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800 GENERAL

1. This section of the specifications covers the furnishing and installing of all storm drainage improvements, storm sewers, storm water inlets, manholes, headwalls, other appurtenances and all related work necessary to complete the storm drainage improvements.
2. All piping and material shall be of the type and materials specified herein. The use of materials other than those specified herein, require written approval from the Town Engineer. All materials shall be new and unused. All pipe sizes and references to pipe diameter on the drawings or in the Specifications are intended to be the nominal inside diameter, and shall be interpreted as such.
3. The work covered by this section will not be accepted until the backfill connected with the work has been completed satisfactorily. Any section of storm sewer line that is found defective in tests, material, alignment, grade, or joints shall be corrected.
4. The Contractor shall provide a copy of the manufacturer's installation recommendations for each type of pipe to each foreman and inspector prior to construction. These installation recommendations shall be followed except where the approved Construction Plans call out different material or installation methods.
5. The Design Engineer or the Town reserves the right to require the testing of pipe and materials after delivery and to reject all pipe or materials represented by the sample which fail to comply with the specified requirements.

801 PIPE DESIGN

1. Storm piping may not be curved or deflected.
2. Pipe inside diameter shall be a minimum of 15-inches for public and private storm sewers, except direct connections to down spout roof gutters or trench drains, see Section 811.
3. For changes in pipe size, the crowns of the pipes shall be at the same elevation, or the incoming flow shall be 0.2-feet above the outgoing flow, whichever is the greater drop across the manhole invert.
4. All pipes shall be laid to provide a minimum velocity in the pipe of 3-feet per second.

802 REINFORCED CONCRETE PIPE (RCP)

1. Circular reinforced concrete pipe shall meet the requirements of ASTM C76. Pipe laying lengths shall be a minimum of 7-feet 6-inches. The class of pipe shall be as indicated on the approved plans. The pipe strength shall be a minimum of Class III. Bedding for concrete pipe shall be 6-inches minimum below the pipe and for 24-



- inches and smaller pipes the bedding shall extend to 1-foot above the top of pipe. For 30-inches and larger pipes the bedding shall extend to the spring line of the pipe. See Detail 800-01 at the end of this section.
2. Arch Culvert reinforced concrete pipe shall meet the requirements of ASTM C506 and the requirements contained herein.
 3. Elliptical reinforced concrete pipe shall meet the requirements of ASTM C507 and the requirements contained herein.
 4. All (RCP) shall be constructed with Type II modified cement. The absorption of the concrete pipe shall not exceed 5.5%.
 5. Gaskets shall be rubber O-ring type per ASTM C361 or rubber neoprene gaskets per ASTM C443. Gaskets will be used in a bell and spigot joint. Other gaskets may be allowed after review of submitted documentation, and approval by the Town Engineer.
 6. Each pipe joint shall conform to ASTM C361, Section 8, with the gaskets confined in a groove cast in the pipe spigot. Pipe with collars in lieu of integral cast bells will not be accepted. The pipe joints shall be designed to withstand, without cracking, the gasket compression plus a differential load across the joint equal to 4,000-pounds per foot of inside diameter.
 7. Each piece of reinforced concrete storm drain pipe shall be plainly and permanently marked showing the pipe class, date of manufacture, and the manufacturer's name or mark. These markings shall be made on the outside of the pipe before curing or shall be painted on the pipe using waterproof paint.
 8. The Town Engineer may require the submittal of reports covering joint leakage, joint shear, cement mill reports, and three edge bearings on each size and class of pipe for review before any pipe is installed in the field. The tests for joint leakage, joint shear, and three-edge bearing are for proof of design only. Reports covering tests made on other pipe of the same size, class, and design as specified herein, and manufactured from materials of equivalent type and quality are generally acceptable.
 9. The Town Engineer may require the submittal of drawings, specifications, and other data showing complete details of the design, fabrication, and construction of the reinforced concrete pipe for review. These submittals shall include data on all materials proposed to be used in the pipe, the size and location of each cage of the reinforcement, joint details including reinforcement, gasket details, and test results on materials, joints, and pipe.

803 REINFORCED CONCRETE BOX CULVERTS

1. Reinforced Concrete Box Culverts may be used on storm sewer projects within the Town of Frederick.



2. Reinforced concrete box culverts shall conform to the requirements of The Colorado Department of Transportation, Standard Plans List, M & S Standards, Latest Edition and ASTM C1433.

804 TRENCHING

1. Trenching is to be performed in accordance with all applicable safety standards, including construction fence, shoring, stepped back trenches, material stockpiles, trench access, etc.
2. The excavation or trench shall be kept free from water until the structure or pipe is completely installed. All efforts should be made to keep the structure free from hydrostatic pressure and flotation.
3. The Contractor shall provide a firm and stable subgrade. Wherever unstable material is encountered in the bottom of the trench said material shall be over-excavated to a depth suitable for construction of a stable subgrade as determined by the Design Engineer and approved by the Town Engineer. A sample design is contained in this section's Details but must be verified as adequate by the Design Engineer if included in Construction Plan details.
4. The contractor shall have no more than 200-linear feet of trench open and waiting for utility line installation. Contractor is to only open as much linear trench as they expect to bed, install pipe, cover with squeegee and select fill, and backfill to surrounding grade in that day. Where excavation is a hazard to automotive or pedestrian traffic, the amount of open trench and the duration of that opening is to be minimized.

805 BEDDING AND SELECT FILL MATERIAL

1. All pipe bedding and cover material shall be "squeegee" or other select material meeting the specifications below. Pipe bedding material shall be crushed or non crushed durable rock well graded between the No. 4 sieve size and the No. 100 sieve size with less than 5% passing the No. 200 sieve. See Table below.

Table 800-1 - Pipe Bedding Gradation	
Sieve Size	Percent Passing (%)
3/8-inch	100
No. 4	40-90
No. 16	10-30
No. 200	0-5



2. Pipe bedding is to be poured into place and hand tamped around installed pipe using shovel handle or a similar tool. To prevent lateral displacement, squeegee shall be deposited uniformly and simultaneously on each side of the pipe.
3. Select backfill, generally excavated on site material, is to be placed on top of the pipe bedding to a compacted depth of 1-foot above top of pipe bell. Select backfill material is to be free from clods and rock greater than 1.5-inches in any dimension. This material to be moistened and thoroughly mixed as needed before placement.

806 BACKFILL AND COMPACTION

1. All pipe will have a minimum of 2-feet of cover from the top of the finished grade to the top of the pipe bell, and shall be capable of withstanding AASHTO HS-20 highway traffic loadings.
2. Backfilling should be timed to minimize the length of open trenches during the day and particularly overnight. Trenches shall not be left open overnight. In the event where this can not be avoided the Contractor shall fence the trench and put up warning signs for safety. The Town is not responsible for the safety of open trenches.
3. Any soil used for trench backfill shall be free from frozen matter, stumps, roots, brush, other organic matter, cinders or other corrosive material, hazardous material, and debris. Water shall be added to the material and the material shall be harrowed, disked, bladed, or otherwise worked to insure uniform moisture content, as specified.

If imported soil is used for trench backfill it shall meet CDOT specifications for Class I structural backfill as defined below:

Table 800-2 - Structure Backfill Class 1	
Size	Percent Passing (%)
2-inch	100
No. 4	30-100
No. 50	10-60
No. 200	5-20

In addition this material shall have a liquid limit not exceeding 35 and a plasticity index of not over six when determined in conformity with AASHTO T89 and T90 respectively.

4. Trenches shall be backfilled promptly after the utility has been installed and inspected. Backfill around manholes and inlets shall be compacted with hand-operated equipment. Backfill material shall be deposited in uniform horizontal layers which may not exceed 8-inches loose. All compacted backfill shall be within the Geotechnical Engineer's Specification of moisture, density, and soil type.



5. Field Compaction tests will be conducted to determine compliance of compaction methods with specified density in accordance with ASTM D2922, Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods.
6. Compaction tests shall be performed at a depth of 1.5-feet above the top of the pipe and in 1-foot vertical increments up to the finish grade. Compaction tests shall be performed at least once per every 100-linear feet as measured along the length of the pipe. If the Town Engineer determines in writing that reliable and uniform results are produced by the Contractor's construction techniques, the frequency of testing may be changed to one every 200-linear feet. Compaction shall be to the following minimum densities unless specified to a different percent by the approved Construction Plans.

Table 800-3 - Minimum Densities	
Type	Minimum Density
Pipe Bedding	90% of Maximum Standard Density
Trench Backfill:	
Under paved roadways, sidewalks, and other paved areas	95% of Maximum Standard Density
Under gravel roadways	95% of Maximum Standard Density
Under footing, foundations, or structures	98% of Maximum Standard Density
Fields and open areas	90% of Maximum Standard Density

7. At the Contractor's option, flowable fill meeting the applicable requirement of Section 300, Concrete, may be used in lieu of trench backfill.
8. The Contractor shall maintain and repair all trench settlement and make necessary repairs to pavement, sidewalks, or other structures which may be damaged as a result of backfill settlement. Contractor shall warrant work for a period of 2-years after conditional acceptance by the Town.

807 INLETS AND INLET GRATES

1. Structures, detention outlets, and inlets shall be reinforced as per the approved plans. All structures shall have steel rebar reinforcement. Inlets may be cast-in-place or precast.
2. Inlets allowed in the Town of Frederick are Type C (Surface inlet), Type D (Surface Inlet), Type R (Curb Inlet), Type 13 (Combination Inlet), and Type 13 (Valley Inlet) as



detailed in CDOT M & S Standards, Latest Edition. Details covering each inlet to be included in Construction Plan details. Type 13 inlet grates may have a smaller 17.75-inch by 36-inch grate with a minimum 1.8-square foot opening only if the smaller grate is considered in the hydraulic calculations. Use of Type R inlets are encouraged due to no grate hazard and low blockage potential.

3. Access covers and steps shall be provided for all inlets. Access covers shall have the words "Storm Sewer, Confined Space, Entry Permit Required" cast on the cover. Access covers will be sized for 24-inch diameter openings, 1-inch thick, designed for heavy traffic loading (H-20 Loading). Inlets over 10-feet in length are to have two access covers installed on the opposite ends of the inlet.
4. Storm sewer penetrations are to be at downstream end of box. No pipes shall enter into the corner of the inlet.
5. Inlet grates in streets, alleys, and areas with pedestrians shall be of a design that is safe for bicycles and pedestrians.
6. New holes for pipeline connections to existing inlets must be cored, not broken open with sledge hammers. Connections and methods to existing inlets must be approved by the Town Engineer.

808 MANHOLES

1. The Contractor shall locate manholes at all changes in grade, alignment, pipe materials, and pipe sizes.
2. Manholes shall be located at street intersections whenever possible.
3. Drop manholes are allowed for storm drainage improvements. No outside drops are allowed on manholes and the Town Engineer may restrict the difference in height between the incoming pipe invert and the outgoing pipe invert.
4. No manholes may be located in sidewalks, pans, gutters, areas of ponding, storm detention basins, or in the crown of the road. If all other manhole locations have been exhausted the Town Engineer may approve in writing a manhole that is located in an area which will experience surface runoff ponding or is in a flow channel. These manholes must have a solid manhole cover, having an integral O-ring type gasket, that can be bolted closed and the manhole ring shall be bolted to the manhole cone.
5. Manholes must be spaced no farther apart than 400-feet for pipes with inside pipe diameters of 15-inches to 36-inches, and 500-feet apart for pipes with inside diameters of 42-inches and larger.
6. Manholes shall be at least 48-inch diameter for pipes between 15-inches to 36-inches diameter. Manholes shall be at least 60-inch diameter for pipes between 42-inches to 48-inches diameter. Manholes shall be at least 72-inch diameter for pipes



between 54-inches to 60-inches diameter. Minimum manhole diameter shall be based on largest diameter pipe entering manhole. Manholes shall have a box base or precast tee for pipes larger than 60-inches diameter. When multiple pipes penetrate a manhole the minimum distance along the inside radius of the manhole shall be 1.5-feet between pipes.

7. Manhole covers shall have the words "Storm Sewer, Confined Space, Entry Permit Required" cast on the cover.
8. Manholes shall be located in areas which allow direct access via all-weather drives by maintenance vehicles.
9. All manholes located outside the dedicated street right-of-way shall be designed and constructed with a watertight, bolted type cover and the manhole ring shall be bolted to the manhole cone.

809 END SECTION AND OUTFALL MATERIAL

1. All storm sewers end sections and outfalls shall have a cast-in-place reinforced concrete headwall or a pre-manufactured flared end section. Pre-cast headwalls are not acceptable. All headwalls, and accompanying wingwalls, shall conform to the CDOT Standard Plans, M & S Standards, Latest Edition and full details shall be included in the construction plans. Pre-manufactured flared end sections shall be made of the same materials as the pipe to which they are connected and shall meet the minimum material specifications applying to the pipe. Refer to Details 800-05 to 800-06B for flared end sections and trash racks.
2. All storm sewer openings that are larger than 15-inches or subject to unauthorized entrance or trash accumulation shall have a designed trash rack with a galvanized coating.
3. Riprap protection shall be per UDFCD Requirements, Chapter 9, Section 3.2.3 *Riprap Size for Riprap Apron and Low Tailwater Basin* in the Urban Storm Drainage Criteria Manual, Volume 2.

810 CONNECTION OF GUTTERS/DRAINS TO STORM DRAINS

1. Roof gutters and trench drains may be direct connected to a storm sewer manhole using plastic pipe. The down spout location, drain connection, and manhole placement should minimize the length of the plastic pipe. The pipe size should be a minimum 2-inch diameter over the designed carrying capacity diameter of the pipe (minimum pipe diameter + 2-inch). Pipe size, slope, specific pipe type, and any special connections are to be called out on plans. Elbows or deflection are not allowed in the pipe run.
2. The Town recommends cleanouts be installed at appropriate intervals. Design Engineer must provide full details of cleanout from wye to surface



- treatment/protection of cleanout lid. The Town Engineer may require cleanouts at any location they deem necessary within the Right-of-Way or publicly owned land.
3. The Town does not assume ownership or maintenance responsibility for roof drains or roof drain connections to storm systems unless specifically stated otherwise in the Town Board approved documents.

811 EXISTING EXTENSIONS-FUTURE STUB OUTS

1. The extensions of storm drainage pipe shall be of the same material as the existing culvert as far as the next manhole/inlet. The physical connection to the existing storm drain system shall be plugged at the first downstream manhole until the storm system has been completed to the satisfaction of the Town.
2. When a storm drain line is anticipated to be extended at a future date, the Contractor shall install a manhole at the end of the line and shall install plugged stub out(s) in the direction(s) of the extension. The length of these stub outs will be directed by the Town Engineer.

812 INSTALLATION OF PIPE AND APPURTENANCES

1. All pipe, fittings, and accessories shall be carefully lowered into the trench with suitable equipment in a manner that will prevent damage to the pipe. Under no circumstances shall pipe or accessories be dropped or dumped into the trench. Pipe and accessories shall be inspected for defects prior to being lowered into the trench. The Town Engineer or a Town representative shall have the authority to reject any pipe, gaskets or any accessories deemed to be below these standards. All foreign matter or dirt shall be removed from the interior of the pipe and the accessories before lowering into the trench. The pipe shall be kept clean by means approved by the Town Engineer during and after installation.
2. Pipe shall be laid to a true line and at uniform rates of grade as shown on the approved plans. Fine grading of the trench shall proceed ahead of pipe laying.
3. Pipe laying should proceed upgrade with the spigot ends of the pipe pointed in the direction of flow. The Contractor shall make all pipe connections to the manholes. When connecting to existing storm drains, the Contractor shall take every precaution necessary to prevent dirt or debris from entering the existing storm drainage system.

813 CONSTRUCTION OF MANHOLES

1. In shallow manholes, less than 3-feet from invert to lid, manhole covers shall be lined up over the pipeline outlet to allow maintenance jetting equipment access to the pipelines. In manholes greater than 3-feet in height, the manhole rim is to be lined up to access rungs (see Details 800-03 and 800-04).



2. Flat top manholes shall only be used due to height constraints and with written approval of the Town Engineer. All flat tops are to be pre-cast and H20 traffic rated, regardless of location. Design Engineer shall submit a specific detail for construction of a flat top manhole.
3. New holes for pipeline connections to existing manholes must be cored, not broken open with sledge hammers. Connections and methods to existing inlets must be approved by engineer.

814 CONSTRUCTION OF STORM WATER INLETS AND STRUCTURES

1. All concrete and steel reinforcing work shall be in accordance with the Colorado Department of Transportation Sections 601 and 602, except as modified by these Standards and Specifications. Additives for concrete, other than those specified in the mix design, shall not be used without prior approval of the Design Engineer and accepted by the Town Engineer in writing. When approved for use, chemical admixtures or additives shall comply with applicable ASTM or AASHTO standards. Calcium chloride or admixtures containing chloride shall not be allowed in reinforced concrete.
2. All casting used shall sit flush with the surrounding concrete.
3. The bottom of all inlet structures shall be formed to drain to the outlet pipe as per the inlet details.

815 TESTING AND FLUSHING PIPE

1. Prior to final acceptance of each section of the storm sewer line, the storm drains shall be cleaned by appropriate methods approved by the Town Engineer. All dirt and debris shall be prevented from entering the existing storm drain system by means of watertight plugs or other suitable methods. The Town Engineer may require the storm sewer line be air pressure tested prior to final acceptance. When an air pressure test is required the contractor shall adhere to the test procedure called out by the Town Engineer. A water test for manholes may also be required by the Town Engineer. This test will be subject to less than a 1-inch per hour rise or fall to pass.
2. Any visible infiltration which the Town Engineer considers to be detrimental to the system shall be repaired in a manner approved by the Town Engineer before the work will be accepted. No manhole will be accepted that has any visible infiltration.
3. Upon completion of the construction, the Town Engineer will carefully inspect all storm drains and appurtenances. Any unsatisfactory work shall be removed and replaced in a proper manner. The invert of the storm drain and manholes shall be left smooth, clean, and free from obstructions throughout the entire length. Manhole rings and covers must be raised to finished grade before acceptance of the storm drain.



4. The storm sewer pipelines may be inspected by camera instead of air tested if approved by the Town Engineer.
5. All inlet structures shall be flushed with water after completion of construction. The inlets are not acceptable if water, dirt or debris remains in the invert of the structure.

816 REFERENCES

Standards Referenced in Section 800:	
Number	Title
ASTM C76	Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
ASTM C361	Reinforced Concrete Low-Head Pressure Pipe
ASTM C443	Joints for Concrete Pipe and Manholes, Using Rubber Gaskets
ASTM C506	Reinforced Concrete Arch Culvert, Storm Drain, and Sewer Pipe
ASTM C507	Reinforced Concrete Elliptical Culvert, Storm Drain, and Sewer Pipe
ASTM C1433	Precast Reinforced Concrete Box Sections for Culverts, Storm Drains, and Sewers
ASTM D2922	Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)

