

- (a) Meter vaults shall be constructed of precast reinforced concrete. Exterior of vault shall be coated with waterproof epoxy.

In areas absent of ground water, vault may be open bottom design, placed on 12-inches of 3/4-inch clean stone. In areas where ground water is normally present, vault shall have a monolithic solid base with a 16-inch square by 4-inch deep sump depression in one corner. Vault shall be placed on a 12-inch bed of 3/4-inch clean stone.

Openings for pipe penetrations shall be smooth and circular, formed or cored. Mechanical seals of the link seal type shall be used to seal penetrations. Ladder rungs shall be provided, constructed of steel reinforced copolymer polypropylene. Manhole rungs shall be installed at the casting plant, spaced 12 inches on center. Vault design shall have a 1.25 safety factor against bouyant uplift.

- (b) Water supply piping shall run straight through the vault without change in elevation. The piping shall be offset in the vault to provide clearance for maintenance. The following required clearances for piping and headroom shall dictate the vault size:
 - 1-foot from the front interior wall to the beginning of the first fitting;
 - 1-foot from the back interior wall to the end of the last fitting;
 - 3-feet from the side interior wall to the closest edge of the meter;
 - 1-foot from the opposite side interior wall to the closest edge of meter;

- 6-feet of headroom with the top of vault at grade.

- (c) Meter vault access shall consist of a locking, single leaf aluminum hatch, 2.5-foot square clear opening as manufactured by Bilco, or equal. Hatch shall be provided with a Bilco "ladder up" or equal device. Hatch shall be installed over the manhole rungs on the 3-foot offset side of the vault.

2.3 *Method of Construction - Water Mains*

- (A) ***Maintenance of Existing Service:*** Interruption of existing water services shall be kept to the very minimum necessary, not to exceed two (2) hours. The Contractor shall be responsible for notifying, in writing, the customers, the WMMUA and the WMMUA Engineer, in addition to all other necessary utility service companies and governmental units where required or affected, forty-eight (48) hours in advance of planned service interruption. In order to minimize service interruptions, the use of wet taps, temporary services or other methods satisfactory to the WMMUA Engineer may be utilized. The form of notices shall be approved by the WMMUA prior to distribution.
- (B) ***Pipe Installation:*** Water mains shall be installed (i) in a street that is formally dedicated to public use or (ii) in easements acquired by the WMMUA. The water main shall normally be installed with a minimum cover of forty-eight inches (48"). The Contractor shall anticipate the necessity of installing a main with a maximum cover of seventy-two inches (72") if required to avoid conflicts with existing utilities and structures. All pipe and fittings shall be carefully lowered into the trench in such a manner as to prevent damage to pipe, fittings and trench sides and shoring. Under no circumstances shall pipe or accessories be dropped or dumped into the trench. All foreign matter or dirt shall be removed from the interior of the pipe and fittings before lowering into position in the trench. The inside of the pipe shall be kept absolutely clean by the Contractor during Construction.
- (C) ***Joints:*** The making of joints shall receive strict supervision by the Contractor and inspection by the WMMUA Engineer and/or WMMUA representative. ALL WATER MAINS MUST BE WATERTIGHT. Joints shall be made only when free from water below the bell. When necessary, special precautions shall be taken by the Contractor to attain this end. Pipe shall not deflect, either vertically or horizontally, in excess of that recommended by the manufacturer of pipes and fittings. Neither shall anything be allowed to enter the pipe upon backfilling or in the future.

When joining fittings, valves or hydrants to the pipe, a short length of pipe shall be used for connection if recommended by the pipe manufacturer. All necessary cutting of pipe shall be done in accordance with the pipe manufacturer's instructions and only clean, square cuts will be approved for use. Receiving ends of fittings, valves and hydrants, and insertion ends of pipes shall be free of lumps, blisters, excess coating and all foreign material prior to joining. When directed by the WMMUA Engineer and/or WMMUA representative, such joints may have to be reinforced through the use of tie rods.

- (D) ***Thrust Blocks:*** Concrete thrust blocking shall be applied at all bends greater than ten (10) degrees, tees, hydrants, reducers, crosses, deadend plugs, blowoff valves, and pipe laid around curves or as otherwise indicated. Tie rods and retainer glands

may be used subject to the approval of the WMMUA Engineer and/or WMMUA representative.

Thrust blocking shall be made of concrete with a mix not leaner than one (1) cement, two (2) sand, five (5) stone, having compressive strength of not less than two thousand five hundred (2,500) psi in twenty-four (24) days when using standard cement. Blocking shall be placed between undisturbed ground and the fixture to be anchored. Thrust blocking shall be located so the bearing surface is in direct line with the major force created by the pipe or fitting. All joints shall be kept free from concrete. When specifically directed by the WMMUA Engineer, an approved metal harness of tie rods and pipe clamps shall be used in lieu of or in conjunction with the concrete thrust blocking. The thrust blocks shall be designed for a minimum pressure of 200 psi. (See detail - Plate No 4, Thrust Block Details)

(E) ***Setting of Hydrants and Valves***

1. ***Hydrants:*** Hydrants shall be set accurately plumb and firmly supported under and all around the barrel by solidly compacting the backfill material. The base or elbow of the hydrant shall be set on a firm and solid foundation. For drainage, six (6) cubic feet of broken stone or coarse gravel shall be placed under and around the base of the hydrant so as to quickly drain water from the barrel after the closing of the main valve. The stone or gravel shall extend above the hydrants drain outlet to prevent clogging. The stone or gravel shall be 3/4" clean stone and shall be wrapped in filter fabric such as that manufactured by Mirafi Company. No hydrant drainage outlet or pit shall be connected to any sewer. Concrete thrust blocking, as previously specified, shall be provided at the base of the hydrant and be so placed as not to obstruct the drainage outlet of the hydrant. Hydrant, tees, and gate valve must be adequately restrained utilizing bolted tie rods. Hydrant interior shall be kept thoroughly clean of any foreign matter. Each hydrant shall be connected to the main pipe with a six inch (6") diameter branch controlled by a six inch (6") gate valve. The six inch (6") diameter branch shall be connected to the main pipe with an approved mechanical joint tee and all restrained jointing, thrust blocks, etc. (Refer to Plate No. 1, Fire Hydrants).

For fire hydrants, the spacing between any dwelling and a hydrant in residential areas shall not exceed 400 feet when measured along the street right-of-way, and the spacing between hydrants in commercial and industrial areas shall be 300 feet or less.

For flushing hydrants, the number and location of the hydrants shall be as determined by the WMMUA Engineer.

2. ***Valves:*** Valves shall be set accurately to and square with the pipe line. Valve stems shall be accurately plumb. Valves, when set, shall be in working order with the interior and working mechanisms free from all foreign matter. Specifications concerning jointing, thrust blocking, and so on, shall be followed in setting a valve. Valve boxes shall:
 - (a) Be set accurately plumb centering the valve stem;

- (b) Rest on solidly compacted backfill;
- (c) Cover the stuffing box of the valve; and
- (d) Meet the surface grade.
- (e) Set to allow equal movement for future raising or lowering of grade.

2.4 *Sterilization*

The interior of all new water mains, fittings and fixtures shall be sterilized before being placed in service. Any sections of pipe line, whether new or part of the existing system, which has been drained or emptied of water during construction, shall be sterilized before being placed in service. The means, methods and materials for sterilization shall be in strict conformance with the rules, regulations and standards of the New Jersey Department of Environmental Protection and AWWA C651. Completed sterilization shall be approved by the WMMUA Engineer before that particular portion of water system is placed in service.

- (A) ***Sterilization Process:*** As each length of pipe is installed, Calcium Hypochlorite Tablets (CHT) will be installed to the upper inside edge of the pipe. The number of tablets required will be based on the size of the pipe being installed. Care should be taken that no foreign matter enters the pipe or fittings as the CHT is being placed.

After a section of main has been completed, to include hydrants but no service lines, the main shall be filled and the calcium hypochlorite tablets allowed to stand for at least twenty-four (24) hours when water temperature is above 41°F, and at least 48 hours when water temperature is at or below 41°F. Residual tests will be taken directly after the main has been filled and again at the end of the twenty-four (24) or forty-eight (48) hour period. Samples for this testing should be taken from locations designated by the WMMUA Engineer and/or WMMUA representative. It is recommended that the initial chlorine residual be at least fifty (50) mg/l. At the end of the twenty-four (24) or forty-eight (48) hour period, the residual should be not less than ten (10) mg/l.

Tests shall be made upon approval of the WMMUA Engineer and/or WMMUA representative with respect to the length of piping to be tested and the timing of the performance of such tests. The Contractor shall supply all labor and equipment for the tests and pay for all associated costs.

- (B) ***Acceptance Requirement:*** Twenty-four (24) hours after satisfactorily disinfecting and flushing the mains, samples of the water shall be taken and tested for the presence of coliforms and non-spore forming bacteria. Samples should be taken from a tap located and installed in such a way as to prevent outside contamination. At least one bacterial test will be required for each 1,000 feet of main disinfected and tested. No main will be accepted if the presence of any count of coliform or unidentified background bacteria are still present following the conclusion of each sample period.
- (C) ***Responsibility For Testing:*** Such tests shall be performed by the WMMUA or an independent laboratory, certified by the New Jersey State Department of Environmental Protection and paid for by the Contractor.

2.5 *Hydrostatic Pressure and Leakage Tests*

(A) *Hydrostatic Testing Procedure*

1. Tests shall be made upon approval of the WMMUA Engineer regarding length of main to be tested and regarding the timing of the performance when main shall be tested. Tests shall be made between valves where practical. Approved temporary plugs and thrust blocking shall be utilized when testing less than valve to valve lengths of mains. The Contractor shall supply all labor and equipment for the testing.
2. A waiting period of thirty-six (36) hours after placing the last concrete thrust blocking using high early strength cement or seven (7) days using standard cement shall be adhered to before testing.
3. The test shall be conducted only after all valves, fittings, hydrants, and other appurtenances have been completely installed, inspected and approved, but before the installation of service lines.
4. The section of main to be tested shall be slowly filled with water, all displaced air to be expelled at the high point of the main. A tap, if necessary, shall be made to accomplish this end. Services shall be checked to insure that all air has been displaced. After the air has been released, the tap shall be tightly plugged. Utilization of an opened corporation stop to expel air may be approved.
5. A hydrostatic pressure of two hundred (200) psi, shall be applied to the main in a manner approved by the WMMUA Engineer, for a period of one (1) hour, or longer if directed by the WMMUA Engineer. If the pressure does not drop within the determined test period, the water main will not require any further pressure testing.

If the pressure drops during the test, the contractor shall investigate the cause of the pressure loss. Any pipe or fixture found cracked, broken or showing leakage, except at joints, shall be removed and replaced with a new pipe or fixture. Joints showing leakage shall be re-made until watertight. If the pipe has been backfilled, the Contractor will be required to locate the point of leakage, re-excavate the pipe, effect repairs to create a water tight system, and backfill the trench all at his own expense. Upon completion of said repairs or replacements, the pressure test shall be repeated until satisfactory to the WMMUA Engineer and/or WMMUA representative.

(B) *Leakage Testing Procedure*

1. Upon approved completion of the initial pressure test noted in Section A above, and if required by the WMMUA Engineer, a leakage test of the same section of main shall be made under a hydrostatic pressure of one

hundred fifty (150) psi.

2. Duration of the test shall be two (2) hours, unless otherwise directed by the WMMUA Engineer and the test shall consist of an examination of all exposed joints for leakage as well as an overall leakage test of the main.
3. During the leakage test, all exposed pipes, fittings, corporation stops, valves, hydrants, joints and couplings shall be carefully examined for leakage. Any pipe or fixture found where the accumulated leakage of that joint exceeds the rate of leakage specified in Table 1 shall be rejected.
4. The hydrostatic pressure and leakage test shall conform to the applicable sections of AWWA C-600 (See Table 1).
5. Rejected joints shall be disassembled and where damaged or defective materials are found they shall be replaced and reassembled by the Contractor.
6. No pipe installation will be accepted until or unless the overall leakage of the main being tested, is less than the rate of leakage specified in Table 1. In calculating leakage, the WMMUA Engineer will make allowance for added or subtracted joints in the pipe line if pipe lengths other than those of eighteen feet (18') standard are under test.
7. Should any test of a section of pipe line disclose overall leakage greater than that permitted, the Contractor shall locate the source or sources, rectify the same and retest the main, all to the satisfaction of the WMMUA Engineer.
8. Where backfilling prior to testing has been permitted by the WMMUA Engineer and test results prove unsatisfactory to the WMMUA Engineer, the Contractor shall uncover the fault, rectify the same, and retest the main to the satisfaction of the WMMUA Engineer, all at the Contractor's expense.

**TABLE 1
WATER MAIN ALLOWABLE LEAKAGE TEST**

ALLOWABLE LEAKAGE FOR MECHANICAL JOINT OR PUSH-ON JOINT PIPE IN 18-FT NOMINAL LENGTHS

Pipe Size - Inches

Avg PSI	3	4	6	8	10	12	14	16	18	20	24	30	36	42	48	54
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Allowable Leakage per 1,000 ft - gph

450	0.48	0.64	0.95	1.27	1.59	1.91	2.23	2.55	2.87	3.18	3.82	4.78	5.73	6.69	7.64	8.60
400	0.45	0.60	0.90	1.20	1.50	1.80	2.10	2.40	2.70	3.00	3.60	4.50	5.41	6.31	7.21	8.11
350	0.42	0.56	0.84	1.12	1.40	1.69	1.97	2.25	2.53	2.81	3.37	4.21	5.06	5.90	6.74	7.58
300	0.39	0.52	0.78	1.04	1.30	1.56	1.82	2.08	2.34	2.60	3.12	3.90	4.68	5.46	6.24	7.02
275	0.37	0.50	0.75	1.00	1.24	1.49	1.74	1.99	2.24	2.49	2.99	3.73	4.48	5.23	5.98	6.72
250	0.36	0.47	0.71	0.95	1.19	1.42	1.66	1.90	2.14	2.37	2.85	3.56	4.27	4.99	5.70	6.41
225	0.34	0.45	0.68	0.90	1.13	1.35	1.58	1.80	2.03	2.25	2.70	3.38	4.05	4.73	5.41	6.03
200	0.32	0.43	0.64	0.85	1.06	1.28	1.48	1.70	1.91	2.12	2.55	3.19	3.82	4.46	5.09	5.73
175	0.30	0.40	0.59	0.80	0.99	1.19	1.39	1.59	1.79	1.98	2.38	2.98	3.58	4.17	4.77	5.36
150	0.28	0.37	0.55	0.74	0.92	1.10	1.29	1.47	1.66	1.84	2.21	2.76	3.31	3.86	4.41	4.97
125	0.25	0.34	0.50	0.67	0.84	1.01	1.18	1.34	1.51	1.68	2.01	2.52	3.02	3.53	4.03	4.53
100	0.23	0.30	0.45	0.60	0.75	0.90	1.05	1.20	1.35	1.50	1.80	2.25	2.70	3.15	3.60	4.05

* The allowable leakage for a pipeline is calculated by multiplying the allowable leakage in gallons per hour per 1,000 ft for the average test pressure and diameter of pipe tested as obtained from the above table by the duration of the test in hours, and the total length in feet of the pipe being tested divided by 1,000.

Example:

Length of pipe tested = 1500 feet
 Duration of test = 2.0 hours
 Average Test Pressure = 150 psi

Solution:

Nominal Diameter of pipe tested = 8 in.
 From table allowable leakage = 0.74 gph/1000 ft.

^ Total Allowable Leakage for test in gallons = $0.74 \times \frac{1,500}{1,000} = 1.11$ gallons

(C) *Testing of Valves, Hydrants, Corporations and Curb Stops*

1. The operating functions of these items shall be tested under normal or higher water pressure and approved by the WMMUA Engineer before acceptance.
2. The drainage outlet of each hydrant shall be tested and approved and the bonnet tested for tightness under pressure.

(D) *Summary of All Testing*

1. Pumps, pipe connections, gauges, meters, water supply and all necessary apparatus and equipment shall be furnished by the Contractor and he shall perform all work required in connection with the tests.
2. Means and/or other methods recommended for testing by the pipe manufacturer, whether or not called for in these specifications, shall be used if and where directed by the WMMUA Engineer.

3.1 **Detailed Specifications – Sanitary Sewer System(s)**

3.2 *Materials*

(A) *Polyvinyl Chloride (PVC) Pipe With Push - on Joint*

1. PVC sewer pipe shall conform to the requirements of ASTM D-3034 for pipe supplied between four inch (4") and fifteen inch (15") diameter, and shall meet the material properties of ASTM D-4396.
2. The minimum wall thickness of the pipe supplied shall conform to standard diameter ratio (SDR) of thirty-five (35), (SDR-35).
3. The pipe supplied shall be factory tested and conform to ASTM tests B-2444 (impact resistance) and ASTM D-2152 (extrusion quality).
4. The pipe and rubber-gasketed standard couplings conforming to ASTM D-3212 shall be factory tested and comply with the requirements of ASTM C-3034 for impact resistance and ASTM D-2152 for quality control of extruded PVC.
5. Gaskets shall be elastomeric material conforming to ASTM F-477, providing a watertight seal.
6. The minimum size pipe for use as a sewer collector shall be eight (8) inches.

(B) ***Cement Mortar Lined Ductile Iron Pipe***

1. Ductile iron pipe shall be manufactured in accordance with ANSI specifications A21.11 (AWWA C111), ANSI specifications A21.51 federal specifications WW-P421c.
2. Cement mortar linings shall conform to current ANSI specifications A21.4-1964, 1/8" thick. Additional protective lining may be required by the WMMUA Engineer where the formation of hydrogen sulfide gas or other corrosive substances may be anticipated.
3. Cement mortar lined ductile iron pipe shall be furnished with mechanical or push-on joints (Tyton) as specified by the WMMUA Engineer.
4. Pipe shall be ductile Class 52 unless otherwise specified.

(C) ***Methods of Construction - Pipes***

1. All pipe and fittings shall be carefully lowered into the trench in such a manner as to prevent damage to pipe, fittings, trench sides or shoring.
2. Under no circumstances shall pipe or accessories be dropped or dumped into the trench.
3. All foreign matter or dirt shall be removed from the interior of the pipe and fittings before lowering into position in the trench.
4. Pipe laying shall proceed upgrade.
5. Care shall be taken to lay the pipe to proper line and grade.

(D) ***Flushing***

1. When required by the WMMUA Engineer, the Contractor shall, after completion, thoroughly flush each section of pipe as may be designated by the WMMUA Engineer, to remove all foreign material which may have entered during construction.
2. The Contractor shall provide water for flushing and shall provide for disposal of water after flushing.

(E) ***Cover of Pipe***

Where cover is insufficient for PVC pipe (generally less than three (3) feet), ductile iron pipe shall be used.

3.3 *Manholes*

(A) *Materials*

1. *Precast Reinforced Concrete:*

- (a) Precast manhole sections shall be four (4) feet internal diameter and shall be manufactured in accordance with ASTM designation C-478 with a minimum strength of 4,000 psi for all sections. Section joints shall be formed to meet the requirements of ASTM C-443.
- (b) Connections between manhole and pipe shall include a watertight gasket or rubber boot cast integrally into the manhole wall and shall meet the requirements of ASTM C-923 and shall be provided with stainless steel strap connection for PVC pipe.
- (c) All joints shall provide a watertight condition. (See detail - Plate No. 6).

2. *Iron Casting Frames and Covers:*

- (a) Castings shall be true to pattern in form and dimension, free from pouring faults, sponginess, cracks, blowholes and other defects affecting their strength and value for the service intended. Castings shall be of close grained gray iron and shall conform to ASTM A-48, Class 30. Castings shall be Campbell Foundry #1203, or equal. All covers shall be solid with no vents and incorporate the "Flow -Seal neoprene gasket" as manufactured by Campbell Foundry, or approved equal. Castings shall be American made.
- (b) Bearing surfaces between cast frames, covers and grates shall be fitted together and match marked to prevent rocking.
- (c) Castings shall have the lettering incorporated as outlined in the detail. (See detail - Plate No. 5).
- (d) Manholes located in flood plains or in areas likely to be flooded shall be provided with water tight manhole frames and cover and shall be Campbell Foundry #6544, or equal 400 lbs with anchor bolts and bolt holes.
- (e) Manholes in unpaved areas shall be finished with manhole frames having locking covers. A camlock style locking device as manufactured by Campbell Foundry, or equal shall be utilized.

5. **Mortar:** Mortar shall be 1:2 cement-sand mortar, the materials conforming to the requirements contained within these specifications.

6. **Manhole Rungs:**
 - (a) Manhole rungs shall be steel reinforced copolymer polypropylene plastic.

 - (b) Rungs shall be fourteen inches (14") wide, M.A. Industries type PS2-PF-SL or equal. Copolymer polypropylene shall be type II, grade 16906 meeting ASTM specifications, encapsulating a 1/2 inch diameter, grade 60, steel reinforcing rod, conforming to ASTM A615, which shall be continuous throughout the rung.

 - (c) The portion of the legs to be embedded in the precast section shall have fins and be tapered to insure a secure bond.

 - (d) Steel reinforced polypropylene plastic manhole rungs shall be driven into tapered holes in the precast riser and cone sections during the manufacture of the sections.

 - (e) Holes for rungs shall be preformed during the casting of the sections and shall not be drilled after casting.

 - (f) The preformed holes shall be a minimum of 3 1/2" deep and shall taper from 1 1/8" to 1 3/8" diameter.

 - (g) Precast sections having rungs which are mortared or grouted in place shall not be accepted.

 - (h) All steps installed in manholes shall be twelve inches (12") apart on center.

(B) **Methods of Construction - Manholes**

1. When cast in place, the foundation for concrete manholes shall be class D concrete.

2. Concrete construction, excavation and backfill shall conform generally to the requirements contained elsewhere within these specifications.

3. Precast concrete barrel sections shall be set vertical with subsequent sections in true alignment. The tongue and groove joints of the barrel sections shall be

sealed with the rubber "o" ring set in the recess. The outside and inside of the joint shall be filled with non-shrink grout.

4. Manhole frames and covers shall be set in a full bed of non-shrink cement. Concrete rings shall be used to bring the casting to grade.
5. When a new manhole is to be placed over an existing sewer, a dog-house manhole shall be provided. The annular space around the existing sewer shall be grouted with non-shrink grout. Concrete fill shall be used to form the benches and flow channels and the existing sewer shall then be cut and the edges brought smooth to the bench (See Plate No. 11).
6. When the depth of the manhole exceeds 14 feet to the bench or when the size and spacing of inlet and outlet sewers requires, a five (5) foot internal diameter manhole shall be used.
7. When a sewer connection is made to an existing manhole, the hole shall be made by core drilling and a KOR-N-SEAL joint shall be installed as recommended by the manufacturer.

(C) *Waterproofing*

1. The exterior of all manholes shall be given two (2) coats of coal tar epoxy water-proofing material, such as Kop-Coat Bitumastic 300M, or approved equal.
2. The material shall be applied in accordance with the instructions of the manufacturer.
3. In cases where precast manhole sections are used, all joints and lifting holes with rubber stoppers shall be filled with a waterproofing mortar mixture, and painted with two (2) coats of the same waterproofing material as used by the manhole manufacturer.
4. The Contractor shall also touch up all areas of the manhole that are damaged due to shipment or construction, before backfilling.

(D) *Drop Manholes*

1. Drop connections shall be provided for lateral sewers entering manholes above the manhole invert whenever the difference in elevation is two feet (2') or more. Generally, drop manholes shall be of the outside drop type. In special cases, an inside drop manhole may be approved by the WMMUA Engineer and/or WMMUA representative. When used, inside drop manholes shall be five (5) feet internal diameter. (See Plate No's 8 and 9).

2. The drop manhole connections shall be constructed as detailed on the plans. Note that reverse ring Y-branches shall be used for pipe sizes less than twenty-four inches (24") in diameter.
3. A concrete encasement shall be installed around each drop manhole connection after the joints have been made.
4. The concrete mix shall develop allowable compressive strength of 2,500 psi at twenty-eight (28) days, slump one (1) to three (3) inches, with a coarse aggregate maximum size of 1 1/2".
5. Backfill shall not be placed within sixteen (16) hours following placement of concrete.

(E) *Setting and Resetting of Castings*

Manhole frames shall be set in a full bed of non-shrink cement and concrete rings, of a maximum twelve inches (12") thick, to assure that the frame and cover are set to the final grade.

3.4 *Testing Procedures*

(A) *Testing - General Guidelines*

1. After flushing and cleaning, all lines shall be inspected to check alignment and other construction defects by means of closed circuit television inspection (CCTV).
2. The WMMUA shall be provided with three (3) digital copies of the sections so inspected, keeping a prescribed log of the stations inspected.
3. Tests shall be made as a check for water tightness of the pipes and manholes conforming to test procedures outlined in these specifications. Those tests shall be performed under the inspection of the WMMUA Engineer and/or WMMUA representative, but the Contractor will provide the labor and any necessary material and equipment.
4. Where PVC pipe is installed, the Contractor shall perform a deflection test to check for excessive vertical deflection.
5. No connection shall be made to the pipes until the tests as directed by the WMMUA Engineer and/or WMMUA representative have been completed and the WMMUA Engineer and/or WMMUA representative has authorized the connection(s) in writing.

(B) ***Air Exfiltration Testing:*** Air exfiltration or smoke tests shall be required by the WMMUA Engineer as described in this section.

1. The sections of the main to be tested shall be isolated by completely blocking all outlets in the section under test.
2. All plugs shall be securely braced as the line is under pressure.
3. Safety precautions shall be in effect and careful attention to the bracing, shoring, etc. shall be observed.
4. The downstream plug in the manhole shall be equipped for an air inlet with suitable valves. Air shall be introduced via compressor which shall feed air into the pipe section. The compressor must be equipped to control the air entry rate and shall have a positive method of preventing pressure from exceeding 5 psig. The air compressor shall be fitted with a blowoff valve set to operate at 5 psig to prevent pressure build-ups which would be harmful to the pipe system.
5. No test may be conducted on a new pipe which does not have a wetted inside condition. Normally required flushing will suffice to accomplish this requirement if the testing is made immediately after the flushing procedure.
6. Air shall be permitted to slowly fill the pipe until a constant pressure of 5.0 psig is maintained. The compressor shall be controlled so that the internal pressure in the line is maintained at 5.0 psig for a minimum of four (4) minutes to permit the temperature of the entering air to equalize with the temperature of the pipe wall. During the four (4) minute stabilization period, all plugs and fittings shall be checked with a water-soap solution. If any leakage is found, the compressor shall be secured, the pressure in the line released and the leaking plugs tightened to stop leakage. If it becomes necessary to interrupt the test to repair plugs, a new four (4) minute time interval for stabilization must be allowed when the line is refilled.
7. When in the opinion of the WMMUA Engineer and/or WMMUA representative the air temperature has reached equilibrium with the pipe wall, the air source shall be disconnected. The pressure prior to disconnection of the air supply shall be observed until air pressure reaches 3.0 psig. When 3.0 psig has been reached, a stop watch shall be started and readings taken until the pressure reaches 2.5 psig. The time required for a loss of 0.5 psig shall be used to calculate the rate of air loss.
8. The loss of air shall be deemed acceptable if the time in seconds for the pressure drop from 3.0 to 2.5 psig is not less than the amount shown on Table 2 for the respective pipe diameter.

9. Air test procedures shall be in strict conformance with ASTM-C-828 standards (Refer to Table 2 for variable pipe size requirements).
10. Safety: The air test may be dangerous if, because of lack of understanding or carelessness, a line is improperly prepared. It is extremely important that the various plugs be installed and braced in such a way as to prevent blowouts. In as much as a force of 250 lbs. (1112N) is expected on an 8 inch (203 mm) plug by an internal pipe pressure of 5 psi (34 kPa), it should be realized that sudden expulsion of a poorly installed plug or of a plug that is partially deflated before the pipe pressure is released, can be dangerous.

As a safety precaution, pressurizing equipment may include a regulator or relief valve set at perhaps (5 psi 34 kPa) to avoid over-pressurizing and damaging an otherwise acceptable line. No one shall be allowed in the manholes during testing.

(C) *Infiltration Testing*

1. The upstream manhole of the section being tested shall be securely plugged.
2. Weirs shall be installed at appropriate locations in the line to measure infiltration.
3. Tests shall be run during wet weather or when ground water is known to be above the crown of the sewer.

TABLE 2
AIR EXFILTRATION TEST FOR SANITARY SEWERS

**Specification Time (min : sec) Required for Pressure Drop From 3.0 to 2.5 psig
When Testing One Pipe Diameter Only**

Pipe Diameter, Inches

Length of Line Feet	4	6	8	10	12	15	18	21	24
100	1 : 53	2 : 50	3 : 47	4 : 43	5 : 40	7 : 05	8 : 30	9 : 55	11 : 24
150	1 : 53	2 : 50	3 : 47	4 : 43	5 : 40	7 : 05	9 : 37	13 : 05	17 : 57
200	1 : 53	2 : 50	3 : 47	4 : 43	5 : 42	8 : 54	12 : 49	17 : 27	22 : 48
250	1 : 53	2 : 50	3 : 47	4 : 57	7 : 08	11 : 08	16 : 01	21 : 49	28 : 30
300	1 : 53	2 : 50	3 : 48	5 : 56	8 : 33	13 : 21	19 : 14	26 : 11	34 : 11
350	1 : 53	2 : 50	4 : 26	6 : 55	9 : 58	15 : 35	22 : 26	30 : 32	39 : 53
400	1 : 53	2 : 51	5 : 04	7 : 54	11 : 24	17 : 48	25 : 38	34 : 34	45 : 35
450	1 : 53	3 : 12	5 : 42	8 : 54	12 : 50	20 : 02	28 : 51	39 : 16	51 : 17

This air test table has been prepared utilizing applicable equations from ASTM C-828. It applies when testing one (1) pipe diameter only and for convenience ignores four inch (4") and six inch (6") lateral sewers, which in most instances creates only insignificant differences in test time.

4. The maximum allowable infiltration shall be one hundred (100) gallons per inch of main diameter, per mile of main pipeline per twenty-four (24) hour duration.
5. Infiltration testing shall be permitted as an alternate test method when approved by the WMMUA Engineer and/or WMMUA representative.

(D) *Exfiltration Testing*

1. Water exfiltration tests may be required at the discretion of the WMMUA Engineer if the absence of groundwater precludes making infiltration tests.
2. When exfiltration tests are run, exfiltration observed will be considered to be equal to infiltration and the above infiltration maximum will apply.