2 Water Construction Standards

2.1 General

A. The work includes furnishing and installing all pipe, fittings, valves, structures and appurtenances required for the proposed system to supply water to users of the City's Water System.

B. Work and materials shall be performed in accordance with the State Plumbing Code when work is within ten (10) feet of buildings.

C. No electrical grounds shall be made on water service pipes where a driven ground rod can provide the needed grounding service. Electrical grounding shall be provided in accordance with the Massachusetts Electric Code.

D. Only one domestic water service shall be installed per parcel.

E. All materials used in public or private water systems within the Town of Framingham's water system must be certified "lead free."

F. All water connections shall be to City owned distribution mains.

G. Submittals required for water projects include:

1. Materials List and Shop Drawings
2. Chlorination and Dechlorination Plan
3. Pressure testing
4. Temporary Bypass Plans
5. As-built Plans

2.2 Temporary Water Bypass

A. All components of the bypass shall be for potable water transmission and distribution with a minimum service pressure of 150 psi. Piping and hose shall be galvanized steel, high density polyethylene (HDPE) or polyvinylchloride (PVC) pipe. All plastic pipe or hose shall bear the imprint of the National Sanitary Foundation (NSF) approval for potable water NSF-PW or shall be capable of meeting the standards established by the NSF for this use.

B. Bypass mains shall be supplied by at least two connections to the existing system either via an existing hydrant or a direct connection to an underground main.

C. Bypass mains shall be a minimum of 6-inches in diameter when supplying water for fire protection to temporary hydrants. Temporary hydrants shall be located in the same approximate location as existing hydrants that have been placed out of service and bagged. The number of hydrants on the temporary bypass shall be greater than or equal to the number of existing hydrants that are placed out of service.

D. Minimum size of bypass mains that do not supply water for fire protection is 2-inches. All temporary services shall be greater than or equal to the diameter of the existing service.

E. Bypass mains shall be laid outside of the traveled and access ways whenever possible and trenched when crossing roadways. All services shall be ramped or trenched.

F. Where possible, services shall be connected to the user's sill cock using a wye fitting with valves to accommodate connections of garden hoses by the user.

G. In the case where the property to be put on bypass utilizes a backflow preventer on the service connection, the temporary bypass connection should be excavated and connected to the existing service connection pipe (i.e., a "Bulkhead" connection) prior to the backflow preventer.

H. Pressure testing and disinfection testing shall comply with the requirements in the following sections.

I. All work shall be coordinated with DPW and the Fire Department and no construction activity shall commence without a minimum of 48 hours advance notice to each department.

2.3 Piping

2.3.1 Pipe

A. All water mains shall be minimum Ductile Iron Class 52, single gasket, double sealing pipe with cement mortar lining. All ductile iron water main pipe shall be rated for a minimum operating pressure of 350 psi. All water mains shall be encased in polyethylene film when the trench is backfilled with control density fill.

B. All water mains shall be minimum 8-inch diameter. All hydrant branches shall be minimum 6-inch diameter.

C. Push-on type joints are recommended on straight runs of pipe. Gaskets must be standard for pipe used and be acceptable to the DPW. Push-on pipe gaskets shall be clean and thoroughly coated with lubricant specified by the manufacturer during installation.

   a. Where petroleum contamination is known or suspected to be in the soil and/or groundwater, nitrile gaskets shall be required.

D. Water pipe shall be installed with minimum distance from sewer and septic pipe as summarized below. Reference detail S 3.5.0

   1. *Horizontal Separation:* Whenever possible, proposed water main shall be laid at a minimum at least 10 feet horizontally from any existing or proposed sewer main. Should local conditions prevent a lateral separation of 10 feet, a water may be laid closer than 10 feet to a sewer main, if:

      - It is laid in a separate trench, or if
      - It is laid in the same trench with the water mains located at one side on a bench of undistributed earth, and if
      - In either case, the elevation of the top (crown) of the sewer is at least 18 inches below the bottom (invert) of the water main.

   2. *Vertical Separation:* Whenever water must cross over sewer mains, the water shall be laid at such an elevation that the bottom of the water is at least 18 inches above the top of the sewer main. When the elevation of the sewer cannot be varied to meet the above requirements, the water main shall be relocated to provide this separation or reconstructed with mechanical-joint pipe for a distance of 10 feet on each side of the sewer. One full length of the water main should be centered over the sewer so that both joints will be as far from the sewer as possible.

   3. When it is impossible to obtain horizontal and/or vertical separation as stipulated above, water and wastewater operations shall be given the opportunity to review and provide more stringent requirements such as:

a. Pipes shall be pressure tested by an approved method to assure water tightness ;and/or

b. Both pipes shall be encased in control density fill (CDF); any ductile or cast iron shall be double wrapped in 6. mil polyethylene plastic.

c. Other.

E. Pipe shall be laid accurately to line and grade in sand bedding conforming to MassDOT Standard Spec. M1.04.0 Sand Borrow and AWWA guidelines. The depth of the sand bedding shall be one half (1/2) the diameter of the pipe under the main and one half (1/2) the diameter of the pipe over the main or 6 inches both under and over the pipe, whichever is greater. Bedding shall be placed in layers not over six inches thick, and each layer shall be thoroughly compacted by tamping and chinking on each side of pipe to provide uniform support.

F. All piping shall be installed with a minimum 5-foot cover. In such cases where 5-foot cover is not possible, the piping shall be appropriately insulated.

G. Backfill material placed above the bedding material and below the roadway foundation shall conform to detail W-2.3.0. Roadway foundation and surface restoration shall conform to Section 5, Roadway Construction Standards, and Section 6, Existing Road Openings, as applicable.

2.3.2 Service Connections

A. The City has standardized on lead-free service connections manufactured by McDonald, Mueller, Ford or an approved equal. Copper tubing shall be of the type commercially known as type "K" soft and conforms to ASTM Specifications B-88-49.

B. Plastic services are allowed on a case-by-case basis. In such circumstances, the City will require that the applicant verify that no petroleum constituents are present in subsurface soil in the vicinity of the service. Plastic water services shall be NSW-PW, listed, High Density Polyethylene (HDPE) blue plastic and shall conform to the following:

a. Copper Tube Size (CTS) – ASTM 2737, 200 psi, PE 3608 or PE 3710, SDR9

b. Iron Pipe Size (IPS) – ASTM 2239, 200 psi, PE 3608 or PE 3710, SIDR7

C. Plastic pipe shall be as manufactured by Silver Line Plastics or approved equal. Dimensional and performance characteristics shall conform to the requirements of AWWA C901. The use of HDPE pipe and tubing may be allowed for water service - two (2) inches or under in diameter (4-inch and larger diameter water services shall use cement lined ductile iron water pipe). HDPE pipe shall be installed with enough slack to compensate for settlement and compaction and shall be laid on a bed of sand conforming to MassDOT M1.04.0.

D. Curb valves shall not include a drain.

E. Curb boxes shall be Erie box style for 1-inch services and Buffalo box style (no rod) for 1-1/2-inch and larger services.

2.3.3 Cut & Cap

A. Cutting and capping of water services greater than 2-inches shall be constructed by cutting out the tee at the main, removing it, and installing a straight piece of pipe. If connecting ductile iron pipe, couplings shall be solid sleeve. If connecting to another material, coupling shall be submitted to the DPW Inspector for approval prior to installation.

2.3.4 Corporations

A. Corporations for 1 inch installations shall be heavy pattern, solid plug, easy turning. The inlet shall be an AWWA (CC) thread. The 1 inch, 1-1/2 inch and 2 inch corporations shall be of a tee head ball valve type which incorporates Teflon seats to assure self-centering of Teflon coated bronze ball. The corporation shall be easy turning and non-binding. The inlet shall be an AWWA (CC) thread. Corporations shall be subject to a sustained hydraulic pressure of 200 psi. All 1½ and 2-inch saddles shall have stainless steel straps.

2.3.5 Fittings

A. Ductile iron fittings shall be used and shall be cement lined. Fittings shall be equipped with a mechanical joint restraint, unless otherwise specified by the DPW. Mechanical joint fittings in sizes 4 inch through 12 inch shall be ductile iron compact fittings and rated for 350 psi working pressure. All nuts and bolts shall be of a type equal to ductile iron or KOR-10 steel T-bolts and nuts or an approved equal.

2.3.6 Couplings

A. Couplings shall be provided with AWWA approved plain, Grade 27, rubber gaskets and track-head bolts with nuts. Couplings shall be Smith Blair, Style 441 or Dress, Style 153; 360 or an approved equal. If the outer diameter of the pipe permits, a Dresser coupling is preferred. Hardware shall be stainless steel.

B. Where petroleum contamination is known or suspected to be in the soil and/or groundwater, nitrile gaskets shall be required.

2.3.7 Repair Clamps

A. All repair clamps shall consist of a stainless steel wrap and stainless steel hardware.

B. The City has standardized Smith-Blair Style 261 or approved equal.

2.3.8 Resilient Seat Gate Valves

A. Resilient seat gate valve bodies shall be manufactured of ductile iron. Gate valves shall be open left (counter clockwise). All valves shall be designed for minimum 250 psi working water pressure.

B. Valve stems shall be stainless steel.

C. The City has standardized on American Flow Control and Kennedy, or approved equal.

2.3.9 Valves

A. Valve boxes shall be heavy duty, adjustable style with the lower part manufactured of cast iron and the upper part of steel or cast iron. All valve boxes shall be designed and constructed to prevent direct transmission of traffic loads to the pipe or valve, and shall have the lower part manufactured of cast iron and the upper part of steel or cast iron. The top of the cover shall be flush with the finish grade. Boxes shall be as manufactured by Bibby Ste-Croix or approved equal.

B. Box covers shall be round frame and cover manufactured by the Bibby Ste-Croix or approved equal. The boxes shall be labeled to differentiate between division valves (“DIV”), Blow-Off (“B.O.”) and generic valves as indicated in the Construction Details.

C. Box covers shall have a minimum height of four (4) inches.

D. All foreign matter shall be removed from valve openings and seat faces. All nuts and bolts shall be checked for tightness.

E. For any T-connections that may be considered a lateral connection, the valve for the lateral line shall be attached with an anchor-T or tapping sleeve if approved by DPW (See Detail W-2.4.1)`. The valves on the main line shall be installed in line with the curb (see Detail W-2.4.3).

2.3.10 Tapping

A. Where there is more than one public water main in a street, the City shall determine which main the owner may tap for water service pipe connection. Water mains designated as transmission mains shall not be tapped for water service, except when approved by the City.

B. Service taps to the distribution main shall be separated by a minimum of 18-inches in all directions.

C. Temporary taps installed for filling and testing a pipe shall be abandoned prior to City acceptance. Abandonment shall include cutting pipe no more than 3-inches from the corporation stop and leaving corporation stop in the closed position.

D. Service taps on active public water mains shall be conducted by DPW staff for all services 2-inches and less in size.

E. Tapping sleeves shall be of the mechanical joint type. The valves shall be flanged by mechanical joint outlet with non-rising stem and designed for vertical burial. Tapping valves shall be rated at 200 psi working pressure and shop tested at 300 psi. Bolts on bonnet and stuffing box shall be stainless steel (316 stainless steel), stuffing boxes shall be "O" ring type. The operating nut shall be 2 inches square. Gaskets shall cover the entire flange surface. Valves shall open left, (counter clockwise).

F. Tapping sleeves shall be no greater than one-half of the diameter of the main being tapped.

G. The City has standardized on American Darling 1004 or an approved equal.

H. Any connection to a public main of asbestos cement material type shall require coordination with DPW staff. For any City-owned pipe, DPW will remove and dispose of asbestos material type, Contractor shall install new tee and pipe.

2.3.11 Restraints

A. Mechanical joint restraints shall consist of individually actuated wedges that increase their resistance to pull out as pressure or external forces increase. The device shall be capable of full mechanical joint deflection during assembly and the flexibility of the joint shall be maintained after burial. They shall have a rated work pressure of 350 psi in sizes 16-inch and smaller and 250 psi on in sizes greater than 16 inches.

B. Thrust blocks may only be used against undisturbed soil. They shall be designed in accordance with the Design Standards using the appropriate concrete and pressures as specified in the Construction Details and the AWWA standards and guidelines.

C. Tie rod systems may be used where approved by the City. All materials shall be steel and coated with an approved bituminous coating or other approved corrosion resistant coatings. Unless otherwise required or approved by the Engineer, the Contractor shall install tie rods in accordance with the following schedule for all fittings:

Minimum Tie Rod Design		
Pipe Size (inches)	**Number of Rods**	**Tie Rod Diameter (inches)**
4”-12”	2	¾”
16”	4	¾”
20” – 24”	4	1 ½”

D. Wedge Action Retaining Joints may be used wherever approved by the City and shall be manufactured of ductile iron conforming to ASTM A536. The mechanical joint restraint shall be Megalug Series 1100 or equal approved by DPW.

2.4 Hydrants

A. Hydrants shall have a 5-1/4-inch valve opened by turning the operating unit in the counter clockwise direction. The hydrant shall have one 4-1/2- inch steamer and two 2-1/2- inch hose connections. The hose and steamer connections shall have National Standard Thread. The operating nuts shall be pentagonal in shape, 1-1/2- inch from point to opposite flat and shall open left (counter clockwise). The hydrant shall be the hub or mechanical-joint type having a 6-inch pipe connection to an 8-inch or larger diameter main.

B. The hydrant valve shall consist of a cast iron valve and valve bottom and hydrant valve rubber. The rod threads shall be permanently sealed from contact with water. The hydrant valve shall seal against the bronze hydrant seat. The upper barrel shall be ductile iron with markings identifying size, model and year of manufacture. The lower barrel shall be ductile iron.

C. The upper barrel shall connect to the lower barrel with a breakable traffic flange and 8 bolts and nuts. This connection shall allow 360 degree rotation of the upper nozzle section.

D. The hydrant shall have a bronze drain ring securely held between the barrel and base flange. It shall provide bronze to bronze threaded connection for hydrant seal. The bronze drain ring shall serve as a non-corrosive multi-port drain channel.

E. Hydrant anchor tees shall be located at the main.

F. The hydrant shall have a minimum working pressure of 200 psi. Hydrant design shall be of positive automatic drain type to prevent freezing.

G. All hydrants that will not be City owned shall be painted red. Hydrants that are City owned, or will be City owned, shall be factory painted with Sherman-Williams brand paint to the City’s paint scheme:

- Hydrant body: hydrant blue b54tz104
- Caps: Pure white-b54w2101

H. The City has standardized on American Darling Model No. B-62B as manufactured by American Flow Control Inc.

2.5 Fire Suppression

A. All new fire suppression (i.e. sprinkler) connections shall be coordinated with and approved by the City’s fire department.

B. Fire suppression connections shall be coordinated with the property owner. Sprinkler valves shall only be operated by a certified sprinkler operator. The certified sprinkler operator shall bleed air from the sprinkler system upon completion of installation.

C. Single-family detached dwellings (i.e. single-family homes) may tap a single fire suppression service connection from their domestic water line if all of the following conditions are met:

1. The connection is made after the water meter
2. A testable backflow preventer is installed on the fire service line next to the connection
3. All pipes used in the fire suppression system are approved to carry potable water
4. Fire suppression system does not contain anti-freeze or any substance other than potable water

A. No fire service connection may be tapped off a domestic service (and vice-versa) for all commercial and multi-family properties. Separate domestic and fire services shall be installed from the building serviced to the public water main.

2.6 Testing of Water System

A. Pipelines shall be tested for strength and for leakage. Tests shall be made for all newly installed pipe and when required by the City. Methods of testing and plans showing sections to be tested shall be submitted to the City for approval, as requested. A 48-hour notice shall be given to the DPW Inspector of Construction and Utilities prior to all tests.

B. Testing shall be at a pressure of 200 pounds per square inch. In certain circumstances, the City may require higher pressure tests.

C. No more than 1,000 feet of water main shall be tested in a single test. In certain circumstances, the City may request smaller sections.

D. The tests for leakage shall last for two hours. The City may allow a one hour test subject to advanced approval.

E. The additional water needed to maintain the required pressure shall be accurately measured in a manner approved by the City. The container shall be clearly labeled with its capacity in gallons. Allowable leakage amounts will be determined by the AWWA standards for pressure testing Ductile Iron pipe (AWWA C600 latest revision).

F. The Contractor shall pay for and make all necessary arrangements for securing the water for test purposes. For projects where water is collected straight from an un-metered source, the Contractor shall meter the water. The City will subsequently bill the contractor on a private job for that water usage. For DPW projects, the Contractor will not be billed, but water usage shall be documented.

G. During this test all hydrant laterals shall be in the open position. The Contractor will not perform a pressure test against existing valves unless authorized by the City.

H. The Contractor shall submit a written report to the DPW summarizing the results. The Contractor shall repair all leaks discovered under any of the required tests and retest the pipe. The City will not accept any installation where a final test has not been passed.

2.7 Disinfection of the Pipeline

A. Prior to disinfection, the Contractor shall submit a detailed disinfection plan to the DPW. The plan shall be prepared consistent with AWWA standards and federal and state regulations, and it shall outline and describe the disinfection procedures.

B. General

1. All water mains, water services, attached appurtenances and connections shall be disinfected in accordance with AWWA Standard C651 continuous feed method and as required below.

2. Disinfection of new mains, including all chlorination, chlorine residual measurements, collection of samples, and certification shall be conducted by a third party testing agency approved by the DPW.

3. All pipe, fittings, and appurtenances shall be kept free from dirt and foreign matter at all times. During construction all open pipe ends and fittings shall be fitted with a water tight plug. At the end of the work day the open pipe in the trench shall be plugged in an equally suitable manner.

4. The Disinfection Plan shall document the locations and methods for applying the chlorine into the pipeline and practices shall conform to AWWA Standard C 651.

5. All water used to disinfect pipe shall be discharged and managed consistent with the appropriate state and local regulations. These shall include the City of Framingham Conservation Commission permitting and the *Illicit Discharges to Municipal Separate Storm Sewer System* bylaw. Discharge to the sanitary sewer or municipal stormwater system is not allowed.

6. Water mains and appurtenances must be completely installed, flushed, disinfected, and satisfactory bacteriological sample results received prior to connections being made to the active distribution system.

C. Chlorination

1. The interior surfaces of new valves, pipe and appurtenances shall be swabbed, as well as the interior surfaces of existing main, both upstream and downstream of the new pipe section, with a minimum five percent concentration of hypochlorite disinfection solution before installation. During the chlorination or chlorinating process, all valves shall be operated, and the chlorine solution shall be drawn through all laterals and appurtenances.

2. The Disinfection Plan shall summarize the intended chlorine dosage and the method for establishing that dosage.

3. In the event of leakage or where repairs are necessary, added disinfection shall be made only by injecting chlorine into the line whereby adequate mixing is assured. If the test results are not satisfactory, additional disinfection shall be required.

D. Flushing and Sampling

1. Water shall be flushed from the line at its extremities and at all outlets until the chlorine residual of the water system being flushed is equal or less than the distribution system level.

2. Sampling – Sampling shall be performed by an independent certified laboratory according to AWWA C651 – Disinfecting Water Mains, Option B. All sampling results shall be submitted to the DPW in writing prior to activation of the water main. If activation is not going to take place within 7 days of passing results this pipe shall be flushed once a week, with Water Department staff on site, until pipe is permanently activated. Failure to do so will result in re sampling and submitting passing results and possibly re disinfection, using the continuous feed method, if sampling results do not pass.

3. Sampling and analysis shall also include Heterotrophic Place Count (HPC) unless Colilert is used. The results of the HPC test shall be submitted in writing.

2.8 Pipe, Valve, and Structure Abandonment/Removal

A. Pipes left in place that are equal to or less than 6 inches in diameter may be left unfilled.

B. Pipes left in place that are greater than 6 inches in diameter shall be filled with LDCC regardless of material (e.g., DI, PVC).

C. Structures left in place shall be demolished down to five feet below ground surface, the bottom shall be cracked and compacted, and the remaining structure filled with CDF, LDCC, or clean gravel, as directed the City Inspector. Demolition debris shall be removed, and the area regraded and compacted over the filled structure.

3 Sewer Construction Standards

3.1 General

A. This Section specifies requirements for a gravity flow sewerage system and pressure sewer system.

B. The work covered under this section includes:

1. Furnishing and installing all pipe, fittings, manholes, structures and appurtenances required for the proposed system to convey sewage by gravity flow conditions.
2. When applicable, will include furnishing and installing all pipe, fittings, valves and structures for a pressure sewer system.
3. Rehabilitation of sewer pipes and structures.
4. Grease Traps.

C. Work and materials shall be performed in accordance with the State Plumbing Code when work is within ten (10) feet of buildings.

D. Work under this section shall comply with federal, state, and local requirements for the design, installation, testing, and certification.

E. Work shall comply with local, state and federal electrical codes to provide "watertight and corrosion resistant" installations. Electrical junctions of any kind are prohibited within the confines of the wetwell.

H. Submittals required for wastewater projects include:

1. Materials List and Shop Drawings
2. Temporary Bypass Plans
3. As-built Plans

3.2 Temporary Wastewater Bypass

A. Bypass mains shall be laid outside of the traveled and access ways whenever possible and trenched when crossing roadways. All services shall be ramped or trenched.

B. Spare plugs of the proper size and material shall be stored on site and available at all times of bypass operation.

C. Pumps shall be either submersible or self-priming type.

D. All bypass piping and system components shall be watertight and pressure rated for the proposed bypass system operating conditions.

E. Surcharging of upstream flows during bypass shall be minimized at all times. The pumping system may not surcharge the upstream sewer more than 18-inches in the vertical direction as measured from the invert of the existing suction manhole from which bypass pumps are withdrawing wastewater. The suction and discharge manholes shall be frequently monitored by the Contractor to observe flow rate and flow depth conditions in the existing system during bypass operations.

F. Flow turbulence in the downstream discharge manhole shall be minimized at all times.

G. All work shall be coordinated with DPW and no construction activity shall commence without a minimum of 48 hours advance notice.

3.3 Gravity Sewer

3.3.1 Gravity Sewer Pipe and Fittings

A. All pipes shall be designed based on the standards established in the Water Environment Federation/American Society of Civil Engineers *Manual of Practice No. FD-5, Gravity Sanitary Sewer Design and Construction*, latest edition, and New England Interstate Water Pollution Control Commission, *Guides for the Design of Wastewater Treatment Works, Technical Report #* 16, latest edition, and sound engineering principals.

B. The connection of the building sewer to the public sewer shall be made at the "Y" branch, if such branch is available at a suitable location. Lateral stubs or stubs for future sewer extensions shall be capped watertight until permanent connections are completed. All lateral stubs shall be approved by the City prior to installation. If no branch is available, a connection may be made by tapping the public sewer by an approved method, then inserting an approved cast iron, ductile iron, stainless steel or PVC "Y" or "T" saddle with stainless steel mounting bands or other approved connection device. Cutting a hole in the public sewer by hand is prohibited.

C. All sewer mains shall be laid with a straight alignment between manholes. When tying into an existing manhole, the manhole wall shall be cored and an insert installed for water-tightness.

D. The minimum pipe diameters for gravity building sewers and public sewers shall be six and eight inches, respectively.

E. Gravity sewers and force mains shall be constructed of Polyvinyl Chloride (PVC) Plastic Pipe and Fittings Polyvinyl chloride pipe and fittings (PVC) shall be minimum SDR 35 with full diameter dimensions conforming to the specifications for Type PSM Polyvinyl Chloride (PVC) Sewer Pipe and Fittings, ASTM Designation D-3034, latest revision, for sizes 3 inches to 15 inches. For sizes 18 inches to 48 inches, the pipe shall comply with ASTM F679, latest record.

F. Pipe color shall be in accordance with Uniform Color Code as established by the American Public Works Association Utility Location and Coordination Council (adopted September 2000).

G. Ductile Iron Pipe (Gravity) – where required by City

1. Ductile Iron Pipe: ASTM A746, Extra Heavy type, bell and spigot end, with Inderon Protecto 401 ceramic epoxy lining or equivalent applied per manufacturer's recommendation.
2. Ductile Iron Pipe Joint: ANSI A21.11, rubber gasket joint.
3. Where petroleum contamination is known or suspected to be in the soil and/or groundwater, nitrile gaskets shall be required.

H. All sewer pipes shall be laid accurately to the lines and grades shown in the Drawings and in conformance with pipe manufacturer's recommended procedures.

I. Pipe shall be handled in an approved manner, using slings or other approved devices. No pipe shall be dropped from trucks or into trenches.

J. Notch under pipe bells and joints, where applicable, to provide for uniform bearing under entire length of pipe.

K. Laying Pipe:

1. Pipe shall be laid accurately to line and grade in three-quarter (3/4") crushed stone. The depth of the crushed stone shall be one half (1/2) the diameter of the pipe under the main and one half (1/2) the diameter of the pipe over the main or 6 inches both under and over the pipe, whichever is greater. Stone shall be placed in layers not over six inches thick, and each layer shall be thoroughly compacted by tamping and chinking on each side of pipe to provide uniform support.
2. Each length of pipe shall be laid with firm, full and even bearing throughout its entire length, in a prepared trench. Pipe shall be laid with bells upgrade unless otherwise approved by the Engineer. Do not permanently support pipes on bells.
3. Every length of pipe shall be inspected and cleaned of all dirt and debris before being laid. The interior of the pipe and the jointing seal shall be free from sand, dirt and trash. Extreme care shall be taken to keep the bells of the pipe free from dirt and rocks so that joints may be properly lubricated and assembled. No pipe shall be trimmed or chipped to fit.
4. No length of pipe shall be laid until the proceeding lengths of pipe have been thoroughly embedded in place, to prevent movement or disturbance of the pipe alignment.
5. All piping shall be laid in the dry with the spigot ends pointing in the direction of flow. Installation shall proceed from the downstream to upstream in all cases.
6. Backfill material placed above the bedding material and below the roadway foundation shall conform to 6.3.1. Roadway foundation and surface restoration shall conform to Section 5, Roadway Construction Standards, and Section 6, Existing Road Openings, as applicable.
7. Impervious material may be required on service connections for a distance 10 feet from the inside wall of the foundation to where crushed stone can start. Pipe shall be laid with the spigot end pointing in the direction of the flow.
8. Sewer pipe shall have a minimum cover of 3 feet unless otherwise approved by DPW.

L. Pipe Extension: Where an existing pipe is to be extended, the same type of pipe shall be used, unless otherwise approved by the Inspector.

M. Full Lengths of Pipe: Only full lengths of pipe shall be used in the installation except that partial lengths of pipe may be used at the entrance to structures, and to accommodate the required locations of service connection fittings.

N. Pipe Entrances to Structures: All pipe entering structures shall be cut flush with the inside face of the structure, and cut ends of the pipe surface within the structure shall be properly rounded and finished so that there will be no protrusion, ragged edges or imperfections that will impede or affect the hydraulic characteristics of the sewage flow. The method of cutting and finishing shall be subject to the approval of the Inspector.

O. Protection During Construction: The Contractor shall protect the installation at all times during construction, and movement of construction equipment, vehicles and loads over and adjacent to any pipe shall be performed at the Contractor's risk.

1. At all times when pipe laying is not in progress, all open ends of pipes shall be closed by approved temporary water-tight plugs. If water is in the trench when work is resumed, the plug shall not be removed until the trench has been dewatered and all danger of water entering the pipe eliminated.

P. Sewer pipe shall be installed with minimum distance from water pipes as summarized below. Reference detail S 3.5.0

1. *Horizontal Separation:* Whenever possible, sewer shall be laid at a minimum at least 10 feet horizontally from any existing or proposed water main. Should local conditions prevent a lateral separation of 10 feet, a sewer main may be laid closer than 10 feet to a water main, if:
   a. It is laid in a separate trench, or if
   b. It is laid in the same trench with the water mains located at one side on a bench of undistributed earth, and if
   c. In either case, the elevation of the top (crown) of the sewer is at least 18 inches below the bottom (invert) of the water main.
2. *Vertical Separation:* Whenever sewer must cross under water mains, the sewer shall be laid at such an elevation that the top of the sewer is at least 18 inches below the bottom of the water main. When the elevation of the sewer cannot be varied to meet the above requirements, the water main shall be relocated to provide this separation or reconstructed with mechanical-joint pipe for a distance of 10 feet on each side of the sewer. One full length of the water main should be centered over the sewer so that both joints will be as far from the sewer as possible.
3. When it is impossible to obtain horizontal and/or vertical separation as stipulated above, water and wastewater operations shall be given the opportunity to review and provide more stringent requirements such as:
   a. Pipes shall be pressure tested by an approved method to assure water tightness ;and/or
   b. Both pipes shall be encased in control density fill (CDF); any ductile or cast iron shall be double wrapped in 6. mil polyethylene plastic.
   c. Other.

Q. Sewer pipe shall be laid at a minimum of 5 feet horizontally from a drainage main and 18 inches vertically from a drainage main.

R. Sewer Pipes-Laser Installation: Sewer pipes shall be laid to required grades by use of a laser and target system, unless otherwise specifically approved in writing by engineer.

3.3.2 Gravity Sewer Couplings and Connectors

A. Fittings, couplings, and adaptors for use with the gravity sewer system shall be Romac Industries, Inc. or an approved equal. Saddles for low-pressure sewers shall be bolt-on premier units. They shall have polypropylene bodies, stainless steel fasteners, stainless steel reinforced outlets.

B. Joints: PVC pipe shall have an integral wall bell and spigot push-on joint with elastomeric gaskets secured in place in the bell of the pipe. The bell shall consist of an integral wall section with a solid cross section elastomeric gasket, factory assembled, securely locked in place to prevent displacement during assembly. Elastomeric gaskets shall conform to ASTM D3212.

C. Spigot pipe ends shall be supplied with bevels from the manufacturer to ensure proper insertion. Each spigot end shall have an “assembly stripe” imprinted thereon to which the bell end of the mated pipe will extend upon proper joining of the two pipes.

D. Where petroleum contamination is known or suspected to be in the soil and/or groundwater, nitrile gaskets shall be required.

3.3.3 Cast Iron Pipe (Gravity) (For Plumbing Code Areas Only)

A. Cast Iron Soil Pipe: ANSI/ASTM A74, Extra Heavy type, bell and spigot end, inside to be asphalt coated per manufacturer standard.

B. Cast Iron Pipe Joint: ASTM C564, rubber gasket joint devices.

C. Transitions between different gravity pipe sizes shall be accomplished by using Fernco, or approved equal flexible eccentric reducing couplings with stainless steel bands. Completed pipelines shall be free of deviations from grade. Visible leaks, broken pipes, etc., shall be repaired or replaced.

D. Fittings for pressure sewer pipe shall be of similar style and material to match the force main material (PVC or DI). Bells shall be gasketed joint conforming to ASTM D3139 with gaskets conforming to ASTM F477. Gasket material shall be equal to that specified for pipe.

3.4 Pressure Sewer

3.4.1 Pressure Sewer Pipe and Fittings

A. Whenever possible, the force main will be designed on a continuous slope so that no "high points" exist, which may result in entrapment of gases and so that no "low points" exist which may induce settlement of solids. If unavoidable, all "high points" will have an air/vacuum release valve, and "low points" will have a cleanout. Details for these appurtenances will be provided and they will be accessible for maintenance without the need for excavation. During backfill, a polyethylene warning tape will be buried two feet below the ground surface along the entire length of the force main. Restrained joints on the force main should be used in place of thrust blocks.

B. The minimum pipe diameters for pressure building sewers shall be two inches. All pipe should be sized based on sound engineering principals.

C. Pressure sewers and force mains shall be constructed of Inderon Protecto 401 ceramic epoxy lined Class 52 DI or SRD 21 (pressure rated) PVC. Polyvinyl Chloride (PVC) Plastic Pipe and Fittings:

1. Size 2 inch to 12 inch diameter, SDR 21, ASTM D-2241, with material per ASTM D-1784, Grade 1, Type 1.
2. Push on joint, bell and spigot type with pressure rating of 200 psi.
3. Joints to meet ASTM F477 and tested to ASTM D-3139 standard.
4. Install at locations and sizes indicated on drawings.

D. Ductile Iron Pipe and Fittings:

1. Pipe size 4 to 12 inches diameter, push-on joint, pressure Class 350, ANSI/AWWA C150/A21.50, inside epoxy coating per manufacturer standard.
2. Pipe size 12 to 24 inches diameter, push-on joint, pressure Class 250, ANSI/AWWA C150/A21.50, inside epoxy coating per manufacturer standard.
3. Fittings, size 4 to 12 inches diameter, pressure Class 350, ANSI/AWWA C153/A21.53, push-on joints per ANSI/AWWA C111/A21.11.
4. Gaskets shall conform to ANSI/AWWA C111/A21.11. Restrained joints shall be provided by a field lock gasket supplied by the manufacturer of the pipe for that purpose. (U.S. Pipe – "FIELDLOK", Clow –"SUPER-LOCK," or U.S. Pipe – "TRFLEX").
5. Pipe and fittings to have an outside coating of asphaltic material per ANSI/AWWA C153/A21.53 and ANSI/AWWA C110/A21.10.
6. Valves and fittings to have an inside coating of epoxy lining applied in accordance with AWWA C550.

E. Flanged Ductile Iron Pipe and Fittings:

1. Pipe and fitting sizes 3 inches to 24 inches, pressure Class 250 psi, per ANSI/AWWA C115 A21.15 with asphaltic coating outside and epoxy coated inside.
2. Flange bolt circle and holes per ANSI/AWWA/C115/A21.15.
3. Gaskets per ANSI/AWWA C111/A21.11.
4. Flange adapters to push-on joint pipe sections shall be supplied by the manufacturer of the pipe.

3.4.2 Pressure Sewer Couplings and Connectors

A. Sleeve Couplings

1. Sleeve Type, Buried will consist of the following materials: Cast iron or epoxy coated steel, middle rings, ASTM A513; Reducer type where required; Followers, two steel rings epoxy coated; Bolts ANSI 21.11/AWWA C111, galvanized; Two wedge section compressible gaskets; Dresser Manufacturing Co. – Style 38, 162, or 128 as appropriate.
2. Sleeve Type, Exposed will consist of the following materials: Steel middle ring, shop prime; Reducer type for different pipe sizes; Two steel follower rings; Two wedge section compressible gaskets; Steel bolts; Dresser Manufacturing Co., Style 38.
3. Thoroughly clean pipe ends for a distance of 8 inches from the ends prior to installing couplings, and use soapy water as a gasket lubricant.
4. Slip a follower ring and gasket (in that order) over each pipe and place the middle ring centered over the joint.
5. Insert the other pipe length into the middle ring the proper distance.
6. Press the gaskets and followers evenly and firmly into the middle ring flares.
7. Insert the bolts, finger tighten and progressively tighten diametrically opposite nuts uniformly around the adapter with a torque wrench applying the torque recommended by the manufacturer.
8. Insert and tighten the tapered threaded lock pins.
9. Insert the nuts and bolts for the flange, finger tighten and progressively tighten diametrically opposite bolts uniformly around the flange applying the torque recommended by the manufacturer.

C. Flexible Connectors:

1. Do not use rubber or elastomeric PVC type flexible couplings to connect pressure sewers.
2. Material shall be compatible with pipes being joined.
3. Maximum allowable deflection per joint shall be 15 degrees or per manufacturer's recommendation, whichever is less.
4. Stainless steel metal retaining rings.
5. Use suitable retaining control rods.

3.4.3 Air Release

1. Air Release and Air and Vacuum Release Valves of size and type specified herein are to be able to fit into structure with ample room for access and maintenance of these units.

2. Air Release and Vacuum Valve shall be similar to a Clow F 3077, Valmatic VM-49BW.3 or approved equivalent, threaded joint end, valve with cast iron body and bronze body seat, all in accord with APCO 400 Sewage Valves with a working pressure of 150 psi. ASTM A48, Class 30 and ASTM B62.
3. Air Release and Vacuum Valve shall be installed in the Air Release chamber as shown along the pressure pipe and at any high points constructed due to changes in the pressure pipe route or elevations.
4. If the air release valve manhole is equipped with a water-tight cover, a vent pipe shall be installed. Vent pipe shall be 4 or 6-inch ductile iron "Candy Cane" with an insect screen.

3.5 Pipe Joints

A. All joints shall be made water-tight.

B. Pipe shall be jointed in strict accordance with the Pipe manufacturer's instruction. Jointing of all pipe shall be done entirely in the trench.

C. Lubricant for jointing of PVC pipe shall be applied as specified by the pipe manufacturer. Use only lubricant supplied by the pipe manufacturer.

D. PVC Pipe shall be pushed home by hand or with the use of bar and block. The use of power equipment, such as a backhoe bucket, shall only be used at the direction of the manufacturer.

E. Field-cut pipe ends shall be cut square and the pipe surface beveled to the size and shape of a factory-finished beveled end. All sharp edges shall be rounded off.

F. Jointing of Ductile Iron and Cast Iron Pipe shall be in accordance with Section 2, Water Construction Standards.

G. Bentonite collars shall be placed every 500 feet on sewer lines placed in the groundwater table that are more than 1200 feet in length. Collars shall extend to the width and height of the stone bed.

3.6 Cured-In-Place Pipeliners

A. Pipeline rehabilitation using cured in place pipeliners (CIPP) may be approved by DPW for existing public sewers 8-inches in diameter and greater. CIPP rehabilitation of public sewers less than 8-inches in diameter is not permitted.

B. The CIPP shall conform to the provisions and all test requirements specified in ASTM D790 – Test Methods for Flexural Properties of Un-reinforced and Reinforced Plastics and Insulating Materials, ASTM F1216 – Rehabilitation of Existing Pipelines and Conduits by the Inversion and Curing of a Resin-Impregnated Tube, and ASTM F2561-11 Standard Practice for Rehabilitation of a Sewer Service Lateral and Its Connection to the Main Using a One Piece Main and Lateral Cured-in-Place Liner.

C. The CIPP shall be designed based on a fully deteriorated condition of the existing host pipe in which it is assumed that the existing host pipe provides no structural support. The CIPP shall be designed to carry soil, groundwater, and other superimposed loads.

D. The CIPP shall be designed in accordance with ASTM F1216 under the following conditions:

1. Fully deteriorated host pipe
2. Height of groundwater above pipe invert = Ground surface elevation
3. Height of soil above pipe = Final design ground surface elevation

4. Live Load = AASHTO HS-20
5. Soil density = 120 lbs. / cubic foot
6. Ovality = 2% to 8%

E. The Contractor shall prepare and submit a design submittal prepared and stamped by a registered professional engineer that includes the following:

1. Description of materials and product samples
2. Design parameters
3. Installation process
4. Long term creep data, testing duration 10,000 hours minimum
5. Proposed flexural modulus and flexural strength
6. Proposed wall thickness supported by design calculations
7. Bypass pumping plan
8. Installer's qualifications and relevant experience

F. The existing sewer shall be cleaned and closed circuit television inspected prior to the CIPP installation to prepare the host pipe and locate the existing service connections.

G. Installation, curing, cool down, finish, and sealing at manhole and service connections shall conform to CIPP manufacturer's requirements. Curing shall be performed using steam unless otherwise approved by DPW and MWRA.

H. All service connections shall be reinstated after the CIPP is installed to no less than 95% of the existing service connection diameter and ground or brushed as required to form a neat lateral opening free of any jagged edges, lips, or protuberances. All service connections shall be grouted to prevent infiltration from the edge of lined sewer main to a minimum distance of 3 feet up the service connection.

I. If any open cut repairs or wye replacements are required, that work shall be completed prior to CIPP lining.

3.7 Cleanouts

A. The sewer cleanouts shall be minimum 6-inch diameter or sized to match the service pipe, whichever is greater. The cleanouts shall be either stubbed 6 inches above surface grade, or completed at finish grade if contained within a hand hole clearly marked "SEWER" per Standard Detail S-3.2.0. Cleanouts shall include a water-tight cap.

3.8 Sewer Manholes

A. All manholes shall be built in accordance with the Details and in the locations shown on the City of Framingham Details.

B. All masonry shall be installed by personnel experienced and skilled in this work, and any person not deemed to be such by the Engineer shall be removed and replaced by a person so qualified.

C. Manholes shall be constructed as soon as the pipe laying reaches the location of the manhole. Should the Contractor continue pipe laying without making provision for completion of the manhole, the Engineer shall have the authority to stop the pipe laying operations until the manhole is completed.

D. The Contractor shall accurately locate each manhole and set accurate templates to conform to the required line and grade. Any manhole which is mislocated or oriented improperly shall be removed and rebuilt in its proper location, alignment and orientation at no additional cost to the Owner.

E. Foundations: All manholes shall be constructed on a 12-inch layer of compacted bedding material. The excavation shall be dewatered to provide a dry condition while placing bedding material and setting the base.

F. Precast Manholes

1. Structures shall be constructed of precast concrete with a one-pour monolithic base in accordance with ASTM C478and installed only after Shop Drawings have been approved. All precast concrete manholes shall conform to the ASTM "Specifications for Precast Reinforced Concrete Manhole Sections," Designation D478.
2. The barrel shall be 4-foot or 5-foot diameter at the City's discretion.
3. The precast structures shall be manufactured with 4,000 psi minimum compressive strength concrete, with eccentric cone section tapering to 30-inch diameter, or flat top, and one pour monolithic base section conforming to ASTM C478. All units to be designed for HS-20 loading.
4. The top grade of the precast concrete cone section shall be set sufficiently below finished grade to permit a maximum of five and a minimum of two courses (laid in the flat position) of eight inch brick to be used as risers to adjust the grade of the manhole frame.
5. Lifting holes on all manhole sections shall be filled with grout.
6. Precast Unit Joint: Butyl rubber section joint conforming to ASTM C443.
7. The date of manufacture and the name or trademark of the manufacturer shall be clearly marked on the inside of each precast section.

G. Manhole frames and covers

1. Manhole frames and covers shall be minimum Class 25 conforming to ASTM "Standard Specification for Gray Iron Castings," Designation: A48. Manhole frame shall have a clear opening of 26 inches and be a minimum of 6 inches in height.
2. The surface of the cover shall have a diamond pattern with the words "FRAMINGHAM SEWER" if in the public right-of-way or "SEWER" if on private property cast thereon for sewer manholes.
3. All manholes frames and covers shall be manufactured by East Jordan Iron Works (formerly LeBaron Foundry Co.) or an approved equal.
4. Manhole covers shall be watertight when placed in the 100-year flood plain, wetland areas, cross country easements, or as determined by DPW, and as specified in federal, state and local regulations. Manhole frames shall be set on a grout pad to make a watertight fit. Watertight manhole covers shall be secured with four (4) stainless steel bolts and have a watertight gasket. The frame and cover shall be watertight up to 15 psig external pressure.

H. The corbel shall be constructed of red brick or reinforced concrete grading rings for adjusting frame to match finished surface. Manhole frame shall be flush with grade using a minimum of two (2) and a maximum of five (5) brick courses. Elevations greater than 6 inches vertical may include riser rings designed for that purpose. Brick shall conform to sewer bricks (made from clay) ASTM designation C32, Grade MS.

I. Inverts

1. Brick invert channels shall be constructed in all manholes to provide a smooth channel for sewage flow through the structure, and shall correspond in shape to the lower half of the pipe. Curve side inverts and layout main inverts (where direction changes) shall be constructed with smooth curves of longest possible radius tangent to adjoining pipelines centerline.
2. Brick shelves shall be constructed to the elevation of the highest pipe crown and sloped to drain toward the flow channel. Only red sewer brick shall be used for any invert, brick shelves and manhole frame adjustments. Brick shall comply with ASTM Standard Specification for Sewer Brick (made from clay or shale), Designation C32, for Grade SA, hard brick.
3. Special care shall be taken in laying brick inverts. Joints shall not exceed three-sixteenth inch in thickness and each brick shall be carefully laid in full cement mortar joints on bottom, side and end in one operation. No grouting or working in of mortar after laying of the brick will be permitted. Bricks forming the shaped inverts in manholes shall be laid on edge.
4. Invert channels shall be built for future extensions where shown on the Drawings and where directed by the Engineer.
5. Inverts shall not be built above ground. All inverts shall be built with the manhole in place (i.e. at the design elevation) and with all pipes installed.
6. All inverts shall be constructed with 4,000 psi concrete in void areas and with sewer brick. Brick shall conform to sewer bricks (made from clay) ASTM designation C32, Grade SS.
7. All sewer inverts are to be constructed once the manhole is installed. Manhole inverts built above ground will not be accepted.

J. Mortar shall be in conformance with ASTM C270, Type M. The mortar shall be composed of Portland cement hydrated lime, and sand, in the proportions of 1 part cement to ¼ part hydrated lime to 3 ½ parts sand, by volume. Sand for masonry mortar shall conform to the gradation requirements of ASTM C144.

K. Cement shall be Type I or II Portland cement conforming to ASTM C150, Standard Specification for Portland Cement. Hydrated lime shall be Type S conforming to ASTM D207.

L. All drop manholes will be of the external type. The drop pipe shall be constructed of minimum SDR 35 PVC. The drop piping and horizontal cleanout sections will be sized the same as the sewer main piping and shall enter the manhole at invert elevation. The drop portion of the piping shall be secured with anchor straps. The drop piping shall be encased with control density fill.

M. Manhole Pipe Connections: Flexible sleeve or rubber gaskets shall be Lock Joint, Kor-n-Seal, A-Lok, or approved equivalent.

3.9 Manhole Connections

A. Manhole pipe connections for precast manhole bases may be accomplished by any method described below. The Contractor shall make sure that the outside diameter of the pipe is compatible with the particular pipe connection used.

1. A tapered hole filled with non-shrink waterproof grout after the pipe is inserted. This connection method will not be allowed when connecting PVC pipe to manholes.
2. The LOCK JOINT Flexible Manhole Sleeve cast in the wall of the manhole base. The stainless steel strap and exposed sleeve shall be protected from corrosion with a bitumastic coating.

3. PRESS WEDGE II gasket cast into the wall on the manhole base. The rubber wedge shall only be driven into the V slot from the outside of the manhole.

4. The RES-SEAL, a cast iron compression ring which compresses a rubber "O" ring gasket into a tapered hole in the wall of the manhole base. Exposed metal shall be protected from corrosion with a bitumastic coating.

5. KOR-N-SEAL neoprene boot cast into the manhole wall. The stainless steel clamp shall be protected from corrosion with a bitumastic coating.

B. Sewer manholes shall be constructed with drop connections when the proposed invert of the connection is at least 2 feet above the manhole invert. Drop connections for differences of less than 2 feet shall also be provided if required by the City.

3.10 Bitumastic Coatings

A. The entire exterior surface of all masonry and concrete (whether precast or cast-in-place) structures associated with sewerage systems, such as: manholes, grease traps, holding tanks, tight tanks, septic tanks, aeration tanks, pump stations, valve pits, etc., shall receive two coats of waterproofing such as Carboline Bitumastic 300M as manufactured by SOMAY Products, Inc., Miami, FL; Sonnoshield HLM 5000 as manufactured by Sonneborn, Shakopee, MN or approved equal at a minimum thickness of 7 mils per coat and a total thickness of 14 mils; however, in no case shall the thickness per coat be less than that recommended by the manufacturer.

3.11 Service Connections

A. General Requirements: The Contractor shall make all required connections of the building sewer service pipes into the sewer system. Work shall include making the service pipe connections into the sewer system pipes or into the manholes located ten (10) feet outside of the proposed building lines. If stubs are constructed for later connection to the building pipes, the ends shall be sealed with watertight plugs.

B. Coordination with Building Contractor: The Contractor shall coordinate the work with the work of the Building Contractor to determine the exact location and elevation of the point of entry into the building.

C. Gravity service connections shall be minimum 6 inch PVC.

D. Sewer service pipe connections to the pipe of the public sewer system shall be made with fittings supplied by the pipe manufacturer. All connections into sewers shall be by wyes, T-wyes, or a Romac saddle, and couplings manufactured for use with the same type of pipe. The Contractor shall install 45 degree wye branch or 90 degree tee fittings in the sewer pipes at all locations where building sewer service pipe connections are shown on the Drawings. Connections of the sewer service pipes shall be made into the wye branches or tees by means of 45 degree bends. The connections shall be made thoroughly watertight and concrete shall be placed under each connection to bear on undisturbed earth and firmly support the connection. Sewer chimneys shall be encased in concrete unless directed otherwise by the City.

E. Service connections made using saddles and tapping sleeves shall be allowed only when authorized by the DPW. Replacement of an existing service shall include the replacement of the existing wye, tap or tee. Penetrations to the sewer main shall be kept to a minimum.

F. All service connections shall have a slope between 2 and 6 percent. Service connections that have a vertical drop of 4 feet to 12 feet between the house sewer invert at the street and the main sewer

invert shall be by sloped line using 22-degree or 45-degree angle connectors to allow snakes and rods to clean the line between the house and the main sewer.

G. Any sewer lateral that contains a 45-degree (45º) bend or greater shall require a manhole. Alternative connections shall be allowed only if reviewed and approved by DPW.

H. Chimney drop sewer services shall only be allowed where the depth of the mainline sewer crown is more than 12-feet from the ground surface. Installation of chimney when the mainline crown is less than 12-feet deep will not be allowed without the prior review by DPW. Service connections shall preferably be installed utilizing the most direct (shortest) route from building to main. Services should be laid out to run perpendicular to the main. Refer to standard installation details for materials and requirements.

I. For grinder pump to gravity sewer connections, the service connections shall be minimum 2-inch DI or SDR 21 PVC. Check valves shall be Y-pattern commercial bronze valves.

J. On private projects, portions of existing service piping to remain shall be video inspected prior to approval to verify pipe condition, ensure integrity, and limit infiltration. The inspection shall be witnessed by DPW staff. Service piping video shall be provided to DPW for final review prior to approval of existing piping reuse.

3.12 Testing of Sewer

A. If the visual inspection of the completed sewer or any part thereof shows any pipe, manhole or joint which allows infiltration of water, the defective work or material shall be replaced or repaired as directed. After completing installation and backfill of sewer pipe to the satisfaction of the DPW, the Contractor shall conduct a line acceptance test under the following procedures.

3.12.1 Gravity Main Testing

A. All gravity sewers that will be become the property of the City of Framingham shall undergo mandrel testing, televised inspection and, as directed by the City, pressure testing. All televised inspections shall be recorded and provided to the City in digital format.

B. Pressure Testing Gravity Sewers – After a manhole to manhole reach of pipe has been backfilled and cleaned, pneumatic plugs shall be placed in the line at each manhole and inflated to 25 psig. Low pressure air shall be introduced into this sealed line until the internal air pressure reaches four psig greater than the average back pressure of any groundwater that may be over the pipe. A minimum two minutes shall be allowed for the air pressure to stabilize.

After the stabilization period (3.5 psig minimum pressure in the pipe), the air hose from the control panel to the air supply shall be disconnected. The portion of line being tested shall be termed “Acceptable” if the time required in minutes for the pressure to decrease from 3.5 to 2.5 psig (greater than the average back pressure of any groundwater that may be over the pipe), shall not be less than the time shown for the given diameters as indicated in the Uni-Bell PVC Pipe Association’s, Handbook of PVC Pipe, current edition, and the following table.

MINIMUM LOW-PRESSURE TEST TIMES

Pipe Diameter (inches)	Minimum Time (min:sec)	Allowable Maximum Length (L = ft) for Minimum Time	Time for Longer Length (sec)
8	3:46	597	0.380L
10	5:40	398	0.854L
12	7:34	298	1.520L
15	14:10	159	5.342L
18	17:00	133	7.692L
24	22:40	99	13.674L
30	28:20	80	21.366L
36	34:00	66	30.768L
42	39:48	57	41.883L
48	45:34	50	54.705L

C. If testing is not feasible between manholes due to live sewer service connections the contractor shall conduct low pressure air testing at each pipe joint.

D. Vacuum testing of service connections may be required as directed by the City.

E. Deflection testing shall be performed on all flexible pipes, if directed by the Inspector. The tests shall be conducted after the final backfill has been in place for at least 60 days to allow for stabilization. Pipe shall be installed so there is no more than a maximum deflection of 5 percent. Deflection testing shall be performed using a specially designed gauge assembly (mandrel) pulled through the complete section. The gauge assembly shall have a diameter of not less than 95 percent of the base inside diameter or the average inside diameter as specified by ASTM. The pipe shall comply with ASTM D2122, Standard Test Method of Determining Dimensions of Thermoplastic Pipe and Fittings. The deflection test shall be performed without mechanical pulling devices. Other testing methods such as electronic deflectometers, calibrated video cameras, or laser profilers must be submitted for review and approval by DPW prior to use.

3.12.2 Pressure Main Testing

A. Except as otherwise directed, pressure sewers (force mains) shall be given combined pressure and leakage tests in sections of approved length. The Contractor shall furnish and install suitable temporary testing plugs or caps; necessary pressure pumps, pipe connections, meters, gauges, gates, and other necessary equipment; and required labor. The Owner and Engineer shall have the option of using their own gauges.

B. Subject to approval and provided that the tests are made within a reasonable time considering the progress of the project as a whole, and the need to put the section into service, the Contractor may make the tests when he desires. However, pipelines in excavation or embedded in concrete shall be tested after the backfilling of the excavation or curing of the concrete and exposed piping shall be tested prior to field painting.

C. The section of pipe to be tested shall be filled with water of approved quality, and air shall be expelled from the pipe. If blow offs are not available at high points for releasing air, the

Contractor shall make the necessary excavations and do the necessary backfilling and make the necessary taps at such points and shall plug said holes after completion of the test.

D. The section under test shall be maintained full of water for a period of 24 hours prior to the combined pressure and leakage test being applied.

E. The pressure and leakage test shall consist of first raising the water pressure (based on the elevation of the lowest point of the section under test corrected to the gage location) to the pressure rating of the pipe or alternately, to two times the maximum calculated operating pressure of the pipe, as approved by the Engineer. If the Contractor cannot achieve the specified pressure and maintain it for a period of one hour, the section shall be considered as having failed the test.

F. Following or during the pressure test, the Contractor shall make a leakage test by metering the flow of water into the pipe while maintaining in the section being tested a pressure equal to the pressure rating of the pipe. If the average leakage during the two-hour period exceeds a rate of leakage indicated in AWWA Section C600 per 24 hours per mile of pipeline, the section shall be considered as having failed the leakage test.

G. Reference the appropriate AWWA standards latest version for tightness testing. At minimum, all force mains shall be pressure tested with a minimum pressure of 150 psi for a minimum of two hours.

H. If the section fails to pass the pressure and leakage test, the Contractor shall do everything necessary to locate, uncover, and repair or replace the defective pipe, fitting, or joint, all at his own expense and without extension of time for completion of the work. Additional tests and repairs shall be made until the section passes the specified test.

I. If, in the judgment of the City of Framingham, it is impracticable to follow the foregoing procedure exactly for any reason, modifications in the procedure shall be made as approved, but in any event the Contractor shall be responsible for the ultimate tightness of the line within the above leakage and pressure requirements. Passing the test does not absolve the Contractor from his responsibility if leaks develop later within the period of warranty.

J. The sewer lines shall be inspected via closed-circuit television (CCTV) after completion with a 2 gpm flow of water to reveal pipe bellies. The remote camera shall also pan to view up the service connections to the Fernco fitting.

3.12.3 Manhole Testing

A. All tests shall be observed by a representative of the DPW and the Contractor on each manhole. Manholes shall be tested by vacuum methods [see below].

B. Vacuum Testing of Manholes – Leakage tests for four and five foot diameter manholes may be made using vacuum testing equipment. This type of test may be used only immediately after assembly of the manhole and only prior to backfilling. The manhole to pipe connection should only be a flexible connector. All lift holes shall be plugged with a non-shrinking mortar. For this test, each four or five foot diameter manhole shall be tested under 10 inches of Hg vacuum.

Manholes shall be vacuum tested per ASTM C1244 – 11. Manholes shall be prepared by plugging all lift holes and pipes entering the manhole. Care shall be taken to securely brace the pipes and plugs to prevent them from being drawn into the manhole. The test head shall be placed at the top of the manhole in accordance with manufacturer's recommendations and a vacuum of 10 inches of mercury shall be drawn on the manhole, the valve on the vacuum line of the test head closed, and the vacuum pump shut off. The time shall be measured for the vacuum to drop to 9 in. of mercury. The manhole shall pass if the time for the vacuum reading to drop from 10 in. of mercury to 9 in. of mercury meets or exceeds the values indicated in the table below. If the manhole fails the initial

test, necessary repairs shall be made by an approved method. The manhole shall then be retested until a passing test is obtained.

	Testing Time (Seconds) for 48 and 60-Inch Diameter Manhole (inches)	
Depth (feet)	48-Inch	60-Inch
8 (and less)	20	26
10	25	33
12	30	39
14	35	46
16	40	52
18	45	59
20	50	65
22	55	72
24	59	78
26	64	85
28	69	91
30	74	98

C. All excess material including dirt, loose concrete, bricks, grit, stones and any other material, shall be removed from all manholes prior to final acceptance by DPW.

3.12.4 Cured-In-Place Pipeliner Testing

A. Post construction acceptance testing of the rehabilitated sewer shall conform to manufacturers requirements, ASTM D5813-04 (2012 or latest edition) - Standard Specification for Cured-In-Place Thermosetting Resin Sewer Piping Systems, and the requirements of Section 3.3.2.

B. For each separate manhole to manhole segment of CIPP installed, at least one sample shall be prepared and tested in accordance with ASTM F1216 and ASTM D790. A “restrained” sample shall be taken for pipes 18-inches or less in diameter. A “flat plate” sample shall be taken for pipes more than 18-inches in diameter. The proposed testing laboratory shall be submitted for approval to DPW. Samples shall be tested to verify that the flexural modulus, flexural strength, and wall thickness of the CIPP are at least equal to the parameters proposed in the approved design submittal.

3.13 Sewer Abandonment

A. Pipes left in place that are equal to or less than 6 inches in diameter may be left unfilled.

B. Pipes left in place that are greater than 6 inches in diameter shall be filled with LDCC regardless of material (e.g., DI, PVC).

C. When abandoning asbestos cement pipe, care shall be used to prevent pipe material from becoming friable, thereby rendering it as regulated asbestos containing material.

D. Structures left in place shall be demolished down to five feet below ground surface, the bottom shall be cracked and compacted, and the remaining structure filled with CDF, LDCC, or clean gravel, as directed the DPW Inspector of Construction and Utilities. Demolition debris shall be removed, and the area regraded and compacted over the filled structure.

3.14 Grease Traps

3.14.1 Exterior Grease Traps

A. Exterior grease traps shall be designed by a registered Professional Engineer. The plans shall be stamped and include the design criteria and calculations used to size the grease trap.

B. Grease traps shall be sized in accordance with Massachusetts Uniform State Plumbing Code 248 CMR 10.00 and shall have a minimum capacity of 1,000 gallons. The grease trap shall be sized to provide a minimum of 24 hours of detention time for the design flow.

C. The discharge concentration for grease trap effluent fats, oils, and grease (FOG) shall not exceed 100 mg/l.

D. The grease trap shall be located a minimum of 10 feet from buildings, property lines, water services, and in compliance with all applicable building and zoning codes. The grease trap shall be located where it is accessible for inspection and cleaning.

F. Sanitary wastewater flow into the grease trap is strictly prohibited. Sanitary flow from the building shall connect to a manhole located downstream of the grease trap. A manhole shall be provided upstream and downstream of the grease trap to facilitate bypass and treatment of flows if the grease trap must be temporarily taken out of service.

G. The grease trap shall be constructed of reinforced concrete and shall be designed for AASHTO HS-20 loading at a minimum. A 1-inch thick butyl rubber gasket shall be provided between precast sections of tank. Buoyancy calculations shall be provided by the Contractor, and if necessary, sufficient ballast (such as a buoyancy slab) shall be provided to counteract buoyancy forces when the grease trap is empty, assuming the groundwater table is at the ground surface. Interior baffles shall be provided to retain collected grease and other materials and prevent the discharge of these materials into the City's sewer system.

I. Water cooled grease traps are prohibited.

J. The grease trap shall be tested to demonstrate water tightness prior to acceptance and use. Testing shall consist of a water infiltration / exfiltration test. The grease trap shall be filled to 4 inches below the outlet invert. Leakage into or out of the tank shall not exceed 10 gallons per 1,000 gallons of tank volume in a 72-hour period. Test shall be performed before backfilling, and shall be witnessed by the Department.

K. The grease trap shall be filled to its normal fluid operating depth with clean water prior to its first use.

L. Unless otherwise required by a schedule established by the DPW, owners or operators shall clean grease traps of accumulated grease and oil in accordance with all applicable local, state and federal laws, and no less frequently than a minimum of once every three months or whenever one quarter of the liquid depth of the trap consists of grease or oil, whichever occurs first. Grease traps shall be cleaned by physically removing accumulated grease, scum, oil or other floating substances and solids. Chemical, biological, or physical means (including flushing with water) shall not be used to release fats, wax, oil, or grease into the sewer, bypass the trap, or otherwise make the trap operate less effectively.

3.14.2 Interior Grease Traps

A. At locations where Exterior Grease Traps cannot be constructed to serve a building, an interior grease trap shall be provided. Interior grease traps shall be the automatic grease and oil removal type and sized and installed in accordance with Massachusetts Uniform State Plumbing Code 248

CMR 10.00. The grease trap shall be sized using a one (1) minute drain down period. The grease trap shall be cleaned of accumulated grease and oil based on the manufacturer's recommendations, applicable local, state, and federal laws, at a minimum monthly, or on a more frequent basis at the discretion of the DPW. A sample point downstream of the grease trap shall be provided to permit sampling at the digression of DPW to ensure compliance.

4 Stormwater Construction Standards

4.1 General

A. This Section specifies requirements for a stormwater management (aka drainage) systems, including conveyance and water quality structures.

B. Groundwater and stormwater runoff should be managed on-site to the extent possible. On-site retainage of stormwater and implementation of other stormwater management measures to control the rate, volume and characteristics of stormwater discharged to the City's storm drainage systems shall be required whenever feasible, with exceptions to be approved by the City. Storm drains, catch basins, manholes, retention/detention structures, water quality structures, permeable surfaces, and related best management practices (BMPs), shall be installed where necessary to provide adequate treatment and onsite infiltration or offsite disposal of surface water from all streets and adjacent land as shown on the proposed plans that require approval by the City prior to construction.

C. Groundwater shall not be managed by or discharged (such as by sump pumps) into the stormwater system. Lowest level floors and the bottom of stormwater BMPs should be at least 3 feet, but no less than 2 feet, above the seasonal high ground water table. The seasonal high ground water table should be field verified at the site.

D. No stormwater discharge shall cause or contribute to an exceedance of water quality standards. Additional stormwater quality controls may be required to reduce pollutant loading from drainage systems that ultimately discharge to a water body listed as an impaired water on the most recent Massachusetts Integrated Report of Waters.

E. Stormwater drainage systems shall incorporate Low Impact Development (LID) techniques, where feasible.

F. No stormwater discharge (point or sheet flow) shall cause flooding or erosion on adjacent properties. Driveways, aprons, and other entrances to the street shall be constructed to prevent roadway drainage from entering the private property.

G. Work under this section shall comply with federal, state, and local requirements. All private and public stormwater management systems shall comply with the most current National Pollutant Discharge Elimination System (NPDES) requirements.

H. The Developer shall process and record permanent easements for communal drainage structures or BMPs located on private property.

I. Calculations and designs shall demonstrate compliance with the DEP Stormwater Management Standards. The specified design storms shall be defined as a 24-hour storm using the rainfall distribution recommended by the National Oceanic and Atmospheric Administration (NOAA) Atlas 14, as amended.

I. Submittals required for stormwater projects include:

1. Designs and calculations showing: post-construction runoff will be equal to or less than pre-construction conditions, recharge, and pollutant removal.
2. Erosion and sediment control plan
3. As-built Plans
4. Recorded easements

5. Long-term operation and maintenance plan for all permanent stormwater management measures. Such a plan shall include non-structural and structural measures to manage stormwater after construction of the new or expanded facility. An approved long-term operations and maintenance plan for that stormwater system shall be recorded with the deed at the Massachusetts Registry of Deeds.

4.2 Erosion Control

A. All construction shall comply with the City's By-Laws/Ordinances regarding clearing, erosion control, and stormwater management. In addition, construction shall comply with any applicable federal and state requirements, including but not limited to National Pollutant Discharge Elimination System (NPDES) Construction General Permit.

B. Silt fencing may be used as one of the primary erosion control measures. Silt fence shall consist of a sheet of synthetic fabric such as polypropylene, nylon, polyester, or polyethylene yarn. Silt fence shall be erected in a continuous fashion from a single roll of fabric. The bottom of the fabric fence shall be buried sufficiently below the ground surface to prevent gaps from forming, usually 4 to 6 inches below ground surface. The fabric shall be installed on the upstream side of the stakes. Stakes shall be strong enough and tall enough to securely anchor the fabric to the ground. Stake spacing shall be no more than 10 feet apart for extra-strength fabric and 6 feet apart for standard strength fabric. Maintenance of the fence is required during construction. Material shall be based on the synthetic fabric requirements as follows:

1. Filtering efficiency: 75% (minimum)
2. Tensile strength: Standard strength: 30 lb./linear inch (minimum), Extra strength: 50 lb./linear inch (minimum)
3. Elongation: 20% (maximum)
4. Ultraviolet radiation: 90% (minimum)
5. Slurry flow rate: 0.3 gal/ft2/min (minimum)

C. Fiber rolls or an approved equal may be used as another primary erosion control measures. Fiber rolls shall be trenched between 3 and 5 inches into the ground, depending on the size of the fiber roll. Fiber rolls shall be staked securely into the ground using wood stakes. A minimum of 3 inches of the stake shall stick out above the roll. Stakes shall be spaced 3 to 4 feet. Fiber rolls placed around drain inlets shall be placed a minimum of one (1) foot back from the inlet.

For slope stabilization, fiber rolls shall be placed perpendicular to the expected flow of stormwater runoff, with the following separation:

1:1 slopes = 10 feet apart
2:1 slopes = 20 feet apart
3:1 slopes = 30 feet apart
4:1 slopes = 40 feet apart

D. Gravel aprons shall be installed at the entrance of construction sites or where new roads under construction are being connected to the public way to prevent sediment from the construction site entering the roadway. Aprons shall be a minimum of 25 feet in length and the width of the proposed street or at least 15 feet in width and filled with 6 inches of 2-inch crushed stone. Regular maintenance to remove trapped dirt and to replace stone shall be provided to keep the public way clean.

E. Silt sacks (or equivalent) shall be placed in down gradient catch basins to prevent sediment from entering the drainage system. Silt sacks shall be periodically cleaned while in use and must be cleaned prior to and after precipitation events. Contractors are advised they may be required to

respond immediately for repair and maintenance at the request of the City within two hours of notification.

F. All soil stockpiles to be in place for more than 14 days shall have erosion controls (e.g., fiber rolls) installed on the down gradient side to prevent migration of soils.

G. All erosion and sediment controls shall remain in effective operating condition during construction activities. The contractor shall inspect all erosion and sediment controls regularly and make the necessary repairs or modifications to ensure effectiveness or as directed by the City Inspector.

H. The contractor shall initiate soil stabilization measures immediately whenever earth-disturbing activities have permanently or temporarily ceased on any portion of the site. The contractor shall complete soil stabilization measures as soon as practicable, but no later than 14 calendar days after the initiation of soil stabilization measures.

4.3 Private Connections to City Drainage System

A. In general, discharge of groundwater or stormwater runoff from sources on private property to the City's drainage system or right-of-way is prohibited. This includes sump pumps, foundation drains, roof downspouts, and runoff from driveways and yards. However, when suitable alternatives do not exist, private drainage systems may be connected to the City drainage system with approval from the DPW.

B. New private stormwater management systems that connect to the City's drainage system shall be approved by DPW and shall be constructed, installed, maintained, repaired, and operated to the satisfaction of the DPW

C. Private drains, including building storm drains for new or existing buildings, groundwater sump drains, cellar drains, and drains from irrigation systems, shall not be connected directly to the City's sanitary sewer system. Illicit connections to the sanitary sewer system shall be removed by the property owner at their expense.

D. For redevelopment projects, existing connections to the City's system that will remain connected shall be video inspected to verify pipe condition and ensure integrity prior to approval of redevelopment plans. The inspection should be witnessed by DPW staff.

E. Proposed private connections must discharge to the City's drainage system by gravity. If the private stormwater system is lower than the City's system, stormwater shall be lifted by approved means to a structure on the private property prior to connecting to the City's MS4.

F. The City assumes no responsibility for the installation and maintenance of private connections or for any damage that may result from their failure or from water backflow from the City's drainage system. The owner is required to submit a waiver to this effect, signed and dated by the owner.

G. Private connections shall include a backflow preventer, cleanout, and a shutoff device in such places that all fittings are accessible to the municipality.

4.4 Drainage Piping

4.4.1 Pipe Material

4.4.1.1 PVC

A. Polyvinyl chloride (PVC) pipe shall not be used in drainage systems within the City right-of-way or other roadways, except for underdrains.

B. The DPW prefers headwalls to pipe ends for most drainage conditions. Designs for pipe ends shall be submitted for approval by the DPW.

C. Minimum inside drainage pipe diameter – 12 inches

D. Outfall protection (e.g. headwalls, riprap) shall be constructed at the open ends of any drainage pipes.

4.4.1.2 High Density Polyethylene (HDPE) Pipe

A. The DPW prefers HDPE for drainage piping.

B. The pipe shall conform to MassDOT Section M5.03.10. Pipe shall be smooth interior wall and corrugated exterior wall, and be water-tight. Pipe shall be minimum 12-inch diameter. Ends shall be bell-and-spigot unless approved by the DPW for the specific application. Pipe shall comply with the requirements for test methods, dimensions and markings found in AASHTO Designations M252 and M294. Pipe shall support an HS-20 live load with a maximum deflection of 5% of the minimum pipe diameter. Pipe and fittings shall be made from virgin polyethylene compounds which conform to the applicable current edition of the AASHTO Material Specifications for cell classification as defined and described in ASTM D3350. Nominal sizes of 12- to 60-inch shall be either AASHTO Type 'S' or Type 'D.'

C. Flared end HDPE sections shall conform to MassDOT Section M5.03.10. They shall also meet AASHTO Designations M252 and M294 as well as cell specifications in ASTM D3350.

4.4.1.3 Reinforced Concrete Pipe (RCP)

A. Pipe and flared ends shall conform to the AASHTO M170 for Standard Strength Reinforced Concrete Culvert Pipe for class III Pipe, Wall B. or ASTM C76 for Reinforced Concrete Culvert and Storm Drain Pipe. All pipe 24 inches in diameter or smaller shall be of the bell and spigot type. Pipes larger than 24 inches in diameter shall be tongue and groove or bell and spigot. A preformed flexible plastic sealing compound of Butyl Mastic Rope Sealer ” 1" size, "EZ Stick" as manufactured by Concrete Products supply or an approved equal shall be used for sealing water-tight joints.

B. Flared end RCP sections shall be fabricated to conform to the requirements of AASHTO M170, Class III except the edge bearing tests shall not be required. The flare shall be of the same thickness and materials as the barrel and shall have steel reinforcement equaling or exceeding the requirements of AASHTO M170, Class III except that a double row of steel will not be required. The end sections shall meet MassDOT Standard Specifications Section 230 and MassDOT Construction and Traffic Standard Details Drawing 206.8.0.

4.4.2 Pipe Laying

A. Pipe, manholes, catch basins, and leaching basins shall be laid in any of the following materials, as specified hereafter or as approved by the inspector.

1. Pea stone (3/8 inch in size)
2. Angular crushed stone or rock, dense or open graded with little or no fines (¼ inch to 1 ½ inches in size).
3. AASHTO classifications A1 and A3: Clean, coarse grained materials, such as gravel, coarse sands and gravel/sand mixtures (1 ½ inches maximum in size).
4. AASHTO classifications A-2-4 and A-2-5: Coarse grained materials with fines including silty or clayey gravels or sands. Gravel or sand must comprise more than 50 percent of Class III materials (1 ½ inches maximum size).

5. Reuse of approved native material shall be sifted to remove rocks larger than 3 inches.

B. Pipe bedding material shall be carefully and lightly tamped under pipe to provide uniform support. Fill to a minimum depth of 12 inches above the top of the pipe. Material for backfilling the rest of the trench, except for sub base (top 15 inches) shall be suitable material, approved by the DPW Inspector. The compaction process shall be material placed in 12-inch lifts and thoroughly compacted by mechanical rammers, vibrators, or other methods to be approved by the Department (e.g., hydraulic plate compactors) to 90 percent Modified Proctor density in off-road or nonstructural areas and 95% in roadway or structural areas. Haunching large-diameter pipes (greater than 30 inches) shall be performed using maximum 8-inch lifts and compacted to 90 percent standard proctor density. Bucket compaction will not be accepted.

C. Minimum Drain Pipe Grades

1. Main lines and cross runs – grades 1% minimum
2. Building storm drainage stubs – 1% minimum
3. Subdrain – 0.5% minimum
4. All other – 0.5% minimum.
5. Any slope greater than 8% requires Department approval.

D. The bottom of the trench shall be excavated to a flat grade 6 inches below the pipe invert for trenches in suitable earth and 12 inches below pipe invert for trenches in rock. When rock or ledge is encountered it shall be removed to such widths as will give a clearance of at least 12 inches on each side of the pipe or other structure and a sand cushion used. The width of trenches shall be sufficient to allow thorough compacting of the refill adjacent to the lower quarters of the pipe

E. Water tight joints shall be used. Pipe shall be watertight according to the ASTM D3212. Joint design shall be bell-and-spigot with an elastomeric rubber gasket meeting ASTM F477 or equal approved by the DPW Inspector.

F. Trenches at pipe joints shall be excavated as necessary to give ample room for properly making and inspecting the pipe joints. RCP joints shall be cement mortared (as specified in MassDOT Section M4.02) carefully placed in the joints around its entire perimeter and mixed relatively dry, in the ratio of one part cement to two parts sand.

G. When laying pipe in groundwater, pipe material and method of installation shall be approved by the DPW Inspector. A qualified engineer shall be consulted to determine dewatering methods, if needed. Water must not be permitted to rise in the trench until all pipes have been securely bedded, jointed and observed by the City and until backfilling has progressed to an elevation at least one foot above the top of the pipe. Temporary plugs shall be installed in open ends of pipe to prevent silt from washing into pipe during construction; and open ends of the pipe shall be closed with suitable plugs upon suspension of the work for any reason.

H. The minimum cover over drainage pipes shall be 3 feet below the pavement slab or as specified by the type of pipe per manufacturer's specifications, whichever is greater. Where the clearance is less than 1 foot below the pavement, provide a design method to maintain the integrity of the pipe and right of way. For drainage pipe outside of the pavement, the minimum cover shall be 18 inches or as specified by the type of pipe, whichever is greater.

I. Pipe ends shall be accurately aligned on compacted gravel fill unless otherwise approved by the DPW. Rip Rap stone shall be placed to line and grade as shown on the plans on a prepared bed of embankment material or existing materials. Each stone shall be placed or embedded to prevent erosion and displacement. Stone size shall be determined by the design storm flow discharging from the pipe.

J. Drainage pipe shall be installed with minimum distance from water pipes as summarized below.

1. *Horizontal Separation:* Drainage mains shall be located at least 5 feet horizontally from sewer mains. The distance shall be measured from inside edge of pipe.
2. *Vertical Separation:* Drainage mains shall be laid to provide a separation of at least 18 inches from either water or sewer lines. The minimum vertical separation is measured from outside of water or sewer main to outside of the storm drain main.
3. At crossings, sewer should cross under drainage lines.
4. When it is impossible to obtain horizontal and/or vertical separation as stipulated above, DPW shall be given the opportunity to review and provide more stringent requirements.

4.5 Drainage Manholes

A. Drainage manholes shall have a minimum inside diameter of 4 feet minimum. Manholes over 12 feet in depth shall have minimum of 5 feet inside diameter.

B. A drainage manhole shall be located at any change in direction or slope of a drain pipe. A drainage manhole will be constructed at private connections to the City's drainage system, unless otherwise approved by DPW.

C. Manholes shall be constructed in series and shall have a distance of no more than 250 feet between manholes, unless otherwise approved by DPW.

D. Cross-drain inverts should, where possible, enter the structure a minimum of one foot (1') above the outgoing invert.

E. When drop manholes are used the drop shall not be more than 3 ½ feet.

F. Contractor shall excavate to a depth of 12 inches below the bottom of and all around the proposed manhole, compact and fine grade and install washed screened gravel as a sub-base material. Pipes shall extend no more than 3 inches inside the interior wall and all openings around pipe entrances and lift holes shall be thoroughly grouted with non-shrink grout prior to back filling. Compaction process shall be the same manner as compaction around pipe.

G. When ground water is higher than the elevation of the bottom of the manhole, ¾-inch to 1-inch washed stone shall be placed around structure to a distance of at least half-way up the barrel of the highest pipe. The manhole shall be tested for tightness prior to backfill and approval.

H. Precast Manholes shall be constructed of reinforced precast concrete monolithic base section, barrel section and dome section meeting the latest applicable requirements of ASTM C478 I and AASHTO M 199, or latest revision thereto. Special manholes shall also meet the requirements of MassDOT Standard Specifications, Section M4.02.14, Precast Units. After curing a minimum of 14 days, the outside surface of the tapered or cone section of precast cement concrete drainage structures shall be dried and cleaned. Pre-cast manholes shall not have steps installed.

I. Constructed in Place Manholes shall be built of precast sump, 6-inch concrete barrel blocks, and 4-inch (pie) plates with an inside diameter of 4 feet. Such manholes shall have a solid (impenetrable) sump. Cement concrete blocks shall conform to ASTM C139. As circular concrete block walls are laid, the horizontal joints and key ways shall be flush full with mortar. As rectangular blocks are laid, all horizontal and vertical joints shall be flushed full with mortar.

J. All joints between the frame, grade rings, dome, barrels and base shall be set in place with non-shrink mortar. Inside the manhole, all joints where the sealing material is not flush with the inside wall shall be grouted with nonshrink mortar and finished by hand / wet-brushed. Tongue and groove sections between barrel sections shall be mortared or use butyl rubber sealants.

K. Risers shall be brick, not concrete blocks. Risers shall be clay or shale brick, and shall conform to the requirements of AASHTO M 91, Grade MM or as specified in MassDOT M4.05.

L. Grade adjustments shall be made using either precast grade rings/risers or clay/shale bricks.

M. Live load design shall be H-20 loading.

N. Manhole frames and covers

1. Manhole frames and covers shall be minimum Class 25 conforming to ASTM “Standard Specification for Gray Iron Castings,” Designation: A48. Manhole frame shall have a clear opening of 26 inches and be a minimum of 6 inches in height.
2. The surface of the cover shall have a diamond pattern with the words "FRAMINGHAM DRAIN" if in the public right-of-way or “DRAIN” if on private property cast thereon for drainage manholes.
3. All manholes frames and covers shall be manufactured by East Jordan Iron Works (formerly LeBaron Foundry Co.) or an approved equal.
4. Manhole covers shall be watertight when placed in the 100-year flood plain, wetland areas, cross country easements, or as determined by DPW, and as specified in federal, state and local regulations. Manhole frames shall be set on a grout pad to make a watertight fit. Watertight manhole covers shall be secured with four (4) stainless steel bolts and have a watertight gasket. The frame and cover shall be watertight up to 15 psig external pressure.

N. The tops of frames and covers shall be set 1/8 inch below finish grade pavement in the street. Final grade locations for installations outside of the paved roadway shall be as approved by the DPW Inspector.

O. Frames shall be set upon a full bed of mortar, and mortar shall be brought up alongside of frame to provide a water-tight joint.

4.6 Catch Basins

A. Catch basins shall be installed on both sides of the roadway, at low points in the roadway, and near the upper point of curvature of the curb roundings of intersecting streets. Catch basins shall not be installed in the roadway within driveway entrances.

B. Catch basins shall be located so that the maximum distance which water will have to flow over the surface shall not be greater than 250 feet.

C. Catch basins shall be connected to manholes and not to other catch basins. Chain basins are prohibited.

D. All basins shall have a sump of at least 48 inches (4 feet) below the invert of the outlet pipe, or otherwise approved by the DPW, and an inside diameter of 4 feet minimum.

E. Contractor shall excavate to a depth of 12 inches below the bottom of and all around the proposed catch basin base, compact and fine grade and install washed screened gravel as a sub-base material. Pipes shall extend no more than 3 inches inside the interior wall and all openings around pipe entrances and lift holes shall be thoroughly grouted with non-shrink grout prior to back filling. Compaction process shall be the same manner as compaction around pipe.

F. When ground water is higher than the elevation of the bottom of catch basins, ¾-inch to 1-inch washed stone shall be placed 2 feet all around structure to a distance of the high ground water elevation. The stone shall be placed against and over the end of the pipe opening to prevent entrance of the finer filling material. The catch basin shall be tested for tightness prior to backfill and approval.

G. Precast Catch Basins shall conform to ASTM C478 and AASHTO M 199, or latest revision thereto. Live load design shall be H-20 loading. Catch basins which are limited by height shall be installed with a flat top slab, cast in place, designed for H-20 loading and cast iron frame cast in place.

H. Constructed in place catch basins shall be constructed of a precast sump, 6-inch cement block and 4-inch (pie) plates that conform to ASTM C139. Live load design shall be HS-25 loading.

I. Drop (aka Direct) inlet catch basins may be connected to standard catch basins. They shall not be connected to drainage manholes unless otherwise approved by DPW.

J. Circular concrete block walls are laid up the horizontal and key ways shall be flush full with mortar above the outlet invert. The dome or cone section shall be constructed in the same manner. The opening between the plates shall be filled with washed, screened gravel and left open. A 24-inch opening shall be left open at the top for a frame and grate.

K. Grade adjustments shall be made using either precast grade rings/risers or clay/shale bricks.

L. Catch basin grates shall be 24-inch square grate with an 8-inch heavy duty frame, East Jordan Iron Works (formerly LeBaron Foundry Co.), LF248-2-4F. Single or dual catch basin grate shall consist of a 24-inch square grate LeBaron Foundry Co. L24SG1-000 or approved equal with an 8-inch heavy duty frame (MassDOT Standard).

M. Grates shall have the following wording cast into the outside borders: "Dump No Waste" and "Drains to Waterway". Text shall be bold capital letters, at least 1 inch high. Placement may be as per manufacturer

N. All catch basins that do not have a flat top slab designed for H-20 loading and cast iron frame cast in place shall be installed using blocks to make a square hole that will accept a frame and grate, and there shall be at least two full courses of brick for frame adjustment.

O. The tops of frames and covers shall be set 1/8 inch below finish grade pavement in the street. Final grade locations for installations outside of the paved roadway shall be as approved by the DPW Inspector.

P. Frames shall be set upon a full bed of mortar, and mortar shall be brought up alongside of frame to provide a water-tight joint.

4.7 Granite Curb Inlets (Throat Stones)

A. Granite Curb Inlets shall be installed at all catch basins. Granite curb and inlets shall be constructed in conformance with MassDOT Standard Specification Section 501, except that cement concrete shall be placed beneath the center section of each curbstone and as backfill in front and behind the curb.

B. The back face for a distance of 3 inches down from the top shall have no projections greater than 1 inch. The front shall be straight split, free from drill holes, and shall have no projection greater than 1 inch or depression greater than 1/2 inch for a distance of 10 inches down from the top. For the remaining distance there shall be no depression or projection greater than 1 inch. The ends shall be squared with the top for the depth of the face finish. The granite curb inlet shall be 6 feet in length, plus or minus 1/2 inch from 17 to 19 inches in depth, 6 inches wide at the top and at least 6 inches wide at the bottom. The reveal shall be 10 inches.

C. Curb inlets set on a radius of 160 feet or less shall be cut to that radius. The gutter mouth at least 3 inches in depth and at least 2 feet in length shall be cut in the front face of the stone. If there is no other curbing, or as applicable, transitional curbing shall be required on both sides of the inlet. The transitional curbing shall be 6 feet in length, with a height equal to the inlet and tapering to grade at the end.

4.8 Drainage Swales

A. Drainage swales shall be stabilized with vegetation or rip rap to prevent erosion.

B. Drainage swales shall be designed to convey the 2-year and 10-year 24-hour storms.

C. The maximum depth of a swale shall be 24 inches. Side slopes shall be no steeper than 3:1 (horizontal: vertical) with a minimum grade of 0.5 percent and maximum grade of 5%. The minimum bottom width for a swale, whether earthen, gravel, or paved is 2 feet.

D. The bottom of the drainage swale shall be at least 3 feet above seasonal high water table or bedrock.

E. The use of swales draining across a sidewalk into the gutter is generally unacceptable. In those cases where necessary, DPW approval shall be required for the design.

4.9 Structural Stormwater BMPs

A. Post-construction structural Best Management Practices (BMPs) shall follow design practices outlined in Volume 2 of the Massachusetts Department of Environmental Protection (DEP) Stormwater Management Standards: "Structural BMP Specifications for the Massachusetts Stormwater Handbook". Stormwater BMPs shall be built in accordance with approved plans and manufacturer's specifications.

B. This document contains standards for some BMPs. The inclusion of these standards is not meant to be an exhaustive listing of approved BMPs. The *Massachusetts Stormwater Handbook* shall be considered as a guide for other BMPs.

C. In accordance with MS4 permit requirements, all stormwater management systems for new development must be designed to:

1. Retain the volume of runoff equivalent to, or greater than, one (1.0) inch multiplied by the total post-construction impervious surface area on the site OR

2. Remove 90% of the average annual load of Total Suspended Solids (TSS) generated from the total post-construction impervious area on the site AND 60% of the average annual load of Total Phosphorus (TP) generated from the total post-construction impervious surface area on the site. Pollutant removal shall be calculated consistent with EPA Region 1's BMP Accounting and Tracking Tool (2016) or other BMP performance evaluation tool provided by EPA Region 1, where available. If EPA Region 1 tools do not address the planned or installed BMP performance any federally or State approved BMP design guidance or performance standards (e.g. State stormwater handbooks and design guidance manuals) may be used to calculate BMP performance, OR

3. meeting a combination of retention and treatment that achieves the above standards.

D. In accordance with MS4 permit requirements, all stormwater management systems for redevelopment must be designed to:

1. Retain the volume of runoff equivalent to, or greater than, 0.8 inch multiplied by the total post-construction impervious surface area on the site OR

2. Remove 80% of the average annual load of Total Suspended Solids (TSS) generated from the total post-construction impervious area on the site AND 50% of the average annual load of Total Phosphorus (TP) generated from the total post-construction impervious surface area on the site. Pollutant removal shall be calculated consistent with EPA Region 1's BMP Accounting and Tracking Tool (2016) or other BMP performance evaluation tool provided by EPA Region 1, where available. If EPA Region 1 tools do not address the planned or installed

BMP performance any federally or State approved BMP design guidance or performance standards (e.g. State stormwater handbooks and design guidance manuals) may be used to calculate BMP performance.

a. Redevelopment activities that are exclusively limited to maintenance and improvement of existing roadways, (including widening less than a single lane, adding shoulders, correcting substandard intersections, improving existing drainage systems, and repaving projects) shall improve existing conditions where feasible and are exempt from part l above. Roadway widening or improvements that increase the amount of impervious area on the redevelopment site by greater than or equal to a single lane width shall meet these requirements.

E. Areas excavated for stormwater BMPs shall be backfilled with clean fill or aggregate.

F. An appropriate number of observation and access points shall be installed to enable inspections and maintenance.

4.9.1 Proprietary Separators

A. If constructed in the public right-of-way, the City has standardized on Stormceptor hydrodynamic separators or approved equal.

4.9.2 Infiltration BMPs

A. Infiltration BMPs are stormwater runoff impoundment constructed on or beneath the surface over permeable soils. Examples include: dry wells, infiltration pits, chambers, perforated pipes, and galleys. Infiltration systems shall be designed and constructed in accordance with The Massachusetts Stormwater Handbook and the EPA NPDES Small MS4 permit.

B. Pretreatment BMPs shall remove at least 25% TSS. In the following areas, at least 44% TSS shall be removed:

1. Areas with rapid infiltration (greater than 2.4 inches/hour);
2. Land use with a higher potential pollutant loads (LUHPPL);
3. Zone II or an Interim Wellhead Protection Area of a Public Drinking Water Source/Supply;
4. Discharge to or near a critical area (Outstanding Resource Waters or bathing beaches).

C. Infiltration systems shall be designed to treat the runoff volume generated by the 2-year and 10-year 24-hour storms.

D. The bottom of the infiltration system shall be at least 3 feet above seasonal high water table or bedrock.

E. Infiltration systems shall be placed only in soil where the permeability allows a percolation rate of at least 0.17 inch/hour. Percolation rates shall be field verified prior to completion of design, when feasible. Do not allow construction equipment to drive across the area intended to be used for infiltration.

F. The infiltration system shall be designed to drain within three days of filling under normal conditions, and completely dewater between storms.

G. Infiltration systems shall be placed at least 10 feet downslope or 100 feet upslope from any building foundations including slab foundations without basements. Systems shall be placed at least 10 feet from property lines.

H. Infiltration systems shall not be used in the following locations:

1. In industrial and commercial areas where petroleum products, herbicides, pesticides, or solvents may be loaded/unloaded, stored, or applied within the drainage area, especially locations with soluble heavy metals and toxic organics in the runoff;

2. In areas with documented soil contamination;
3. Where the soil around and below infiltration basin does not have the necessary permeability to infiltrate the entire Stormwater Quality Design Storm runoff volume; or
4. Where infiltration would create a significant risk for basement seepage or adversely impact a septic system's disposal field.

4.10 Testing of Drainage System

A. At the discretion of the Department, a mandrel test shall be conducted following completion of pipe laying.

B. Placement of curb, gutter, sidewalk, or asphalt concrete pavement shall not occur until the DPW Inspector has approved the mandrel test. The DPW Inspector shall be present through the duration of the mandrel testing.

C. The allowable deflection (reduction in vertical inside diameter) for all non-rigid pipe shall be 7.5 percent maximum. The deflection shall be tested by pulling a mandrel which is 92.5 percent of the inside pipe diameter through all installed pipe. The mandrel shall be the "go/no-go" type and shall be pulled without mechanical assistance. At each location in which the mandrel cannot pass, the cause shall be ascertained. Obstacles in the pipe shall be removed. If it is determined that the deflection exceeds 7.5 percent, that a gasket has been improperly installed or that the pipe has been damaged due to trenching for another utility, the respective section of pipe shall be re-bedded or removed, replaced and re-bedded using water tight repair couplings. A passing mandrel retest is required. At the contractor's discretion, any sections of non-rigid pipe not passing the mandrel test may be televised to ascertain the problem.

D. A CCTV inspection may be requested after installation, with the results being provided to the DPW.

4.11 Pipe/Structure Abandonment

A. Pipes left in place that are equal to or less than 6 inches in diameter may be left unfilled.

B. Pipes left in place that are greater than 6 inches in diameter shall be filled with LDCC.

C. Structures left in place shall be demolished down to five feet below ground surface, the bottom shall be cracked and compacted, and the remaining structure filled with CDF, LDCC, or clean gravel, as directed the City Inspector. Demolition debris shall be removed, and the area regraded and compacted over the filled structure.

4.12 Long-term Maintenance

A. Private stormwater management systems will be constructed, installed, maintained, repaired, and operated by their owners, at the owner's expense. Ongoing maintenance of stormwater management systems placed on private property, rather than within the City right-of-way limits, shall be responsibility of the property owner or homeowners' association.

B. The owner of any property on which a drainage system is located is responsible for the maintenance and upkeep of the system. The inspection and maintenance of the drainage systems shall be performed at minimum on an annual basis, and more frequently depending on the circumstances.

C. The owner shall provide documents that describe the long-term operation and maintenance of all permanent stormwater management measures. Such a plan shall include non-structural and structural measures to manage stormwater after construction of the new or expanded facility. An approved long-term operations and maintenance plan for that stormwater system shall be recorded with the deed at the Massachusetts Registry of Deeds.

5 Roadway Construction Standards

5.1 General

A. This Section specifies requirements for a roadway design and construction.

B. For the purposes of these Standards, streets shall be classified as Local, Collector and Arterial. These classifications are shown in the City Subdivision Rules and Regulations as Residential Access, Residential Subcollector and Primary.

C. Street design minimum standards for Primary Streets shall conform to the best accepted design practice as recommended by the Institute of Traffic Engineer's Street and Highway Design Manual and the MassDOT Project Development and Design Guide, in consultation with the DPW.

D. Pavement shall be designed to provide a 20-year life based on soil and traffic conditions. The pavement cross section shall be approved by the City Engineer.

E. Nothing shall not interfere with the sight distance of the traveled way.

F. These construction standards need to be met as conditions for acceptance of streets.

A. As-Built Drawings shall be submitted to the DPW upon completion and acceptance of work.

5.2 Roadways

5.2.1 Design

A. Location, alignment, and street design minimum standards for Residential Subcollector and Residential Access shall conform to the requirements contained in the current edition of the City of Framingham Subdivision Regulations and the following Street Design Minimum Standards.

Street Design Minimum Standards

Characteristic	Street	
	Residential Subcollector	**Residential Access**
Maximum Grade	6%	8%
Minimum Grade	1%	1%
Maximum Grade of leveling area at approach of Intersections (negative grade required)	2% for 100 feet	2% for 50 feet
Horizontal Alignment: • Minimum radius at centerline	500 feet	200 feet
Vertical Alignment: • K - Value	30 feet per percent Change in grade, 100 feet min.	25 feet per percent Change in grade, 100 feet min.
Width in all Zoning Districts except R-4: • Street width (see note 2 below) • Roadway width	60 feet 28 feet	60 feet 24 feet
Width in all Zoning Districts R-4: • Street width (see note 2 below) • Roadway width	80 feet 26 feet	70 feet 24 feet
Intersections • Minimum intersection angle	70 degrees	70 degrees

• Minimum distance between entering streets not Directly opposite each other	275 feet	275 feet
Minimum radius:	25 feet	20 feet
○ Street sideline	32 feet	27 feet
○ Curb radius	See note 1 below	See note 1below
• Stopping Sight Distance		
Sidewalk Width	5 feet	5 feet
Dead-End Streets		
• Maximum length		500 feet
• Minimum length		225 feet
• Maximum radius of Cul-De-Sac:		
○ Street Sideline Radius		70 feet
• Minimum radius of Cul-De-Sac:		
○ Street Sideline Radius		60 feet
○ Curb Radius		45 feet
○ Island Radius		20 feet

Note1. Stopping sight distance, measured 25 feet from the edge of the intersection traveled way, shall be provided. The stopping sight distance requirement shall be calculated using a hypothetical travel speed that is 10 m.p.h greater than the posted or designed speed. A clear sight distance at 3.75 feet above pavement to 0.5 feet above pavement shall be maintained. Landscaping, fencing and other structures may not be sited where they could obstruct the required sight distances or could otherwise jeopardize safety.

Note 2. Right-of-way widths in excess of the standard street widths designated in Table 1, above, shall be required where, due to topography, additional width is necessary to provide adequate earth slopes. Such slopes shall not be in excess of four-to-one.

B. Property lines at residential street intersections shall be rounded or cut back to provide for a radius of at least 7 feet less than the curb radius.

C. The maximum grade for cul-de-sacs shall be four percent (4%).

D. The minimum pavement cross section shall be:

1. Local Streets: 1.5 inches of Top Course material placed on 2.5 inches of Binder Course material founded on 4 inches of Dense Graded Crushed Stone on 8 inches of Processed Gravel or Dense Graded Crushed Stone. This pavement structure shall be placed on the backfill.

2. Collector Streets: 2 inches of Top Course material placed on 4 inches of Binder Course material placed in two equal courses founded on 4 inches of Dense Graded Crushed Stone on 8 inches of Processed Gravel or Dense Graded Crushed Stone, with at least 4 inches of natural subbase.

3. Arterial Streets: 3 inches Modified Top Course material placed in two courses on one 5-inch course of Binder Course material founded on 4 inches of Dense Graded Crushed Stone on 8 inches of Processed Gravel or Dense Graded Crushed Stone with at least 4 inches of natural subbase.

5.2.2 Clearing (including excavating or stripping poor material)

A. All vegetation and debris shall be removed within the Right of Way unless specified by the DPW to remain. Then all muck (peat) and topsoil shall be entirely removed from the Right of Way. All material that does not conform to Special Borrow (MassDOT Standard Spec. M1.02.0) shall be removed to a depth of 16 inches below finish grade. No utilities shall be installed until this requirement is completed.

5.2.3 Subgrade

A. All fill areas within 4 feet of the proposed subgrade shall be filled with Special Borrow except it shall contain no stone larger than 6 inches in greatest dimension and shall be placed and compacted in layers not exceeding 12 inches in depth, compacted measurement.

1. Special borrow for fill shall conform to MassDOT Standard Spec. M1.02.0.
2. Processed gravel for subbase shall conform to MassDOT Standard Spec. M1.03.1.
3. Gravel borrow shall conform to MassDOT Standard Spec. M1.03.0, Type b.
4. Washed crushed stone for subbase shall range in size from ¾ inch to 1½ inch, conforming to MassDOT Standard Spec. M2.01.4 to M2.01.2 and shall be hard, durable and reasonably free from flat or laminated particles to furnish free draining material.

B. All cut areas shall be excavated to16 to 20 inches below finish grade, unless the material meets the standard for Gravel Borrow. Fill areas with a depth 4 feet or greater shall be filled with Special Borrow. All filled areas shall be rough graded and compacted to not less than 95 percent of the maximum dry density of the material as determined by the Standard AASHTO Test Designation T 99, Compaction Test Method C at optimum moisture content.

C. The subgrade shall be shaped to a true surface conforming to the proposed cross section of the roadway and compacted in accordance with the procedure stated above. All depressions and high spots shall be filled with special borrow or removed and compacted until smooth and satisfactorily compacted. A tolerance of 1/2 inch above or below the finish subgrade will be allowed provided that 1/2 inch above or below grade is not maintained for a distance longer than 50 feet and that the required grade is maintained in the subgrade. Any portion of the subgrade which is not accessible to a roller shall be compacted with mechanical tampers. The DPW shall approve subgrade construction before sub-base material and pavement is applied.

D. Before the gravel is spread, the subgrade shall be prepared as noted above and shaped to a true surface conforming to the proposed profile and cross section of the road. Gravel shall be spread and rolled true to lines and grades with an approved three-wheel roller or approved equal, weighing not less than ten (10) tons to yield an 8-inch depth after rolling. All sub-base layers shall be compacted to not less than ninety-five (95) percent of the maximum dry density of the material as determined by the Standard AASHTO T99 compaction test: method C at optimum moisture content. Any depression that appears during or after rolling shall be filled with gravel borrow or dense-graded crushed stone and compact until the surface is true and even. When required by the DPW, samples of the gravel to be used shall be tested for gradation by a sieve analysis and the compacted gravel shall be tested for compaction. All tests shall be paid for by the Contractor.

E. Dense graded crushed stone shall be placed and compacted to produce a 4-inch layer on top of the gravel sub-base in conformance with MassDOT Standard Spec. Section 402. Dense graded crushed stone for subbase shall conform to MassDOT Standard Spec. M2.01.7.

5.2.4 Pavement

A. Hot Mix Asphalt (HMA) shall conform to MassDOT Standard Section M 3.11.00.

B. Superpave shall conform to MassDOT Document 00717

C. The binder course material shall be applied to the prepared sub-base with a 3/8-inch pitch per foot from crown to gutter line. Tack coat shall be required between the binder course and top course as specified in the MassDOT Standard Sections 460 and M3.11.06. Hot Mix Asphalt placement shall conform to MassDOT Standard Section 460.

D. Pavement shall not be placed on frozen material or when weather conditions predict freezing temperatures. When binder course will be left over winter months, all castings shall be set to surface grade of the binder course of asphalt for the winter season and then reset before the top course of pavement is applied. No permanent asphalt pavement shall be laid after November 15th or before April 1st, unless approved by the DPW.

E. The setting of granite curbing, the installation of utilities, and any other construction that is required in a street shall be completed before the finish course of bituminous concrete is laid

5.2.5 Pavement Markings

A. To match existing pavement marking applications, pavement markings shall be white or yellow reflectorized thermoplastic, epoxy, or other matching material conforming to MassDOT Standard M7.01. For existing pavement marking applications, pavement markings shall be placed in conformance with MassDOT Standard Section 860

B. For all new roadway construction, pavement markings shall be white or yellow reflectorized epoxy pavement markings conforming to MassDOT Engineering Directive E-05-003, dated June 16, 2005 and to MassDOT Standard Section 860. New pavement markings shall be placed in conformance with MassDOT Engineering Directive E-05-003, dated June 16, 2005.

C. Traffic markings must be restored by end of day, either after removal or paving. Temporary markings are allowed.

5.2.6 Curbing

A. Curbing shall be installed in the gutter line of all proposed roadways. Curbing shall be set with a 7-inch reveal.

B. If constructed in the public right-of-way, the City has standardized on granite curbing. Granite curbing and inlets shall be type VA-4, conforming to the requirements of MassDOT Standard Specifications.

C. HMA or Bituminous Berm may be used as approved by the DPW. Hot mix asphalt (HMA) curbing shall be type 1, 2, or 3, conforming to the requirements of MassDOT Standard 106.2.0. HMA Berm shall conform to MassDOT Standard Section M3.11.0. HMA Curb shall conform to MassDOT Standard Section M3.12.0. Bituminous Berm shall conform to MassDOT Standard Section 470. Bituminous Curb shall conform to MassDOT Standard Section 501.

5.3 Driveways

A. Driveways and private entrances shall be designed, permitted and constructed to conform to City of Framingham Bylaw (Article VI, Section 8) and MassDOT standards. A plan stamped by a licensed professional engineer is required for commercial and industrial development. The engineer's plan must include calculated safe sight distances in each direction. Construction cannot begin until the plan is approved by the City Engineer.

B. Residential driveways (not on scenic roads) shall have a minimum width of 12 feet and a maximum width of 20 feet.

C. Driveway aprons and other sidewalk areas where vehicular traffic may reasonably be expected to occur shall be laid in one course, 6 inches thick, and shall be constructed to the same specifications as sidewalks and meet the proposed sidewalk grades.

D. Driveways shall be located a minimum of 25 feet from any intersecting street corner radius.

5.4 Guard Rail

A. Guard Rail shall be COR-TEN® with steel or wood posts in conformance with MassDOT Standard M8.07.0. Guard Rail shall be constructed in conformance with MassDOT Standard Section 601. See Construction Details for requirements.

5.5 Signs

A. Proposed sign locations shall be staked in the field for review and approval by the City prior to installation.

B. Street signs shall use only upper-case white letters with a blue background. Sign dimensions, material, colors, text and post height shall conform to the latest version of the MUTCD.

C. Traffic signs shall be reflectorized aluminum in conformance with MassDOT Standard Sections 828 and M9.30.0.

D. Traffic signs shall not be screen printed, with the exception of STOP, YIELD, and DO NOT ENTER signs. All should be of a vandal / graffiti proof type.

E. Sign orientation to roadway shall follow the latest version of the MUTCD.

5.6 Sidewalks

A. Sidewalks shall be a minimum width of five (5) feet.

B. Portland Cement Concrete for sidewalks shall conform to the applicable requirements of Section M4 and Section 701 of the MassDOT Standard Specifications. FIBERMESH fibers (100% virgin polypropylene, collated, fibrillated fibers) at a rate of 1.5 lb. per cubic yard of concrete shall be added for reinforcement. Installation shall be per manufacturer's recommendations.

C. Concrete shall be installed on an 8-inch gravel sub-base prepared in the same manner as for the traveled way with a minimum width of five feet six inches (5'6"). Satisfactory forms shall be installed to assist in securing proper alignment. The concrete walk surface shall be laid in one course to a finished depth of 4 inches. The walk shall have a cross slope of 1.5 percent toward the roadway to provide proper drainage.

D. Testing of grade shall be done with a 10-foot straight edge placed parallel to the center line of the course; there shall be no deviation from a true surface in excess 1/4 of an inch.

E. Sidewalks shall be broom finished prior to scoring. The sidewalk slab shall be scored to form 5-foot panels. Traverse preformed expansion joints shall be installed at 30-foot intervals.

F. Wheelchair ramps shall be 6 inches thick and shall be installed in strict compliance with the current AAB/ADA Rules and Standards. Wheelchair Ramps and brick red Detectable Warning Panels shall be installed in accordance with the "Rules and Regulations of the Architectural Access Board – 521 CMR."

G. Truncated dome warning panels shall be brick red in color.

5.7 Loam and Seed

A. Side slopes shall be constructed at a maximum slope of 4 feet horizontally to 1 foot vertically (4:1) from the edge of the street side lines to the existing ground surface. Slopes shall be covered with loam, 6 inches in compacted depth, and fertilized, limed and seeded.

B. The loam grassed areas shall be 6 inches thick. Fertilizer shall be applied to the loam at a rate of 0.2 pounds per square yard and worked into the seed bed with an application of lime, if needed to

achieve the required pH range. As soon as the seed is sown, it shall be covered with a thin layer of loam, rolled and watered. The grass strip shall be seeded at the rate of 3.6 pounds per 100 square yards. Grass shall grow to a satisfactory cover before being accepted by the City.

C. In locations where erosion is possible, erosion controls shall be in place until the vegetation has substantially rooted. Erosion, gullies and other damage will need to be reseeded as necessary until an adequate growth of grass is achieved

D. Loam Borrow shall conform to MassDOT Standard Spec. M1.05.0 or shall be the product of a commercial sand and gravel processing facility. It shall be uncontaminated by saltwater, foreign matter, or substances harmful to plant growth. The acidity range of the Loam Borrow shall be pH 5.5 to 7.0.

E. Fertilizer shall be of a 10-6-4 composition.

F. Seed composition shall be 60% Red Fescue, 20% Red Top, 20% Kentucky Blue. Seed shall be of the previous year's crop and in no case shall the weed seed content exceed 1% by weight.

5.8 Granite Bounds and Monuments

A. All existing roadway monumentation shall be inventoried and protected. Any and all proposed impacts shall be brought to the attention of the Engineering Division immediately.

B. The Engineering Division shall be notified immediately if any survey monuments are uncovered, exposed or damaged.

C. Bounds shall conform to MassDOT Standard Spec.M9/04.8. They shall be 4 feet in length. Granite bounds shall be of sound granite, the top and bottom faces parallel and the front and back shall be straight split. The bounds shall be cut to the dimensions shown on the detail and shall be plain or lettered as indicated on the plans or as directed. The stone shall be pointed on the top and on four sides and for a distance of not less than 6 inches below the top. The top shall be 6 inches square and shall have a drill hole in the center 1.5 inch in depth and 0.5 inch in diameter, with the bottom somewhat flared.

D. Any damage to roadway monuments prior to acceptance by the City shall be repaired in a manner satisfactory to the DPW and the full cost of such repair shall be paid by the Contractor. Any material used which does not meet the standards of the DPW shall be replaced by the Contractor at no cost to the City. The monumentation shall be replaced, realigned, and/or reset to its intended position and certified as to the correct location by a Massachusetts registered professional land surveyor. All proposed impacts shall immediately be brought to the attention of the Engineering Division. Bounds shall be of granite as directed and shall be set at points designated by the Engineer and in conformity with these specifications. Replacement or new bound installation shall be directly overseen by a Professional Land Surveyor licensed in the Commonwealth of Massachusetts. Surveyor’s notes and layout data shall be provided to the Engineering Division.

E. Bounds shall be set in conformance with MassDOT Standard Specification Section 710. The bounds shall be set at the depth and position as directed, and they shall not project above the ground more than 6 inches after final grading. Bounds located in lawns shall be set with the top of the bound 2 inches below the surface. Bounds located in sidewalks or drives shall be set with the top of the bound flush with the surface. Material for backfilling shall consist of suitable excavated material carefully placed about the bound and thoroughly tamped. When the excavation is in earth not suitable for backfilling, the Contractor shall furnish clean gravel or sand for backfill.

F. When the bound location falls on solid ledge and the use of a drill steel rod is directed by the Engineer, a 1.5 inch hole shall be drilled to a depth of 18 inches and a drill steel rod as specified under Subsection 710.40 shall be placed in the hole. The rod shall be set so that the hole is on the

bound point. The drill steel rod shall project above the ledge from 1 inch to 2 inches, and shall be grouted with a 1:1 mortar mix.

6 Trenches and Street Openings

6.1 General

A. Any contractor, corporation, public utility or person desiring to open a public way must comply with the City's Street Opening Permit (SOP) policy and the associated standard operating procedures. For further information, please refer to City of Framingham Web site link as follows: https://www.framinghamma.gov/207/Street-Opening-Obstruction-Trench-Permit.

E. All trench repair work must be guaranteed and bonded as required in the City's Street Opening Permit (SOP) policy. All trenches, whether on public or private property, that are at least 3 feet in depth and less than 15 feet in width, regardless of the length, shall be permitted throughout the City of Framingham as required by Massachusetts law, 520 CMR 14.00. All work shall be conducted in strict accordance with the latest OSHA regulations.

F. Work within public roadways is not permitted between November 15 and April 1, unless special approval is granted by the DPW.

E. No excavation shall remain open after working hours (7:00 a.m. to 5:00 p.m. or as specified in specific City requirements). All excavations shall be backfilled and paved, or covered with steel plates as approved by DPW at the end of work each day.

F. Workmanship:

1. The Contractor shall furnish all materials and conduct the job in an orderly, timely, quality controlled manner. Materials shall conform to the specifications in Section 5 Roadway of the City's Construction Standard.
2. The Contractor shall keep a competent foreman and sufficient competent employees to carry on the work with proper speed and in accordance with the requirements of law and other public authorities and to the reasonable satisfaction of the DPW.
3. The Contractor shall conduct the work in a manner that will not unreasonably interfere with other work being done by the City, by contract or otherwise. If deemed necessary by the DPW, the work done under these standards shall conform to the progress of said other work. The Contractor shall cooperate with the contractors or employees who may be doing work for the City, and with public service corporations affected by the work in arranging for storage places, temporary support for structures, repairs, etc.
4. All temporary repairs shall be properly maintained by the Contractor to assure good rideability conditions until the end of the guarantee period or until permanent restoration has been made, whichever first occurs.
5. Permanent pavement restoration accomplished by utility companies shall be properly maintained to assure good rideability conditions until acceptance by the DPW.
6. All existing roadway monumentation shall be inventoried and protected. Any and all impacts shall be brought to the attention of the Engineering Division immediately.

G. Disposal of removed pavement, concrete, soil, or other material shall comply with the DPW's Waste Management and Soil Management specifications. The disposal location and management plan shall be pre-approved by the DPW, prior to the start of any work.

H. All traffic devices, signs, pavement markings or traffic loops disturbed, damaged, altered or removed by the Contractor shall be promptly replaced by the Contractor, unless otherwise directed by the DPW, in accordance with City and State of Massachusetts rules and regulations at the

expense of the Contractor. The Contractor shall promptly repair all other damage caused by the work or activities. Street markings (centerlines, crosswalks, stop bars, lane markings, etc.) and traffic loops shall be replaced no later than thirty (30) days after completion of work or as may be directed by the City Engineer. If work disturbs centerlines or lane markings on primary streets, the Contractor shall place temporary reflective markers immediately after the pavement is placed. Traffic markings must be restored by end of day, either after removal or paving. Temporary markings are allowed.

I. A complete Street Opening Permit shall be submitted to and approved by the DPW prior to commencing work. The DPW requires that a traffic management plan be prepared and submitted for review and approval with the Street Opening Permit application.

6.2 Excavation

A. DIG SAFE shall be contacted to determine the location of all existing underground utilities prior to any excavation. Framingham Fire Department shall be contacted to mark out their lines.

B. The maximum length of open trench permissible at any time shall be two hundred (200 feet) feet, and no greater length shall be opened for pavement removal, excavation, construction, backfilling, repairing, or any other operation without the express written permission of the City.

C. Sections of sidewalks and curbs shall be removed to the nearest real joint or scored line.

D. Tunneling, boring or other methods may be required by the DPW to avoid or minimize pavement removal.

E. Removal of asphalt pavement:

1. All initial excavations into paved street surfaces shall be precut in a neat line with pavement breakers or saws. The initial cutting of the pavement shall be restricted to the area directly over the sidewalls of the proposed trench to be excavated, or as directed by the DPW.
2. Heavy duty pavement breakers may be prohibited by the City when the use endangers existing substructures or other property.
3. No irregular shapes will be allowed. No shape will be allowed that would prevent compaction equipment from adequately compacting all of the area. The shape of pavement cutouts shall be rectangular, or a combination of rectangular and square shapes unless otherwise agreed to by the City and Contractor.
4. Pavement edges shall be trimmed to a neat vertical face free of loose materials and neatly aligned with the centerline of the trench.
5. Unstable pavement shall be removed over cave outs and overbreaks and the subgrade shall be treated as the main trench.
6. The Contractor shall make every effort to avoid damage to existing pavement to remain. Any damage shall be promptly repaired by the Contractor.

F. Removal of concrete pavement:

1. Saw cutting of reinforced Portland cement concrete is required with the depth of the cut being the full depth of the pavement unless otherwise directed by the DPW to retain reinforcement. Sawcutting may be required by the DPW outside of the limits of the excavation over cave-outs, overbreaks and small floating sections.
2. Reinforced concrete pavement, to the extent possible, shall be removed without cutting the reinforcement. The bars or mesh, when cut, shall be severed as close to the center of the

trench as practicable and bent back to permit accomplishment of the work. When the pavement is ready to be permanently replaced, the reinforcement shall be bent back into position and reinforced with other bars or mesh which shall overlap the ends of existing reinforcement not less than twelve (12) inches and be securely wired together. Contact faces between new and existing concrete pavement shall be bonded using an approved epoxy binding agent installed and applied in accordance with the manufacturer's instructions, unless otherwise directed by the DPW.

G. All material excavated from trenches and piled adjacent to the trench or in any street shall be piled and maintained in a manner that will not endanger those working in the trench, pedestrians or users of the streets, and so that as little inconvenience and obstruction as possible is caused to those using streets and adjoining property. The excavated material shall be hauled away from the site by the end of each working day.

H. The Contractor shall secure the necessary permission and make all necessary arrangements for all required storage and disposal sites.

I. When excavated material is laid along the side of the trench, it shall be kept trimmed. Whenever necessary in order to expedite the flow of traffic or to abate the dirt or dust nuisance, toe boards or bins may be required by the DPW to prevent the spreading of dirt into traffic lanes. If any portion of the excavated material is allowed to be used as backfill, it shall be stockpiled separately from all other materials.

6.3 Steel Plates in Roadways

A. Steel plates shall not be used without DPW approval.

B. Steel plates shall not be used between November 15 and April 1 without DPW approval, or at any time when snow or freezing rain is forecasted.

A. Plates and supporting members shall be steel, either new or used.

1. All materials shall be sound and free of damage or deterioration that would adversely affect functions.
2. Load and deflection calculations shall be used on ASTM A36 / A36M steel unless Contractor provides evidence that all steel used for the plate systems will be a higher strength grade.

C. Steel plates in vehicular and pedestrian traffic areas shall be coated with an approved skid-resistant coating, if required by the DPW. Preparation of the surface and application of the coating shall be in accordance with all of the manufacturer's guidelines. Coatings shall be maintained on 100 percent of the surface of plates carrying vehicular and pedestrian traffic. Repairs shall be made to worn or deficient areas.

D. Design Requirements:

1. The Contractor shall select and design the temporary steel plate and supporting system. The design calculations and Drawings shall be prepared, signed, and stamped by a Professional Engineer registered in the Commonwealth of Massachusetts experienced in design of temporary traffic decking.
2. Design shall be in accordance with Loads and Design Criteria standard to the industry for this type of work, and with the following requirements:
    a. For vehicular ramps, limit maximum grade to 5 percent.
    b. For pedestrian ramps, limit maximum grade to 8 percent.
    c. Conform with Americans with Disabilities Act Accessibility Guidelines (ADAAG) at all pedestrian traffic locations.

d. Design of support members shall allow clearances for existing and relocated utilities.

e. Provide access to utilities, fire hydrants, and other facilities requiring unique access. Requirements at each site shall be obtained from the respective agencies affected.

E. Construction Methods:

1. Not more than two (2) steel plates shall be used at any time.
2. Steel plates shall be secured with pins and asphalt to prevent movement.
3. Plates shall overlap the trench width by at least 2 feet on each side.

F. Maintenance:

1. Inspect the condition of temporary steel plates at least once a day. Continuously maintain plates to conform to design requirements and construction requirements. Immediately repair defects such as broken, bent, or loose plate members, and protruding fasteners. Patch adjacent paving as potholes develop, and immediately re-secure and bed loose transition members, plates, and ramps to the existing pavement.
2. Maintain steel plates free of accumulations of snow, ice, water, mud, and debris.
3. Perform maintenance, repair, or replacement whenever there is noticeable deterioration of any material or component from its original conditions.

6.4 Backfill

A. In unpaved areas, excavations shall be backfilled as directed by the DPW with approved material conforming to MassDOT Spec M1.02.0.

1. Special borrow for fill shall conform to MassDOT Standard Spec. M1.02.0.
2. Processed gravel for subbase shall conform to MassDOT Standard Spec. M1.03.1.
3. Gravel borrow shall conform to MassDOT Standard Spec. M1.03.0, Type b.
4. Washed crushed stone for subbase shall range in size from ¾ inch to 1½ inch, conforming to MassDOT Standard Spec. M2.01.4 to M2.01.2 and shall be hard, durable and reasonably free from flat or laminated particles to furnish free draining material.

A. Special Borrow shall be thoroughly compacted in layers not to exceed twelve inches (12 inches) in thickness until flush with the surrounding ground surface. All backfill shall be rough graded and compacted to not less than 95 percent of the maximum dry density of the material as determined by the Standard AASHTO Test Designation T 99, Compaction Test Method C at optimum moisture content. If the backfilled material settles, additional approved materials shall be installed by the Contractor, as required, to keep the surface even. After settlement is completed, the excavated area shall be left by the Contractor in as good a condition as before the work was started.

B. Temporary sheeting and bracing used to support the side walls shall be removed, unless otherwise directed by the DPW, as backfilling progresses. When backfilling has reached the bottom of a brace, the latter and its horizontal ranger shall be removed, and this procedure shall be repeated throughout the backfilling operation. The sheeting shall be pulled in short increments, care being taken to avoid significant lateral movements of the sides of the trench. During and after pulling the sheeting, the backfill in the space formerly occupied by the sheeting shall be compacted.

C. Whenever water is found standing in the excavation area, the water shall be removed by pump or other means before backfilling operations may commence.

D. Backfilling shall be performed as soon as practicable so that the least possible subsequent settling will occur. In most cases backfilling shall occur on the same day as the excavation was begun. If this is not feasible due to the complex nature of work, emergency, or unpreventable conditions, the Contractor shall notify the DPW that same day, if not sooner, and take appropriate measures to protect public safety and infrastructure until work commences again the following day.

E. Backfill in paved areas shall be granular gravel borrow, processed gravel, sand or crushed stone material. At the City's discretion, in-situ material conforming to MassDOT Spec M1.02.0, Special Borrow may be used for trench backfill above the pipe bedding material and below the roadway foundation materials. The backfill shall be spread in layers not exceeding eight inches (8 inches) in loose depth and thoroughly compacted, up to the pavement subgrade surface. All backfill shall be rough graded and compacted to not less than 95 percent of the maximum dry density of the material as determined by the Standard AASHTO Test Designation T 99, Compaction Test Method C at optimum moisture content.

F. Broken pavement, large stones, roots and other debris shall not be used in backfill. Unused excavated material shall be removed from the jobsite and disposed of in a manner that will minimize interference and obstruction with pedestrian and vehicular traffic. No material shall be left within the right-of-way once the repair and/or installation is complete.

G. The City will allow, and may in some cases require under certain conditions, as an alternate, Controlled Density Fill (CDF) under the following conditions:

1. Only Type IE, Excavatable, Fill will be allowed.
2. This material shall not be used for bedding material or in situations that will cause floating of the utility lines, or in the presence of cast iron or steel pipes.
3. CDF placement in trenches shall be fully barricaded or police protected for a minimum of three (3) hours after the pour or until a set is reached that will prevent a hazard to animals or humans.
4. CDF shall be placed up to the pavement subgrade surface.
5. CDF shall be separated from gas lines with a minimum of six (6) inches of sand cover over the lines.
6. CDF shall be allowed to set up in accordance with manufacturer's recodmmendation before backfilling or paving.

6.5 Temporary Pavement

B. Temporary pavement shall be hot-mixed asphalt MassDOT Type I top course material conforming to MassDOT M3.01.0 and M3.11.07.

A. Upon the completion of proper backfilling, the Contractor shall install temporary pavement. The Contractor shall take all reasonable measures to complete temporary pavement on the same day excavation work was begun. If same day paving is not achievable due to complexity of work, emergency, or unpreventable conditions, the Contractor must notify the DPW as soon as practicable that same day and take appropriate measures to protect the public safety and infrastructure until work commences again the following day. The most stringent measures will be required on primary streets. Same day paving will typically be required if work is not expected to be continued the next day, regardless of location.

B. The Contractor shall notify the DPW 48 hours prior to beginning paving operations for inspection. All hot mixed asphalt paving must first be approved by the DPW or designee as to depth and materials; this *applies to both temporary and permanent paving activities*.

1. Receipt of notification of the anticipated timing of all paving activity must be acknowledged by the DPW.
2. Contractors shall endeavor to make a follow-up notification by 7:00 AM of each workday that paving is still anticipated. In the event of schedule changes or emergencies, the Contractor shall provide a minimum of one-hour notification to assure inspection availability.
3. If a City inspector is not able to be on site within 24 hours of the acknowledged anticipated start time of paving activity, the Contractor may be allowed to commence paving. Inspector may sample in-place material for specification compliance.
4. Contractors who do not provide proper notification of paving activities may be subject to required removal and replacement of pavement for the purpose of inspection.

C. The total thickness of the gravel base material and temporary pavement shall be of an adequate thickness to allow for the proper permanent roadway cross section. Extra gravel base may need to be installed.

D. All temporary pavement shall be hot mixed asphalt, conforming to MassDOT Standard Section 460, placed in two (2) inch compacted courses to a total depth of four (4) inches. If existing pavement depth is greater than eight (8) inches, temporary pavement shall be placed in two (2) inch compacted courses to a total depth of six (6) inches. If a layer of concrete, cobblestone, granite pavers, or other supporting material also exists, the Contractor shall install concrete to match that depth prior to installing temporary pavement.

E. If excavation (or pavement damage) occurs at or within twenty four (24) inches of the edge of trench, the Contractor shall place temporary pavement to the edge of existing sound pavement.

F. Hot mixed asphalt paving of trenches deemed by the DPW to be major excavation shall be paver applied, unless otherwise authorized by the DPW.

G. A pavement marker shall be installed. The markers will display the year the work was completed and identify the owner by color-coding. Color coding is as follows:

1. Water – BLUE
2. Sewer – GREEN
3. Highway/Drainage – WHITE
4. DPW capital project – PURPLE
5. Street Opening Permit – ORANGE (Temporary pavement remaining minimum 120 days) RED (Permanent pavement)

H. The Contractor shall maintain the temporary pavement and shall keep the temporary pavement in acceptable condition until the end of the guarantee period, or until permanent pavement is installed.

I. Refilling of bar holes made in the street or sidewalk shall immediately, upon completion of the work, be filled with compacted, granular material up to three (3) inches below the paved surface and the remaining three (3) inches filled with an approved asphalt plug.

J. All traffic control signs approved by the DPW for removal, relocation, or replacement shall be immediately replaced by the Contractor, unless otherwise directed by the City Engineer. No such traffic control sign shall be removed, relocated or replaced without the express approval of the DPW.

6.6 Permanent Pavement

A. Permanent pavement materials shall conform to the same MassDOT Standard Specifications as required for temporary pavement. Pavement markings shall conform to MassDOT Standard Section 860.

B. The existing pavement shall be saw cut a minimum of six (6) inches beyond the initial excavation limits to expose a six (6) inch width of undisturbed soil.

C. The temporary pavement, backfill and undisturbed soil shall be removed to the depth of the proposed pavement and disposed of offsite.

D. The permanent pavement shall be:

1. Local Streets: 1.5 inches of Top Course material placed on 2.5 inches of Binder Course material founded on 4 inches of Dense Graded Crushed Stone on 8 inches of Processed Gravel or Dense Graded Crushed Stone. This pavement structure shall be placed on the backfill.

2. Collector Streets: 2 inches of Top Course material placed on 4 inches of Binder Course material placed in two equal courses founded on 4 inches of Dense Graded Crushed Stone on 8 inches of Processed Gravel or Dense Graded Crushed Stone.

3. Arterial Streets: 3 inches Modified Top Course material placed in two courses on 5-inches of Binder Course material placed in two equal courses founded on 4 inches of Dense Graded Crushed Stone on 8 inches of Processed Gravel or Dense Graded Crushed Stone.

E. Trench backfill and roadway foundation materials shall be checked for compliance with 95 percent compaction requirement. If compaction is found to be less than 95 percent, trench shall be re-compacted before paving will be allowed.

F. In cases where the existing pavement adjoining a proposed excavation is in need of rehabilitation, the City and Contractor may enter into a mutual agreement such that the Contractor undertakes the pavement rehabilitation as part of their pavement restoration.

G. The Contractor will not be required to repair or replace damaged pavement existing prior to commencement of the work unless excavation operations result in small, unstable sections. These shall be removed and replaced as part of the work.

H. Mechanical compactors will be permitted for repairs less than 10 square yards. Repairs exceeding 10 square yards shall be rolled with an appropriately sized, power-driven, steel-wheeled roller to obtain specification density.

I. Hot-mixed asphalt materials shall be laid upon an approved clean, dry, compacted surface, spread and struck off to the established grade and elevation, giving regard to the loss in depth between loose and compacted mixtures. Immediately after the hot mix asphalt mixture has been spread, struck off, and surface irregularities adjusted, it shall be thoroughly and uniformly compacted.

J. Each course of hot-mixed asphalt shall be compacted separately, meeting the requirement of 92 percent minimum compaction of standard laboratory maximum theoretical density for the specific material.

K. Permanent pavement restorations shall not be allowed to commence until at least one hundred twenty (120) days have passed since the installation of approved temporary hot-mixed asphalt pavement.

L. All saw cut vertical faces of existing pavement shall be neat, free of loose materials, and tack coated with an approved asphalt emulsion by applying the emulsion material in conformance with

MassDOT Standard Specifications Section 460.62, to fully cover the surfaces prior to pavement installation.

M. A tack coat shall be applied to the sub-base surface, or previous course surface.

N. If two or more excavations are made for the same utility or Contractor in the same construction season and are within six (6) feet of each other, edge to edge, they shall be permanently restored as one trench, including the pavement between excavations.

O. Same requirement shall apply, if in a future season, an excavation for the same utility or Contractor occurs within six (6) feet and the first has not yet been permanently restored.

P. If an excavation for the same utility or Contractor falls within six (6) feet of another excavation already permanently restored, the permanent pavement of the second excavation shall include all surface pavement between both excavations.

K. A pavement marker shall be installed. The markers will display the year the work was completed and identify the owner by color-coding. Color coding is as follows:

1. Water – BLUE
2. Sewer – GREEN
3. Highway/Drainage – WHITE
4. DPW capital project – PURPLE
5. Street Opening Permit – ORANGE (Temporary pavement remaining minimum 120 days) RED (Permanent pavement)

Q. The Contractor shall perform the necessary restoration beyond the limits of the street pavement, including lawns, esplanades, shrubs, gardens, curbing, sidewalks, underdrains, separations fabrics, fences, walls, etc. Upon completion of the permanent repairs outside the limits of the street pavement, the Contractor shall notify the DPW in writing that the permanent repairs and/or replacements have been completed, setting forth the date of completion. The Contractor shall maintain the repaired area outside of the pavement for a period of three (3) years after completion, with the exception that once proper horticultural growth has been established, no further horticultural maintenance will be required.

7 Street Lighting Construction Standards

7.1 General

A. Main line electric, telephone, cable and fire alarm shall be meet the material and installation requirements of the respective utility owner. Secondary electric, telephone, cable television and fire alarm lines shall be placed in the grass strip or sidewalk inside the proposed public right of way, but outside of the traveled way on the opposite side of the centerline of the street as the water main. Conduit runs and handholes for street lights shall be placed in the sidewalk or grass areas abutting the roadway. Service pedestals and their connections shall be located on private property with easements.

B. References in this section to the "Standard Specifications" shall mean MassDOT's Highway Division Standard Specifications for Highways and Bridges dated 1988, and all Supplemental and amended Specifications.

C. All materials and work shall be designed to meet all requirements of the latest edition of the National Electric Code (NEC), and all local codes.

D. All street lighting materials and their installation shall fully meet the requirements of Eversource and be accepted by Eversource prior to the City accepting these facilities. Street light standard locations are subject to review by the City's DPW and Eversource (Electric) prior to their installation.

E. Wiring and connections shall be tested for continuity and ground before service conductors are connected and shall demonstrate insulation resistance by megger test as required at not less than 500 volts. Insulation resistance between conductors and grounds for secondary distribution systems shall meet National Electrical Code (NEC) requirements

F. Submittals required for street lighting projects include:

1. Materials List and Shop Drawings
2. As-built Plans
3. Recorded easements

7.2 Conduit

A. Conduit material for street lighting shall be Schedule 40 Polyvinyl Chloride (PVC) plastic and shall meet the requirements of UL 651, NEMA TC-2 and Eversource.

B. Conduit for the service connection from the Eversource system to the street lighting service pedestal shall be 2-inch in size. A spare 2-inch conduit shall also be provided for future use.

C. Conduit from service pedestal to street lights shall be 2 inches in size.

D. Conduits between street lights must run from handhole to handhole with laterals to street lights.

E. Minimum depth of conduits for street lighting shall be 2'-0" as measured from the finish grade. Conduit shall be deeper as necessary to avoid conflicts with other utilities.

F. All street lighting conduits shall be encased in 2,500 PSI, ¼-inch AGG cement concrete as shown in detail, whether in the public right of way or within easements on private property.

7.3 Handhole

A. Electrical handholes for street lighting shall be open bottom, precast polymer units. They shall have minimum nominal dimensions of 13-inch wide x 24-inch long x 18-inch deep and arranged for bottom conduit entry and include grounding rod and ground conductor. They shall be Quazite #PG1324BB18 or approved equal.

B. Handhole covers shall be bolt down type and labeled with notation to read "Street Lighting". Handholes shall be heavy duty type and rated for installation adjacent to traffic areas. They shall be Quazite #PG1324WA41 or approved equal.

C. Handhole covers shall be set flush with the top of sidewalk and shall be positioned no closer than 12 inches to the edge of the concrete sidewalk.

7.4 Light Standard Foundation

A. Street light standard foundations shall be constructed per the Standard Specifications and details. Any deviations must be submitted to the City for approval.

B. Cylindrical foundations shall be as specified by lighting manufacture, including number, type and location of anchor bolts. Pre Cast foundations shall be made of minimum 5,000 psi concrete (at 28 days) and have steel reinforcement meeting ASTM A-615, grade 60 (cover to steel, 1-inch minimum). Foundations shall have a minimum of two (2) 2-inch PVC conduits for lighting circuits, 180 degrees apart.

C. Foundations are to be installed flush with finished grade in sidewalk areas and 3 inches above finished grade in grass areas. Anchor bolts to be ¾-inch diameter by 30-inch long "j-hook" type galvanized steel (4 per foundation) or as otherwise required by the manufacturer.

D. Foundations shall be provided with 2-inch galvanized rigid metal conduit in foundation and coupling and 2-inch plastic type NM conduit stub out to adjacent handhole.

7.5 Wire & Splicing

A. Conductors shall be No. 12 through No. 8 AWG, NEC type THWN/THHN, meeting the requirements of UL 83. Conductors for power and lighting shall be no smaller than No. 12 AWG. Electrical wire shall have XHHW insulation.

B. All conductors shall be annealed copper, 98% conductivity, Class B stranded, except conductors used for power and lighting circuits No. 10 AWG and smaller which may be solid. All conductors should be rated for 600 volts or less, with a thermal rating of 90° C.

C. The outside covering of all wiring for power, lighting, grounding, and control uses shall be color coded to identify polarity.

D. Conductors shall be joined in handholes using back to back copper compression type single barrels lugs joined using durium bronze hardware and insulated using a Raychem Gel Cap water resistant stub splice cover as detailed.

7.6 Service Connection Underground

A. Electric service shall be coordinated with and conform to all current policies of the electric utility company.

B. Service connection shall include a three-wire single phase solid neutral service conductors, conduits, conduit riser or connection to utility company pad mounted transformer; all installed in

accordance with the Code and utility company. Meter shall be furnished and installed by the utility company.

7.7 Service Pedestal

A. Enclosure: Enclosure shall be a NEMA 3R rated UL: listed convection ventilated and consist of a cabinet and a gasketed door assembly, constructed from 5052-h32 sheet aluminum alloy (less than 0.02% copper) of at least 1/8-inch thickness. The enclosure shall be free of dents, cracks and other imperfections and shall be mounted on a concrete base.

B. Enclosure shall be provided with two (2) adjustable ”c” mounting channels on both side walls and back wall of the enclosure and an aluminum back panel. Enclosure shall be CP3A Slimline series as manufactured by MILBANK, or approved equal. The construction features and details shall comply with the manufacturer’s requirements.

C. Panel board: The branch circuit breakers frame shall be rated 100 amperes with a UL listed interrupting rating of 18,000 amperes symmetrical at 240 volts.16 circuit.

D. Receptacle: Receptacle shall be a specification grade NEMA 5-20R ground fault circuit interrupter type and stainless steel cover in a surface utility outlet box. Receptacle shall be manufactured by Hubbell, Leviton or Bryant.

E. Switch and Lighting Fixture: Switch shall be specification grade 120/277VAC 20amp switch and stainless steel cover in a utility outlet box. Lighting fixture shall be a surface mount LED.

F. Meter Socket: Meter socket shall be utility company approved UL listed 100 amp 240/120V 1 phase 3 wire outdoor type. Number of terminals, bypass release and other features shall be provided as to match utility meter.

G. Grounding Electrode: Grounding electrodes shall be ¾-inch diameter by 8-foot long copperweld rods. Rods shall be driven vertically. Coordinate with all existing conditions and follow “call before dig” procedures prior to driving the rods.

H. Location and orientation of the street lighting service pedestal shall be such as to ensure easy access to the cabinet for maintenance as well as to provide protection from damage including snow removal. The location shall not prohibit pedestrian travel. The location of pedestal shall be approved by the City Department of Public Works in advance of placement.

I. All branch circuitry originating from the cabinet shall be routed directly into the circuit breakers. Two (2) -2-inch stub outs shall be provided to street lighting handhole below grade. One active and one for future use.

J. Cabinet shall be installed per manufacturer’s requirements for a level and plumb installation. Provide touched up finish paint, as required for any blemishes.

K. Ground all systems and equipment in accordance with best industry practice and herein stated requirements.

7.8 Street Light Pole & Luminaire

A. Light Pole shall be manufactured by P&K Tubular Products Madison Series Cat. NO. RFT6M14MYS - 12 flute cross section with 3 ½-inch OD tenon BLACK and Madison BLACK decorative base.

B. Anchor bolts shall be supplied by the pole. Anchor bolt shall be completely hot-dip galvanized. Each anchor bolt shall have a hex nut, flat washers and lock washer. The anchor base shall conform to ASTM A36. Bolt circle diameter and length shall be per pole manufacturer's requirements.

C. Luminaire shall employ white, long life LED type lamps and IES Type III asymmetrical light distribution with cutoff vertical control to minimize uplight. Luminaire shall be King Luminaire K199 Series Cat. NO. K199R-B2AR-III-100(SSL)-1063-120:277-K18-SST-PEC-GFI-3K-BLACK - (100 WATTS - 7,157 LMS).

8 Landscaping and Tree Work

8.1 General

A. This Section specifies requirements for other utilities or work on City owned property that was not previously covered in the above sections.

B. Notification shall be provided to Tree Warden during the planning and specification development of projects where tree protection may be required. The Tree Warden may require that a City-approved certified arborist oversee construction activities related to tree protection.

C. A pre-construction meeting with the Tree Warden shall be conducted at least two weeks prior to construction to review tree protection procedures.

D. A written guarantee shall be provided to the City that trees planted in the City will thrive for a minimum of two (2) years.

8.2 Trees

A. All tree work shall be completed in accordance with the requirements of the Tree Warden and/or planning board as appropriate.

B. When specifying trees to be planted on or near the roadways in the City, specifications shall identify species and cultivar. The more disease resistant cultivars shall be recommended.

C. Trees shall be tagged with identification as to location of origin, species, and cultivar. Notification shall be provided to the Tree Warden to provide time for inspection and verification of tree species and cultivar.

D. When planted, an area around the trees shall be mulched for a minimum of 3 feet from the tree or twice the size of the root ball, whichever is greater. The area immediately around the tree trunk (within 2 inches of the trunk) shall remain un-mulched.

1. The planting hole shall be at least 2 times the width of the rootball, up to 5 times the rootball.
2. Burlap, twine, and wire baskets shall be entirely removed after planting.
3. Place the tree in the hole at both the appropriate upright angle and depth.
4. Replace the soil so that there is no excessive coverage to roots or contact above the root flare at the stem.
5. Add a two- to three-inch layer of mulch, not contacting the bark of the tree.
6. Immediately water the tree, with a plan for regular follow-up watering.
7. Provide a final quality-control check, where depth of the structural roots is verified, with the use of a chaining pin or other measuring implement.

E. Tree protection shall include the following.

1. Tree protection shall be provided for each tree within the work area.
2. The tree protection zone shall extend out from the center of the trunk to a radius of 1.5 feet per inch of DBH (DBH = diameter of trunk at 4.5 feet above ground).
3. Primary tree protection shall include 2” x 4” boards in 8-foot lengths vertically strapped around the trunk, at a maximum of 8 inches apart, on center. No penetration of the tree trunk shall be allowed except as approved by a certified arborist or the Tree Warden.

4. Secondary tree protection shall include fencing around the tree protection zone.
5. No storage of any materials or equipment shall be allowed within the tree protection zone.
6. No parking shall be allowed within the tree protection zone.
7. No roots greater than 2 inches shall be cut during construction activities.
8. Any pruning of tree limbs shall be done under the direction of a certified arborist.
9. During excavation, major roots as determined by the Tree Warden shall be exposed using an air spade and flagged for protection.
10. Vertical mulching shall be required if soil compaction levels exceeds 75% or more than 3 passes by heavy equipment are expected.
11. If travel is required within the tree protection area, a layer of at least 6 inches of wood chips, mulch, or other matting as approved by the Tree Warden shall be laid down to protect the roots. The matting shall be removed and the area restored to pre-construction conditions upon completion of the work.
12. For construction where trees roots may be damaged, only root pruning methods may be used for removal. The Tree Warden shall be notified and a plan submitted to the Tree Warden for approval.
13. Curb cuts should not be closer than five (5) feet from the trunk of any adjacent tree.

F. Trees that, in the judgment of the Engineer or the Tree Warden, have been irreparably damaged by the Contractor shall be replaced in kind and in size, or with a quantity of 2-inch caliper replacement trees (the quantity of which shall be determined by the Engineer) such that the cumulative caliper of the replacement trees will be up to the equivalent diameter of the lost tree at breast height. Cost of removal of a destroyed tree, including roots and stumps, as well as the cost of replacement trees, shall be paid for by the Contractor.

G. A written guarantee shall be provided to the City that trees planted in the City as per the contract will thrive for a minimum of two (2) years. The guarantee shall include replacement of trees that the Tree Warden has determined are not thriving. Replacements shall be required to have the same guarantees as the original trees.

8.3 Loam and Seed

A. Loam Borrow shall conform to MassDOT Standard Spec. M1.05.0 or shall be the product of a commercial sand and gravel processing facility. It shall be uncontaminated by saltwater, foreign matter, or substances harmful to plant growth. The acidity range of the Loam Borrow shall be pH 5.5 to 7.0.

B. Fertilizer shall be of a 10-6-4 composition.

C. Seed composition shall be 60% Red Fescue, 20% Red Top, 20% Kentucky Blue. Seed shall be of the previous year's crop and in no case shall the weed seed content exceed 1% by weight.

D. The loam shall be 6 inches thick. Fertilizer shall be applied to the loam at a rate of 0.2 pounds per square yard and worked into the seed bed with an application of lime, if needed to achieve the required pH range. As soon as the seed is sown, it shall be covered with a thin layer of loam, rolled and watered.

E. Areas shall be seeded at the rate of 3.6 pounds per 100 square yards. Grass shall grow to a satisfactory cover before being accepted by the City.

F. In locations where erosion is possible, erosion controls shall be in place until the vegetation has substantially rooted. Erosion, gullies and other damage will need to be reseeded as necessary until an adequate growth of grass is achieved

9 References

A. The following summarizes select standards applicable to these Design Standards. This list is not exclusive; other standards may apply. The latest revision of each standard shall be referenced.

B. All materials and execution shall conform to the highest applicable standards. If there is a conflict between other standards, or between other standards and these Design standards, then the most stringent criteria shall apply.

Standards	Title/Subject
29 CFR 1926	OSHA Safety and Health Regulations for Construction
29 CFR 1926.1101	OSHA Safety and Health Regulations for Construction, Sub Part Z, Toxic and Hazardous Substances: Asbestos
29 CFR 1010.1001	OSHA Occupational Safety and Health Standards, Subpart Z, Toxic and Hazardous Substances: Asbestos
248 CMR 10.00	Massachusetts Uniform State Plumbing Code 248 CMR 10.00
521 CMR	Rules and Regulations of the Architectural Access Board
AASHTO Section 30	Division II (General-Interim 1998)
AASHTO M 91	Sewer and Manhole Brick (Made from Clay or Shale)
AASHTO M 170	Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
AASHTO M 199	Standard Specification for Precast Reinforced Concrete Manhole Sections (ASTM C478)
AASHTO M 252	Corrugated Polyethylene Drainage Pipe
AASHTO M 288	Standard Specification for Geotextile Specification for Highway Applications
AASHTO M 294	Corrugated Polyethylene Pipe, 300- to 1500-mm Diameter
AASHTO T 99	Standard Method of Test for the Moisture-Density Relations of Soils Using a 5.5-lb Rammer and a 12-in. Drop (Compaction Test Method C)
ADA	American with Disabilities Act
ATSSA	Guide to Temporary Traffic Control in Work Zones
ASTM A36 / A36M	Standard Specification for Carbon Structural Steel
ASTM A48	Standard Specification for Gray Iron Castings
ASTM A513	Standard Specification for Electric-Resistance-Welded Carbon and Alloy Steel Mechanical Tubing

ASTM A536	Standard Specification for Ductile Iron Castings
ASTM A615	Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A616	Standard Specification for Rail-Steel Deformed and Plain Bars for Concrete Reinforcement.
ASTM A74	Standard Specification for Cast Iron Soil Pipe and Fittings
ASTM A746	Standard Specification for Ductile Iron Gravity Sewer Pipe
ASTM A888	Grey Cast Iron, Cast Iron Class 20
ASTM B62	Standard Specification for Composition Bronze or Ounce Metal Castings
ASTM C32	Standard Specification for Sewer and Manhole Brick (Made From Clay or Shale)
ASTM C33	Standard Specification for Concrete Aggregates
ASTM C76	Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
ASTM C139	Standard Specification for Concrete Masonry Units for Construction of Catch Basins and Manholes
ASTM C144	Standard Specification for Aggregate for Masonry Mortar
ASTM C150	Standard Specification for Portland Cement
ASTM C270	Standard Specification for Mortar for Unit Masonry
ASTM C443	Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets
ASTM C478	Standard Specification for Precast Reinforced Concrete Manhole Sections
ASTM C564	Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings
ASTM C1244	Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test Prior to Backfill
ASTM D1557	Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3)
ASTM D1784	Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D207	Standard Specification for Shellac Varnishes
ASTM D2241	Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)

ASTM D2321	Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity — Flow Applications
ASTM D2412	Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading
ASTM D2487	Standard Practice for Classification of Soils for Engineering Purposes (USCS)
ASTM D2737	Standard Specification for Polyethylene (PE) Plastic Tubing
ASTM D3034	Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC)
ASTM D3139	Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
ASTM D3212	Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
ASTM D3350	Standard Specification for Polyethylene Plastics Pipe and Fittings Materials
ASTM D4101	Standard Specification for Polypropylene Injection and Extrusion Materials
ASTM D478	Standard Specification for Zinc Yellow (Zinc Chromate) Pigments
ASTM D5813-04	Standard Specification for Cured-In-Place Thermosetting Resin Sewer Piping Systems
ASTM D790	Test Methods for Flexural Properties of Un-reinforced and Reinforced Plastics and Insulating Materials
ASTM F1216	Rehabilitation of Existing Pipelines and Conduits by the Inversion and Curing of a Resin-Impregnated Tube
ASTM F2561-11	Standard Practice for Rehabilitation of a Sewer Service Lateral and Its Connection to the Main Using a One Piece Main and Lateral Cured-In-Place Liner
ASTM F477	Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F679	Standard Specification for Poly(Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings
ATSSA	Guide to Temporary Traffic Control in Work Zones
AWWA C104/ANSI 21.4.	American National Standard for Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
AWWA C105/ANSI A21.5.	American Standard for Polyethylene Encasement for Ductile-Iron Pipe Systems
AWWA C110/ANSI A21.10.	American National Standard for Ductile-Iron and Grey-Iron Fittings, 3 Inch Through 48 Inch for Water

AWWA C111/ANSI A21.11.	American National Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C115/ANSI A21.15	Standard for Flanged Ductile-Iron Pipe With Threaded Flanges
AWWA C150/ANSI A21.50.	American National Standard for the Thickness Design of Ductile-Iron Pipe
AWWA C151/ANSI A21.51.	American National Standard for Ductile-Iron Pipe, Centrifugally Cast, for Water or Other Liquids
AWWA C153/ANSI A21.53.	American National Standard for Ductile-Iron Compact Fittings, 3 In. Through 64 In.
AWWA C502.	AWWA Standards for Dry-Barrel Fire Hydrants
AWWA C504	AWWA Standard for Rubber-Seated Butterfly Valves
AWWA C509.	AWWA Standard for Resilient-Seated Gate Valves for Water Supply Service
AWWA C515.	AWWA Standard for Reduced-Wall Resilient-Seated Gate Valves for Water Supply Service
AWWA C600.	AWWA Standard for the Installation of Ductile-Iron Water Mains and Their Appurtenances
AWWA C651.	AWWA Standard for Disinfecting Water Mains
AWWA C901.	Polyethylene (PE) Pressure Pipe and Tubing, ½ Inch – 3 Inch, for Water Service
City of Framingham	City of Framingham Standard Operating Procedures for the Management of ACM
Mass DLS	453 CMR 6. Current Asbestos Regulations
MassDEP	310 CMR 7.00. Air Pollution Control Regulations. Includes Section 7.09 *Dust Odor, Construction and Demolitions* and 7.15: *Asbestos*
MassDEP	Asbestos Cement Pipe Guidance Document (June 2011).
MassDEP	Guidelines for Public Water Systems (April 2014)
MassDEP	Stormwater Management Policy
MassDEP	Massachusetts Stormwater Handboook
MassDEP	310 CMR 10.00, Wetland Protection Act
MassDOT	Standard Specifications for Highways and Bridges, Construction and Traffic Standard Details (1996 et seq.)
MassDOT	Construction and Traffic Standard Details
MassDOT	Work Zone Safety Guidelines for Massachusetts Municipalities and Contractors

MUTCD	Manual of Uniform Traffic Control Devices (MUTCD)
NFPA 70	National Electrical Code with Massachusetts and amendments
NOAA	National Oceanographic and Atmospheric Administration: Technical Paper No. 40, May 19“1 "Rainfall Frequency Atlas of the United States"
US DOT	49 CFR 100-185. Hazardous Materials Transportation
USEPA	USEPA Region 1, MS4 Program
US EPA	National Emission Standards for Hazardous Air Pollutants (NESHAPS) Title 40, Part 61
US EPA	Guide to Respiratory Protection for the Asbestos Abatement Industry
US EPA	In a Guidance Letter dated July 17, 1991, identified as Control # C99 within the Agency Applicability Determination Index, the U.S. EPA determined that “the pumping of grout into buried lines is not a process which, in and of itself, would cause asbestos cement pipe to become regulated asbestos containing material.”

Appendix A
Plan Content Requirements

The following are required to be included on plans submitted to the DPW for advance project review, comment input and approval. Only plan submittals containing the proper level of information presented in the specified format will be plan reviewed and processed. Hence, to avoid rejections or delays the applicant should accurately prepare the appropriate Plan Submittal Package following the content items outlined below.

1. Drawing must be drawn to scale with the scale preference being 1"=20' including the depiction of a North Arrow. Orient such that North points towards the top of the sheet. The horizontal scale of the plan and profile shall be the same.
2. All drawing sheets shall have a border, title, and revision block that includes at a minimum:
    a. Engineering firm name and address/contact information including telephone and email
    b. Project name
    c. Property address and street name
    d. Drawing creation date
    e. Scale
    f. Revision block represented to facilitate the documentation of any follow-up revision plan submittals numbers/revision description/revision date with all revision information made on the drawing (layout or annotation) clearly cloud circled and each cloud noting the revision number
3. All existing vs. all proposed design construction conditions (drawing and annotation) must be distinguished by different line weight treatment as follows: Existing conditions depicted lighter or narrower and proposed design conditions shown heavier or bolder line weight representation.
4. Original Massachusetts Licensed Professional Engineer's or Professional Land Surveyor's stamp and signature on all drawings.
5. In addition to key dimensions and location ties, the size, material, and vintage must be shown for all existing and proposed infrastructure (mains and services or branches) needed to support the project be it City and/or public and/or private owned (i.e. Water, Sewer, Storm Water, Traffic Signal, Telecom, Electric, Gas, etc.)
6. Locus map showing the parcel in relation to the surrounding properties
7. Name of record owner(s) of land shown on the plan
8. Identification of parcel by sheet, block, and lot number of Assessors Maps.
9. Property lines, easements and/or other legal rights within the property lines. Locations of all existing and proposed easements. Locations of all existing and proposed roadway monumentation.
10. Location of all buildings and lot lines on the lot, including ownership of lots, and street lines, including intersections within 300 ft.
11. Boundaries and existing and proposed topography of the property, including contours at a 2-foot interval, using National Geodetic Vertical Datum 1929(NGVD29) as it may be updated from time to time and specifying NGVD29 on all elevation drawings, specifically indicating the areas on which the activity is proposed to occur, and clearly noting if the activity is on an area greater than 4,000 square feet or on Slopes 15% or greater
12. Dimensions of proposed buildings and structures, including gross floor area, floor area ratio, total lot coverage of building, and breakdown of indoor and outdoor floor area as to proposed use. Area dimensions to include Lot Coverage of Building, Paved Surface Coverage, and Landscaped Open Space and Other Open Space, with percentages of these items to be provided and to total 100 percent of the lot area.
13. Locations and dimensions, including total ground coverage, of all driveways, maneuvering spaces and aisles, parking stalls and loading facilities, and proposed circulation of traffic.

14. Location of pedestrian areas, walkways, flow patterns and access points, and provisions for handicapped parking.
15. Location, size, and type of materials for surface paving, curbing, and wheel stops.
16. Location, dimension, type and quantity of materials for open space, planting, and buffers where applicable.
17. Provisions for storm water drainage affecting the site and adjacent parcels, and snow disposal areas. Drainage computations and limits of floodways shall be shown where applicable.
18. Accurate depiction of rim and invert elevations for storm drainage and sanitary sewer, sanitary service wyes with distances to nearest structure, water line gates and water service valves
19. Cross sections, design details or profiles as appropriate
20. Curbing, sidewalk, driveway curb opening, parking areas, walkways, and road layout identified and dimensioned
21. Photometric plan showing the intensity of illumination expressed in foot-candles at ground level within the interior of the property and at the property boundaries; location, orientation, height, wattage, type, and style of outdoor luminaire.
22. Zoning Table to be located on both the front page of the submitted plans and on the Parking Plan/Site Plan page.
23. Water service, sewer, waste disposal, and other public utilities, accurately positioned, on and adjacent to the site.
24. The size and location of all existing and proposed buildings, structures, utilities, roads, driveways, parking areas, and areas of cut and fill on the site and the location of all structures on abutting properties within 100 feet of the property lines of the parcel
25. All wetlands and wetland resource areas as defined in M.G.L. Ch. 131, §40, and the Framingham Wetlands Protection Bylaw, Article V, §18 of the General By-laws, drainage patterns, and watershed boundaries. Also include a delineation of the 100-year floodplain and all bodies of water, including vernal pools, streams, ponds, and coastal waters within 125-feet of the project site/limit of work and the delineation of a 50-foot no-build and 30-foot no-cut/no alteration zone
26. Location of any rare and endangered species as mapped by the Massachusetts Natural Heritage Program
27. The location of any proposed stockpile locations
28. Detailed drawings and design calculations of all temporary and permanent stormwater management and Erosion and Sediment control structures and devices. Drawing Legend depicting all symbols and line types

As-built Plan Requirements

An as-built plan of project improvements (roadway, site work, and utilities), in both hardcopy and electronic formats, shall be submitted for review and approval. A stamped paper hardcopy of the as-built plan shall be submitted for review. Once approved, a stamped hard copy and electronic copies (AutoCAD and PDF) of the as-built plan shall be submitted for archival. All drawing sheets shall not exceed ARCH Size D (24" x 36") and shall be prepared at readable plan scale, preferably consistent with the design plan scale. Plans shall be prepared in monochrome format utilizing gray scale and line types to differentiate features (color as-built plans will not be accepted).

Electronic as-built information shall be in both AutoCAD 2008 and Acrobat PDF formats. The AutoCAD file shall conform to the current version of the MassGIS Standard for Digital Plan Submission. The electronic CD/DVD media shall be properly labeled with the Project Name, date, and all file names.

The as-built plan shall include:

1. North arrow, scale, and date.
2. Name of record owner(s) of land shown on plan.
3. Identification of parcel by sheet, block, and lot number of Assessor's Maps.
4. Property lines, easements, and/or legal rights within the property lines.
5. Location of all buildings and lot lines on the lot, including ownership of lost, and street limits
6. Boundaries and final topography of the property, including contours at a minimum 2 foot interval, using National Geodetic Vertical Datum 1929(NGVD 1929) and specifying NGVD on all elevation drawings.
7. Original Massachusetts licensed Professional Engineer's or Professional Land Surveyor's stamp and signature, and date stamped, on all drawings.
8. All drawing sheets shall have a border and a title block that include project name/street location, and Engineering Firm telephone contact numbers/address information.
9. Drawing Legend depicting all symbols and line types.
10. Utilities accurately positioned (Cable, Drainage, Electric, Gas, Telephone, Sewer, Water, Etc.) as applicable.
11. Size and materials identified for all new City utilities and service connections (Storm Drainage, Sanitary Sewer and Water).
12. Key dimensions (and ties) depicted for all new City utilities and service connections. Ties shall include dimensions from fixed objects to water valves, angle fittings, reducing fittings, sleeves, service taps, etc. and dimensions from fixed objects to sewer cleanouts, main taps, couplings, angle fittings, etc.
13. Rim and invert elevations for storm drainage and sanitary sewer. Ties to sanitary service wyes with distances from the main to nearest structure. Ties to water line gates and water service valves.
14. Cross sections, design details or profiles as appropriate.
15. Curbing, sidewalk, driveway curb opening, parking areas, walkways, and road layout identified and dimensioned
16. Wetland boundaries and restrictions (e.g. 30-foot No Disturb Zone), edge of buffer zone, location of riverfront and flood zones.

Appendix B
Construction Details

Detail Number	Detail Title
W-2.1.0	Typical Water Connection for 1” Service
W-2.1.1	Typical Water Connection for 1-1/2” to 2” Service
W-2.1.2	Typical Fire Service for 1 ½” to 2”
W-2.1.3	Typical Fire Service (Tapping Sleeve)
W-2.1.4	Typical Connection (Tapping Sleeve)
W-2.2.0	Typical Thrust Restraint Wedge Action Type Joints
W-.2.2.1	Typical Thrust Restraints Using Tie Rods and Friction Clamps
W-2.2.2	Typical Thrust Block Detail
W-2.3.0	Water Main Trench Detail
W-2.4.0	Gate Valve
W-2.4.1	Typical Anchor Tee Installation
W-2.4.2	Air Release Valve/Blow Off
W-2.4.3	Valve Location at Intersection
W-2.4.4	Water Gate Covers
W-2.4.5	Water Valve Box
W-2.5.0	Fire Hydrant Installation
W-2.6.0	Water Main Lowering Detail
W-2.6.1	Water Crossing Under Railroad
W-2.7.0	Detail of Cut and Remove of Water Connection 4” and Over
W-2.7.1	Detail of Cut and Capping of Water Connection 4” and Over
W-2.8.0	Meter Installation
S-3.1.0	Service Connection (Gravity)
S-3.1.1	Service Connection (Saddle)
S-3.1.2	Chimney
S-3.1.3	Service Connection (Grinder)
S-3.2.0	Above Grade Clean Out
S-3.3.0	Plug for Abandoning Sanitary Sewer
S-3.3.1	Plug for Sanitary Sewer
S-3.4.0	Typical Sewer Manhole
S-3.4.1	Typical Drop Manhole (Outside)
S-3.4.2	Force main Manhole
S-3.4.3	Sewer Manhole Cover
S-3.4.4	Manhole Seal
S-3.5.0	Sewer Crossing
S-3.6.0	Backwater Valve Assembly

Detail Number	Detail Title
S-3.7.0	Typical Grease Trap
S-3.7.1	Typical Grease Trap Sizing and Notes
D-4.1.0	Single Grate Catch Basin
D-4.1.1	Direct Inlet Catch Basin
D-4.1.2	Dual Grate Catch Basin
D-4.2.0	Drain Manhole
D-4.2.1	Eccentric Manhole
D-4.2.2	Sump Manhole
D-4.3.0	Manholes and Catch Basins General Notes and Dimensions
D-4.3.1	Raising Castings
D-4.4.0	Rip Rap Apron at Pipe Outfalls
D-4.5.0	Typical HDPE Pipe Trench Detail
D-4.6.0	Flared HDPE End Sections
R-5.1.0	Roadway Cross Section
R-5.1.1	Cut and Fill Slopes
R-5.1.2	Granite Curbs
R-5.1.3	Bituminous Berms
R-5.1.4	Pavement Transition
R-5.1.5	Roadway Widening and Overlay 6-Ft Wide or Greater
R-5.1.6	Roadway Widening and Overlay 6-Ft Wide or Less
R-5.1.7	Pavement Details for Trench Restoration
R-5.1.8	Continuous Zone Trench Restoration
R-5.2.0	Guard Rail
R-5.2.1	Guard Rail (Double Face)
R-5.3.0	Wheelchair Ramp Notes
R-5.3.1	Wheelchair Ramp Type A
R-5.3.2	Wheelchair Ramp Type B
R-5.3.3	Wheelchair Ramp Type C
R-5.3.4	Wheelchair Ramp Type D
R-5.3.5	Wheelchair Ramp Type E
R-5.3.6	Detectable Warning Panel
R-5.4.0	Typical Curb Cut Plan – Residential Driveways No Sidewalk
R-5.4.1	Full Depth Driveway Apron – Section No Sidewalk
R-5.4.2	Sidewalk Through Driveway
R-5.4.3	Full Depth Driveway – Section Cement Concrete Sidewalk Crossing
R-5.5.0	Cross Walk
R-5.5.1	Decorative Cross Walk
R-5.6.0	Steel Plate Installation

Detail Number	Detail Title
R-5.7.0	Traffic Sign Installation Notes
R-5.7.1	Traffic Sign Detail Sidewalk or Median Installation
R-5.7.2	Traffic Sign Detail Non-sidewalk Installation
R-5.7.3	Street Name Sign Installation Notes
R-5.7.4	Street Sign Detail Sidewalk Installation
R-5.7.5	Street Sign Detail Non-sidewalk Installation
R-5.7.6	Granite Bound Detail
R-5.8.0	Trench Detail for Communications Conduit
E-7.1.0	Primary Duct Bank Section in Roadway
E-7.2.0	20” Diameter Light Pole Base
E-7.3.0	Typical Pole Base, handhole and Pole Foundation
E-7.4.0	Lighting Load Center
E-7.5.0	Handhole and Conduit Detail
E-7.6.0	Pole with K199 Luminaire
E-7.7.0	Pole with D323 Luminaire