

SECTION 7

7. SANITARY SEWER STANDARDS

7.01 General

Sanitary sewerage refers to waste water derived from domestic, commercial and industrial pretreated waste to which storm, surface, and ground water are not intentionally admitted. Pretreatment will follow all the requirements as set forth by the City of Castle Rock.

Any extension of the City's sanitary sewer system must be approved by the City of Castle Rock and must conform to the current City of Castle Rock Comprehensive (Master) Sanitary Sewer Plan, Cowlitz County Health Department, Department of Ecology (DOE), and Department of Health (DOH) requirements.

Maintenance of a private sewer, building, or side sewer will be the responsibility of the property owner. Maintenance of the lateral to and including the point of connection to the sewer main will be the responsibility of the property owner.

A. Sanitary Sewer/Water Main Crossings

The Contractor will maintain a minimum of 18 inches of vertical separation between sanitary sewers and water mains. The minimum cover for water main of 36 inches may be reduced to 30 inches upon approval by the City to provide for as much vertical separation as possible. If the minimum vertical separation is not met, then standards for water-sewer separation shown on drawing CRO28SS will apply.

The longest standard length of water pipe will be installed so that the joints will fall equidistant from any sewer crossing. In some cases where minimum separation cannot be maintained, it may be necessary to utilize water main rated pipe for the sewer line, or to encase the water pipe and/or sewer service in pipe or concrete. No concrete will be installed unless specifically directed by the City.

B. Staking

All surveying and staking will be performed by an engineering or surveying firm capable of performing such work and possessing the appropriate business licenses. The engineer or surveyor directing such work will be licensed by the State of Washington.

A preconstruction meeting will be held with the City prior to commencing staking. All construction staking will be inspected by

the City prior to construction and staking will be maintained throughout the construction.

The minimum staking of sewer lines will be as follows:

- a. Centerline alignment must be staked with cuts and/or fills to flowline at 25 feet and 50 feet from the manhole or structure, and every 50 feet from there on, unless more frequent staking is required for construction at the discretion of the City Inspector.
 - b. Manholes must be staked with hubs to include invert elevations of all pipes and top of rim elevations to finished grade.
 - c. Location of valves and fixtures will be staked for force mains.
- C. Trench Excavation
- a. Clearing and grubbing where required will be performed within the easement or public right-of-way as permitted by the City and/or governing agencies. Debris resulting from the clearing and grubbing will be disposed of by the owner or contractor in accordance with the terms of all applicable permits.
 - b. Trenches will be excavated to the line and depth designated by the City to provide a minimum of 36 inches of cover over the pipe. Except for unusual circumstances where approved by the City, the trench sides will be excavated vertically and the trench width will be excavated only to such widths as are necessary for adequate working space as allowed by the governing agency. All necessary shoring operations will be performed to ensure that the excavation can be carried out in accordance with Washington Industrial Safety and Health Administration (WISHA) and the Occupational Safety and Health Administration (OSHA) Safety Standards. The trench will be kept free of water until joining is complete. Surface water will be diverted so as not to enter the trench. The owner will maintain sufficient pumping equipment on the job to ensure that these provisions are carried out.
 - c. The contractor will perform all excavation of every description and whatever substance encountered and boulders, rocks, roots, and other obstructions will be entirely removed or cut out to the width of the trench and to

a depth 6 inches below the sewer grade. Where materials are removed from below the sewer grade, the trench will be backfilled to grade with material satisfactory to the City and thoroughly compacted.

- d. Trenching and shoring operations will not proceed more than 100 feet in advance of Pipe laying without approval of the City, and will be in conformance with Washington Industrial Safety and Health Administration (WISHA) and Occupational Safety and Health Administration (OSHA) Safety Standard.
- e. The bottom of the trench will be finished to grade with hand tools in such a manner that the pipe will have bearing along the entire length of the barrel. The bell holes will be excavated with hand tools to sufficient size to make up the joint.
- f. The Contractor will maintain the presence of a “competent person” as defined by the Washington State Department of Labor and Industries when any trench excavation and backfill work is being done at the project site.

D. Backfilling

Backfilling will not commence until the pipe installation has been inspected and approved.

Backfilling and surface restoration will closely follow installation of pipe so that not more than 100 feet is left exposed during construction hours without approval of the City.

Selected backfill material will be placed and compacted around and under the sewers by hand tools to a height of 6 inches above the top of the sewer. The remaining backfill will be compacted to 95 percent of the maximum density in traveled areas, and 90 percent outside traveled areas. Where governmental agencies other than the City have jurisdiction over roadways, the backfill and compaction will be done to the satisfaction of the agency having jurisdiction. If suitable backfill material, as determined by the City, is not available from trenching operations, the City may order the placing of bedding conforming to the current WSDOT/APWA Section 7-08.

E. Street Patching and Restoration

Temporary restoration of trenches will be accomplished by using 2-inch HMA Class B PG 58-22 when available or 2-inch medium-

curing (MC-250) liquid asphalt (cold mix), U.P.M., 2-inch asphalt treated base (ATB), or steel plates.

ATB used for temporary restoration may be dumped directly into the trench, bladed, and rolled. After rolling, the trench must be filled flush with asphalt concrete pavement to provide a smooth riding surface.

Prior to beginning street trenching work, the contractor will ensure that temporary patching material is stockpiled at the project site, both for completing and maintaining the temporary patching.

All temporary patches will be maintained by the contractor and will be made permanent within 10 working days. Patches that are not properly maintained will be identified by the City Construction Inspector and repaired by the City at the developers/contractors/private utility's expense.

F. Pavement Restoration

a. Introduction

Trench cuts in roadways greatly degrade the condition of the pavement, as well as reduce the design life. The most significant damage can be seen in newer pavements. A restored trench cut in a newly paved road lowers the Pavement Management System (PMS) rating 30 points (on a scale of 0 to 100). It is the goal of pavement restoration to have a pavement in better or as good as pre-trench cut condition. This can be achieved through prevention of trench cuts through utility coordination and high-quality pavement restoration.

b. Lane Width Restoration Requirements

For longitudinal utility trench cuts in pavements over 5 years old, a minimum two-inch overlay or full-depth pavement reconstruction is required for the following widths:

- One-lane overlay or reconstruction—When trench cut or patch is within one travel lane.
- Two-lane overlay or reconstruction—When trench cut or patch is within two travel lanes
- Additional overlay or reconstruction—When the remaining pavement area to the edge of existing pavement on either side is less than one travel lane or pavement is less than five years old No

longitudinal joints will be allowed in the wheel path.

c. Pavement Restoration Requirements

Table 7.1 describes pavement restoration requirements for various size projects and various existing pavement conditions.

d. Transverse Utility Crossings

Transverse utility crossings must be bored or completed by another trenchless method. Bore pits must be restored per Section 7.01.G.

e. Trench Cuts in New Pavements

Trench cuts are not permitted in pavements that have been constructed or rehabilitated within 5 years. Rehabilitation includes all surface treatments including chip seal, slurry seal, and asphalt overlay. If there is no other option but to cut into a new pavement, the pavement must be restored per Table 7.1 requirements.

f. Exemption From Pavement Restoration Requirements and Financial Penalties.

Utilities can appeal in writing directly to the Public Works Director for exemption from pavement restoration requirements and financial penalties associated with trenching in new pavements.

Utilities will be exempt from pavement restoration requirements and financial penalties if there is no other viable alternative and under the following conditions:

1. If the City failed to give 6 months' notice of an upcoming roadway rehabilitation project either because of:
 - a) A change in property ownership, or
 - b) A change in the City's Capital Facilities Plan.
2. An emergency project requiring immediate attention for the preservation of life or property.

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TABLE 7.1 PAVEMENT RESTORATION REQUIREMENTS			
Project Type	New Pavement <5 years old	Pavement >5 years old	Pavements identified by the City to be reconstructed within 2 years
Large Projects—Consists of a project requiring a longitudinal trench cut through the paved roadway surface 50 linear feet or greater, or four or more traverse trench cuts per 300 linear feet of roadway.	Complete reconstruction, grind/inlay, or overlay of entire paved surface (all lanes). Pavement section based on pavement design. *	Grind/inlay, reconstruct, or overlay. Width per lane requirements in section 7.01.G. Pavements based on pavement design.	Depending on intended reconstruction strategy. Could utilize lesser pavement restoration. Minimum restoration is patch per Standard Plan CRO29SS.
Small Projects—Consists of a project requiring a longitudinal trench cut through the paved roadway surface less than 50 linear feet or less than four trench cuts per 300 linear feet of roadway.	Patch per Standard Plan CRO29SS. Trench restoration penalty assessed per square yard of trench as required by Standard Plan CRO29SS.	Patch per Standard Plan CRO29SS.	Depending on intended reconstruction strategy, could utilize lesser pavement restoration. Minimum restoration is patch per Standard Plan CRO29SS.
Emergency Projects—A project that could not be foreseen requiring immediate attention for the preservation of life or property	Grind/inlay, reconstruct, overlay, or patch (depending on project size - see above). Width per lane requirements in Section 7.01.G. Pavement section based on pavement design.	Grind/inlay, reconstruct, overlay, or patch (depending on project size - see above). Width per lane requirements in Section 7.01.G. Pavement section based on pavement design.	Depending on intended reconstruction strategy, could utilize lesser pavement restoration. Minimum restoration is patch per Standard Plan CRO29SS.

* If it is determined by the Public Works Director that full paved surface restoration impacts are excessive (i.e., traffic congestion, business impacts), restoration can be reduced to trench restoration only and a fee-in-lieu equal to the cost of full paved surface restoration assessed.

g. Construction Requirements

1. All trench and pavement cuts will be made uniformly by wheel or saw cutting. If edge of trench line degrades, ravel, or is non-uniform, additional saw cutting will be required prior to final patch or paving.
2. Tack will be applied to the existing pavement and edge of cut and will be emulsified asphalt grade CSS-1 as specified in the latest version of the WSDOT/APWA Standard Specifications. Tack coat will be applied as specified in Section 5-04 of the latest version of the WSDOT/APWA Standard Specifications.

3. Asphalt concrete Class B will be placed on the prepared surface by an approved paving machine and will be in accordance with the applicable requirements of Section 5-04 of the latest version of the WSDOT/APWA Standard Specifications, except that longitudinal joints between successive layers of asphalt concrete will be displaced laterally a minimum of 12 inches unless otherwise approved by the Public Works Director. Fine and coarse aggregate will be in accordance with Section 9-03.8 of the latest version of the WSDOT/APWA Standard Specifications. HMA over 3 inches thick will be placed in equal lifts not to exceed 3 inches each.

Grinding: Connection to existing asphalt at center line, lane edges, and overlay ends shall be made by grinding. Feathering of asphalt is not acceptable without written approval from the Public Works Director. Grind can be a few inches off centerline to avoid existing striping.

Surface smoothness will be per Section 5-04 of the latest version of the WSDOT/APWA Standard Specifications. The paving will be corrected by removal and repaving of the trench only.

Asphalt concrete pavement for wearing course will not be placed on any traveled way between October 15 and April 1 without written approval from the Public Works Director.

Asphalt for prime coat will not be applied when the ground temperature is lower than 50°F, without written permission of the Public Works Director.

Asphalt concrete will not be placed on any wet surface, or when the average surface temperatures are less than those specified in the following table, or when weather conditions otherwise prevent the proper

handling or finishing of the bituminous mixtures:

SURFACE TEMPERATURE LIMITATIONS		
Compacted Thickness (Feet)	Surface Course	Sub-Surface Courses
Less than .10	55° F	55°F
0.10 to 0.20	45° F	35°F
0.21 to 0.25	35° F	35°F

4. All joints on trenching or overlays will be sealed using crack sealant as specified in latest version of the WSDOT/APWA Standard Specifications Section 9-04.10 (ASTM D-1190).
5. When trenching within the roadway shoulder(s), the shoulder will be restored to its original or better condition.
6. The final patch will be completed as soon as possible and will be completed within 10 days after first opening the trench. This time frame may be adjusted if delays are due to inclement paving weather, or other adverse conditions that may exist. However, delaying of final patch or overlay work is allowable only subject to the Public Works Director’s approval. The Public Works Director may deem it necessary to complete the work within the 10-day time frame and not allow any time extension. If this occurs, the Contractor will perform the necessary work as directed by the Public Works Director.

G. Trench Backfill

All crushed surfacing materials will conform to Section 4-04 of the latest version of the WSDOT/APWA Standard Specifications. The subgrade will be compacted to 95 percent maximum density, as described in Section 2-03 of the latest version of the WSDOT/APWA Standard Specifications.

All granular backfill material will conform to Section 9-03.19 of the WSDOT/APWA Standard Specifications. The trench will be compacted to 95 percent maximum density, as described in Section 2-03 of the WSDOT/APWA Standard Specifications.

If the existing material is determined by the City to be suitable for backfill, the contractor may use the native material except that the top 8 inches of trench will be 2.5-inch-minus ballast. All trench

backfill materials below the roadway base and subbase level will be compacted to 95 percent density.

When trench width is 18 inches or less and is within the traveled way, trench will be backfilled with control density fill (self-compacted flowable fill) Class B as defined by Washington Aggregates and Concrete Association. The aggregate will be 3/8-inch minus.

Backfill compaction and placement will be performed in compliance with WSDOT/APWA Standard Specifications. Replacement of the asphalt concrete or Portland cement concrete pavement will conform to the latest version of the WSDOT/APWA Standard Specifications.

H. Testing

Prior to acceptance and approval of construction, the following tests will apply to each type of construction.

a. Gravity Sewer

1. After the pipes have been cleaned, the gravity sewer pipe will be subject to a low pressure air test per the current WSDOT/APWA Specifications. The contractor will furnish all equipment and personnel for conducting the test under the observation of the City inspector. The testing equipment will be subject to the approval of the City.

The contractor will make an air test for his own purposes prior to notifying the City to witness the test. The air test for acceptance will be made after the trench is backfilled and compacted and the roadway section is completed to subgrade.

All wyes, tees, and end of side sewer stubs will be plugged with flexible joint caps, or acceptable alternates, securely fastened to withstand the internal test pressures. Such plugs or caps will be readily removable and their removal will provide a socket suitable for making a flexible jointed lateral connection or extension.

2. Testing of the sewer main will include a television inspection by the City. The first television inspection will be conducted at the City's expense. Any additional televising that is deemed necessary

may be addressed in either of two manners. At the City's discretion, the contractor can have the City perform the work and reimburse the City for all associated labor and materials, or the contractor may perform the inspection under direct supervision of City personnel. Television inspections performed without City personnel present will be deemed invalid and will be repeated at the contractor's expense. Television inspection will be done after the air test has passed, the manhole has been channeled, and before the roadway is paved. Immediately prior to a television inspection, enough water will be run down the line so it comes out the lower manhole and the line is flushed clean.

Acceptance of the line will be made after the television inspection tape has been reviewed and approved by the Inspector. Any tap to an existing system needs to be televised as well.

The City will televise the new line during periods of high groundwater within the first 2 years after construction and acceptance of the line. Any conditions resulting in inflow and infiltration (I & I) will be considered a system failure that will be repaired by, and at the expense of, the contractor.

3. A vacuum test of all manholes is required prior to acceptance. The structure will be tested in accordance with ASTM-C 1244-93. This test method covers procedures for testing cast in place or precast concrete manhole sections, using the vacuum test method to demonstrate the integrity of the installed materials and the construction procedures. Testing will be done in the following manner:
 - a. All lift holes and pipes entering into the manhole will be plugged, taking care to securely brace each plug from being drawn into the structure.
 - b. The test head will be placed at the top portion of the structure in accordance with the manufacturers' recommendations.
 - c. A vacuum of 10 inches of mercury will be drawn on the manhole, the valve on the

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vacuum line of the test head closed, and the vacuum pump shut off. With the valves closed, the time will be measured for the vacuum to drop by 1 inch to 9 inches. The manhole will pass the vacuum test if the time is greater than the time shown in TABLE-7.2, which gives allowable time loss in seconds (i.e., test section is acceptable if vacuum does not drop below 9 inches until after the times shown in the table have expired).

Depth (ft)	Diameter (inches)								
	30	33	38	42	48	54	60	66	72
	Time (seconds)								
8	11	12	14	17	20	23	26	29	33
10	14	15	18	21	25	29	33	36	41
12	17	18	21	25	30	35	39	43	49
14	20	21	25	30	35	41	48	51	57
16	22	24	29	34	40	46	52	58	67
18	25	27	32	38	45	52	59	65	73
20	28	30	35	42	50	53	65	72	81
22	31	33	39	46	55	64	72	79	89
24	33	36	42	51	59	64	78	87	97
26	36	39	46	55	64	75	85	94	105
28	39	42	49	59	89	81	91	101	113
30	42	45	53	63	74	87	98	108	121

- d. If the manhole fails the initial test, necessary repairs will be made by an approved method. The structure will then be retested until a satisfactory test is obtained.
- e. If the manhole joint is displaced during the vacuum test, the manhole will be disassembled, the seal replaced, the structure reassembled, and retested until compliance is obtained.
- f. Testing can be done either before or after backfill operations around the structure; however, if during backfill operations it is found that the structure has been disturbed and it is suspected that the integrity of the joint has been compromised, retesting will be required.

the air in the line has been released before requesting the City to witness the test.

2. A water test for all wet wells in accordance with the manhole water test for gravity sewer will be required.
3. Verification of operating parameters such as, pump operation, alarms, and an electrical inspection are required prior to acceptance of all lift stations.

I. General Notes

The General Notes on the following page(s) will be included on any plans dealing with sewage system design. In addition, the specific notes for gravity sewers will be included when these utilities are part of the project.

GENERAL NOTES (SANITARY SEWER MAIN INSTALLATION) (TO BE PRESENT ON ALL SUBMITTALS)

1. All workmanship and materials will be in accordance with City of Castle Rock standards and the most current copy of the State of Washington Standard Specifications for Road, Bridge and Municipal Construction (WSDOT/APWA).
2. City of Castle Rock datum (NAD 83/91 and NAVD 88) will be used for all vertical control. A list of benchmarks is available from Cowlitz County.
3. All approvals and permits required by the City of Castle Rock will be obtained by the contractor prior to the start of construction.
4. If construction is to take place in the County right-of-way, the contractor will notify the County and obtain all the required approvals and permits.
5. A preconstruction meeting will be held with the City of Castle Rock Construction Inspector prior to the start of construction.
6. The City of Castle Rock Construction Inspector will be notified a minimum of 48 hours (two working days) in advance of a tap connection to an existing

main. The inspector will be present at the time of the tap.

7. The contractor will be fully responsible for the location and protection of all existing utilities. The contractor will verify all utility locations prior to construction by calling the Underground Locate Line at 1-800-424-5555 a minimum of 48 hours (two working days) prior to any excavation.
8. All sewer mains will be field staked for grades and alignment by a licensed engineering or surveying firm qualified to perform such work. Staking will be maintained throughout construction.
9. All pipe and services will be installed with continuous tracer tape installed 12" to 18" under the proposed finished subgrade. The marker will be plastic non-biodegradable, metal core or backing marked sewer that can be detected by a standard metal detector. If visibility cannot be maintained between structures along the straight alignment of a sewer, toning wire will be installed above the sewer line at a depth no greater than 48 inches.

If toning wire is required, it will be UL listed, type UF, 14 gage copper taped to the top of the pipe to prevent movement during backfilling. The wire will be laid loosely enough to prevent stretching and damage. The wire will be wrapped to manhole or cleanout rings on gravity sewers.

Toning wire will be tested prior to acceptance of the pipe system. A written notice from the contractor to the City 2 days prior to the test is required. On a curvilinear sewer, the wire will be brought up, bared and wrapped three times around the manhole ring. Tape will be Terra Tape "D" or approved equal. The tape and wire will be furnished and installed by the contractor.

10. Bedding of the sewer main and compaction of the backfill material will be required in accordance with the above mentioned specification (See General Note 1).

11. All manholes or cleanouts outside the paved area will be installed in accordance with standard plans CRO03SS and CRO06SS.
12. When temporary street patches are allowed by the City, cold mix asphalt will be placed and compacted to a maximum depth of two inches. Contractor will be responsible for maintenance as required by the City.
13. Erosion control measures conforming to the requirements of the City of Castle Rock & Cowlitz County will be taken by the contractor during construction to prevent infiltration of existing and proposed storm drainage facilities and roadways.
14. Provide traffic control plan(s) in accordance with the Manual on Uniform Traffic Control Devices (MUTCD) as required.
15. It will be the responsibility of the contractor to have a copy of the approved construction plans on site at all times.
16. Any changes to the design will first be reviewed and approved by the developer's project engineer and the City of Castle Rock.
17. After backfilling, but prior to paving, all mains and appurtenances will be inspected and approved by the City of Castle Rock Construction Inspector. Approval does not constitute final acceptance of the sewer line. The contractor will retain the responsibility to repair all deficiencies and failures revealed during all required testing for acceptance and through the duration of the warranty. It will be the contractor's responsibility to notify the City of Castle Rock for the required inspections. Any main or appurtenance backfilled prior to inspection will be re-excavated for inspection.

GRAVITY

1. Gravity sewer mains will meet the following: PVC pipe conforming to ASTM P 3034 SDR 35, ASTM F 794, or ASTM F 679 Type 1 with joints and gaskets conforming to ASTM 3212 and ASTM F 477.

2. Precast manholes will meet the requirements of ASTM C 478. Manholes will be Type 1 – 48 inches unless otherwise specified on the plans. Joints will be rubber gasketed conforming to ASTM C 443 and will be grouted from the inside. Lift holes will be grouted from the outside and inside of the manhole. (See General Note 1.)
3. Side sewer services will be PVC, ASTM D 3034 SDR 35 with flexible gasketed joints. Side sewer connections will be made by a tap to an existing main or a wye branch from a new main connected above the springline of the pipe. Side sewer services will be installed according to applicable standard detail(s).
4. All lines will be high velocity cleaned and subjected to a low pressure air test per current WSDOT/APWA Specifications after backfilling, but prior to paving (See General Note 1). Hydrant flushing of lines is not an acceptable cleaning method. Testing of the sanitary sewer main will include television inspecting of the main by and at the expense of the Contractor.

Immediately prior to television inspecting, enough water will be run down the line so it comes out the lower manhole and the line is flushed clean. Acceptance of the line will be made after the television inspection tape has been reviewed and approved by the inspector. A test of all manholes in accordance with Castle Rock standard is also required. Testing will take place after all underground utilities are installed and compaction of the roadway subgrade is completed.

7.02 Gravity Sewer

A. General

All sewers will be designed as a gravity sewer whenever physically and/or economically feasible or as outlined in the comprehensive plan.

B. Design Standards

The design of any sewer extension/connection will conform to City Standards, Department of Ecology's "Criteria of Sewage Works Design," and any applicable standards as set forth herein.

The layout of extensions will provide for the future continuation of the existing system as determined by the City and as outlined in the Comprehensive Sewer Plan.

New gravity sewer systems will be designed on the basis of an average daily per capita flow of sewage of not less than 100 gallons per day. See the DOE table on the next page on Design Basis for Sewage. This figure is assumed to cover normal infiltration, but an additional allowance will be made where conditions are unfavorable. Generally, laterals and submain sewers should be designed to carry, when running full, not less than 400 gallons daily per capita contributions of sewage.

When deviations from the foregoing per capita rates are used, a description of the procedure used for sewer design will be submitted to the City of Castle Rock for review by the City Engineer. The minimum size for submains and mains will be 8-inch nominal diameter. The minimum size for a lateral within the street right-of-way will be 4 inches.

C. Main Line – Gravity

a. Main line sewers, unless otherwise approved by the City Engineer, will be constructed using materials conforming to one of the following:

- PVC pipe 6 inch to 15 inch diameter must meet either ASTM D 3034, SDR 35 solid wall pipe, or ASTM F 794 for solid seamless profile pipe.
- PVC pipe 18 inch to 27 inch diameter will conform to ASTM F 679 Type 1 only.

- HDPE Pipe may be used upon approval of the Public Works Director and City Engineer. Minimum SDR shall be 32.5.

All joints for PVC pipe will conform to ASTM D 3212 with rubber gaskets conforming to ASTM F 477. Ribbed pipes will not be allowed for use in the sanitary sewer system.

- b. Gravity sewer will maintain a minimum depth of five feet, unless otherwise approved, to provide gravity service to adjoining parcels, adequate head room within manholes for maintenance personnel, future areas to be served, and vertical clearance between water and sewer lines. Actual depth will be determined by slope, flow, velocity and elevation of existing system.
- c. All building sewer connections to the main will be made with a sanitary tee (wye) connection. A double-sweeping wye cleanout assembly will be provided at the edge of the property line, as shown in Standard Drawing CRO21SS and CRO33SS, when laterals are installed as part of sewer main rehabilitation work. Backflow prevention devices may be required based on the most recent edition of the I.P.C. All new mains connecting to existing mains will require the installation of a new manhole if not made at an existing manhole.

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CRITERIA FOR SEWAGE WORKS DESIGN WASHINGTON STATE DEPARTMENT OF ECOLOGY					
Discharge Facility	Design Units	Flow* (gpd)	BOD (lb/day)	SS (lb/day)	Flow Duration (hours)
Dwellings	per person	100	0.2	0.2	24
Schools with showers and cafeteria	per person	16	0.04	0.04	8
Schools without showers and with cafeteria	per person	10	0.025	0.025	8
Boarding schools	per person	75	0.2	0.2	16
Motels at 65 gal/person (rooms only)	per room	130	0.26	0.26	24
Trailer courts at 3 persons/trailer	per trailer	300	0.6	0.6	24
Restaurants	per seat	50	0.2	0.2	16
Interstates or through highway restaurants	per seat	180	0.7	0.7	16
Interstate rest areas	per person	5	0.01	0.01	24
Service stations	per vehicle serviced	10	0.01	0.01	16
Factories	per person per 8-hour shift	15-35	0.03-0.07	0.03-0.07	Operating Period
Shopping centers	per 1,000 square feet of ultimate floor space	200-300	0.01	0.01	12
Hospitals	per bed	300	0.6	0.6	24
Nursing Homes	per bed	200	0.3	0.3	24
Homes for the aged	per bed	100	0.2	0.2	24
Doctor's office in medical center	per 1,000 square feet	500	0.1	0.1	12
Laundromats, 9 to 12 machines	per machine	500	0.3	0.3	16
Community colleges	per student and faculty	15	0.03	0.03	12
Swimming pools	per swimmer	10	0.001	0.001	12
Theaters, drive-in type	per car	5	0.01	0.01	4
Theaters, auditorium type	per seat	5	0.01	0.01	12
Picnic areas	per person	5	0.01	0.01	12
Resort camps, day and night, with limited plumbing	per campsite	50	0.05	0.05	24
Luxury camps with flush toilets	per cam site	100	0.1	0.1	24

* Includes normal infiltration.

- d. All sewers will be designed and constructed to give mean velocities, when flowing full, of not less than 2.0 feet per second, based on Manning's formula using an "n" value of 0.013. The following minimum slopes should be provided; however, slopes greater than these are desirable.

Sewer Size (Inches)	Minimum Slope (Feet per foot)
8	0.0040
10	0.0028
12	0.0022
14	0.0017
15	0.0015
16	0.0014
18	0.0012
21	0.0010
24	0.0008
27	0.0007
30	0.0006
36	0.0005

Under special conditions, slopes slightly less than those required for the 2.0 feet per second velocity may be permitted by the City Engineer. Such decreased slopes will only be considered where the depth of flow will be 30 percent of the diameter or greater for design average flow. Whenever such decreased slopes are proposed, the design engineer will furnish with the plans his computations of the depths of flow in such pipes at minimum, average, and daily or hourly rates of flow. Larger pipe size will not be allowed to achieve lesser slopes.

Sewers will be laid with uniform slope between manholes.

- e. Gravity sewers will be designed with straight alignment between manholes. When visibility cannot be maintained between sewer structures along the straight alignment of a sewer, toning wire will be installed over the pipe. When required, the toning wire will be installed at a depth no greater than 48 inches. Toning wire will be UL listed, type UF, 14 gage copper, taped to the top of the pipe to prevent movement during backfill. The wire will be laid loosely enough to prevent stretching and damage. The wire will be wrapped to manhole or cleanout rings on gravity sewers and will be accessible from ground level.

D. Connection to Existing System

- a. At connection to existing system, all new sewer connections will be physically plugged until all tests have been completed and the City approves the removal of the plug.

- b. Connection of new pipelines to existing manholes will be accomplished by using cored holes drilled for the connection. The transition of connecting channels will be constructed so as not to interrupt existing flow patterns. All connections will utilize Kor-N-Seal fittings.
- c. Connection of a pipe line to a system where a manhole is not available will be accomplished by pouring a concrete base and setting manhole sections. The existing pipe will not be cut into until approval is received from the City.
- d. Connections to manholes requiring a drop will follow the criteria as outlined in Section 7.02.F.
- e. Connections where an existing stub out is not available or where a new building sewer is the same size as the existing main will be accomplished by the installation of a new manhole.
- f. Taps will be done by use of a core drill and will not be allowed to protrude into the existing main. A City inspector will be notified 48 hours (two working days) prior to any tap of a City sewer and will be present to witness the tap. Appropriate tapping saddles are required. The inspector will collect all tapping cores from the contractor, or will be informed if the cores were washed into the sewer. At the contractor's option, the City will install a tap for a standard fee after the contractor provides properly installed and approved shoring devices.

E. Manholes

Precast manholes will meet the requirements of ASTM C 478 with either a precast base or a cast-in-place base made from 4000 psi structural concrete. Manholes will be Type 1, 48-inch diameter minimum. The minimum manhole frame opening will be 24 inches. Joints will be rubber gasketed conforming to ASTM C 443 and will be grouted from the inside. Lift holes will be grouted from the outside and inside of the manhole. Manholes constructed of other materials may be approved by the City Engineer, provided they meet the requirements of Section 2.318 of Department of Ecology's "Criteria for Sewage Works Design." Material specifications need to be submitted for review before an alternate material will be considered. See Standard Drawings CRO01SS and CRO02SS for details.

Eccentric manhole cone will be offset so the manhole cover will not be located in the tire track of a travel lane.

Manhole frames and covers will be cast iron casting marked “Sewer” conforming to the requirements of ASTM A-30, Class 25, and will be free of porosity, shrink cavities, cold shuts or cracks, or any surface defects that would impair serviceability. Repairs of defects by welding or by the use of smooth-on or similar material will not be permitted. Manhole rings and covers will be machine-finished or ground-on seating surfaces so as to assure non-rocking fit in any position and interchangeability. Manholes located in areas subject to inflow will be equipped with a PRECO sewer guard watertight manhole insert or approved equal.

Where lock-type castings are called for, the casting device will be such that the cover may be readily released from the ring and all movable parts will be arranged to avoid possible binding.

All castings will be coated with a bituminous coating prior to delivery to the job site.

Safety steps will be fabricated of polypropylene conforming to an ASTM D-4101 specification, injection molded around a 1/2-inch ASTM A-615 grade 60 steel reinforcing bar or hot dipped galvanized bar with anti-slip tread. Steps will project uniformly from the inside wall of the manhole. Steps will be installed to form a continuous vertical ladder with rungs equally spaced on 12-inch centers.

Manholes will be provided at a maximum of 400-foot intervals, at intersections, and at changes in direction, grade or pipe size.

Slope through the manhole will be a minimum 1/10th of one-foot from invert in to invert out, unless otherwise approved by the City Engineer.

Where a smaller sewer joins a larger one, the invert of the larger sewer should be lowered sufficiently to maintain the same energy gradient. An approximate method for securing these results is to place the 80 percent depth point of both sewers at the same elevation.

Pipe material will be consistent between manholes.

Straight grades between invert out of last manhole and connection to existing are preferred over drops whenever possible. Care must be taken when designing steep grades so as not to create a situation of excessive velocity or excavation. Grade changes associated with “sweeps” will not be allowed.

The angle between the line(s) entering a manhole and the line leaving will be no less than 90 degrees.

An outside drop connection will 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 will be filleted to prevent solids deposition.

All manholes that are to be owned and maintained by the City will be accessible at all times to operations and maintenance equipment and vehicles. Access drives may be required to provide a sufficient driving surface for City vehicles, at the discretion of the City Engineer.

Inside drop connections will not be allowed, except as approved by the City Engineer when an outside drop is not possible (see Standard Drawing CRO05SS).

Outside drop structures will be constructed per standard drawing CRO04SS

Manhole Sizing will be determined by the following criteria:

- a. 48-Inch Manhole
 1. Two connecting pipes, 8-inch to 12-inch diameter
 2. Three connecting pipes, 8-inch to 10-inch diameter, perpendicular.
 3. Four connecting pipes, 8-inch diameter, perpendicular
- b. 54-Inch Manhole
 1. Two connecting pipes, 8-inch to 12-inch with more than 45° deflection
 2. Three connecting pipes, 10-inch to 12-inch diameter, perpendicular
 3. Four connecting pipes, 10-inch to 12-inch diameter, perpendicular

- c. 72-Inch Manhole
 - 1. Two connecting pipes. 15-inch to 18-inch diameter with less than 45° deflection
 - 2. Three connecting pipes, 15-inch diameter, perpendicular
 - 3. Four connecting pipes, 15-inch diameter, perpendicular

In the above criteria, “deflection” refers to the angle between any 2 pipe channels in the manhole.

For other pipe configurations, the size of the manhole will be approved by the City Engineer.

The above configurations will provide adequate shelves and room for maintenance and TV inspections.

F. High Velocity Protection

Where velocities greater than 15 feet per second are expected, special provisions such as thrust blocking and piping materials will be made to protect against displacement by erosion and shock, and the presence of hydrogen sulfide gas.

G. Cleanouts

Cleanouts are not an acceptable substitute for manholes, however, they may be used in lieu of manholes at the end of 6-inch and 8-inch-diameter lines of not more than 150 feet in length. Locations of cleanout for building sewers are governed by the Uniform Plumbing Code as adopted.

All cleanouts in City right-of-way will be extended to grade. See detail CRO06SS

H. Building Sewer

A building or side sewer refers to the extension from a building sewer beginning 5 feet outside the outer foundation wall at the structure to the sanitary sewer main. Building sewers from the main to the right-of-way line will be minimum 4 inch diameter. Each property will be served by an individual building sewer. In addition, both units of duplexes will be served by separate laterals. Maintenance of the building sewer, up to and including the connection point at the sewer main, will be the responsibility of the

property owner. Prior to connection of a building sewer to the public sewer a connection permit must be obtained from the City. Materials and design criteria for a building sewer are covered by the Uniform Plumbing Code (UPC) as adopted. Inspection of the building sewer from five feet outside the structure to the sewer main will be the responsibility of City's designated building inspector.

I. Request for City Ownership of Private Sewers

The owner(s) of a private sewer system, as defined in 7.05.A, building sewers and laterals excluded, may request City assumption of a private system. The procedure for this request is as follows:

1. The owner will submit a written request to the City of Castle Rock identifying the private sewer system to be considered.
2. The City of Castle Rock will process and review the request, analyze the system as-built records, and evaluate the public benefit received from City assumption of the private system.
3. If the result of the private sewer system analysis shows City assumption provides public benefit, testing of the sewer will be conducted. All tests applicable to new sewers will be performed (refer to Section 7.01.I). If it is determined that the public receives no benefit from the assumption of a private system, the City will provide a letter denying the request with specific information stating the reason(s) for denial.
4. If the result of the testing shows the system conforms to current City Standards, the City will provide a letter of acceptance with directions to the owner to provide the City with the appropriate transfer documents, i.e., bill of sale and easements if necessary.
5. If the inspection reveals deficiencies with the system, the owner of the private system may elect to make the repairs specified by the City. After the owner notifies the City of the repairs, the City will re-test the system to verify that the line conforms to current standards.

7.03 Lift Stations

A. General

All lift stations will be designed to serve the appropriate basin as identified in the Comprehensive Sewer Plan.

B. Design Standards

The design of any lift station will conform to City standards, Department of Ecology's "Criteria of Sewage Works Design" and applicable standards as set forth herein and in Sections 3.020 and 3.040. Each lift station will be evaluated for buoyancy resistance using site specific soil and groundwater information.

The following equipment and special modifications are standard requirements for all permanent wastewater lift stations constructed within the City of Castle Rock. The following requirements are minimum standards and not all inclusive:

1. The proponent is required to provide the City of Castle Rock a fee simple site outside existing right-of-way for construction of the lift station. The site will have sufficient area with dimensions that allow for easy and safe access to the lift station.
2. A concrete slab 6 inches in depth, will surround the pump station wet wells and dry wells, with a minimum of two feet side exposure for all openings. The slab will be continuous between the wet well and the dry well, and will be installed at ground level as per detail CRO20SS.
3. An access road, with easement, that will support 20,000-pound axle loads throughout the year, will be provided from the nearest public road to the station, to allow for maintenance of the station.
4. The dry well will be vented with an exhaust fan to meet state safety standards.
5. Wet well will be provided with a permanent, attached, full depth, internal galvanized access ladder, impervious to corrosion, and mounting socket for the City's portable hoist.
6. Entry lid to the station wet well will be located closest to the access drive. The lift station will be accessible at all times to operations and maintenance equipment and vehicles.

7. Entry lid to the station dry well will be constructed of aluminum with rust proof coating or fiberglass.
8. Station entry access will be keyed to match all other city package stations. The Best Lock key system with single key operation of the mechanism will be supplied for all other lock points and padlocks, a blank tumbler will be supplied, and the City will key to the desired code.
9. Dry wells will be provided with an automatic sump pump plumbed to the lift station wet well.
10. Dry wells will be provided with dehumidifier equipment appropriately sized to remove moisture from the dry well.
11. Safety guards will be provided for all exposed drive lines and couplings.
12. Spare parts will be provided as recommended by the manufacturer, with a minimum of one spare impeller, one complete set of seals, filters, and one set of volute gaskets. Four complete sets of O&M manuals, and a list of the nearest dealers for spare parts and repair will be provided. All replacement parts will be readily available from distributor in the U.S.A.
13. The pumps, motors, and wet well will be in compliance with current engineering practice. They will be fully compatible as an assembly, and will be engineered for the specific basin.
14. The station will be designed to have an isolation valve located in the discharge line between the station and the pumping bypass port, no less than 12 pipe diameters from the dry well.
15. City water will be provided to the station for hose down and pump seal supply. An approved back flow prevention device will be provided on the water supply line outside the dry well to protect the public water system. The back flow device will be tested by a Washington State-certified backflow assembly tester, with the results forwarded to the Castle Rock Public Works Department Cross-Connection Program, prior to acceptance of the system. The back flow device will be covered by a hot box to prevent freezing.

16. A 100 amp minimum 480/277 volt, 3 phase, 4 wire main service will be provided as per plans.
17. All electrical equipment will be enclosed in a free-standing, vandal proof, all-weather enclosure NEMA 3R or better. (Refer to Standard Drawing CRO19SS.)
18. A 100 amp minimum, 480-volt, 3 phase emergency power hookup will be provided. The transfer switch will be sized to accommodate the load with a 100-amp minimum. The receptacle will be Crouse-Hinds AREA-10314 or Appleton ADR-1033 4 wire 3 pole with male pins.
19. The electrical equipment will include a 5-kVA minimum transformer in the dry well for the 120 volt single phase equipment.
20. Wiring will be THHN stranded copper.
21. Lift station telemetry will consist of a RUGID PLC, 12 volt isolated power supply, Metricom radio, and antenna cable with lightning arrestor and 6dB gain stick antenna, which will be supplied and installed by the contractor. Alarm and station status points will be as per attached list. The telemetry will be enclosed in a NEMA 1 enclosure within the electrical cabinet. Prior to ordering the above equipment, the contractor will contact the City of Castle Rock's Department of Public Works, for complete ordering specifications for the above telemetry. Nominal lead time is 12 weeks.
22. Pump control system will be of the solid state programmable logic controller (PLC) type, RUGID model 9 or approved equivalent. The system will possess a solid state liquid level sensing device of the 4-20ma analog design. The controller will be compatible with all established City systems and will be accessible for ease of maintenance.
23. Pump motors will be 3 phase, 480 volt, and be provided with elapsed time meters.
24. Verification of operating parameters by City personnel, such as pump operation, alarms, and an electrical inspection is required prior to acceptance of all lift stations.
25. Wetwell Sizing Criteria:

- a. Provide a holding period not to exceed 10 minutes for the design average flow per DOE Criteria for Sewage Works Design, Section 3.222.
- b. Provide for minimum of 45 seconds pump run time per pump cycle, and a maximum of ten pump cycles per hour.

26. Lift Station Emergency Storing Criteria

Option #1:

- a. Emergency storage will be provided for 2 hours of design average flow using a peaking factor of 2. This calculation is to be submitted with the system design and approved by the City Engineer.

Note: The 2-hour time was determined as an average response time by a City crew. The peaking factor was set at 2, as opposed to 3 or 4, due to typical emergency being caused by power outage.

- b. All volume above area basements and below the hydraulic gradient may be used as emergency storage, i.e., wetwell, conduit, and manholes. This condition must be verified by calculation and submitted for approval by the City Engineer.

Option #2:

- a. Provide emergency power per DOE Criteria for Sewage Works Design, Section 3.34.

- 27. The program for the pump controls will be furnished and installed by City of Castle Rock personnel. For assistance contact the Public Works Director at 274-4876.
- 28. Pump station design will be a wet well - dry well, as manufactured by Smith and Loveless, Paco, or Hydronix, and currently in use by the City of Castle Rock, or equal.
- 29. Plans and specifications must be submitted and approved in writing prior to ordering a package lift station.
- 30. Alarm and Station Status points:
 - Wetwell level - Blue
 - Seal pressure - White with red stripe
 - Pump #1 run - Red with green stripe

Pump #2 run	- Red with yellow stripe
Pump # 1 auto	- White with green stripe
Pump #2 auto	- White with yellow stripe
A/C power fail	- Red
Generator run	- Purple
Generator fail	- White with black stripe
Low wetwell	- White with blue stripe
High wetwell	- Red with black stripe
Drywell flood	- Pink
Intrusion	- Brown
Fire	- Orange
Pump # 1 call	- Green
Pump #2 call	- Yellow

The contractor will supply and install all sensors for the above alarm points and connect them with the appropriate wire size and color to an alarm terminal strip. The alarm points terminated on the terminal strip will be identified by number and a label showing the number, and alarm will be provided adjacent to the terminal strip. From the terminal strip to the telemetry terminal strip, all points will be connected by a single multi conductor shielded cable encased in a single conduit. The following note will be added to all lift station plans:

Prior to ordering and wiring of telemetry components, the contractor will contact the City of Castle Rock Public Works for approval of Telemetry Components at 274-4876.

See Section 7.04, Pressure Sewer for additional information regarding force mains.

7.04 Pressure Sewer (Force Main)

A. General

Low pressure systems, i.e., force mains may be considered for situations where high ground water table or topography make gravity sewer impractical.

B. Design Standards

The design of any sewer extension/connection will conform to City standards, Department of Ecology's "Criteria of Sewage Works Design," and any applicable standards as set forth herein.

The layout of extensions will provide for the future continuation of the existing system as determined by the City. In addition, main

extensions will be extended to and across the side of the affected property fronting the main.

The system will be designed at full depth of flow on the basis of an average daily per capita flow as shown on the table in Section 7.02.B. A coefficient of friction of 120 will be used for the Hazen-Williams “C” value.

New sewer systems will be designed by methods in conjunction with the basis of per capita flow rates. Methods will include the use of peaking factors for the contributing area, allowances for future commercial and industrial areas, and modification of per capita flow rates based on specific data. Documentation of the alternative method used will be provided along with plans.

The applicable General Notes in section 7.02.B will be included on any plans dealing with pressure sanitary sewer design.

C. Force Main

a. Material

Force mains to 12 inches will be PVC C900 with ductile iron fittings and gasketed joints. A more rigid pipe may be required where unlimited trench widths occur. All ductile iron pipe and fittings will be coated or PE lined and designed for use with corrosive materials.

b. Depth

Force mains will have a minimum 30 inches of cover to top of pipe. See Section 7.01.B for sanitary sewer/water main crossing requirements.

c. Velocity

The minimum velocity allowed is 3 feet per second (fps) at average Dry Weather Flow. Maximum velocity allowed will be 8 fps.

D. Surge Protection

PVC pipe is subject to fatigue failure due to cyclic surge pressures. Lift stations will be constructed to minimize rapid changes in velocities and a properly sized surge tank and “soft start and stop” pump controls, if required.

E. Air/Vacuum Valves

Air release valves and air/vacuum valves will be constructed as shown in Standard Drawing CRO08SS and located at the high points of the line within a manhole or approved vault that provides 18 inches of clearance on all sides between the assembly and the walls. Air release valves will be fitted with an activated carbon canister sewer guard to prevent the release of disagreeable odors to the surrounding area. Grades will be designed to minimize the need for air/vacuum valves when practical. Vehicular access to valve is required for maintenance.

F. Force Main Drain

Provisions to drain a force main to facilitate repairs or to temporarily remove force main from service will be provided. This may be accomplished through the use of a valved tee connected to a drain line at the low point of the line, with isolation valves on both sides of the tee along the main. A manhole will be set over the force main at the valved tee.

G. Thrust Blocking

Location of thrust blocking will be shown on plans. Thrust block concrete will be Class B, 3,000 psi, poured against undisturbed earth. A plastic barrier will be placed between all thrust blocks and fittings.

See standard detail number CRO26SS and CRO27SS in water section. Restraining joint systems may be allowed in lieu of thrust blocking when designed by a licensed engineer and approved by the City Engineer. Restraining joint brand, type, and size will be specified on the plans.

H. Force Main Termination

Hydrogen sulfide odors (H₂S) and the buildup of sulfuric acid (H₂SO₄) occur in the operation of a force main. To mitigate these conditions some type of control method(s) will be used. This may include chemical addition at the pump station and/or at or near the terminus. The outfall manhole (point of connection where force main discharges into gravity sewer) and the next downstream manhole on the gravity sewer will be lined with PVC to protect the system against corrosion. Spray-on coatings will not be accepted. The PVC lining will be cast into the walls and floor of the manhole. No exposed concrete will be permitted. All work will be done in accordance with manufacturer's recommendations and must be approved by the City. If a new outfall manhole and subsequent downstream structures are installed as part of the new system design, the configuration will be approved by the City. In all other cases, the PVC liner will be installed in previously existing system manholes. The downstream gravity sewer line pipe connecting these manholes will also be protected from the affects of hydrogen sulfide.

7.05 Private Sewer Lines

A. General

Private Sewer - will be that portion of the system located on private property where no easements are granted to the City, including gravity laterals, building sewers, and sewer collection systems internal to single parcel developments; such as, apartment complexes, condominiums, townhouses, shopping centers, commercial office parks, mobile home parks, etc. It also includes the portion of the lateral between the property line and force main or gravity sewer. Private sewer systems shall be constructed to City Standards. Maintenance of private sewer will be the responsibility of the property owner(s).

B. Specifications for New or Replaced Private Sewer Lines

- a. Use approved sewer line materials such as Schedule 40 ABS plastic pipe or ASTM 3034 (thick wall) PVC plastic pipe.
- b. Connect to the existing cast iron or ABS plastic house drain, which should be located at least 2 feet from the house with a mechanical joint coupling or other approved connection.

- c. When using bell end pipe, lay bell ends of pipe facing house.
 - d. Pipe should ideally run at a uniform slope of 1/4 inch to 1 foot of fall (2%).
 - e. Changes in direction of sewer line and cleanout risers should be made with Y's and 45 degrees bends or combo TYs. Do not use sanitary T's or short sweeps.
 - f. A cleanout must be installed within 4 feet of the house, at the property line, every 100 feet, and to protect any changes in direction over 135 degrees. Cleanouts must be readily accessible by extending them to near finish grade and must flow in the same direction as the sewer.
 - g. Call 274-8181 for the Building Inspector when piping is completed and before backfilling. Do not backfill with materials that could damage or break the piping.
 - h. Special procedures for sewers replaced at the City's written request (Sewer Rehab. Areas or LIDs): The cleanout at the property line will be installed by the property owner. After your sewer passes a visual inspection by the Building Department the pipe must be backfilled except for the cleanouts at the house and the property line.
- I. Sewer Hook-up Procedures
- a. Acceptable Materials
 - ABS – 4 inch minimum diameter, sewer grade, Schedule 40 pipe
 - PVC – 4 inch minimum diameter, ASTM 3034 or equivalent per UPC
 - Other – UPC approved with IAPMO Logo
 - Grade of Sewer Pipe:
 - 1/4 inch per foot
 - 1/8 inch per foot when impractical conditions exist and permission is obtained from administrative authority prior to placement of sewer line
 - For terrain sloping greater than 1/4 inch per foot, stepping methods should be employed; contour grading of sewer slope is permitted providing approved and appropriate fittings are installed according to accepted plumbing

practices without undue strains or bends placed on the sewer pipe

b. Imbedment:

- Depth: minimum 12 inches from top of pipe to finish grade
- Bed: shall be of approved materials – fine granular material (i.e., sand is preferred over coarse materials) – avoid sharp rocks
- Water lines in same trench: water line must be 12 inches above sewer with a 12-inch offset

c. Clean Outs Required:

- One at building – inside or outside at end of building drain and extended to grade
- At intervals not exceeding 100' in straight runs
- For each aggregate change in direction exceeding 135°
- See standard plan CRO33SS (sewer diagram example)