CITY UTILITIES
DESIGN STANDARDS MANUAL

Book 5
Materials (MA)
MA6 Sanitary Sewer Materials and Testing Requirements

March 2018

MA6.01 Purpose

This Chapter covers typical materials used non-pressure and pressurized sanitary sewer utility projects. Variances form these materials must be approved in compliance with Chapter - GR3 Variances.

MA6.02 Allowable Pipe Materials and Testing Requirements

Figure MA6.1 summarizes pipe materials used for sanitary sewer installations and is to be used as a reference for acceptable sanitary sewer pipe materials. The following Sections within this Chapter list more detailed requirements for each pipe material.

Figure MA6.1 Allowable Pipe Materials

Pipe Material	Designation	[1]Min. Cover (ft)	Sizes (Diameter, in.)		Bedding Requirements	Master Spec Number
			Minimum	[2]Maximum		
Ductile Iron (DIP)	AWWA C151	4	8	60	Flexible Detail - BS-5	33 05 33
Reinforced Concrete	RCP-ASTM C76		24	144	Rigid Detail - BS-4	33 05 34.13
	HEP/VEP-ASTM C507		24/36	144		
Polyvinyl Chloride(PVC)	ASTM D3034		8	15	Flexible Detail - BS-5	33 05 37.13
	ASTM F679		18	27		
Polyvinyl Chloride(PVC) Pressure	AWWA C900		4	12		33 05 37.16
	AWWA C905		14	36		
High Density Polyethylene (HDPE) Pressure	AWWA C906		2	24		33 05 38.16
Dual Wall Corrugated Polypropylene (PP)	ASTM F2736		8	27		33 05 51
Fiberglass Reinforced Plastic (FRP)	ASTM D3262		18	27		33 05 39

Note: 1 - Minimum cover from finished grade to top of pipe (O.D), at completion of all project restoration.
Note 2 - Proposed pipe sizes larger than 27-inch diameter for PVC, PP, and FRP and sizes larger than 24-inch for HDPE shall have the approval of City Utilities.

1. Pipe Testing Requirements

   The following subsections include quality assurance and quality control requirements for the pipe material listed in this chapter.

2. Quality Assurance

A. Manufacturers Qualifications

- Pipe manufacturers shall have a minimum of 5 years of successful experience producing specified pipe and fittings, and document their success by showing evidence of at least 5 installations in satisfactory operation within the United States.
- Concrete pipe and fittings shall be from a source listed in the most recent INDOT list of Certified Precast Concrete Producers, in accordance with ITM 813.

B. Supply and Compatibility

- Pipe, fittings and appurtenances shall be suitable for the specified service and integrated into the overall piping system by the pipe supplier.

Allowable infiltration/exfiltration for any portion of the sewer shall not exceed 100 gallons per inch of pipe diameter per day per mile of pipe.

3. Field Quality Control

This section covers pipe-testing requirements after installation of the pipe. The following testing is required for sanitary sewer projects:

- Vertical Deflection Test (Mandrel Test) for Flexible Pipe
- Televised Inspections (for public projects)
- Low Pressure Air Test

The following testing for sanitary sewer pipe is used based on project specific requirements:

- Hydrostatic Test
- Infiltration/Exfiltration Test
- Large Diameter Pipe Joint Test

A. Vertical Deflection Test (Mandrel Test) for Flexible Pipe

1. Vertical deflection tests are conducted not less than 30 days after the bedding and backfill have been placed.
2. Testing is conducted on all pipe runs (defined as length of continuous pipe from structure to structure) containing 3 or more pipe-to-pipe joints.
3. A rigid ball or mandrel that has a diameter of at least 95% of base inside diameter or average inside diameter of piping is used. The ball diameter depends on which is specified in applicable ASTM standard, including the appendix, to which the pipe is manufactured.
4. The test is performed without mechanical pulling devices.

5. Pipe segments that exceed a deflection of 5% are not acceptable and must be replaced/repaired in compliance with City Utilities Engineering standards.

B. Televised Inspection

1. Televise completed sewer and appurtenant structures, including manholes and chambers, and provide to City Utilities Engineering copy of video on digital video disc (DVD) or portable storage device. Software shall be compatible with Pipelogics version 6.0 software.
2. Inspection shall be performed by a company certified in Pipeline Assessment Certification Program (PACP) by National Association of Sewer Service Companies (NASSCO). Provide copy of PACP certification prior to starting inspection.
3. Televising shall conform to coding and reporting standards and guidelines specified in PACP. Identify report annotations, pipe conditions, and pipe defects in accordance with PACP. Severity ratings shall be calculated in accordance with PACP.
4. Camera for main line shall be pan-and-tilt, radial viewing, pipe inspection camera that pans plus-or-minus 275 degrees and rotates 360 degrees. Use camera with an accurate footage counter that displays on television monitor exact distance of camera from centerline of starting manhole. Use camera with height adjustment so that lens is always centered at one-half inside diameter or higher in pipe being televised. Provide lighting system that allows features and condition of pipe to be clearly seen. Camera shall operate in 100 percent humidity. Camera, television monitor, and other components of video system must produce a minimum 450-line resolution colored video picture. Picture quality and definition shall be satisfactory to City Utilities Engineering.
5. Repair apparent leaks in pipe in manner satisfactory to City Utilities Engineering without additional cost to City Utilities and re-televise the pipe.

C. Low Pressure Air Test for Gravity Sewers:

- DIP (for diameters ≤ 36-inches)
- PVC
- HDPE
- RCP

1. Plug and bulkhead ends of pipe segment to be tested.
2. One plug shall have an orifice to pass air and a second orifice shall be continuously connected to a pressure

gauge having a range of 0 to 10 psi, minimum divisions of 0.10 psi, and accuracy of 0.04 +/- psi.

3. The air supply line shall have a positive on-off valve and suitable means for readily disconnecting from the control panel.
4. The section of pipe shall be pressurized to approximately 4 psi.
5. The air shall be shut off and allowed to stabilize for a minimum of 2 min. If during this time the pressure drops below 3.5 psi, more air shall be added to raise pressure to a minimum of 3.5 psi.
6. After the air has stabilized, the air line shall be disconnected and timing will begin.
7. The time of test in minutes will be equivalent to one-half of the nominal diameter of the pipe being tested.
8. The maximum allowable pressure drop during the specified time period will be 1.0 psi.

D. Hydrostatic Testing for:

- DI Pressure Pipe (AWWA Manual M41)
- PVC Pressure Pipe (AWWA Standard C605)
- HDPE Pressure Pipe (ASTM F2164)

1. Preparation for Testing:

   - Follow appropriate preparation for testing as specified in the manuals above for specified pipe material.
   - Prior to testing, the contractor shall ensure that the line is clean and free of dirt and debris.
   - Prior to testing, ensure that adequate thrust protection is in place and joints are properly installed.
   - Prior to testing, install test riser and ensure equipment is properly calibrated.

2. Test Procedure for DIP and PVC Pressure Pipe:

   - Fill pipeline slowly to minimize air entrapment and surge pressures. Fill rate shall not exceed one foot of pipe length per second in pipe being tested.
   - Expel air from pipe as required. Obtain approval of City Utilities Engineering prior to tapping pipe for expelling air.
   - Examine exposed joints and valves, and make repairs to eliminate visible leakage.
   - Add fluid as required to pressurize line to 150 psi or otherwise specified test pressure. Maintain test pressure for a stabilization period of ten minutes before beginning test.

- Timed test period shall not begin until after pipe has been filled, air has been expelled, and pressure stabilized.
- Timed Test Period: After stabilization period, maintain test pressure for at least two hours. During timed testing period, add fluid as required to maintain pressure within five psig of required test pressure.
- Pump from test container to maintain test pressure. Measure volume of water pumped from test container and record on test report. Record pressure at test pump at 15 minute intervals for duration of test.
- Results of the test shall be logged using the inspection form provided in Exhibit MA6-1.

3. Test Procedure for HDPE Pressure Pipe:

- Fill pipeline slowly to minimize air entrapment and surge pressures. Fill rate shall not exceed one foot of pipe length per second in pipe being tested.
- Expel air from pipe as required. Obtain approval of City Utilities Engineering prior to tapping pipe for expelling air.
- Examine exposed joints and valves, and make repairs to eliminate visible leakage.
- The test section and the test liquid shall be allowed to equalize to a common temperature.
- After filling pipeline and purging air, gradually pressurize pipe to 150 psi or otherwise specified test pressure and maintain required test pressure for 4 hours for pipe to expand. During expansion, add fluid to maintain required test pressure. Begin timed test period after expansion period and other requirements are met.
- Timed test period shall not begin until after pipe has been filled, exposed to required wetting period, air has been expelled, and pressure stabilized.
- Timed Test Period: After 4-hour expansion phase, reduce test pressure by 10 psig and do not add liquid. Test pressure shall then remain steady for 1 hour, indicating no leakage.
- If no visible leakage is observed and pressure remains within 5% of the original test pressure for 1 hour, a passing test is indicated.
- Results of the test shall be logged using the inspection form provided in Exhibit MA6-2.

4. Makeup Water Allowances:

   - The allowable makeup water allowance is the maximum amount of water that is added into a pipeline undergoing hydrostatic pressure testing. The allowable leakage rates for the various pipe materials and joints are listed below.
   - Pipes with flanged, welded, or fused joints
     - No addition of makeup water
   - Allowance rates for DIP and PVC pipes joined with rubber gaskets as sealing members include the following joint types; bell and spigot, push on, mechanical, bolted sleeve type couplings, grooved and shouldered couplings
     - Calculate makeup water rates using the following equation.

       $$Q = \frac{LD\sqrt{P}}{148{,}000}$$

       Where:

       Q = quantity of makeup water (gph)
       L = length of pipe section being tested (ft)
       D = nominal diameter of the pipe (in)
       P = average test pressure during the hydrostatic test (psi_{gauge})

     - Figure MA6.2 represents the calculated values of rates per 1,000 feet of pipe at the 125 psi test pressure.

Figure MA6.2 Allowable Testing Allowance for DIP and PVC Pipe (per 1,000' of pipeline at 125 psi)

Nominal Pipe Diameter (in)	Testing Allowance (gph)
4	0.30
6	0.45
8	0.60
10	0.76
12	0.91
16	1.21
20	1.51
24	1.81
30	2.27
36	2.72
42	3.17
48	3.63
54	4.08
60	4.53

Note: Table is an excerpt from AWWA M41 and AWWA C605.

E. Continuity Testing

Continuity testing of the tracing wire shall be performed by the contractor in the presence of the engineer. Continuity testing shall be performed using a direct-connect signal generating device and Schonstedt or equivalent underground pipe locating equipment along mains. Breaks in conductivity shall be repaired and the wire re-tested until tracing wire passes test.

F. Joint Acceptance Testing: For pipes larger than or equal to 36-inches

Conduct joint testing on the following:

- RCP (ASTM C1103)
- FRP
- PVC
- PP

1. Joint Test Procedure:

- Conduct individual joint tests on each joint for 36-inch and larger precast concrete pipe, in accordance with ASTM C1103.
- Prior to testing, clean the joint and interior surface to eliminate debris, and as necessary wet the pipe walls.
- Conduct joint test as Work progresses, do not complete backfilling until joint has successfully passed testing.

- The line for pressurizing the void volume shall include a 6 psi pressure relief device.
- Position the testing apparatus over the joint and make sure the end element sealing tubes straddle both sides of the joint. For the water test the bleed-off petcock must be located at the top dead center.
- Joint Air or Water Test
    - Pressurize the void with air or water to 3.5 psi greater than the pressure exerted by ground water above the pipe. Allow the air pressure to stabilize before shutting of the air or water supply and start of test timing.
    - If pressure holds, or drops less than 1 psi in 5 sec, the joint is acceptable.
    - If the joint fails, it shall be retested, or repaired if necessary and retested.
    - If the pressure required for the test is greater than 6 psi to meet the testing requirement listed above, the joint test shall not be used.

G. Infiltration/Exfiltration Testing

Conduct infiltration/exfiltration testing on the following:

- All gravity pipe materials

The allowable infiltration/exfiltration for any portion of the sewer shall not exceed 100 gallons per inch of pipe diameter per day per mile of pipe.

If the infiltration/exfiltration in any section of the sewer is greater than the above infiltration rate, the contractor shall make required repairs and retest the sewer segment until listed infiltration rate is met.

Below are the infiltration/exfiltration test requirements:

1. Infiltration Test Procedure:

- Conduct testing from manhole to manhole or between more than 2 manholes. The length of main tested shall not exceed 700 feet.
- Stop all dewatering operations and allow the groundwater to return to its normal level.
- Groundwater level shall be 2 feet above the crown of the pipe for the entire test section.
- Plug all pipe outlets discharging in to the upstream manhole.
- Measure the groundwater elevation and determine the average head over the test section.

- Measure infiltration leakage at the outlet of the test section, using one of the following methods:
    - Fill a small container of known volume and record the time it takes to fill the container.
    - Install small weirs and record the flow over the weir.
    - Install an electronic flow monitoring device.
- If the test section fails, repair and retest until section passes infiltration test.

2. Exfiltration Test Procedure:

- Plug and bulkhead ends and lateral connections of pipe segment to be tested and admit fluid until the pipe is full. Admit fluid slowly to minimize air entrapment. Groundwater level shall be below the pipe during exfiltration test.
- Before measuring leakage, allow fluid to wet pipe interior for the following period:
    - Concrete Pipe: 48 hours.
    - Cement Mortar-lined Pipe: 24 hours.
    - Other Pipe: Wetting period not required.
- Maintain hydrostatic head during test to equal an elevation two feet above present and future maximum groundwater elevation at pipe segment tested. Determine test water surface elevation for each pipe segment.
- Provide minimum hydrostatic head during test of two feet above crown of upstream end of pipe segment tested.
- Add fluid from test container or from metered supply as required to maintain test water level within three inches of test head throughout the test.
- Test duration shall be at least two hours.

MA6.03 Ductile Iron Pipe (DIP)

This section covers ductile iron pipe (DIP) for buried applications. Figure MA6.3 lists acceptable ductile iron pipe for sanitary sewer applications.

- Standard ductile iron pipe is cement mortar lined with a bituminous seal-coat.
- Consider alternative linings for services involving abrasives, pH levels below 4 and above 12 (6 and 12 without seal coat), acids, industrial wastes, chemicals and scum and grease lines.

Figure MA6.3 –Ductile Iron Pipe

Material	Designation	Pressure Class		Joints	Gaskets	Lining	Coating	Sizes (in)	
		Class	Designation					Min	Max
Ductile Iron (DIP)	AWWA C151	350	AWWA C150	Push-on AWWA C111	Vulcanized SBR	Cement Mortar-AWWA C104	Asphaltic-AWWA C151	8	12
		250-350						14	60

1. Exterior Coating

   Minimum thickness of the asphaltic coating is 1-mil.

2. Exterior Wrap

   Encase DIP and appurtenances in a polyethylene wrap in accordance with AWWA C105. Polyethylene wrap supplied in sheets or tubes is acceptable. Minimum thickness of linear low-density polyethylene film is 8-mils. Circumferential wraps of adhesive tape should be placed at 2-foot intervals along the barrel of the pipe.

MA6.04 Reinforced Concrete Pipe (RCP)

This section covers RCP for use in non-pressure sanitary sewer applications. Figure MA6.4 list various non-pressure concrete utility piping.

Figure MA6.4 Reinforced Concrete Pipe

Material	Class	Designation	Joints	Gaskets	Sizes (in)	
					Min	Max
Reinforced Concrete Pipe (RCP)	III IV V	ASTM C76	Bell and Spigot	Rubber Gasket ASTM C443	24	144
[1]Horizontal Elliptical Pipe (HEP)	HE-II HE-III HE-IV	ASTM C507	Tongue and Groove	Flexible Sealant ASTM C990	24	144
[1]Vertical Elliptical Pipe (VEP)	VE-III VE-IV VE-V VE-VI				36	144

Note-1-The sizes listed are the pipe designated equivalent round size; refer to the related ASTM for exact pipe dimensions.

1. Reinforced Concrete Pipe (RCP)

   - Select pipe class based on the project specific external live and dead loads.
   - Class III pipe is the minimum class accepted for sanitary sewers.

   A. Reinforced concrete pipe with bell and spigot joints uses either of the following gaskets.

      - Rubber gaskets conforming to ASTM C443 intended to be watertight.

- Flexible Joint Sealants conforming to ASTM C990 intended to prevent the flow of solids through the joint.

2. Horizontal and Vertical Elliptical Pipe (HEP / VEP)

- Select pipe class based on the external live and dead loads.
  - Horizontal elliptical pipe - Class HE-II is the minimum accepted for public storm water facilities.
  - Vertical elliptical pipe - VE-III is the minimum accepted for public storm water facilities.
  - Elliptical pipe size is specified by (rise" x span").

MA6.05 Polyvinylchloride (PVC) Pipe- Non-Pressure

This section covers non-pressurized PVC pipe, Figure MA6.5 lists typical PVC pipe.

Figure MA6.5 Polyvinylchloride (PVC) Pipe-Non-Pressure

Material	Designation	Joints	Gaskets	Fittings	Sizes (in)	
					Min	Max
PVC Pipe	ASTM D3034	Bell and Spigot	ASTM F477 and ASTM D3212	ASTM D3034	8	15
	ASTM F679			ASTM F679	18	27

1. PVC Pipe

   Pipe manufactured per ASTM D3034 is available in four standard dimension ratios (SDR). For sanitary sewers, a minimum wall thickness of SDR 35 is required.

   Pipe manufactured per ASTM F679 is available in three pipe stiffness's. For sanitary sewers, a minimum pipe stiffness of forty-six (46) psi is required.

MA6.06 Polyvinylchloride (PVC) Pipe - Pressure

This section covers pressurized PVC pipe and the various joint types. Figure MA7.4 list typical pressure PVC pipe used for buried applications. Tracing wire must be used when this pipe is specified.

1. Pressure PVC Pipe

   Minimum wall thickness for sanitary sewer applications is DR 18, sizes are based on DIP size.

2. Gaskets

   When pipe is installed in oil contaminated soils use Nitrile Gaskets.

3. Pipe Material Designation

   Pipe and couplings are made from PVC compounds having a minimum cell classification of 12454, as defined in ASTM D 1784.

Figure MA6.6 Polyvinylchloride (PVC) Pipe- Pressure

Material	Designation	Joints	Gaskets	Fittings	Sizes (in)	
					Min	Max
Polyvinyl Chloride Pipe (PVC)	AWWA C900	Bell and Spigot	ASTM F477 ASTM D3139	AWWA C110 AWWA C111	4	12
	AWWA C905				14	36
Certa-Lok PVC	AWWA C900/RJ™	PVC Coupling	ASTM F477	Ductile Iron	4	16

MA6.07 High Density Polyethylene Pipe (HDPE)-Pressure

This section covers pressurized HDPE pipe. FigureMA7.5 list typical HDPE pipe used for buried applications. Tracing wire must be used when this pipe is specified.

1. Pressure HDPE Pipe

   Minimum wall thickness for sanitary sewer applications is is DR11, sizes are based on DIP size.

2. Pipe Material Designation

   Pipe material used for the manufacture of HDPE shall be extra high molecular weight, high density ethylene/hexane copolymer PE 4710 polyethylene resin meeting the requirements of ASTM D3350 with a cell classification of PE 445574C.

3. Pipe Joints

   All joints must be butt-fused or jointed with electrofusion couplings. Mechanical joints and couplings are prohibited.

4. Adaptors

   Fused mechanical joint adaptors shall be used to connect to fittings and valves. Pipe stiffeners are not permitted.

Figure MA6.7 High Density Polyethylene (HDPE) - Pressure

Material	Designation	Joints	Gaskets	Fittings	Sizes (in)	
					Min	Max
High Density Polyethylene (HDPE) Pressure Pipe	AWWA C906	Butt Heat Fusion ASTM D3262	-	Ductile Iron	2*	24

*Note: * 2-inch diameter is minimum size for low pressure systems. 4-inch shall be the minimum diameter for all other applications.*

MA6.08 Corrugated Polypropylene Pipe (PP)

Figure MA6.8 lists typical PP. PP for sanitary sewers is available in corrugated dual wall pipe with water tight joints.

Figure MA6.8 Polypropylene (PP) Pipe

Type	Pipe Designation	Joints	Gaskets	Fittings	Sizes (in)	
					Min	Max
Dual-Wall Corrugated PP Pipe	ASTM F2736	Bell and Spigot (ASTMF2736)	ASTM F477	ASTM F2736	8	27

1. Dual Wall Corrugated Polypropylene Pipe (PP)

   Corrugated dual walled PP pipe has a smooth interior liner in the waterway and includes exterior corrugation that helps brace the pipe against deformations.

   - Sanitary sewer joints and fittings shall be watertight and conform to the requirements of ASTM D3212.

MA6.09 Fiberglass Reinforced Plastic (FRP) Pipe

This section covers FRP pipe for sanitary sewers. Figure MA6.9 lists typical FRP pipe.

Figure MA6.9 Fiberglass Reinforced Plastic (FRP) Pipe

Type	Pipe Designation	Joints	Gaskets	Fittings	Sizes (in)	
					Min	Max
Fiberglass Reinforced Plastic (FRP) Pipe	ASTM D3262	Field Connection-Fiberglass Sleeve Coupling – ASTM D4161	ASTM F477	ASTM D3262	18	27

MA6.10 Building Sewers and Appurtenances

This section covers building sewer and appurtenances for all connections to the public sanitary sewer.

1. Pipe Materials

   Figure MA6.10 lists appropriate building sewer pipe materials.

Figure MA6.10 Building Sewer Pipe Materials

Type	Pipe Designation	Classification	Joints	Gaskets	Fittings	Acceptable Minimum Size (in)
						Min
Polyvinyl Chloride Pipe (PVC)	ASTM D3034	SDR35	Bell and Spigot	ASTM F477 ASTM D3139	ASTM D3034	6
						6
High Density Polyethylene (HDPE) Pipe	AWWA C906	DR 11	Butt Heat Fusion ASTM D3261	-	-	1 ¼ *

**For low pressure building sewer, minimum acceptable size is 1 ¼-inch. For all other applications, use minimum diameter of 6-inches.*

2. Building Connection and Cleanouts

   For acceptable building sewer connections, refer to standard detail SAN-1. Schedule 40 PVC clean out caps are acceptable for building sewer cleanouts.

3. Grease Interceptor and Sand/Oil Separators

   For acceptable grease interceptors, refer to standard details STR-24 and STR-24-1.

4. Inspection Manholes/Non- Metered Control Manhole

   For acceptable metered control manholes and non-metered control manholes, refer to standard details STR-11-1 and STR-11-2, respectively.

MA6.11 Manholes

1. Quality Assurance

   A. Manufacturer Qualifications

   Precast sanitary sewer manholes shall be from a source listed in the most recent INDOT list of Certified Precast Concrete Producers.

   B. Supply and Compatibility

   Imperfections in precast manhole sections may be repaired, subject to the approval of City Utilities Engineering, after demonstration by the manufacturer that a strong and permanent repair will result. Repairs shall be carefully inspected before final approval.

C. Field Quality Control

Conduct vacuum testing on all sanitary sewer manholes in accordance with ASTM C1244.

- Temporarily plug pipe connections entering manhole to be tested.
- All pipes entering the manhole shall be temporarily plugged, taking care to securely brace the pipes and plugs to prevent them from being drawn into the manhole.
- Following set-up of test apparatus, draw vacuum of 10-inches of mercury on manhole being tested. The time shall be measured for the vacuum to drop to 9-inches mercury.
- Start test upon reaching specified test vacuum. Test duration shall be in accordance with ASTM C1244.
    - Minimum test times for various manhole diameters shall conform to the Figure MA6.11 per ASTM C1244, or be 1 minute, whichever is longer:

Figure MA6.11 Vacuum Test Times (Modified table per ASTM C1244)

Depth (ft)	Diameter, in.												
	48	54	60	66	72	78	84	90	96	102	108	114	120
Time, in seconds													
<4	60												
6													
8													
10											63	67	71
12								62	67	71	76	81	85
14						62	67	72	78	83	89	94	100
16					69	70	76	83	89	95	101	108	114
18				65	73	79	86	93	100	107	114	121	128
20			65	72	81	88	95	103	111	119	126	135	142
22		64	72	79	89	97	105	114	122	131	139	148	156
24		64	78	87	97	106	114	124	133	143	152	161	170
26	64	75	85	94	105	114	124	134	144	155	164	175	185
28	69	81	91	101	113	123	133	145	155	167	177	188	199
30	74	87	98	108	121	132	143	155	166	178	189	202	213

2. Sanitary Sewer Manholes

Precast sanitary sewer manholes are manufactured by wet or dry cast methods using forms. Figure MA6.12 lists typical sanitary sewer manholes. Sanitary manholes shall be constructed with Type II Portland Cement and have a maximum water/cement ratio of 0.45.

Figure MA6.12 Sanitary Sewer Manholes

Material	Designation	Standard Drawing	Joints	Gaskets*	Sizes (in)	
					Min	Max
Precast Concrete	ASTM C478	STR-20-1 STR-20-2 STR-20-3 STR-20-4	Tongue and Groove	Preformed Flexible Sealant (ASTM C990)	48	96**

*Note *: Rubber gaskets manufactured in accordance with ASTM C44, may be used in lieu of preformed flexible sealant.*
*Note **: For structures larger than 96" in diameter, consult CUE.*

3. Joint Exterior

   A. To seal the exterior of the manhole joint use a trowable butyl rubber backplaster around the circumference of the joint. The following materials and manufacturers are acceptable:

      - Trowable EZ Stik # 3 by Press Seal Gasket Corporation, or
      - Approved Equal

   B. To protect the trowable butyl rubber backplaster install polyethylene plastic sheeting covering the butyl rubber. The following materials and manufacturers are acceptable:

      - 6-mil polyethylene plastic sheeting film by Visqueen, or
      - Approved Equal

4. Metal Castings and Rings

   Refer to Section MA6.12, Castings, Frames, and Covers.

5. Manhole Steps

   Manhole steps are not acceptable in sanitary sewer manholes.

6. Poured In Place Manhole Bases

   For manhole diameters of 48-inches, refer to standard detail STR 12-1. For manhole diameters ranging from 54 to 96-inches refer to standard detail STR 12-2.

7. Resilient Connectors between Manhole Structures and Pipes.

   To protect against infiltration and create a watertight joint, provide a resilient connector between each pipe entering and exiting the manhole. Refer to Figure MA6.13 for acceptable resilient connectors.

Figure MA6.13 Resilient Connectors

Pipe Size Range	Designation	Manufacturers and Products	Detail
≤36-inch Diameter	ASTM C923	Press Seal PSX: Positive Seal	STR 14-1
		NPC Kor N-Seal II 306 Series	
> 36-inch Diameter		A-Lok Premium	STR 14-2
		Press Seal WS 30: Waterstop Grouting Ring	

MA6.12 Castings, Frames, and Covers

In pedestrian traveled areas, castings frames and covers must comply with current ADA requirements with a max opening of ½-inch. Utilize pick hole plugs as appropriate.

1. Sanitary Metal Castings

   This section covers iron castings for various types of manhole frames and covers. Figure MA6.14 lists sanitary sewer manhole metal castings

Figure MA6.14 Metal Castings

Casting Type	Designation	Class	Standard Drawing Number	Neenah Foundry Company		East Jordan Iron Works Inc.	
				Frame	Lid/Grate	Frame	Lid/Grate
24" Sanitary Manhole Casting	ASTM A48	35B	C-1-1	R-1772	Solid	1022Z1	Solid
Watertight Sanitary Manhole Casting			C-2-1 C-2-2	R-1772	Solid Bolted	1022Z1PT	Solid Bolted
Standard Cleanout Casting			C-3-1 C-3-2	R-1976	Solid	1578	Solid

2. Manhole Adjusting Rings and Chimney Seals

   A. Concrete riser rings are used to adjust the finish elevation of the metal casting. Adhere grade rings using a preformed flexible joint sealant manufactured in accordance with ASTM C990 and AASHTO-M198. Maximum number of rings that may be used on a structure is 2. Adjusting rings may range in height from 2-inches to 6-inches. See detail STR-23-1.

B. To protect against infiltration and help seal the joints between the manhole structure, adjustment rings, and metal castings, provide one of the following external chimney seals:

- External Chimney Seal by Cretex Specialty Products, or
- Wrapidseal by CANUSA-CPS, or
- Approved Equal.

MA6.13 Sanitary Lift Station Components

1. Duplex Submersible Pump Stations

The following material requirements are specific to duplex submersible lift stations.

A. Pumps

Base lift station pump design on current manufactures recommendations of Xylem Flygt Pumps.

B. Pump Design

The pumps shall be automatically and firmly connected to the discharge connection, guided by 304 stainless steel guide bars extending from the top of the station to the discharge connection. There shall be no need for personnel to enter the wet well. Sealing of the pumping unit to the discharge connection shall be accomplished by a machined metal to metal watertight contact. No portion of the pump shall bear directly on the sump floor.

C. Pump Construction

Major pump components shall be grey cast iron, ASTM A-48, Class 35B, with smooth surface devoid of blow holes or other irregularities. All exposed nuts and bolts shall be AISI Type 316 stainless steel. All metal surfaces coming in contact with the pump, other than stainless steel or brass, shall be protected by a factory applied spray coating of acrylic dispersion zinc phosphate primer with a polyester resin paint finish on the exterior of the pump.

D. Cable Entry Seal

The cable entry seal design shall preclude specific torque requirements to insure a watertight and submersible seal. The cable entry shall consist of a single cylindrical elastomer grommet, flanked by washers, all having a close tolerance fit against the cable outside diameter and the entry inside diameter and compressed by the body containing a strain relief function, separate from the function of sealing the cable. The assembly shall provide ease of changing the cable when necessary using the same entry seal. The cable entry junction chamber and motor shall be separated by terminal board, which shall isolate the interior from foreign material gaining access through the pump top.

E. Pump Motor

The pump motor shall be a NEMA B design, induction type with a squirrel cage rotor, shell type design, housed in an air filled, watertight chamber. The stator windings shall be insulated with moisture resistant Class H insulation rated for 180°C (356°F). The stator shall be insulated by the trickle impregnation method using Class H monomer-free polyester resin resulting in a winding fill factor of at least 95%. The motor shall be inverter duty rated in accordance with NEMA MG1, Part 31.The stator shall be heat-shrink fitted into the cast iron stator housing. The use of multiple step dip and bake-type stator insulation process is not acceptable. The use of bolts, pins or other fastening devices requiring penetration of the stator housing is not acceptable. The motor shall be designed for continuous duty handling pumped media of 40°C (104°F) and capable of no less than 15 [30 for Premium Efficiency Motors] evenly spaced starts per hour. The rotor bars and short circuit rings shall be made of cast aluminum. Thermal switches set to open at 125°C (260°F) shall be embedded in the stator end coils to monitor the temperature of each phase winding. These thermal switches shall be used in conjunction with and supplemental to external motor overload protection and shall be connected to the control panel. The junction chamber containing the terminal board shall be hermetically sealed from the motor by an elastomer compression seal. Connection between the cable conductors and stator leads shall be made with threaded compression type binding posts permanently affixed to a terminal board. The motor and the pump shall be produced by the same manufacturer.

The combined service factor (combined effect of voltage, frequency and specific gravity) shall be a minimum of 1.15. The motor shall have a voltage tolerance of plus or minus 10%. The motor shall be designed for operation up to 40°C (104°F) ambient and with a temperature rise not to exceed 80°C. A performance chart shall be provided upon request showing curves for torque, current, power factor, input/output kW and efficiency. This chart shall also include data on starting and no-load characteristics. The motor horsepower shall be adequate so that the pump is non-overloading throughout the entire pump performance curve from shut-off through run-out. The motor shall be capable of continuous submergence underwater without loss of watertight integrity to a depth of 65 feet or greater.

The power cable shall be sized according to the NEC and ICEA standards and shall be of sufficient length to reach the junction box without the need of any splices. The outer jacket of the cable shall be oil resistant chlorinated polyethylene rubber. The cable shall be capable of continuous submergence underwater without loss of watertight integrity to a depth of 65 feet or greater.

F. Bearings

The pump shaft shall rotate on two bearings. Motor bearings shall be permanently grease lubricated. The upper bearing shall be a single deep groove ball bearing. The lower bearing shall be a two row angular contact bearing to compensate for axial thrust and radial forces. Single row lower bearings are not acceptable.

G. Mechanical Seal

Each pump shall be provided with a tandem mechanical shaft seal system consisting of two totally independent seal assemblies. The seals shall operate in a lubricant reservoir that hydro dynamically lubricates the lapped seal faces at a constant rate. The lower, primary seal unit, located between the pump and the lubricant chamber, shall contain one stationary and one positively driven rotating tungsten-carbide ring. The upper, secondary seal unit, located between the lubricant chamber and the motor housing, shall contain one stationary tungsten-carbide seal ring and one positively driven rotating tungsten-carbide seal ring. Each seal interface shall be held in contact by its own spring system. The seals shall require neither maintenance nor adjustment nor depend on direction of rotation for sealing. No system requiring a pressure differential to offset pressure and to affect sealing shall be used.

Each pump shall be provided with a lubricant chamber for the shaft sealing system. The lubricant chamber shall be designed to prevent overfilling and to provide lubricant expansion capacity. The drain and inspection plug, with positive anti-leak seal shall be easily accessible from the outside. The motor shall be able to operate dry without damage while pumping under load. Seal lubricant shall be FDA approved, non-toxic.

H. Protection

All stators shall incorporate thermal switches in series to monitor the temperature of each phase winding. At 260 degrees F, the thermal switches shall open, stop the motor and activate an alarm. A leakage sensor shall be provided to detect water in the stator chamber. The float leakage sensor (FLS) is a small float switch used to detect the presence of water in the stator chamber. When activated, the FLS will stop the motor and send an alarm both local and/or remote. Use of voltage sensitive solid state sensors and trip temperature above 125 degrees C (260 degrees F) shall not be allowed. The thermal switches and FLS shall be connected to a mini CAS (Control and Status) monitoring unit. The mini CAS shall be designed to be mounted in the control panel.

2. Pipe and Valves

A. Pipe

The discharge pipe and fittings shall be ductile iron Class 350. Inside pipe and fittings shall be flanged. Bell end pipes or fittings with

mechanical joints shall be provided at or near the outside face of the station well. Piping shall be supported independent of the sewage flanges. Piping joints shall be EBAA Iron Works Megalug Series 1100 mechanical joint restraints for ductile iron pipe.

All metal piping other than cast or ductile iron and copper tubing shall be galvanized steel pipe. Guide rails and all interior miscellaneous metals, including bolts, shall be stainless steel.

B. Valves

All plug valves shall be lever operated. One lever shall be provided for each plug valve. All plug valves shall be Dezurik Style PEF eccentric plug valve with square nut actuator.

All check valves shall be iron body, bronze mounted with outside weight and lever swing type with bolted covers and flanged ends. Provide swing type check valves as manufactured by Clow or M & H, The style of swing check valve varies with size, specific the lever and weight based on specific project requirements.

3. Wet Well, Valve Vaults

A. Wet Well and valve vaults shall be circular pre-cast concrete, conforming to the requirements of ASTM C478, with a minimum compressive strength of 4,000 psi.

B. Gaskets: Use rubber O-ring gaskets manufactured in accordance with ASTM C443.

- Use a sand-cement mixture mortar to seal the interior joints. Mortar mix shall be one part cement to two parts sand.
- Wrap the exterior joints with a 6-inch wide EZ-wrap.

4. Station Access Hatches

The following manufacturers are acceptable for lift station access hatches:

- Bilco
- Halliday

A. Frames shall be ¼-inch extruded aluminum with an anchor flange around the perimeter. Mill finish with bituminous coating to be applied to exterior frame by manufacturer.

B. Door leaf shall be ¼-inch aluminum diamond plate reinforced with aluminum stiffeners. The door shall open to 90-degrees and lock automatically in that position. Door shall be built to withstand a live load of 300 lbs per square foot.

C. Use all stainless steel hardware. Handle shall be snap lock and removable.

D. A 1 ½-inch drainage coupling shall be provided in the right front corner of the channel frame.

E. Factory finish shall be aluminum lacquer. All surfaces in contact with concrete shall have a bituminous coating.

F. The access hatches shall be of the minimum size required for unobstructed access or equipment removal.

G. Each access hatch shall be equipped with aluminum safety grating. The safety grate shall be made of 6061 – T6 aluminum safety grating per the most current edition of the Specification for Aluminum Structures by the Aluminum Association, Inc. The grating shall withstand a minimum live load of 300 psf, using 17,300 psi as the design stress for the aluminum. Both the access hatch and safety grating shall be from the same manufacturer.

- Grate openings shall be 5-inches by 5-inches.
- Provide grates with a permanent hinging system, which will lock the grate in the 90-degree position once opened.
- Coat the grate with an OSHA type safety orange color powder coating system applied by electrostatic spray process.

5. Electrical, Controls, and Control Panels

The following requirements may change depending on the type of power that is available at the site.

A. Level sensors

Provide a multi-point float stick and a submersible continuous level sensor to measure water depth in the wet well. The multi-point float stick shall serve as the primary level sensor. Cable and probe lengths are based on wet well depth and control panel location. The following are acceptable level sensors:

- Pump Control and Monitoring Equipment: MultiTrode®, Inc. MultiSmart model MSM3MP.
- Continuous Level Sensors: MultiTrode® model MTPT with mounting bracket, intrinsic safety barrier, and other items as required.
- Multi-point float stick: MultiTrode® probe, mounting brackets, intrinsic safety barrier, and other items as required.

B. Enclosures

- The enclosure shall contain a properly sized cooling unit. Enclosures only require installation of a cooling unit if controls and VFD will be placed in same enclosure. Cooling units manufactured by ICE QUBE INC. are acceptable.
- The interior of the enclosure shall be provided with properly sized industrial grade corrosion inhibitors.

- The enclosure shall be provided with thermostatically controlled, properly sized condensate heater. The heater shall be mounted on the lower portion of the enclosure internal panel.
- Furnish a door limit switch actuated panel fluorescent light, similar to Hoffman Catalog No. A LFDA2.
- Include a door intrusion alarm.
- Integrate alarm beacon light.
- Panduit shall be installed as a wire way. This wire way should be 40% larger than required for future wiring.
- All conduit entry into the enclosure, originating from the wet well, shall be sealed with explosion-proof conduit seals to prevent moisture and gas vapors from entering the enclosure.
- All wiring within the enclosure must use plastic wiring ducts. Do not mix low level signal wiring with high voltage (110 Volts AC or greater) wiring in the same duct.
- Include reference sheet in an archival quality acid-free sheet protector. It shall list initial pump set points, float stick set points, and wet well elevations. Include level controller 'zero' elevation.
- Enclosure shall be NEMA 4X stainless steel.

C. Power

The incoming pump power wiring shall be terminated at distribution lugs and shall be provided with voltage surge arresters to protect all equipment mounted within the enclosure from switching surges and lightning induced surges.

- Locate surge arresters in such a manner as to facilitate inspection and future replacement of damaged units. Comply with UL 1449 and ANSI C62.41 Standards.

Power within the panel shall be distributed further through thermal magnetic circuit breakers and motor circuit protectors, which shall be accessible from the front of the swing-out panel without opening the swing-out panel. Provide the following:

- A motor circuit protector for each pump
- If the incoming power is 480 Volts AC or higher then use a circuit breaker for a 480/120 Volt AC transformer, and require a minimum 6-foot clearance.
- Circuit breakers shall have minimum interrupting rating of 25,000 Amperes.
- Separate incoming terminals for control circuit panel control power, pressure transducer power supply and telemetry transceiver.

If the incoming power is 480 Volts AC or higher then use a transformer to obtain 120 Volts AC power.

- Transformer shall be high efficiency type, with 105 º C temperature class, extra regulation and low losses.
- Size transformer to feed all 120 Volts AC within the enclosure +20%. Minimum size of the transformer shall be 1.0 KVA.

Provide conduit seal offs, a NEMA 7 junction box, and terminal strips for all control wiring and power wiring entering and exiting rated spaces.

Distribute 120 Volt AC power through single pole circuit breakers, which shall have minimum interrupting rating of 10,000 Amperes. Provide a circuit breaker for each of the following items:

- Motor control circuit.
- Panel light and thermostatically controlled enclosure heater described above.
- Convenience GFI receptacle.
- Additional as specified on single line diagram.

Include a duplex convenience receptacle. Receptacles shall be 15 Ampere, Ground Fault Interrupting (GFI) non-feed through types.

Protect each motor power with magnetic only motor circuit protector. Motor circuit protectors shall be as follows:

- Size, voltage and configuration shall be as required.
- Provided with adjustable instantaneous trips.
- Minimum rating: 25,000 Amperes Interrupting Capacity (AIC).

Provide each pump starter with the following:

- A minimum of two sets of normally open starter auxiliary contacts.
- A minimum of two sets of normally closed starter auxiliary contacts.
- One set of normally open auxiliary overload alarm contacts.

Provide terminal blocks, which shall be grouped together, for remote control and monitoring wiring.

Provide all electro mechanical relays as necessary to achieve the intended operation as described. Relays shall be plug-in ice-cube style, 3PDT or 4PDT, with manual operator and indicator light. Contacts shall be rated a minimum of 10 amps at 240 VAC.

Manufacturers shall be as listed below. Products of other manufacturers assembled to provide all specified functions, including reliability equal to or exceeding that of the manufacturers listed below may be submitted for approval.

- Circuit breakers and motor circuit protectors shall be Square D or Eaton.
- Pilot and control devices shall Allen-Bradley, or Square D.

Pump station shall have either a permanent generator or a generator receptacle with a service-rated manual transfer switch.

Generator receptacles shall be as follows:

- 100A – Arktite #AREA10426S22
- 200A – Arktite #AREA20427S22
- 400A – Arktite #AREX40428S22

All generator receptacles shall be male.

Manual transfer switch shall be double throw fused safety switch, service rated, NEMA 3R enclosure. Approved manufacturers shall be Square D, Siemens and Eaton Cutler-Hammer.

D. Pump Controller

The listed pump controller is only intended for a maximum of 3 pumps.

Use a microprocessor based, intelligent pump controller with pre-configured pump control logic and fault handling.

- Provide pump control module and user interface model #IO-3PC (MultiTrode).
- Provide motor protection module, model #IO-3MP (MultiTrode).

Standard functions: The pump controller shall be provided with pre-configured (default) parameters which are selectable via the user interface keypad, including:

- Set point adjustment for pump activation/deactivation and level alarms.
- Level device inputs: 4-20mA signal or (conductive) level probe.
- Redundant level device inputs.
- Selectable between charge (fill) & discharge (empty).
- Pump control of up to 3 pumps.
- Pump grouping and alternation.
- Station optimization including:
    a. Maximum off time for any pump.
    b. Maximum pumps to run simultaneously.
    c. Maximum pump starts per hour.

d. Inter-pump start and stop delays.
e. Maximum run time for any pump.
f. Blocked pump detection.

- Well washer control functions.
- Well clean out (periodic pump down to off point).
- Alternate profiles of level set points (Conditional pump management).
- Data logger functions.
- 3-phase supply monitoring and supply protection including:
    a. Under-voltage.
    b. Over-voltage .
    c. Phase fail.
    d. Phase rotation.
    e. Monitoring of dc supply, battery voltage, and internal temperature.
- Additional Functions (Firmware Enabled):
    a. Over current and under current detection.
    b. Ground / earth fault.
    c. Insulation resistance testing for motor windings.
    d. KVA, kW and power factor measurement.
- Calculated flow function.
- Input/Output Description.

Available I/O types shall include:

- Digital inputs (voltage free, discrete input).
- Digital outputs (240V, 5A resistive).
- Analog inputs (10bit) (4-20ma).
- Analog outputs (10bit) (4-20ma).
- Standard (Configurable) Digital Inputs:
    a. Seal/Leakage sensor.
    b. PTC Thermistor or other over temp device.
    c. PT100.
    d. ITT Xylem FLS Sensor.
    e. Conductive probe (for liquid level sensing).
- Motor Protection & Monitoring Inputs:
    a. Insulation resistance test (IRT) to 1000v, 1 phase per pump.
    b. 3-phase current monitoring.
    c. 3-phase supply monitoring.
    d. Three (3) current transformers (CTs) shall be supplied and installed per pump. Each pump's full load amps (FLA) are to be taken into consideration to obtain correct CT ratio.

User Interface:

- The field hardware shall include a user interface for operations and configuration. The display shall provide

status of the pump station, control of pumps, resetting of faults and configuration of parameters.

- The following parameters shall be displayed on the main status screen:
    a. Level.
    b. Set points for alarms and pump start/stop.
    c. Pump Running/Stopped.
    d. Pump Available.
    e. 3-phase current for each motor Pump faults.
    f. 3-phase supply.

Provide access to Faults, History, Information and Settings.

The following information screens and parameters shall be available via the keypad:

a. Elapsed Time accumulators for each pump & the pump station.
b. Number of Starts accumulator for each pump & the pump station.
c. Flow values, either derived from calculations or via a flow meter, including inflow, pump flow rate, total volume.
d. Overflow information, including start time, duration, estimated volume.
e. Insulation resistance value for each motor.
f. Status of Inputs & Outputs.

The following control functions/devices shall be industrial grade oil tight and watertight types. Each pump shall be provided with the following controls (through the user-interface), which shall be visible from the front of the swing-out panel, with the enclosure door opened:

a. Pump mode for each pump, (Hand/Off/Auto) – 22.5-mm operator.
b. Pump fault reset.
c. Level alarm reset.
d. An amber “FAIL” pilot light.
e. An amber “SEAL FAILURE” pilot light.
f. A red motor ”RUN” pilot light.
g. A green motor “OFF” pilot light.
h. A “RESET” push button.
i. A non-resettable elapsed time meter.
j. A non-resettable elapsed time meter for when both pumps operate simultaneously.

In addition to previously listed points to be indicated by the system the following conditions shall also be indicated:

a. Communication Fail
b. Inflow Rate

c. Outflow Rate
d. Pump Run Status (all pumps)
e. Pump Failure (all pumps)
f. Power Failure
g. Volume Today
h. Volume Yesterday
i. Wet Well Level
j. Wet Well High Level
k. Personnel at Station

E. Communications

Complete telemetry systems include antenna mountings, panels, and interfaces. All local codes relating to antenna height requirements, aircraft flight paths, FAA code and other pertinent issues must be adhered to. The system shall communicate with City Utilities SCADA system via an MDS licensed frequency radio, configured to coordinate with City Utilities' system for remote communications.

The pump controller shall include the following types of connection ports:

- Ethernet port up to 10Mbit/s.
- (3) RS232 ports up to 115kBit/s.

The communication protocols supported shall be as follows: MODBUS RTU, DNP3, MULTI (Multitrode Protocol)

F. Wiring

- All wiring shall be stranded copper, minimum 12-gauge for power wiring, 14-gauge for control wiring, THHN-THWN type.
- All conduit above grade and entering/exiting rated spaces shall be pvc-coated rigid steel conduit.
- Conduit below grade, not entering/exiting rated spaces shall be Schedule 40 PVC non-metallic.

Seal-offs shall be provided for all conduits entering/exiting rated spaces.

MA6.14 Force Main Appurtenances

This section covers water appurtenances, for potable water distribution systems. Including:

- Buried Piping Identification
- Restraint Devices
- Fittings

1. Buried Piping Identification

   The following materials are used for identifying buried force mains. Tracing wire is used on all force mains regardless of diameter.

   A. Tracing Wire

      Use # 10 or stronger High Strength, Copper Clad Steel Reinforced, HDPE insulated tracing wire with 21% conductivity for locating purposes and a minimum break load of 600lbs. Tracing wire insulation shall be green.

   B. Waterproof Connection Device

      Use a DRYCONN direct bury lug to connect mainline tracing wire to service line tracing wire and splice tracing wire.

2. Restraint Devices for PVC

   For restraining force main joints use wedge action retainer glands that are manufactured in accordance with AWWA C110 or AWWA C153. The following types or approved equal are acceptable:
   - EBBA Iron– MegaLug
   - Romac – RomaGrip
   - Sigma – One-Lok
   - Stargrip – Series 3000

   When force main diameter exceeds 16-inches, consult with City Utilities for appropriate restraint devices.

3. Restraint Devices for HDPE

   Fused mechanical joint adaptors shall be used.

   Thrust anchors or approved equal shall be used where the Poisson effect is anticipated.

4. Fittings

   Fittings for force mains shall be ductile iron and conform to the requirements listed in Figure MA6.15. Appropriate pressure rating, gaskets, bolts, and nuts shall be used for joints. All valve bolts are to be stainless steel.

Figure MA6.15 – Force Main Fittings

Fittings	Designation	Gaskets	Coating	Lining
Standard	AWWA C110	AWWA C111	Asphaltic	Cement Mortar AWWA C104
Compact	AWWA C153			