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IOWA WASTEWATER FACILITIES DESIGN STANDARDS

CHAPTER 12

IOWA STANDARDS FOR SEWER SYSTEMS

12.0 GLOSSARY

12.0.1 Lateral - A sewer that discharges into a submain or other sewer and has no other common sewer tributary to it.

12.0.2 Submain - A sewer into which the wastewater from two or more lateral sewers is discharged and which discharges into a main or trunk.

12.0.3 Main - The principal sewer to which submains are tributary; also called trunk sewer.

12.0.4 Trunk - The principal sewer to which submains are tributary; also called main sewer.

12.0.5 Interceptor - A sewer used to transport the flows from main and trunk sewers to a central point for treatment and discharge.

12.0.6 Outfall - A sewer that receives wastewater from a treatment plant and carries it to a point of final discharge.

12.1 GENERAL

The Iowa Standards for Sewer Systems are designed to be used for review of plans and specifications and the construction of sanitary sewer systems and extensions to such systems. When engineering justification satisfactory to the executive director is provided substantially demonstrating that variation from the standards will result in either 1) at least equivalent effectiveness while significantly reducing costs, or 2) improved effectiveness, such a variation from standards may be accepted by the executive director.

12.2 DESIGN PERIOD

In general, sewer system design shall consider the estimated ultimate tributary population, except in considering parts of the system that can be readily increased in capacity. Similarly, consideration shall be given to the maximum anticipated capacity of institutions, industrial parks, etc. Laterals and submains shall be designed for estimated ultimate development. The design of trunks (mains) and interceptors) shall take into consideration a reasonable planning period (50 years) and cost effectiveness. When the project does not provide for the ultimate capacity, a report detailing a plan for providing the ultimate capacity shall be developed.

12.3 MINIMUM BASIS OF DESIGN

12.3.1 Assumptions

12.3.1.1 Dry Weather Flow

One hundred gallons per capita per day (gpcd) shall be used in design calculations as the minimum average dry weather flow. This 100 gpcd value may, with adequate justification, include maximum allowable infiltration for proposed sewer lines.

12.3.1.2 Sewer Design Capacity

Maximum hourly domestic flow, additional maximum waste water flow from industrial plants, inflow and groundwater infiltration, and sewage pumping station capacity shall be considered in determining the required capacities of sanitary sewers.

12.3.1.3 Infiltration Design Allowance

If no actual data is available, an assumed infiltration design allowance for existing sewers should be added to the design flow. For existing systems, the minimum infiltration design allowance for the existing sewers shall be no less than 200 gallons per inch of pipe diameter per mile of pipe (gpdpipm). Allowance for service lines should be included.

12.3.1.4 Design Flow

The minimum design flow may be determined when the average dry weather flow is known. The minimum design flow may be calculated by multiplying the average dry weather flow by the ratio found in Appendix I.

12.3.1.5 Minimum Design Equivalents

Type of development

a. single family - 3-3.5 units/acre, 3 people/-unit, or 10 people/acre

b. multi-family (med. density - 4.5 units/acre, 3 people/unit, or 15 people/-acre

c. multi-family (high density) - 6-12 units/-acre, 2.5 people/unit, or 30 people/acre

d. commercial - 5000 gpd/acre

e. industrial - 10,000 gpd/acre

Lower design values may be approved by the executive director for known or measured flow rates.

12.3.1.6 Carrying Capacity of Pipe

Pipe sizes 8" - 15" shall carry the design flow at a depth of no more than 0.75 of the pipe diameter.

12.4 MATERIALS

Standards shall be as listed below for the respective materials.

a. Rigid Pipes	Material Spec.	Joint Spec.
Clay	ASTM C 700-75	ASTM C425-75
Non Reinforced Concrete	ASTM C 14-75	ASTM C 443-76
Reinforcement Concrete	ASTM C 76-76 ASTM C 655-73	ASTM C 443-76
Concrete Pressure Pipe	ASTM C 361-76	ASTM C 361-76
Cast Iron	ANSI A21-1-67 (AWWA C101-67) ANSI A21-6-75 (AWWA C106-75) ANSI A21.8-75 (AWWA C108-75) ANSI/AWWA C110-77	ANSI A21-11-72 (AWWA C111-72)
Ductile Iron	ANSI A21.50-76 (AWWA C150-76) ANSI A21.51-76 (AWWA C151-76) ANSI/AWWA C110-77 ASTM A536-77	ANSI A21.11-72 (AWWA C111-72)

b. Flexible Pipes	Material Spec.	Joint Spec.
Polyvinyl Chloride (PVC)	ASTM D3034-77 ASTM D3033-77 (SDR $\leq$ 35)	ASTM D3212-76 ASTM D2855-77

c. Composite Pipes

Composite Pipes	Material Spec.	Joint Spec.
Acrylonitrile Butadiene Styrene (ABS) Composite	ASTM D2680-76	ASTM D2680-76

d. Pressure Pipe

All pipe for pressure applications shall conform insofar as appropriate, to the standard specifications referred to in the "Iowa Standards for Water Supply Distribution Systems".

All other sewer pipe material shall conform with the appropriate ANSI, AWWA or ASTM specifications.

12.5 DETAILS OF DESIGN

12.5.1 Diameter

No public gravity sanitary sewer shall be less than eight inches in diameter, with the following exception.

For unsewered communities, six-inch diameter sewers may be used for the last 800 feet (approximately two blocks) of sewer, provided the six-inch sewer has sufficient hydraulic capacity and is a dead end not subject to future extension. A manhole or a cleanout must be provided at the end of the six-inch lateral sewer pipe.

12.5.2 Depth

Sewers should be sufficiently deep so as to receive sewage from basements and to prevent freezing. Precautions such as insulation and increased slope shall be provided for sewers that cannot be placed at a depth sufficient to prevent freezing.

12.5.3 Slope

All sewers shall be designed and constructed to give average velocities when flowing full of not less than 2.0 feet per second based on Kutter's formula using an "n" value of 0.013 for raw sewage. The following are the minimum slopes which shall be provided.

Sewer Size	Minimum Slope (ft./100 ft.)
8"	0.400
10"	0.280
12"	0.220
15"	0.150
18"	0.120

21"	0.100
24"	0.080
27"	0.067
30"	0.058
36"	0.046

Smaller "n" values may be considered when the wastes are treated, or for pipes 48 inches or larger. A velocity less than 2.0 fps may be considered only under the following conditions.

a. Deep or continuous rock excavation.

b. Velocities down to 1.5 feet per second may be accepted only when a lift station can be eliminated, and where the ratio of the cost of constructing a lift station and sewer to the cost of constructing a sewer only is greater than five. Cost ratios shall be based on a lift station designed to meet not more than the minimum standards of the Iowa Department of Water, Air and Waste Management.

Under no circumstances will the average design velocity when flowing full be allowed to drop below 1.5 feet per second based on Kutter's formula using an "n" value of 0.013.

The following exceptions to the above requirements in this section shall apply for unsewered communities only.

A minimum velocity of 2.0 feet per second when flowing full should be maintained in all sewer mains. However, in specific cases where savings in sewer cost are possible or a lift station could be eliminated, a minimum sewer velocity of 1.5 feet per second when flowing full will be permitted. An "n" value of 0.013 shall be used for design of PVC pipe, vitrified clay pipe, and ABS truss pipe. Minimum slopes for 8" sewers flowing full at 2.0 feet per second and 1.5 feet per second shall be 0.40 ft./100 ft. and 0.22 ft./100 ft. Minimum slopes for 6" sewers flowing full at 2.0 feet per second and 1.5 feet per second shall be 0.60 ft./100 ft. and 0.34, ft./100 ft. In cases where a minimum sewer design velocity of 1.5 feet per second is used, the city will be required to give written assurance to the department that any additional sewer maintenance required by reduced slopes and velocities will be provided.

12.5.4 Alignment

Sewers 24 inches or less shall be laid with straight alignment between manholes.

The following exceptions to the above requirement in this section shall apply for unsewered communities only.

Vertical and horizontal curved or variable grade sewer construction may be proposed by the design engineer. Whenever curved or variable grade sewer construction is proposed, the design engineer is to develop a proposed design basis and submit it to the department for review.

The city will be required to give written assurance that arrangements will be made for hydraulic sewer cleaning equipment to be available when necessary for cleaning curvilinear sewers.

12.5.5 Increasing Size

When sewers of different sizes and greater than 10 inches in diameter are joined, the inverts should be placed to maintain energy gradient. An approximate method for securing these results is to place the 0.8 depth point of both sewers at the same elevation.

12.5.6 High Velocity Protection

Where velocities greater than 15 feet per second are attained, special provisions shall be made to protect against displacement by erosion and shock.

12.5.7 Manholes

12.5.7.1 Location

a. Manholes shall be installed:

1. at the end of each sewer line;
2. at all changes in pipe size, grade or alignment;
3. at all sewer pipe intersections;
4. at intervals not exceeding 400 feet for sewers 24 inches or less or at intervals not exceeding 500 feet when adequate cleaning equipment is available.

b. Spacing of manholes over 500 feet may be permitted in sewers larger than 24 inches if the owner has adequate cleaning equipment.

c. Cleanouts may be permitted in place of a manhole at the end of lines which are less than 150 feet in length.

d. The following exceptions to the requirements for manhole location and cleanouts in this section shall apply for unsewered communities only.

Manhole spacing for 6 and 8-inch sewers shall be a maximum of 400 feet or at intervals not exceeding

500 feet when adequate cleaning equipment is available. All other sewers shall have a maximum manhole spacing of 800 feet, with manholes also to be placed at the junctions of sewers. When the manhole spacing exceeds 400 feet, the city will be required to give written assurance that appropriate sewer cleaning equipment suitable to clean the distances between manholes will be made available when necessary.

Cleanouts can be installed at the ends of sewers of any size in lieu of manholes. If the sewer is ever extended, the cleanout must be removed and a sewer manhole constructed at that point if the maximum distance between manholes has been reached. Cleanout lids should be bolted down to prevent entry of foreign objects.

12.5.7.2 Drop Type

A drop pipe should be provided for a sewer entering a manhole at an elevation of 24 inches or more above the manhole invert. Where the difference in elevation between the incoming sewer and the manhole invert is less than 24 inches, the invert should be filleted to prevent solids deposition.

12.5.7.3 Diameter

The minimum diameter of manholes shall be 48 inches. The minimum diameter of manhole openings shall be 22 inches.

12.5.7.4 Watertightness

Manholes shall be pre-cast or poured in place concrete. Manholes shall be waterproofed on the exterior.

Inlet and outlet pipes shall be joined to the manhole with a gasketed flexible watertight connection or any watertight connection arrangement that allows differential settlement of the pipe and manhole wall to take place.

12.5.7.5 Frame and Cover Assembly

Manhole covers shall be non-vented; however, covers with a pickhole are acceptable. Frame and cover assemblies shall weigh at least 300 pounds when installed in areas subject to vehicular traffic and at least 200 pounds in other areas.

Watertight cover assemblies shall be required on manholes subject to flooding. Bolt-down cover assemblies shall be required on manholes subject to inundation on a floodplain.

12.5.7.6 Flow Channel

The flow channel through manholes shall be made to conform in shape and slope to that of the sewers.

12.5.8 Protection of Water Supplies

12.5.8.1 Cross Connections

There shall be no physical connection between a public or private potable water supply system and a sewer, or appurtanence thereto, which would permit the passage of any wastewater or polluted water into the potable water supply.

12.5.8.2 Wells

Sewers constructed of standard sewer materials shall not be laid within 75 feet of a public well or 50 feet of a private well. Sewers constructed of water main materials may be laid within 75 feet of a public well and within 50 feet of a private well but no closer than 25 feet to either.

12.5.8.3 Horizontal Separation of Gravity Sewers from Water Mains

Gravity sewer mains shall be separated from water mains by a horizontal distance of at least 10 feet unless:

a. the top of a sewer main is at least 18 inches below the bottom of the water main, and

b. the sewer is placed in a separate trench or in the same trench on a bench of undisturbed earth at a minimum horizontal separation of 3 feet from the water main.

When it is impossible to obtain the required horizontal clearance of three feet and a vertical clearance of 18 inches between sewers and water mains, the sewers must be constructed of water main materials meeting both a minimum pressure rating of 150 psi and the requirements of Sections 8.2 and 8.4 of the "Iowa Standards for Water Supply Distribution Systems." However, a linear separation of at least 2 feet shall be provided.

12.5.8.4 Separation of Sewer Force Mains from Water Mains

Sewer force mains and water mains shall be separated by a horizontal distance of at least 10 feet unless:

a. the force main is constructed of water main materials meeting a minimum pressure rating of 150 psi and the requirements of Section 8.2 and 8.4 of the "Iowa Standards for Water Supply Distribution Systems" and

b. the sewer force main is laid at least 4 linear feet from the water main.

12.5.8.5 Separation of Sewer and Water Main Crossovers

Vertical separation of sanitary sewers crossing under any water main should be at least 18 inches when measured from the top of the sewer to the bottom of the water main. If physical conditions prohibit the separation, the sewer may be placed not closer than 6 inches below a water main or 18 inches above a water main. The separation distance shall be the maximum feasible in all cases.

Where the sewer crosses over or less than 18 inches below a water main one full length of sewer pipe of water main material shall be located so both joints are as far as possible from the water main. The sewer and water pipes must be adequately supported and have watertight joints. A low permeability soil shall be used for backfill material within 10 feet of the point of crossing.

12.5.8.6 Exceptions

Should physical conditions exist such that exceptions to Sections 12.5.8.3, 12.5.8.4, and 12.5.8.5 of this standard are necessary, the design engineer must detail how the sewer and water main are to be engineered to provide protection equal to that required by these sections.

12.5.9 Connection of Dissimilar Pipe

Suitable couplings shall be used for joining dissimilar materials. The leakage limitations on these joints shall be in accordance with Section 12.7 of these standards.

12.5.10 Inverted Siphons

Inverted siphons should have not less than 2 barrels, with a minimum pipe size of 6 inches and shall be provided with necessary appurtenances for convenient flushing and

maintenance; the manholes shall have adequate clearance for rodding; and in general, sufficient head shall be provided and pipe sizes selected to secure velocities of at least 3.0 feet per second for average flows. The inlet and outlet details shall be arranged so that the normal flow is diverted to 1 barrel, and so that either barrel may be cut out of service for cleaning.

12.5.11 Sewer Crossing Under a Waterway

The top of all sewers entering or crossing streams shall be at a depth below the natural bottom of the stream bed sufficient to protect the line. One foot of cover over the top of the line is required where the sewer is located in rock or cased and three feet of cover is required in other material. In major streams, more than the three feet of cover may be required.

In paved channels, the top of the sewer line should be placed below the bottom of the channel pavement. Sewer outfalls, headwalls, manholes, gate boxes, or other structures shall be so located that they do not interfere with the free discharge of flood flows of the stream. Sewers located along streams shall be located outside of the stream bed.

Sewers entering or crossing streams shall be constructed of cast or ductile pipe with mechanical joints or shall be so otherwise constructed that they will remain water tight and free from changes in alignment or grade. Sewer systems shall be designed to minimize the number of stream crossings. The stream crossings shall be designed to cross the stream as nearly perpendicular to the stream flow as possible. Construction methods that will minimize siltation shall be employed. Material used to backfill the trench shall be stone, course aggregate, washed gravel, or other materials which will not cause siltation. Upon completion of construction, the stream shall be returned as near as possible to its original condition. The stream banks shall be seeded and planted, or other methods employed to prevent erosion. The design engineer shall include in the project specifications the method or methods to be employed in the construction of sewers in or near streams to provide adequate control of siltation.

12.5.12 Aerial Crossings

Support shall be provided at all joints in pipes utilized for aerial crossings. The supports shall be designed to prevent overturning and settlement.

Precautions against freezing, such as insulation and increased slope, shall be provided. Expansion jointing shall be provided between above-ground and below-ground sewers.

For aerial stream crossings the impact of flood waters and debris shall be considered. The bottom of the pipe should be placed no lower than the elevation of the 50 year flood.

12.6 DETAILS OF CONSTRUCTION

12.6.1 Excavation

12.6.1.1 Trench Bottom

The trench shall be excavated to grade. Bell holes shall be the minimum size that will permit construction of satisfactory joints and ensure uniform bearing of the barrel on the trench bottom, while avoiding bearing on the bells.

12.6.1.2 Trench Width

The width of the trench shall be ample to allow the pipe to be laid and jointed properly and to allow the backfill to be placed and compacted as needed. The trench sides shall be kept as nearly vertical as possible. When wider trenches are dug, appropriate bedding class and pipe strength shall be used.

12.6.1.3 Rock Removal

Ledge rock, boulders and large stones shall be removed to provide a minimum clearance of four inches below and on each side of all pipe.

12.6.1.4 Dewatering

All water entering the excavations or other parts of the work shall be removed until all the work has been completed. No sanitary sewer shall be used for the disposal of trench water, unless specifically approved by the engineer and then only if the trench water does not ultimately arrive at existing pumping or sewage treatment facilities.

12.6.2 Bedding

12.6.2.1 Rigid Pipe

Bedding classes A, B, or C, as described in ASTM C12-74 (ANSI A106.2) or ASCE MOP No. 37, shall be used for all rigid pipe provided the proper strength pipe is used with the specified bedding to support the anticipated load.

12.6.2.2 Flexible Pipe

Bedding classes I, II, or III, as described in ASTM D2321-74 (ANSI K65.171) shall be used for all flexible pipe provided the proper strength pipe is used with the specified bedding to support the anticipated load.

12.6.2.3 Composite Pipe

Except as described in ASTM D2680-76, the bedding classes for composite pipe shall be the same as for flexible pipe.

12.6.2.4 Bearing and Support

If the material encountered at the bottom of the trench is not satisfactory for bedding pipe, the unsatisfactory material shall be removed and replaced by material that will give proper support and compaction.

12.6.3 Installation

12.6.3.1 Rigid Pipe

Installation procedures, as described in ASTM C12-74 (ANSI A106-2) shall be used for all rigid pipe provided the proper strength of pipe is used.

12.6.3.2 Flexible Pipe

Installation procedures, as described in ASTM D2321-74 (ANSI K65.171) shall be used for all flexible pipe provided the proper strength pipe is used.

12.6.3.3 Composite Pipe

Installation procedures for composite pipe shall be the same as for flexible pipe except as specified in ASTM D2680-76.

12.6.4 Backfill

Backfill shall be of suitable material removed from excavation except where other suitable material is specified. Debris, frozen materials, large clods or stones, organic matter, or other unstable materials shall not be used for backfill within 2 feet of the top of the pipe.

Backfill shall be placed in such a manner as not to disturb the alignment of the pipe.

12.7 TESTING

12.7.1 Deflection Test

Deflection tests shall be performed on all flexible pipe. The deflection test shall be conducted after the final backfill has been in place at least 30 days.

No pipe shall exceed a deflection of 5%.

If the deflection test is to be run using a rigid ball or mandrel, it shall have a diameter equal to 95% of the inside diameter of the pipe and the tests shall be performed without mechanical pulling devices.

12.7.2 Allowable Leakage

The maximum allowable infiltration or exfiltration for any new gravity sanitary sewer section, including all manholes, is 200 gallons per inch of diameter per mile of pipe per day. Manholes may be tested separately.

12.7.3 Leakage Test

12.7.3.1 Line Infiltration Test Using a Weir

The crown of the pipe shall be covered with not less than two feet of water at the highest point in the section tested. The test head shall be maintained for not less than 24 hours before a weir measurement is made.

The infiltration should be measured by means of a V-notch weir located in the downstream manhole. All service connections and stubs shall be capped or plugged to prevent the entrance of ground water into the line at these connections.

12.7.3.2 Line Exfiltration Test

The inlet of the upstream and downstream manholes shall be closed with watertight bulkheads. Then the sewer and the upstream manhole shall be filled with water until the elevation of water in the upstream manhole is two feet higher than the top of the pipe in the line being tested, or two feet above the existing ground water in the trench, whichever is the higher elevation. The exfiltration will be measured by determining the amount of water required to maintain the initial water elevation for one hour from the start of the test. If the average head above the section being tested exceeds two feet, then allowable leakage can be increased by 5% for each additional foot of head. This test is

preferable for dry areas where ground water head over the pipe does not exist at the time of the test.

12.7.3.3 Line Low-Pressure Air Test

ASTM C828-76T, Low Pressure Air Test of Vitrified Clay Pipe Sewer Lines (4 to 12 in.), shall be utilized when air testing sewer pipe.

12.7.3.4 Manhole Exfiltration Test

The inlet and outlet of the manhole shall be plugged and the manhole filled to at least the depth that is used in testing the line. Allow the water to stand one hour and refill to the original elevation. After a specific time, usually 15 minutes to 1 hour, record the difference in elevation and convert into gallons per hour lost through manhole leakage.

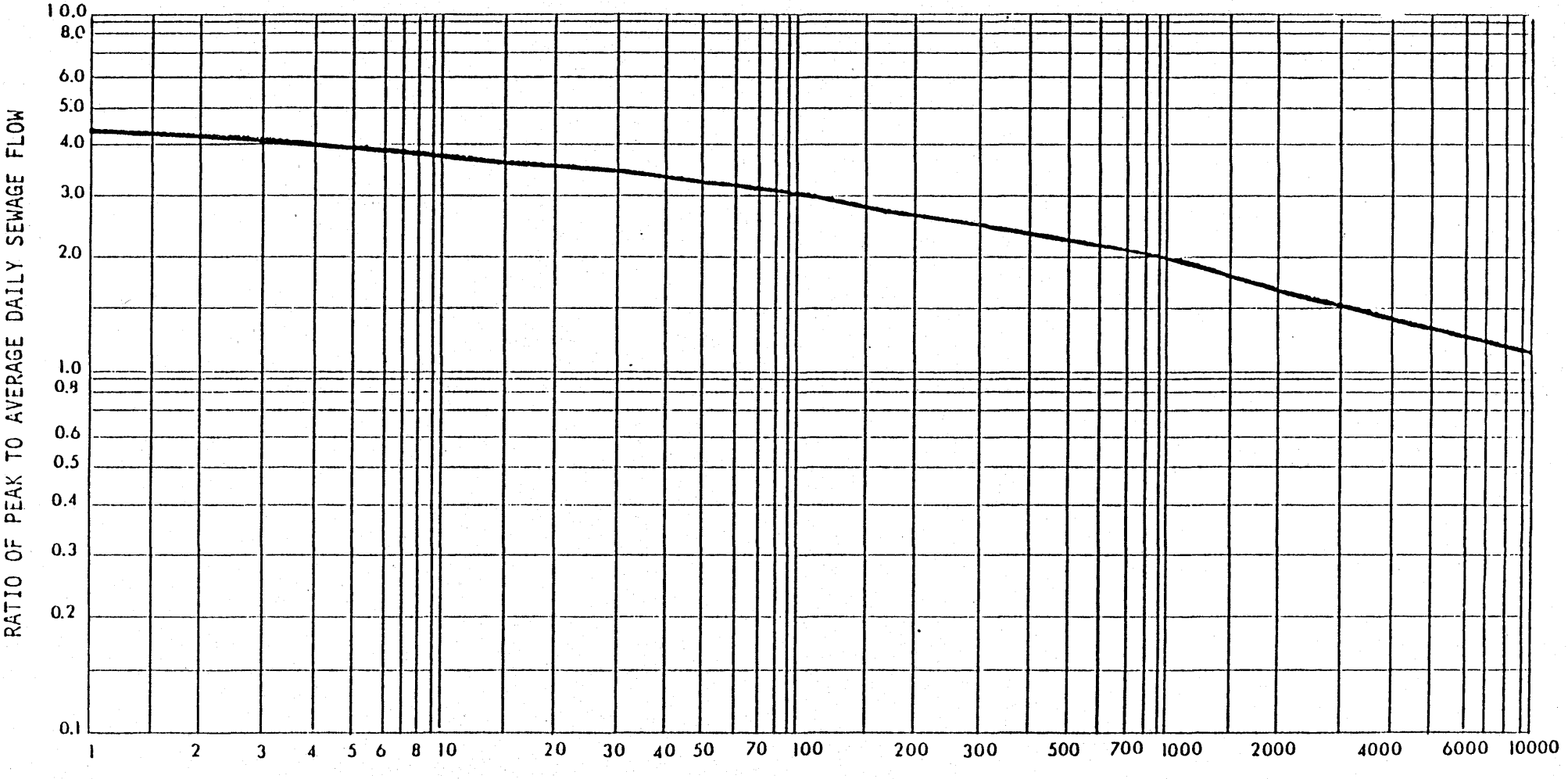
To get actual line exfiltration subtract manhole loss from loss determined during line exfiltration test.

12.7.3.5 Exceptions

Replacement of existing sewers which have service connections may be exempted from the leakage testing requirements

12.7.4 Alignment Test

Sewers shall be checked for alignment by either using a laser beam or lamping. The light should be visible through the section of pipe lamped. The results of the alignment test shall be evaluated by the design engineer.



NOTE: Curve Source: Fair, G.M. and Geyer, J.C., "Water Supply and Waste-Water Disposal." 1st Ed., John Wiley & Sons, Inc., New York (1954)

Curve, $\frac{18 + \sqrt{P}}{4 + \sqrt{P}}$ (P = Population in Thousands)

Appendix I