

SCOPE

- I 1.1 This practice covers the design and installation of industrial, chemical, storm water and sanitary sewer waste water collection systems. It does not cover the design and installation of above ground or pumped systems, or waste treatment facilities or structures.
- I 1.2 **An asterisk (*)** indicates that additional information from the Owner's Engineer is required or approval by the Owner's Engineer is required.

SUMMARY OF ADDITIONAL REQUIREMENTS

- R 2.1 **Table 1** lists the standards which shall be used with this practice as applicable.

TABLE 1

STANDARDS	
ASTM Standards	
A 48	Gray Iron Castings
A 53	Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
A 74	Cast Iron Soil Pipe and Fittings
A 746	Ductile Iron Gravity Sewer Pipe
C 12	Installing Vitrified Clay Sewer Pipe Lines
C 14 / C 14M	Concrete Sewer, Storm Drain and Culvert Pipe
C 32	Sewer and Manhole Brick (Made from Clay or Shale)
C 76 / C 76M	Reinforced Concrete Culvert, Storm Drain and Sewer Pipe
C 139	Concrete Masonry Units for Construction of Catch Basins and Manholes
C 279	Chemical-Resistant Masonry Units
C 361 / C 361M	Reinforced Concrete Low-Head Pressure Pipe
C 425	Compression Joints for Vitrified Clay Pipe and Fitting
C 443 / C 443M	Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets
C 466	Chemically Setting Silicate and Silica Chemical-Resistant Mortars
C 478 / C 478M	Precast Reinforced Concrete Manhole Sections
C 700	Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated
C 789 / C 789M	Precast Reinforced Concrete Box Sections for Culverts, Storm Drains, and Sewers
C 850 / C 850M	Precast Reinforced Concrete Box Sections for Culverts, Storm Drains, and Sewers with Less Than 2 ft (0.6 m) of Cover Subjected to Highway Loadings
D 471	Rubber Property - Effect of Liquids
D 1869	Rubber Rings for Asbestos-Cement Pipe
D 2241	Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
D 2321	Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications
D 2665	Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings
D 3034	Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings
D 3035	Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter
D 3262	"Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Sewer Pipe
D 3753	Glass-Fiber-Reinforced Polyester Manholes
D 3754	"Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Sewer and Industrial Pressure Pipe
D 3839	Underground Installation of "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe
D 3840	"Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe Fittings for Nonpressure Applications
F 477	Elastomeric Seals (Gaskets) for Joining Plastic Pipe
F 679	Poly Vinyl Chloride (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings
F 714	Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter
F 789	Type PS-46 Poly (Vinyl Chloride) (PVC) Plastic Gravity Flow Sewer Pipe and Fittings
F 894	Polyethylene (PE) Large Diameter Profile Wall Sewer and Drain Pipe
F 949	Poly Vinyl Chloride (PVC) Corrugated Sewer Pipe With a Smooth Interior and Fittings
F 1336	Poly (Vinyl Chloride) (PVC) Gasketed Sewer Fittings
ANSI / AWWA Standards	
C110	Ductile-Iron and Gray-Iron Fittings, 3 in. through 48 in., for Water and Other Liquids
C151	Ductile-Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water or Other Liquids
C203	Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot-Applied

IP 3-2-1		Sewer Systems	 INTERNATIONAL PRACTICE
Page 2 of 13			
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DEFINITIONS

- I 3.1 Sewer waste water collection systems include the following:
 - a. **Sanitary Sewers** which collect waste from the toilet facilities, lavatories, showers and floor drains in rest, wash and locker rooms.
 - b. **Storm Water Sewers** or Clean Water Sewers which collect rain water runoff, firewater and condensate/blowdown that is not normally subject to hydrocarbon/oil, or toxic chemical contamination.
 - c. **Chemical Sewers** which collect acid, caustic or other chemical wastes which require neutralization or treatment prior to discharge to industrial sewers.
 - d. **Industrial Sewers** or Oily Water Sewers which collect process waste water, and hydrocarbon/oil contaminated waste water including rainwater or firewater runoff from areas normally subject to hydrocarbon/oil contamination and condensate/blowdown with hydrocarbon/oil or chemical contaminants.
- I 3.2 **Combined Sewer Systems** are those systems which combine two or more types of system (service) defined in **Par. 3.1** prior to any treatment. The most common type of combined system is an Industrial and Storm Water Sewer System. Combined systems shall meet the most stringent requirements of all the individual sewer systems included in the combined system.
- I 3.3 **Mains** are sewer lines connecting manhole to manhole carrying combined effluent from laterals or sublaterals.
- I 3.4 **Laterals** are sewer lines collecting the effluent from two or more sublaterals discharging to manholes on mains.
- I 3.5 **Sublaterals** are sewer branches collecting effluent from individual inlets such as drains and catch basins.
- I 3.6 **Drains** are small sewer inlets/connections (such as an open end pipe or fitting) discharging through a sealed connection to the sewer system from discrete sources, such as pump bases, equipment drips, low points of floors, etc., but not from outside surface drainage.
- I 3.7 **Open channel floor or pavement drains** are continuous troughs or trenches collecting surface drainage discharging to the sewer system.
- I 3.8 **Catch basins** are used to collect surface drainage and process wastes in individual drainage areas and to trap sediment at the point nearest the source.
- I 3.9 **Manholes** are used in sewers as junction points and sediment traps, and to provide access for maintenance and inspection.
- I 3.10 **Seals** [minimum 6 in. (150 mm) hydraulic] are used to prevent vapor emission out of inlets, and to isolate the various parts of a sewer system, preventing vapor travel and spread of fire or explosion.
- I 3.11 **Toe walls** are raised curbs which control spillage and drainage of storm, process and fire water.
- I 3.12 **Vents** are pipes open to the atmosphere to prevent blowing of seals by pressure buildup.
- I 3.13 **Integrated Plant** is a group of two or more individual process units located within a common process block and designed to be interdependent in operation (heat exchanger integration, lack of intermediate tankage, etc.).
- I 3.14 **Deferred runoff** is the controlled release of rainwater which has been held or impounded during the rainfall in a designated area such as a tank dike enclosure.



MATERIALS

- R 4.1 **Sewer piping material selection** shall be based upon the design structural loading conditions and shall comply with the applicable ASTM standards and limitations listed below:

PIPE MATERIAL	ASTM STANDARD	LIMITATIONS
Cast-Iron Soil Pipe	A 74(M)	Only for no or low load use in/under buildings to a connection point 5 ft (1.5 m) outside. CISP shall be Extra-Heavy.
Ductile Iron	A 746 AWWA C151	Can be used for any service where chemically resistant to waste. Fittings shall be per AWWAC110.
Reinforced Concrete Pipe or Culvert	C 14(M) C 76(M) C 361(M) C 789(M) C 850(M)	Can be used for any service where chemically resistant to waste. Internally coat with Coal Tar-Polyamide Epoxy for waste containing sulfur compounds, or anaerobic conditions favorable to hydrogen sulfide generation.
Carbon Steel	A 53	Black steel, flanged pipe shall be internally lined per AWWA C203, and can be used for any service where lining is chemically resistant to waste. Welded pipe is not suitable where internal coating can not be applied to joints after welding. Externally coat and wrap all CS pipe per AWWA C203 as follows: Single-Coat, Single-Wrap; or Double-Coat, Double-Wrap system
"Fiberglass" (Glass- Fiber-Reinforced Thermosetting-Resin)	D 3262 D 3754	Resins, and coatings if applicable, shall be selected to be resistant to all waste water chemical constituents and environmental (temperature, etc.) conditions anticipated. Installation shall be per ASTM D3839.
Polyethylene (PE) (HDPE)	D 3035 F 714 F 894	Can be used for any service where chemically resistant to waste, and operating temperatures do not exceed material limits. Installation shall be per ASTM D2321.
Poly Vinyl Chloride (PVC)	D 2241 D 2665 D 3034 F 679 F 789 F 949	Can be used for any service where chemically resistant to waste, and operating temperatures do not exceed material limits. Gasketed fittings shall be per ASTM F1336. Installation shall be per ASTM D2321.
Vitrified Clay	C 700	Only for use in non-impact and no direct contact load situations.

- R 4.2 **Pipe material and strength selection**, and installation shall be based on the following:
- Minimum earth cover shall be at least 1 ft (300 mm) below frost line, and not less than the smaller of 3 ft (900 mm) or one pipe diameter below finished grade.
 - Superimposed wheel load of 16,000 lbs (7260 kg) and 1.5 factor for impact unless otherwise specified.
 - For rigid pipe, a bedding factor based on the method and class of bedding selected, pipe crushing strength based on the three edge method, and a safety factor of 1.5 for the applicable ASTM pipe material standard shall be used to establish the safe supporting strength (design load) of the pipe.
 - For flexible pipe other than ductile iron, a bedding constant and modulus of soil reaction based on the method and class of bedding, a pipe stiffness based on a parallel-plate loading test, and safety factor of 2 applied to the critical deflection limit for the applicable ASTM pipe material standard shall be used to establish the design deflection limit of the pipe.
 - For ductile iron pipe, the minimum pipe thickness/strength shall be per ASTM A 746 or AWWA C151 for the laying condition selected, or shall be based on a maximum design deflection of 3% and design ring bending stress of 48 psi (330 MPa) using the modulus of soil reaction, and deflection and bending coefficients based on the method and class of bedding selected.

- R,E 4.3 **Pipe joints** shall be suitable for the service and waste water properties. Where zero leakage over the life

of the sewer is required, welded/fused or flanged/mechanically locked gasketed joints shall be used compatible with the type of pipe selected. Where nominal infiltration/exfiltration over the life of the sewer is permissible, push-on compression gasket joints may be used.

- R,E 4.4 **Rubber gaskets for push-on joints** shall be natural rubber, synthetic rubber, a blend of both or a thermoplastic elastomer as follows:
- a. For sanitary and storm sewers, gaskets shall be per ASTM C 443(M) for concrete pipe, ASTM D 1869 for cast-iron and ductile iron pipe, ASTM C 425 for vitrified clay pipe, and ASTM F 477 for polyethylene, poly vinyl chloride and "fiberglass" pipe.
 - * b. For industrial sewers, gaskets shall be per a. above, and shall be oil resistant per ASTM D 471 tested using ASTM Oil No. 3 and Reference Fuel C as a minimum which represent light lubricating oil and motor gasoline respectively. Additional hydrocarbon resistance for solvents, additives, etc., shall be as specified.
 - * c. For chemical sewers, gaskets shall be suitable for the chemicals anticipated and subject to approval by the Owner's Engineer.

R 4.5 **Materials for manholes, catch basins and other drainage facilities** shall be as follows:

ITEM	MATERIAL
a. Covers and frames	Cast iron, ASTM A 48, Class 25 minimum
b. Segmental concrete block	ASTM C 139
c. Brick	ASTM C 32
d. Precast concrete manholes	ASTM C 478(M)
e. Concrete	3000 psi (20.7 MPa) minimum compressive strength with cement type as required for sulfate resistance
f. Polyethylene	ASTM F 894
g. "Fiberglass"	ASTM D 3753, D 3262 or D 3840

- R 4.6 Manholes, catch basins, other drainage structures, and their **tops/lids/covers which are accessible to vehicles** shall be designed for a truck wheel load of 16,000 lbs (7260 kg) unless otherwise specified.
- E 4.7 **Segmental concrete block and brick shall not be used** for industrial or chemical sewer catch basins, manholes, etc. Where used, joints shall be watertight and resistant to the waste water constituents. **Masonry joints shall not be used** for industrial or chemical sewers.
- R 4.8 **Chemical sewer catch basins, manholes, etc.,** shall be made of materials resistant to the waste water constituents subject to Owner's Engineer approval, or lined with acid resistant brick or tile per ASTM C 279 Type III and potassium silicate mortar per ASTM C 466 or equally resistant mortar.
- O 4.9 **Materials for drain system piping from refrigerated and pressurized storage vessels**, including valves outside the enclosure shall be suitable for the lowest temperature which may be encountered during a spill.
- R,C 4.10 Cement-sand ratio for mortar shall be as follows:
- a. For masonry joints: 1:2
 - b. All other mortar: 1:3
- R 4.11 **All manholes and catch basins constructed of masonry** shall be covered on the outside with a minimum of 5/8 inch (15 mm) mortar covering.
- S 4.12 **Asbestos containing materials** shall not be used.

DESIGN

- I * 5.1 **Air emissions from the sewer waste water system** shall be controlled as required by industrial hygiene and local environmental requirements.
- C 5.2 Pipe shall be used for all waste water collection except as follows:
- a. Open ditches are acceptable for storm water drainage outside process areas which are not normally subject to hydrocarbon/oil or chemical contamination and not subject to rain water runoff from areas subject to contamination.
 - b. Natural sheet runoff is acceptable from unused plant areas that are not contaminated.