

CHAPTER 6

SEWER SYSTEM DESIGN STANDARDS

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CHAPTER 6

SEWER SYSTEM DESIGN STANDARDS

6.00 Objective

These Design Standards are intended to assist, but not to substitute for competent work by design professionals. It is expected Engineers will bring to each project the best of skills from their respective disciplines.

These Design Standards are also not intended to limit unreasonably any innovative or creative effort that could result in better quality, better cost savings, or both. Any proposed departure from the Standards will be judged, however, on the likelihood such variance will produce a compensating or comparable result, in every way adequate for the user and City of Keizer resident.

Permanent sanitary sewer facilities shall be provided to all property (legal lots of record) created by partitioning or subdivision of land within the City per these Standards.

These Design Standards have the Objective of developing a sanitary sewer system that will:

- a. be consistent with the adopted sewer master plan and associated updates;
- b. be of adequate design to carry the expected flow, within the design life, and at sufficient depth to serve adjacent properties;
- c. have sufficient grade to maintain a minimum velocity of 2-feet per second when flowing half full;
- d. have sufficient structural strength to withstand all external loads which may be imposed;
- e. be of materials resistant to both corrosion and erosion with a minimum design life of 50 years;
- f. be economical and safe to build and maintain; and
- g. prevent infiltration or inflow of ground and surface waters.

Alternate materials and methods will be considered for approval on the basis of these objectives.

6.01 Additional Referenced Standards

Design of sanitary sewer facilities, and related improvements in the City of Keizer shall conform to these Design Standards, City of Keizer Standard Construction Specifications, and certain sections (as required by the City Engineer) of the current edition of the following referenced standards, publications, or documents:

1. City of Salem Sanitary Sewer Design Standards
2. Oregon Plumbing Specialty Code
International Association of Plumbing and Mechanical Officials (IAPMO)
3. One and Two Family Dwellings Code
Council of American Building Officials (CABO)
4. City of Keizer Sanitary Sewer Master Plan and Updates

6.02 Special Design Problems

The design of the following are considered special items and are not covered in detail in these Standards:

- a. Sewage Pump Stations
- b. Force Mains
- c. Siphons
- d. Relining of Existing Sewers
- e. Internal Sealing of Existing Sewers
- f. Treatment Plants
- g. Energy Dissipaters
- h. Regulating Devices
- i. Flow Measurement Devices
- j. Hydrogen sulfide and/or hazardous gases

Review and approval of the above special items by the City shall be required. When requested by the City, full design calculations shall be submitted for review prior to approval.

6.03 General Design Requirements

Sanitary sewers shall be designed to remove the domestic sewage and industrial wastes from residential, commercial or industrial buildings, and all public and private establishments where possible.

Storm water, including street, roof, or footing drainage, shall not be discharged into the sanitary sewer system but shall be removed by a system of storm drains or by some other method apart from the sanitary sewer system.

Unpolluted cooling waters shall not be discharged into sanitary sewers. The overflow drains and filter backwash lines of swimming pools shall drain into a sanitary sewer.

In general, sewer systems shall be designed to care for future loads and for ultimate development of the specific drainage area concerned.

As a condition of sewer service, all developments will be required to provide public sewers to serve adjacent upstream parcels in order to provide for an orderly development of the drainage area. This shall include the extension of sewer mains in easements across the property to adjoining properties and across the street frontage of the property to adjoining properties when the main is located in the street right-of-way. This shall include trunk sewers that are oversized to provide capacity for upstream development.

Grinder pumps and force mains shall be maintained by the owner of the property served.

6.04 Sanitary Sewer System Capacity

Design flows shall be determined in accordance with the City of Keizer Sanitary Sewer Master Plan.

Design Per Capita Peak Hourly Flow for lateral sewer shall be a minimum of 400-gallons per capita per day (gpcd)

Note: Per capita peak hourly flows are the sum of peaked average daily domestic flows and infiltration inflow. The per capita peak hourly flows for trunk sewers must be computed for each case because of variable peaking factors.

It is recommended that design calculations include estimates of average maximum and minimum daily flows. The submission of design calculations will not ordinarily be required, but designers should be prepared to substantiate pipe sizes, layout, population estimates, land uses, or other design assumptions.

These factors may be used to estimate the peak daily flow that includes an allowance for infiltration.

Design capacity of main and trunk sewers shall be designated on the following basis:

- a. **Lateral sewers.** Design capacity shall be based on sewers flowing one-half (1/2) full.
- b. **Trunk sewers.** Design capacity shall be based on sewers flowing full, without head.

6.05 Sanitary Sewer Construction Plans

a. **Cover Sheet**

The Cover Sheet shall be prepared in accordance with the requirements of Chapter 1 of these Design Standards.

b. **Sewer System Plan and Profiles**

Plan view of sanitary sewer lines shall be to a scale of 1" = 50' and shall contain the following information:

1. Adjacent Street curbs and property lines, right-of-way and utility easements referenced to property corners, street intersections, or section lines. On construction permit projects adequate 2-foot contour lines or property corner and curb elevations to help determine if existing basements or proposed daylight basements in new subdivisions can or should be served.
2. Location of each manhole and sewer appurtenance shall be numbered and stationed to facilitate checking the plans with the profiles. The stationing shall be tied to existing property corners or street monuments with the relationship of each manhole and cleanout shown to the property corners (minimum two directions). Each line with a separate designation (A 0+00, B 0+00, etc.) shall be stationed continuously upgrade from 0+00 at its point of connection to another line (0+00 represents the centerline of the existing manhole or existing plug or cleanout if a main extension). Also to be shown is each service tee stationed with the size and depth at property line indicated.
3. Location of water courses, stream and railroad crossings, culverts, and storm drains that cross the alignment within 500-feet of the proposed extension in order to prevent future grade conflicts. All watercourse crossings must show the 100-year flood plain. This information may be shown on the 1" = 200' site plan.
4. Location of wells (identify existing wells, public and private, including abandoned wells), water main valves, pump stations, and blowoffs within a 100-foot radius of the proposed extension. All manholes, water mains, services, gas mains, underground power, and other utilities either crossing the alignment within 250-feet of the terminus of the proposed extension or adjacent to the proposed extension within the right-of-way or within 10-feet of the easement line. The intent is to prevent grade conflicts of all future extensions.

Profiles for the individual sanitary sewer lines shall be to the same horizontal scale on the same sheet and drawn immediately below the corresponding plan view to a vertical scale of 1" = 5' (or as approved) reading from 0+00 left to right, and shall contain at least the following information in addition to the above:

- 1) Location of manholes and other appurtenances with each manhole numbered and stationed as stated above.
- 2) Profile of the existing and proposed ground and/or pavement surface and sewer invert.
- 3) Size, slope, length, and type of material of the line between consecutive manholes.
- 4) Elevation of original ground, finished grade, proposed rim elevation, and sewer inverts at each manhole (Mean Sea Level Datum, U.S.G.S.). The benchmark used as a basis for vertical control in the design shall be shown on the plans and referenced as stated above.
- 5) Railroad and culvert crossings, ditch, or stream crossings with elevations of the ditch or streambed and the 100-year flood elevation profile and casing details.
- 6) Utility crossings that conflict with the proposed sewer installation.
- 7) All existing or abandoned wells, public or private.
- 8) All existing facilities upon which work is to be performed, i.e., installation, repair, or removal.

SPECIAL NOTE: The design engineer shall field locate and verify the alignment, depth, and inverts of all existing facilities shown on the plans that will be crossed by proposed facilities and shall certify them with a note on the plans. City as-builts are only to be used as an aid to the design engineer when field verifying the existing facilities.

6.06 Sanitary Sewer Design

The following physical design requirements shall be utilized by engineers for the design of public sanitary sewer systems in the City. *These design requirements may be used for private systems when plumbing code requirements cannot be met, provided the system is designed and appropriately certified by a professional civil engineer.*

a. Pipe Materials

Pipe materials shall be as allowed in City of Keizer Standard Construction Specifications. Alternate materials may be approved on a case-by-case basis by the City.

b. Size

Lateral sewers shall not be less than 8 inches inside diameter and shall begin at a manhole and shall terminate at a manhole except as allowed in applicable sections of these Design Standards.

c. Minimum Slope

1. All sanitary sewers shall be laid on a slope which will produce a mean velocity, when flowing half full of at least 2-feet per second, which is based upon Manning's pipe friction formula, using a roughness coefficient, valued at not less than 0.013, or the pipe manufacturer's recommendations, whichever is greater. The minimum acceptable slope for various pipe sizes with an "n" value of 0.013 are listed below:

MINIMUM SANITARY SEWER PIPE GRADE

Inside Pipe Diameter (inches)	Minimum Grade (feet per 100 feet)
6 (Private sewers only)	0.60 to 0.75
8	0.40
10	0.30
12	0.22
15	0.15
18	0.12
21	0.10
24	0.09
27 & larger	0.08

In general, gradients greater than those shown above are desirable and are particularly recommended on the upper ends of lateral sewers.

In theory, new PVC sewers have a manufacturer's "n" value of 0.009; however, sand and grit as well as slime build-up on the pipe walls renders a true "n" value with time of 0.013; hence, an "n" value of less than 0.013 will not be considered for approval.

Engineers are cautioned not to specify sewers of sizes which are obviously larger than is necessary for satisfactory carrying capacity but which are specified in order to meet grade requirements, i.e., a ten-inch pipe for an eight-inch pipe to acquire a decrease in slope.

2. Grades (slopes) shall be determined to the center of the manhole. The average between any inlet Slope (Si) and outlet Slope (So) in percent across the manhole shall not exceed 25 percent.

$$Si + So/2 = \text{less than 25 percent (feet per 100 feet)}$$

The above formula will limit the difference between the inlet and outlet inverts measured at the manhole walls from exceeding one (1) foot for an average manhole diameter of four (4) feet. Application is to sewers with a slope in excess of 19 percent.

3. Generally, a vertical offset in grade exceeding twenty-five hundredths (0.25) of a foot will not be permitted. Exceptions will be the following:
 - When a smaller diameter connects to a larger diameter sewer.
 - When a grade conflict exists with an existing utility, the maximum vertical drop may be 1 foot or as approved.
 - When a vertical drop greater than 2-feet is approved, an outside drop must be installed.

The intent is to prevent the difference in pipe inverts at the manhole wall on steep sewers from exceeding 1-foot, which with the offset permitted in above, renders it impossible to insert a TV camera into the outfall line if the average slope exceeds 25 percent.

d. Anchor Walls

Sewers on slopes of 20 percent or more shall be secured by anchor walls.

Where velocities greater than fifteen (15) feet per second are attained, the pipe material shall be ductile iron and special provision shall be made to protect manholes against erosion and displacement by shock. This may be accomplished by installing one additional manhole to decrease the slope or to split a 90° horizontal direction change into two (2) 45° incremental changes.

e. Minimum Depth

All sanitary sewers shall be laid at a depth sufficient to drain building sewers, to protect against damage by frost or traffic, and to drain basement sewers where practical. Sufficient depth shall mean the minimum cover from the top of the pipe to finish grade at the sewer alignment.

Under normal conditions, sanitary sewers in residential areas shall be placed in the street with the following minimum cover:

Lateral Sewer - 6 feet

Trunk Sewer:

in the roadway - 8 feet

in easements - 8 feet

Where the topography is relatively flat and existing sewers are shallow (five (5) feet or less), the minimum cover may be three (3) feet. Less than three (3) feet of cover will require the installation of ductile iron pipe. See Table 6.1 for class of pipe required.

In a new designated residential hillside subdivision, mainline and lateral sewers shall be placed in the street at a depth sufficient to drain building sewers on the low side of the street.

Deviation from the above standards will be considered on a case-by-case basis when one of the following circumstances exist and the required documentation is submitted:

1. **Underlying rock strata**

Required: A request in writing to the City together with a soils report including a plan and profile certifying bed rock exists 3-feet below the undisturbed ground surface at all investigated alignments.

2. **A ditch or stream must be crossed**

Required: A plan and profile; horizontal scale 1" = 20' and vertical scale 1" = 2'.

Table No. 6.1
DUCTILE IRON PIPE CLASS REQUIREMENTS
 for Sewers with less than 3'-0" of Cover

Pipe Size (inches)	Depth of Cover (ft.)	In Fills Use D.I. Class	Standard Trench Use D.I. Class
4 (Service Lines)	0.5	51	51
	1.0	51	51
	1.5	51	51
	2.0	51	51
6 (Service Lines)	0.5	53	50
	1.0	51	50
	1.5	50	50
	2.0	50	50
8	0.5	54	50
	1.0	52	50
	1.5	50	50
	2.0	50	50

6.07 Sanitary Sewer Location

a. **Relation to Water Lines and Other Utilities**

Sanitary sewers shall be separated from water pipes and sources of domestic water in accordance with OAR Chapter 333.

b. **Sewers in Streets or Easements**

Unless approved by the City, sewers shall be located in the street right-of-way within five (5) feet of the street centerline on the low side of the street. Sewers in easements will be allowed only after all reasonable attempts to place the mains in the right-of-way have been exhausted. All easement installations must be approved by the City on a case-by-case basis. If streets have curved alignments, the center of the manhole shall not be less than six (6) feet from the curb face on the outside of the curve nor the sewer centerline less than six (6) feet from the curb face on the inside of the curve. The intent is to prevent a conflict with new storm drain lines while still providing for the least number of manholes required to traverse a curve.

When it is approved by the City to locate sewers in easements, the sewer shall be centered in the easement and the conditions of the easement shall be such that the easement shall not be used for any purpose that would interfere with the unrestricted use for sewer main purposes. Under no circumstances shall a building or structure, tree, or fence be placed over a sanitary sewer main or sewer easement. This shall include overhanging structures with footings located outside the easement. All manholes within easements and pipelines over 24-inch diameter regardless of location shall have lock down lids.

Easements for sewers less than 12-inches in diameter shall have a minimum width of 10-feet. Sewers 12 to 15-inches in diameter shall have a minimum easement width of 15-feet, and sewers greater than 15-inches in diameter, shall have a minimum easement width of 20-feet.

Easement locations for public sewer mains serving a PUD, apartment complex, or commercial/industrial development shall be in parking lots, private drives, or similar open areas which will permit an unobstructed vehicle access for maintenance by City forces.

Sewers with more than 6-feet of cover and/or inside diameters of 24-inches or greater will require wider easements. A slope of one horizontal to one vertical from the sewer invert to ground surface will be used in determining easement width. Easement widths shall vary from the 10-foot minimum by 5-foot increments, i.e., 10, 15, 20-feet, etc.

Common placement in the easement of sewer and storm drain line may be allowed under certain conditions subject to approval by the City.

Common easements will be reviewed on a case-by-case basis. Separation of utilities must meet Oregon State Department of Environmental Quality (DEQ) requirements.

All easements must be furnished to the City for review and approval prior to recording.

c. **Relation to Streams and Drainage Channels**

Generally, the top of all sanitary sewers entering or crossing streams shall be at a sufficient depth below the natural bottom of the streambed to protect the sewer line. One (1) foot of cover is required where the sewer is in rock, three (3) feet of cover is required in other materials. In paved channels, the top of the sewer line shall be placed at least six (6) inches below finish grade of the bottom of the channel, except as provided above.

Sewers located along streams shall be located outside of the streambed and sufficiently removed to provide for future possible stream channel widening. All manhole covers shall have waterproof, lock-down lids, at or below the 100-year flood elevation.

Sewers crossing streams or drainage channels shall be designed to cross the stream as nearly perpendicular to the stream channel as possible and shall be free from change of grade.

Pipe shall be ductile iron pipe conforming to AWWA C151, pressure class 350, with an 18-foot length of pipe centered on the stream or drainage channel centerline. The ductile iron pipe shall extend to a point where a one-to-one slope, that begins at the top of the bank and slopes down from the bank away from the channel centerline, intersects the top of the pipe.

Concrete encasement will be required when the above cover requirements cannot be met. Each deviation from the above requirements will be reviewed on a case-by-case basis.

6.08 Sanitary Sewer Alignment

Sewer lines shall be laid on a straight alignment and uniform slope between consecutive manholes.

Horizontal and vertical curves in sanitary sewers are not permitted.

6.09 Sanitary Sewer Appurtenances

Detailed drawings shall be included for all sanitary sewer appurtenances including manholes, pump stations, siphons, stormwater diversion, etc. Appropriate references to the City's Standard Details may be used in lieu of details actually shown on the plans.

6.10 Manholes and Cleanouts

a. **Cleanouts**

Cleanouts will not be approved as substitutes for manholes, except at the upper end of lateral or main sewers that will be extended on the same grade and alignment during the next construction phase. All cleanouts will be considered on a case-by-case basis and approved by the City.

b. **Manhole Taps**

When an existing manhole is tapped to install a new sewer which will drain into the manhole, the new sewer shall enter the manhole with the invert a minimum 0.25-foot below the shelf elevation of the manhole and a channel shall be formed in the shelf of the manhole to the invert of the existing sewer.

c. **Manhole Location**

Manholes shall be placed at the following locations:

1. Every change in grade (grade break) or alignment of a sewer.
2. Every point where there is a change in size or abrupt change in invert elevation (drop) change of a sewer.
3. Each intersection or junction of a sewer.
4. Upper end of all lateral sewers, except as provided in (b) above.
 - Adjacent to the radius point of a cul-de-sac that has 3 or more parcels of land fronting on the cul-de-sac.
 - In front of the last property or lot being served, 10-feet past the common lot line of the adjoining parcel served.
5. At intervals of 450-feet or less. *Deviation from this requirement shall be reviewed on a case-by-case basis for approval, considering whether or not flushing and cleaning equipment can adequately service the proposed sewer line.*
6. At any point where a service or private sewer of 8-inches or larger intersects a sewer main.

Manholes shall not be located in the curb or in the gutter. Placement of manholes behind the curb shall be reviewed on a case-by-case basis for approval. Consideration shall be given to those sewer lines that already exist behind the curb.

Two manholes shall be installed when the horizontal deflection angle between a lateral or main connection to an existing sewer is less than or equal to 75°. Spacing of such manholes shall be a minimum of 10-feet outside to outside.

The intent is to prevent a new lateral sewer connection from discharging into an existing sewer opposing the existing flow.

Where practical, manholes shall be located at street intersections. All manholes from which future sewer line extensions are anticipated, shall have a pipe stub designed and installed at the grade and direction of the anticipated sewer main extension. Pipe stubs shall be a minimum of 8-inches in size and shall protrude at least 1-foot outside of the manhole base.

Risers shall be used to bring casting to grade. Combined riser sections shall not exceed six inches in height between cone and casting.

d. **Drop Manholes**

Outside drop assemblies shall be provided for pipe lines 12-inches in diameter and smaller when entering a manhole at a distance of more than 24-inches above the invert of the outlet line. The vertical displacement shall be measured at the inside manhole walls and not the manhole centerline. Larger pipelines shall be introduced into the manhole at the manhole invert.

SPECIAL NOTE: Drop manholes shall only be used in extreme cases of slope difference between existing and proposed sewer lines or when very special conditions exist such as a conflict with existing facilities that cannot be relocated.

Approval of the City after review of the plans by appropriate design, construction, and maintenance sections is required to construct a drop manhole.

e. **Drop Across a Structure**

The drop across a structure shall normally be one-tenth (0.10) of a foot. Where there is to be more than 60° of horizontal deflection angle between any inlet and outlet line of a structure, the vertical drop from said inlet and outlet line of a structure shall be at least two-tenths (0.20) of a foot.

f. **Metering Manhole**

A metering manhole shall be installed on all systems meeting one of the following criteria:

1. A private sewer that contributes more than 10,000 gallons per day to the public sewer.
2. A private sewer which serves more than one structure on the same premises, (private collection system).

g. **General**

Manholes and wet wells over 20-feet in depth or pipes over 36-inches in diameter shall have structurally sound grated working platforms (nonmetallic covered) for maintenance and fall protection, spaced not greater than 15-feet apart.

Pipelines 36-inches and larger in diameter shall have manhole openings of 30-inches in diameter.

Where manhole rims are 2-feet or greater above grade or finished ground, the manhole lids shall be made of aluminum.

6.11 Sewer Service Lines and Private Collection Systems

a. **Sewer Service Lines**

Sewer service lines are those portions of the sewage system between the public sewer and the structure being served, which are installed and maintained by property owners or agencies other than the City.

As a minimum criterion, construction of the house or building sewer service line shall be of the same quality and meet the same requirements as the public sewer with regard to materials, watertightness, and location. In addition, these sewers shall conform to the State and local plumbing codes and restrictions. No roof, surface, foundation, or stormwater drain lines shall be connected to the public sewers.

Sewer service lines shall not tie into an existing manhole except in special cases approved by the City. Exception: Services may tie into a manhole that is located in a cul-de-sac provided the line is not planned to be extended in the future. A cleanout shall be installed at the property line when the building sewer is connected to the sewer service line. For long sewer service lines in existing residential areas, a cleanout shall be installed at property line and at 100-foot intervals thereafter. Sewer service lines shall have at least 4-feet of cover at the property line. Generally, the topography of the property will dictate how deep the service line must be.

Each individual building site shall be connected by a separate sewer service line connected to the public or private main sewer. Combined sewer service lines will be permitted only when the property cannot legally be further divided. An example of this is a residential lot with a house and unattached garage or shop with plumbing facilities.

The minimum inside diameter of a sewer service line shall be 4-inches and shall be equal to or greater than the building plumbing stub (building drain) diameter. The minimum inside diameter of sewer service lines to serve multifamily dwellings or commercial buildings shall be 6-inches. Fixture unit equivalents shall be determined in accordance with the Oregon Plumbing Specialty Code.

Minimum sizes and slopes for sewer services, based on the fixture unit equivalents, shall be in accordance with the Oregon Plumbing Specialty Code.

Sewer service lines for townhouses and similar cluster housing developments shall be installed on a uniform slope from the main line sewer connection to a point 5-feet from the end of the building drain conforming to the above requirements.

A backwater check valve shall be installed when the lowest floor level of a house to be connected to the public sewer is below a point which is 12 inches above the top of the nearest upstream manhole or cleanout structure. A gate valve in addition to the required backwater check valve is optional but should be considered for installation for additional protection should the backwater valve fail or become clogged with debris.

b. **Private Collection System**

Private collection system sewers shall be designed in conformance with main line standards specified herein when plumbing code grade requirements cannot be met. Subsection (a) of this section must be used for sewer service lines in the system with the following exceptions:

1. The minimum size sewer line upstream of the monitoring manhole structure shall be 6-inches.
2. A manhole is required at the connection to the City main.
3. A monitoring manhole is required at the property line upstream from the manhole connection at the City main required above.

The monitoring manhole shall consist of a standard manhole with the inlet pipeline invert placed 0.4-foot above the outlet invert. The inlet pipe shall extend 1-foot past the manhole wall and shall be cut in half 6-inches from the outfall end and the top half of the pipe removed. The channel shall be formed from the outfall end to the outlet line in the usual manner.

The intent is to provide a half round section of pipe inside the manhole into which City personnel will place flow-monitoring equipment.

c. **Locating Building Sewers and Private Collection Systems**

All sewer piping shall have an electrically conductive tracer wire, 14-gauge minimum size, insulated copper, and green sheeting, installed in the trench for the purpose of locating pipe in the future. The tracer wire shall run the full length of the installed pipe, with one end located around the mainline or lateral. The other end of the tracer wire shall be of sufficient length for an electrically conductive splice.

6.12 Sanitary Sewers for Floating Structures

- a. Floating structure sanitary sewers shall consist of pressurized flexible main lines insulated against freezing and restrained against transverse movement that are connected to the public main through a monitoring manhole on shore.
- b. Each dwelling containing plumbing facilities shall have a holding tank and a grinder pump connected to the pressurized line. Said connection shall be by a detachable coupling with a gate valve and check valve installed downstream of the connection. The gate valve shall be on the pressure line side followed by the check valve before the detachable coupling. The detached coupling on the dwelling side of the connection shall also have a gate valve to prevent leakage or accidental discharge during repairs or moving the floating structure.
- c. Details of the following must be submitted along with plan and profiles: mooring methods and devices, methods of insulating pipeline against freezing, pipeline hangers, flexible connections and appurtenances, dock or walkway to which facilities are connected.
- d. Profiles shall include not only the land-based sewer connection but also the high, low, and 100-year floodwater surface elevation with details of how the pipeline system is to react to said water surface elevation changes.

6.13 Special Plan Review

The City of Keizer currently contracts with the City of Salem to review all sanitary sewer construction plans and inspect all sanitary sewer construction projects. All fees for these services shall be paid by the Developer or other project representative.