STANDARD CONTRACT DOCUMENTS

AND

TECHNICAL SPECIFICATIONS

FOR

UTILITY AND STREET CONSTRUCTION

September 2019

CITY OF RAYMORE, MISSOURI
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TABLE OF CONTENTS (2019)

Storm Sewer Specifications

1.00 GENERAL DESIGN CRITERIA

1.01 General

The design criteria presented in this article are the minimum standard to be followed in the design and construction of the Raymore Storm Sewer System. These minimum standards are not intended to be used as a substitute for actual construction specifications and design computations.

1.02 Design Requirements

1. Design Formula for Rate of Run-off:
   The Rational Method shall be used in storm sewer design within the City of Raymore.

   The Rational Method uses the basic formula Q = KCiA for estimating runoff from rainfall where:

   Q = Rate of Run-off in cubic feet per seconds.

   i = Average rainfall intensity in inches per hour for the period of maximum rainfall of a given frequency of occurrence, having a duration equal to the greatest time required for the runoff to flow from the most remote part of the drainage area to the point under design. This period of time is known as the "Time of Concentration".

   C = Runoff coefficient, which is the ratio of the amount of water draining from a given area to the total amount of rainfall within the same period of time.

   A = Drainage is in acres tributary to the point under design.

   K = Coefficient (K=1.0 for 10-yr, K=1.1 for 25-yr, K=1.25 for 100-yr)

2. Rainfall and Intensity
   The minimum storm design frequency for roadway conveyance systems in a closed conduit shall be as follows:

   a. Residential Streets: Ten (10) year event

   b. Industrial/Commercial: Twenty five (25) year event

   c. Arterial: One Hundred (100) year event

   Overland and overflow swales shall be designed to accommodate a 100 year event.

In addition to the design criteria for the roadway conveyance system, a separate drainage plan is required based on the 100 year frequency storm. The drainage from the 100 year frequency storm shall be routed using surface channeling. Routing of the 100 year storm through the project area shall be done such that no buildings are inundated with storm water. As part of the drainage plan, the elevation of the minimum building opening will be specified for each lot adjacent to the proposed 100 year storm flow. Minimum building openings shall be at an elevation such that each lot will allow runoff to flow in accordance with the drainage plan without ponding on any lot. All lots must be graded and maintained in accordance with the approved plan. The Contractor/Developer is required to include in the recorded restrictions for the development a covenant that the owner or owners of the specified lots shall not change or alter the grade for their lots and shall maintain the drainage flow lines for the 100 year storm routing. The City Engineer may also require proof that said covenants have been included in the deed restrictions for the specified lots and that they have been recorded.

All design calculations shall be arranged in a manner such that they can be easily checked. A sketch or map shall accompany the calculations showing point of intercepting storm water. These points of the interceptions shall be numbered and coincide with the numbered points of interception on the design calculation sheet.

All plans and supporting documentation for storm sewers shall be signed and sealed by a licensed professional engineer in the State of Missouri.

3. Minimum and Maximum Design Velocities
   a. The minimum system velocity when flowing full will be 3.0 feet per second.

   b. The maximum system velocity when flowing full will be 14.0 feet per second.

   Deviation from the above shall be only upon the approval of the City Engineer.

4. Methods of Conveying Storm Water for a Ten Year Frequency Storm
   Storm water shall be conveyed in one of the following manners.

   a. Open Improved Channels

      (1) Grass Swales – Grass swales may be used in areas where the runoff from a ten year frequency storm does not exceed five cubic feet per second and the velocity does not exceed five feet per second.

(2) Lined Channels – Concrete, riprap and gabions may be used to convey storm water. Channels shall be sized to carry the flow from a ten year frequency storm entirely within the limits of the channel. All lined channels shall be constructed on dedicated easements. The width required shall be a minimum of 7.5 feet beyond the outside edge or walls of the actual lined section.

(a) Concrete Channel Slope – The paved ditch may have either vertical (railings may be required) or sloping sides. If the sides are sloped, the maximum slope shall be one and one half horizontal to one vertical.

Maximum sod slope allowed above the concrete lining shall be four feet horizontal to one foot vertical.

(b) Riprap – Maximum side slopes for riprap shall be three horizontal to one vertical. Maximum sod slope allowed above riprap shall be four horizontal to one vertical.

(c) Gabions – Gabions shall be manufactured in such a manner that their sides, ends lid and diaphragm (s) can be assembled to form rectangular units of the specified dimensions.

Gabions shall be a single unit construction. The front, base, back and lit shall be woven into a single unit. The ends and diaphragm (s) shall be factory connected to the base.

All perimeter edges of the mesh forming the gabion shall be securely selvedged (woven) so that the joints obtained have at least the same strength as the wire mesh itself.

The gabion shall be equally divided into cells, each having a length equal to the width of gabion, by diaphragm (s) of the same mesh and gage as the gabion body. Design calculations, in accordance with the manufacturer's recommendations, will be submitted for approval.

(3) Street Swale – Street swales to divert water across a street shall only be permitted on residential classification streets. Flow of runoff water across a street shall be limited to one cubic foot per second.

When street swales are utilized, water shall not be diverted across a through street. If neither street is a through street, storm water shall be diverted across the street with the least traffic, as directed by the City Engineer.

b. Underground Pipe

The minimum inside diameter shall be 15 inches. Reinforced concrete pipe shall be used for all storm sewer within rights-of-way or at locations as determined by the City Engineer, corrugated metal pipe may be used for underground storm sewer construction at other locations. NOTE: Driveway culverts, if required, may be concrete, cmp, or steel. HDPE pipe is not permitted on the ROW.

c. Open Unimproved Channels

(1) An open, unimproved channel may be used to convey storm water for a flow of 200 cubic feet per second or greater, at the upstream end of the channel crossing, the plat boundary, during the 10-year frequency storm. Such a channel is subject to approval by the City. A detailed plan showing size, type, location, and drainage calculations must be submitted with a written request. Such drainage courses will be allowed only where provisions have been established for private perpetual maintenance. The City will not maintain the channel.

Energy dissipaters shall be installed within unimproved channels where the velocity of flow exceeds five feet per second for a ten year storm. Dissipaters may be constructed of riprap or concrete as required for lined channels herein.

(2) Channels with flows less than 200 cubic feet per second at the upstream end of the channel crossing the plat boundary will be designed in accordance with Item 4a "Open Improved Channels" and 4b "Underground Pipe" except where natural site conditions would negate the effects of structural improvements. In these instances, the procedures in paragraph (1) above apply.

5. Inlet and Gutter Flow Design

Inlets shall be located to limit the width of flow in street gutters at the time of peak discharge of the design period storm to the following limits:

BACK TO BACK OF CURB STREET WIDTH IN FEET	MAXIMUM ALLOWED SPREAD IN EACH OUTSIDE CURB LANE FROM BACK OF CURB IN FEET
28 or less	10.5
Over 28 to 36	11.5
Over 36	12.0
Divided Roadways	As above for each direction roadway
Arterial and Collector Street Intersections And Pedestrian Crosswalks	6.0

Gutter spread calculations shall be provided for all inlet locations.

1.03 Manholes, Curb Inlets, Junction Boxes and Yard Inlets

1. Manholes, curb inlets, junction boxes and yard inlets shall be designed and constructed to conform to ASTM C478 and as shown as follows:

   a. Curb Inlets per Standard Detail Strm-1

   b. Yard Inlets per Standard Detail Strm-2

   c. Junction Boxes per Standard Detail Strm-3

   NOTE: A trash guard is required on all inlet openings larger than 6".

2. Minimum inside dimension shall be as follows:

   a. 4' – 0" – pipe size 24" or less

   b. 5' – 0" – pipe size 27" to 36"

   c. 6' – 0" – pipe size 42" to 48"

   NOTE: When pipe nominal diameter exceeds 48", special manhole may be required. Such manholes shall be cast-in-place and shall be detailed on the engineering plans.

3. Access for inspection and maintenance for storm sewers 36" and smaller, will be through manholes, catch basins or yard inlets located where feasible at:

   a. All changes in alignment and grade: miter joints may be accepted for pipe sizes greater than 42" at an angle of 45 degrees or less.

   b. Changes in conduit size

   c. Branch connections

   d. Probable future connections

   e. Such additional locations as required to provide access within the maximum intervals

   The maximum interval between points of access into storm sewers will vary with pipe. Diameters as follows:

15”	400 foot maximum
18” to 36”	500 foot maximum
42” to 48”	600 foot maximum
54” and larger	700 foot maximum

1.04 Reinforced Concrete Box Culverts

Box culverts shall be constructed of reinforced concrete, and shall be designed in accordance with Missouri Department of Transportation Specifications.

1.05 Extension of Underground Pipe to Plat Boundary and Inlets and Outlets

Enclosed storm sewer systems shall extend to the plat boundary with riprap placed downstream of the end section. At the Developer’s option, the end section may stop prior to the plat boundary with riprap extending to the plat boundary, in accordance with Standard Detail Strm-4. In all cases, the pipe end section shall extend to at least the property line of an individual lot. If the pipe does not extend to the plat boundary, the Developer shall provide the City of Raymore with an irrevocable letter of credit or escrow money for extension of the pipe to the plat boundary when the adjacent property is developed.

1.06 StormWater Detention Requirements for Land Disturbances from Construction Activities

1. General
   The provisions of the section apply to all land disturbance construction activities including residential (single-family and multi-family), commercial and industrial development. Storm water detention facilities shall be constructed and in operation prior to any construction or impervious surface and so noted on the engineering drawings.

2. Methods of Storage
   There are numerous methods which may be utilized to provide the amount of storage required. In many instances one type of detention system cannot conveniently or economically provide the required or needed amount of stormwater storage. Limitations in storage capacities, site development conditions, soil limitations and other related constraints may require that more than one method be utilized. The various methods of detention including conditions, limitations, inspection, and maintenance responsibilities are defined in Chapter 450 ‘Stormwater Management’ of the City of Raymore’s Unified Development Code. A listing of the various methods follows:

   a. Rooftop Storage
   b. Parking Lots

c. Recreations Areas
d. Dry Reservoirs
e. Permanent Lakes
f. Underground Storage

3. Design
Detention shall be designed and built according to the latest edition of the Kansas City Metropolitan A.P.W.A. and these specifications. The more restrictive applies. A complete set of the plans along with the following design data shall be submitted for the City Engineer's review for all detention facilities:

a. Engineering drawings showing dimension of detention and details of outlet works.

b. Area – Capacity curves for proposed detention facility plotted as datum elevation as ordinates and cumulative volume of storage as abscissas.

c. Discharge characteristics curve of outlet works plotted in units of detention facility water – surface elevation as ordinates and discharge rate (C.F.S.) as abscissas.

Data from the above items 'b' and 'c' may be waived at the discretion of the City Engineer.

1.07 Storm, Water Detention Requirements for Land Disturbance from Construction Activities in Excess of 25 Acres

Storm water detention requirements for watersheds in excess of 25 acres shall utilize one of the following methods for all platted land disturbance activities including residential (single-family and multi-family) commercial and industrial developments. Alternate methods may be allowed upon approval of the City Engineer.

1. SCS TR55

2. HEC - 1

3. HEC - 2

Computer printouts and calculations shall be submitted along with submittals outlined in Section I, Paragraph F, Item 3 "Design Data Submittal" under this Article.

4. Exemptions: Storm water detention on site is not required when drainage basin/watershed modeling, considering fully developed conditions in accordance with the land use, demonstrates that no increase in peak

flows at critical downstream locations for the design storm occurs following development of the site.

2.00 MATERIALS

2.01 Storm Sewer Pipe

1. Corrugated Metal Pipe - All corrugated metal pipe, coupling bands, fittings and end sections shall be fabricated from steel corrugated metal sheets and galvanized in accordance with AASHTO Designation M36.

   Gauges shall be 14 gauge for pipe diameters 15" through 54" and 12 gauge for pipe diameters 60" or greater, or, if aluminized, 16 gauge for pipe diameters less than 54" and 14 gauge for pipe diameters 60" or greater unless loading conditions dictate a higher strength pipe. Pipe joints shall be banded and gasketed as specified in the AISI Handbook of Steel Drainage and Highway Construction Products. Corrugated metal pipe shall not be used in street rights-of-way unless approved by the Engineer for a driveway culvert.

2. Reinforced Concrete Pipe - All reinforced concrete pipes shall conform to the current ASTM Specification C76, with the following exceptions:

   a. The reinforced concrete pipe shall have a wall thickness of not less than 'B' as defined in the C76 specifications.

   b. The pipe class shall be as designated on the plans, and shall not be less than Class II except when the pipe is located under streets, in which case the pipe class shall not be less than Class III.

   c. Reinforcement - Circumferential reinforcement shall be the full circle type. Elliptical or part-circle reinforcement will not be acceptable unless otherwise approved by the City Engineer.

   d. Joints - Joints shall be rubber gasket or mastic joints as follows:

      (1) Rubber gasket joints - Rubber gasket joints shall conform to the current ASTM Specification C443.

      (2) Mastic joints - Mastic joints shall he a bitumastic material applied in accordance with the manufacturer's recommendations. A sufficient amount of material shall be applied to fill all voids in the joint.

   e. Fine Aggregates - Fine aggregates shall consist of clean natural sand conforming to ASTM C33. Artificial or manufactured sand will not be acceptable.

f. Joint Separation - In laying pipe, the maximum joint separation for mastic joints shall not exceed:

Pipe Size	Maximum Separation
15" – 48"	3/8"
54" – 72"	½"
84" – 144"	¾"

g. Bends – when approved on the plans by the City Engineer, bends for concrete pipe shall be fabricated from segments of a steel cylinder with concrete or mortar lining and reinforced concrete exterior covering or from segments of concrete pipe miter cut while the pipe is still green.

Steel cylinders shall be at least ten gage and shall be lined with concrete or mortar a minimum of three-fourths (3/4) inches thick. Bends fabricated from steel cylinders shall be designed for the same three-edge bearing loads as the adjacent pipe.

Bends factory fabricated from miter cut segments of concrete pipe, the reinforcing steel shall be welded and each joint shall be encased in concrete after installation. Concrete encasement shall be at least eight inches thick and as shown on the approved engineering plan.

2.02 Manholes

Manholes shall be constructed complete with ring and cover, fittings, and other appurtenances, in accordance with the following criteria and standard details:

1. Concrete – 4000 PSI mix with entrained air

2. Precast Sections – Circular precast concrete shall meet the requirements of ASTM C478. Joints shall be a bitumastic material or preformed flexible joint sealant.

3. Dimensions – Standard Details Strm-1, Strm-2 and Strm-3.

4. Flexible Joint – Hamilton – Kent "Kent Seal", Bidco Sealants, Inc. "Bidco C56" or approved equal. The minimum bead dimensions shall be one square inch.

5. Coal Tar Paint – Kopper's "Bitumastic Super Service Black". Tnemec "46 – 460 Heavy Tnemecol", Porter "Tar Mastic 100" or approved equal.

6. Flexible Gaskets – Flexible gaskets shall be Press – wedge, PSX (Press Seal Gasket Corporation), A – Lok (A – Lok Products, Inc.) or approved equal.

7. Portland Cement – Portland Cement shall conform to ASTM C150, Type I of II. When high early strength is required, Type III can be used.

8. Fine Aggregate – Fine aggregate shall meet the requirements of ASTM C33.

9. Coarse Aggregate – Coarse aggregate shall meet the requirements of ASTM C33.

10. Mortar – One part Portland cement, Type II, three parts sand, one fourth parts hydrated lime, conforming to ASTM C207.

11. Manhole Steps – Steps are NOT permitted in manholes.

12. Reinforcing Steel – ASTM A615, Grade 60.

2.03 Casting

1. Manhole Ring and Covers shall be as follows:

   a. Clay & Bailey → Model No. 2020 (medium duty)

   b. Neenah → Model No. R-1669 (Heavy duty)

   c. Deeter → Model No. 1332

   d. EJIW → Model No. 1501A1 Product No 00150130

2. Manhole Frame with Bolted Lid

   a. Clay & Bailey → Model No. 2014

   b. Neenah → Model No. R1916E

2.04 Curb Inlets, Junction Boxes and Yard Inlets

Curb inlets, junction boxes and yard inlets shall be constructed complete with ring and cover and other appurtenances, in accordance with the following criteria and Standard Details Strm-1 through Strm-3 and Strm-5 & 6.

1. Concrete – 4000 psi, with entrained air.

2. Portland Cement – Portland cement shall conform to ASTM C150, Type I or Type II.

3. Fine Aggregate – Fine aggregate shall meet the requirements of ASTM C33.

4. Coarse Aggregate – Coarse aggregate shall meet the requirements of ASTM C33.

5. Mortar – One part Portland cement, Type II, three parts sand, one fourth part Hydrated Lime, conforming to ASTM C207.

6. Dimensions – Standard Detail Strm-1 for Curb Inlets
   Standard Detail Strm-3 for Junction Box
   Standard Detail Strm-2 for Yard Inlet

7. Steps – NOT allowed in manholes

8. Reinforcing Steel - ASTM A615, Grade 40, Grade 60.

9. Casting - Ring and covers per Standard Detail Strm-5 shall be as follows:

   a. Clay & Bailey -Model No. 2020 or 2002

   b. Neenah -Model No. 1669

   c. Deeter -Model No. 1332

2.05 Reinforced Concrete Box Culverts

Reinforced concrete box culverts shall be designed and constructed in accordance with Missouri Department of Transportation Specifications.

2.06 Lined Channels

1. Concrete Lined Channels - All concrete lined channels shall consist of poured in place, air entrained, reinforced concrete.

   The concrete slump shall be kept as low as possible consistent with proper handling and thorough compaction. Unless otherwise authorized by the City Engineer, slump shall not exceed four (4) inches.

   The minimum 28 day acceptable compressive concrete strength as determined by ASTM C39 shall be 4,000 psi, KCMMB-4K mix.

   a. Testing - Unless otherwise stipulated or authorized by the City Engineer, a minimum of four compression test cylinders shall be made from each maximum 50 cubic yards of pour. One of these cylinders shall be tested at an age of seven days and two cylinder shall be tested at an age of 28 days. One cylinder shall be held in reserve. Concrete test cylinders shall be made, cased, and in conformity with ASTM C192 and tested in conformity with ASTM C39.

All costs associated with the testing of concrete cylinders shall be at the expense of the Contractor/Developer performing the construction of paved ditches. One copy of the test results shall be supplied to the City Engineer.

b. Reinforcing - The reinforcing for the concrete shall be designed to withstand all earth and water pressures imposed upon the sides. The minimum amount of reinforcing placed in any section of the concrete pavings shall be flat sheets of 6" x 6" spacing welded wire fabric, six gauge thickness. Wire fabric shall conform to ASTM A184.

2. Riprap Channels

Riprap channels shall be constructed in accordance with Standard Detail Strm-7.

a. Stone for riprap and gabion linings shall consist of quarried rock and be sound, durable and angular in shape. Material shall be free from cracks, seams or other defects. Shale and stone with shale seams are not acceptable.

b. Riprap shall have a minimum thickness of 18 inches or 1.5 times as thick as the larger stones, whichever is greater. At least 60% shall be of pieces having a volume of one cubic foot or more. No more than 6 percent of the stones shall weigh less than 10 pounds.

c. Soil stabilization blanket shall be used in conjunction with riprap at the outlet end of pipe.

d. Riprap shall <u>not</u> be grouted.

3. Gabion Lined Channels

Gabion Lined Channels shall be designed in accordance with "Kansas City Metropolitan Chapter of the APWA Standard Specifications and Design Criteria"

3.00 INSTALLATION

3.01 Lined Channels

1. Concrete Lined Channels
Concrete shall be placed in accordance with APWA, Section 2208.5, beginning at the lower end of the portion of the ditch to be lined and progressing toward the upper end. Concrete shall be reinforced with the type of reinforcement and in the manner indicated on the approved Engineering Drawings. Contraction or construction joints shall be spaced and formed as indicated on the approved engineering drawings.

A broom finish is required. Immediately after the finishing operations are completed, the concrete shall be protected and cured in conformance with the requirements specified in APWA Section 2208.4.

2. Riprap Channels
Riprap shall be placed at the locations and to the dimensions shown on the approved engineering drawings.

Riprap shall be graded as necessary to form a dense blanket. The finished surface shall present an even surface conforming to the lines, grades, and sections given. Riprap shall be placed to a minimum depth of 18 inches.

Riprap shall be placed in such a manner that voids created by larger pieces are filled in by smaller pieces and no voids extend directly through the riprap to the surface below. The riprap shall be placed in rows transversely to the centerline of the ditch and in the manner indicated on the drawings.

Riprap for entrance and outlet erosion protection shall be installed in accordance with Standard Details Strm-4. The outlet erosion protection shall extend to the edge of the water when a pipe outlets to an existing body of water.

3.02 Gabion Lined Channels

1. General Installation of gabions shall conform to the requirements of the following paragraphs, subject to additional directions of the manufacturer, as approved by the City Engineer.

2. Manufacturer's Representative The gabion manufacturer shall send a representative, experienced in gabion construction, to the job site to monitor the Contractor/Developer's work and construction techniques.

3. Assembly

a. Each gabion shall be removed from the bundle, unfolded flat on the ground, and all kinks and bends flattened.

b. The gabion unit shall then be assembled individually, by erecting the sides (front and back), ends and diaphragm(s), ensuring that all creases are in the correct position the tops of all sides level.

c. The four corners of the gabion unit shall be laced first, followed by the edges of internal diaphragm(s) to the sides.

d. The lacing procedure shall consist of cutting a length of lacing wire approximately one and one-half times the distance to be laced - not to exceed five feet. Secure the wire terminal at the corner by looping and twisting, proceed to lace with alternating single and double loops at approximately five inch intervals. Securely fasten the other lacing wire terminal.

4. Installation

a. The assembled gabion units shall be carried to the job site and placed in their proper locations. Care shall be taken not to damage the filter cloth. For structural integrity, all adjoining empty gabions must be laced along the perimeter of their contact surfaces in order to obtain a monolithic structure.

b. The following method applied to three foot three inch high gabions; once the gabion units are laced together, they shall be stretched to effective alignment. This operation shall be carried out after several empty gabion units have been positioned. The first gabion in the line shall be partially filled to provide the necessary anchorage. Any stretching shall be carried out using a come-along or other means of at least one ton capacity.

c. While under tension, the gabion joints shall be carefully controlled against any possible unraveling.

d. Whenever gabion structures require more than one tier, the upper empty gabion tier (under tension) shall also be laced to the top of the lower one.

e. For gabions less than three feet three inches in height, the above procedures shall be modified in accordance with instructions provided by the manufacturer and approved by the City Engineer.

5. Filling

a. Gabions shall be filled with stone meeting the requirements of Section II, Paragraph G, Item 3.0 "Stone Fill for Gabions" under this Article.

b. Gabions may be filled by almost any type of earth-handling equipment such as: backhoe, gradall, crane, etc.

c. Care shall be taken when placing stone fill to assure that the sheathing on PVC coated gabions will not be broken or damaged.

d. Gabions shall be filled in layers, not to exceed one foot at a time. Two connecting wires shall be placed between each layer in all cells along all exposed faces of the gabion. All connecting wires shall be looped

around two mesh openings and the wire terminals shall be securely twisted to prevent their loosening.

e. The cells in any row shall be filled in stages so that local deformation may be avoided. That is, at no time shall any cell be filled to a depth exceeding one foot more than the adjoining cell.

f. Along all exposed gabion faces, the outer layer of stone shall be carefully placed and paced by hand, in order to ensure proper alignment and a neat, compact square appearance.

g. The last layer of stone shall be leveled with the top of the gabion to allow proper closing of the lid and provide an even surface for the next course.

h. Well packed filling without undue bulging, and secure lacing, is essential.

6. Lid Closing

a. The lids shall be stretched tight over the filling, using crowbars or lid closing tools, until the lid meets the perimeter edges of tile front and end panels.

b. The lid shall then be tightly placed along all edges, ends and diaphragm(s) in the same manner as described above for assembling.

c. Well packed filling without undue bulging, and secure lacing, is essential.

7. Cutting and Folding Mesh

a. Where shown on the Plans or otherwise directed by the City Engineer, the gabion mesh shall be cut, folded and wired together to suit existing site conditions. The mesh must be cleanly cut and the surplus mesh cut out completely, or folded back and neatly wired to an adjacent gabion face. The cut edges of the mesh shall be securely laced together with lacing wire in the manner described above for assembling.

b. The assembling, installation, filling and lid closing of the reshaped gabions shall he carried out as specified above.

8. PVC Coating

a. The PVC coating on the wire shall have continuity.

b. A coating compound material, recommended by the manufacturer of the Gabions and approved by the City Engineer, shall be on hand and applied where any PVC coating is broken because of abrasion during shipment or during construction. Excessively damaged gabions will be rejected.

3.03 Handling and Storage

All pipe, fittings and accessories shall be loaded, unloaded, stored and installed in such a manner to prevent structural damage or coating damage. Any damaged material shall be replaced or restored to its original condition at the Contractor/Developer's expense.

3.04 Inspection of Materials

A Public Works Inspector will inspect pipe, fittings and accessories for damage or defect prior to installation. Damaged or defective materials shall be replaced or restored to its original condition.

3.05 Alignment

Pipe shall be laid to the lines and grades as shown on the approved engineering drawings.

3.06 Cleaning

All pipe, fittings and accessories shall be kept clean of foreign matter while being handled or stored. During installation, foreign matter shall not enter the pipe or appurtenances. At the end of each working day, a temporary plug shall be installed at the termination of the pipe line.

3.07 Sewers in Relation to Water Main: Separation of Water Mains, Sanitary Sewers and Storm Sewers

1. Adequate Separation Factors The following factors should be considered in providing adequate separation:

   a. materials and type of joints for water and sewer pipes,

   b. soil conditions,

   c. service and branch connections into the water main and sewer line,

   d. compensating variations in the horizontal and vertical connections,

   e. space for repair and alterations of water and sewer pipes,

   f. off-setting of pipes around manholes and other sewer structures.

2. Parallel Installation

   Storm sewers shall be laid at least five feet horizontally from any existing or proposed sanitary sewer or water main.

The distance shall be measured edge to edge. In cases where it is not practical to maintain this separation, the department may allow deviation on a case-by-case basis, if supported by data from the design engineer. Such deviation may allow installation of the storm sewer closer to the water or sanitary, provided that the storm is laid in a separate trench.

3. Crossings
   Storm crossing of the water and sanitary mains shall be laid to provide a minimum vertical clear distance of 18 inches between the outside of the storm and the outside of the water and sanitary main. This vertical clearance can be either above or below the water and sewer.

4. Exception
   The department must specifically approve any variance from the requirements of Items 2 and 3 when it is impossible to obtain the specified separation distances.

5. Sewer Manholes and Other Structures
   No water line shall be located closer than ten feet to any part of a sanitary sewer manhole or other sanitary sewer structure. No water line shall be located closer than five feet to any part of a storm sewer curb inlet, junction box, or other storm sewer structure.

4.00 EXCAVATION, TRENCHING AND BACKFILLING

4.01 General
The trench shall be so dug that the pipe can be laid to the alignment and depth required and shall be excavated only so far in advance of pipe laying as the Engineer shall specify. The trench shall be so braced and drained that the workmen may work therein safely and efficiently. All trenches shall be sheeted and braced to a safe angle of repose. Such angle of repose shall be no less than that repose required by the requirements of the Occupational Safety and Health Act (OSHA).

It is essential that the discharge of any required trench dewatering pumps be conducted to natural public drainage channels, drains or storm sewers. Discharge location(s) shall be approved by the Engineer prior to dewatering.

4.02 Class of Bedding
Granular bedding as shown on Standard Detail Strm-7 shall be used unless a different class of bedding is called for elsewhere in the contract documents. Any special bedding shall be in accordance with the Special Provisions.

1. Granular Bedding:

Granular bedding shall be achieved by bedding the pipe with ordinary care in an earth foundation formed in the trench bottom by a shaped excavation which will fit the pipe barrel with reasonable closeness for a width of at least 50% of the outside pipe diameter. The side fills and area over the pipe, to a minimum depth of six inches above the top of the pipe, shall be filled with embedment material. Embedment materials shall be granular bedding approved by the City. Embedment materials shall be compacted in six (6) inch lifts to a point six (6) inches above the pipe and to a density of at least ninety five (95) percent of standard proctor density as described by ASTM Methods D698.

4.03 Trench Width and Description

The trench width at the top of the excavation may vary depending upon the depth of the trench and the nature of material encountered. The width of the trench shall also be kept at a minimum to prevent excess destruction of the existing ground surface.

For trench width at the top of the pipe greater than specified in the paragraph above, the Engineer may direct the Contractor to provide a higher class of bedding or a higher strength pipe (or both) than that required by the contract documents; without additional compensation therefore, as the Engineer deems necessary to satisfy the design requirements.

4.04 Correcting Faulty Grade

Any part of the trench excavated below grade shall be corrected with approved material and thoroughly compacted without additional compensation to the Contractor.

4.05 Pipe Foundation in Poor Soil

When the bottom of subgrade is soft and in the opinion of the Engineer cannot adequately support the pipe, a further depth and/or width shall be excavated and refilled to pipe foundation grade with material approved by the Engineer and thoroughly compacted; or other approved means such as piling, shall be adopted to assure a firm foundation for the pipe with extra compensation allowed the Contractor as provided elsewhere in these specifications.

This provision only applies in those instances/locations when normal dewatering operations are not considered viable and/or poor soil conditions exist as determined by the Engineer. The Contractor shall furnish, drive and place piling if ordered by the Engineer. Piles shall be driven in exact position at locations determined by the Engineer. The Contractor at his own expense must replace piles not correctly positioned at the completion of driving.

4.06 Pipe Foundation in Rock

The space between the bottom of the trench in rock conditions and the required bedding of the pipe as per Section 4.02 (Class of Bedding) as shown on Standard Detail Strm-7 shall be backfilled with granular material, approved by the Engineer, thoroughly tamped. No additional compensation for placing or tamping this material shall be allowed.

4.07 Solid Rock Excavation Defined

Solid rock excavation shall include such rocks as are not decomposed, weathered or shattered and which will require extraordinary construction activities as determined by the Engineer including but not limited to blasting, barring, wedging or use of air tools for removal. Under this classification shall be included the removal of any concrete or masonry structure (except concrete pavement, curb, gutter and sidewalk) exceeding one (1) cubic yard in volume that may be encountered in the work.

4.08 Blasting Procedure

The hours of blasting will be fixed by the Engineer. The Contractor's methods of procedure relative to blasting shall conform to local and state laws and municipal ordinances.

4.09 Braced and Sheeted Trenches

The Contractor shall adequately brace and sheet excavation wherever necessary to prevent caving or damage to nearby property. The cost of this temporary sheeting and bracing, unless provided for otherwise, shall be considered as part of the excavation costs without additional compensation to the Contractor. Trench sheeting shall remain in place until pipe has been laid, compacted to a depth of one foot (1') over the top of the pipe. Sheeting, bracing, etc., placed in the "pipe zone" (that part of the trench below a distance of one foot (1') above the top of the pipe) shall not be removed without the written permission or written order of the Engineer; that sheeting thereby left in place shall be paid for at the unit price bid. Sheeting ordered left in place by the Engineer in writing shall be paid for at the unit price bid. The Contractor may also leave in place, at his own expense, to be embedded in the backfill of the trench any sheeting or bracing in addition to that ordered left in place by the Engineer for the purpose of preventing injury or damage to persons, corporations or property, whether public or private, for which the Contractor under the terms of this contract is liable.

4.10 Backfill

Backfill under pavements, driveways, sidewalks, and other paved areas:

1. Flowable fill shall be used for backfill under all paved areas. Flowable fill mix design must be approved by the Engineer prior to placement. Backfill shall be placed as shown on Standard Detail St-11 (APWA p26-14).

Backfill in areas other than paved areas:

2. Backfill shall be finely divided, excavated material, free from debris, organic material, frozen material, and stones larger than six inches.