

## **900 SEWERAGE WORK**

### **ITEM 901 - PIPE SEWERS COMPLETE IN PLACE**

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**901.01 Description.** This work shall consist of the construction of pipe sewers complete in place. The work shall be in accordance with these specifications and in conformity with the lines and grades shown on the plans, or as established by the Engineer. This work shall include: Excavating for pipes and bedding for same, including clearing and grubbing, fill or embankment, and the removal of all materials necessary for placing the pipe except removals listed separately; furnishing and placing concrete or granular bedding, concrete backing or encasement, and compacted backfill, granular backfill, compacted granular backfill or concrete backfill as required, trench dams; constructing and subsequently removing all necessary cofferdams, cribs and sheeting; constructing and placing all necessary bulkheads; removal of water; all pipe joints; furnishing, installing and testing all necessary pipe of the types specified or shown on the plans; joining to existing and proposed sewers and appurtenances as required; restoration of disturbed facilities and surfaces; maintenance of traffic, drainage and existing facilities all as shown on the drawings and as specified, unless otherwise provided for by separate pay items. Structures shall be as specified and paid for under Item 604.

**901.02 Materials and Material Handling.** Pipe shall be of the size and kind specified in the proposal and shown on the plans and shall meet the requirements of the pertinent Sections of 706, 720 or 801. When the kind of pipe is not specifically itemized in the proposal or shown on the plans, any of the following kinds may be used.

Specific materials shall be as follows:

1.	Concrete for encasement, cradle, backing and backfill Class A.....	499, 905
2.	Concrete for blocking - Class C.....	499
3.	Stone or gravel bedding - No. 57 or No. 8.....	703
	Compacted granular material.....	912.02
4.	Cement for mortar.....	701
5.	Sand for mortar.....	703.03
6.	Lime for mortar.....	712.04
7.	Gaskets for Concrete Pipe Joints.....	901.15
8.	Gaskets for Vitrified Clay Pipe Joints.....	901.15
9.	Gaskets for PVC Pipe Joints.....	901.15
10.	Gaskets for Ductile Iron Pipe Joints.....	901.15
11.	Non-Reinforced Concrete Pipe.....	706.01
12.	Reinforced Concrete Pipe.....	706.02
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14.	Vitrified Clay Pipe, Extra Strength.....	706.08
15.	Poly Vinyl Chloride (PVC) Sewer Pipe.....	720.01
16.	Ductile Iron Pipe.....	801.03
17.	Precast Reinforced Concrete Box Sections.....	706.05
18.	<i>High Density Polyethylene Pipe (HDPE)</i> .....	<i>720.01</i>

The Contractor shall exercise due care in material handling to prevent field and installation damage which could impair the function and durability of the installation. Particular attention is required in the handling of thermoplastic conduits during cold weather.

**901.03 Excavation.** The Contractor shall excavate all material of whatever nature encountered, including rock in place unless a separate item is provided for rock excavation, necessary for the construction of work as shown on the *Standard Drawings* or plans and as specified. All excavation, except as otherwise required, permitted or ordered in writing by the Engineer shall be in open trench.

*All existing pavements, walkways, curbs, etc. shall be sawcut before removal. If during construction, the pavements, walkway, curb, etc. is damaged beyond the original saw cut, the damaged area shall be recut to neat lines as directed by the Engineer. The cost of saw cutting shall be included in the items of the contract and no separate payment will be made therefor.*

**901.04 Limit as to Width of Trench.** The width of trench below the elevation of the outside top of the barrel of the sewer shall not exceed the specified width when shown on the construction drawings unless permitted or ordered in writing by the Engineer. Sufficient sheeting, bracing, timbering, etc., shall be provided, installed and used by the Contractor to maintain the sides of the trench in a substantially vertical position; and, in such a manner so as to protect and preserve, life, property or the use of such property and no separate payment will be made for such sheeting, bracing, timbering, etc. necessitated by the Contractor's operations to accomplish and carry out this responsibility.

Where a sewer is to be placed within an embankment or the top of the sewer is above existing ground, the embankment, *constructed in accordance with Section 203* requirements, shall be constructed at least to 30 inches (0.76 m) above the outside top of the sewer pipe before trenching. The trench shall be then excavated to the minimum width necessary for the proper placing and backfilling of the sewer as described in Section 901.17.

For installation of thermoplastic pipe, the trench excavation shall conform to the standard drawings or ASTM D2321, 6.1 through 6.5 where it is more restrictive than set forth above.

**901.05 Unauthorized Excavation.** All excavation outside or below the limiting lines for bedding as shown on the standard drawings shall be classed as unauthorized excavation and shall be filled by and at the Contractor's own cost and expense in a manner and with material approved by the Engineer.

**901.06 Subgrade.** It is expected that satisfactory material will be found at the subgrade of the trench if adequate water removal facilities are provided. If soft, spongy, unsuitable or similarly unacceptable material is encountered at the subgrade upon which the bedding material is to be placed, this unsuitable material shall be removed or dewatered as directed by the Engineer in writing. The following will govern the prosecution of the work involved.

1. If the unsuitable material is removed by written order of the Engineer, it shall be replaced by stone foundation as specified in Item 906 and paid for as indicated therein.
2. If the dewatering of the subgrade materials, by whatever means is used by the Contractor, produces a subgrade acceptable to the Engineer for placing the bedding material, no additional payment will be made for the work and the payment for this work will be included in this item.

**901.07 Excavation Material.** All excavated material in excess of that required for backfilling shall be disposed of by the Contractor. Public or private property shall not be used for this purpose without the written permission of the owner. Excavated material

required for backfill, except as hereinafter provided for under Surface Soil as per Section 901.18, may be stored on the bank of the trench immediately adjacent to the work under construction where space is available within the right-of-way acquired for the work, provided, however, that such storage shall not interfere with the access to and maintenance of traffic, drainage and utilities as herein specified.

*The location of an off-site disposal area shall be approved by the Engineer.*

Ingress and egress to all properties along the line of the work shall be maintained, except as permitted, in writing, by the Engineer.

**901.08 Removal of Obstructions.** The removal of any obstructions, including abandoned sewers *or water lines*, which may be encountered or is necessary for the construction of the work, shall be done by the Contractor at his own expense under the direction of the Engineer.

*When existing pipes are encountered in removal operations and are determined by the Engineer to be inactive, they shall be plugged or sealed at both ends where broken.*

Where a portion of an existing concrete or clay sewer is to be abandoned and removed under this contract, the Contractor will be required to construct brick or concrete bulkheads in the undisturbed section of the abandoned sewer as directed. The locations of bulkheads may be, but are not necessarily, shown on the drawings. Where the existing sewer to be abandoned is of a material other than clay, brick or concrete, the undisturbed section shall be capped or plugged as directed. The cost of this work is to be included in the several items of the contract and no separate payment will be made therefor.

**901.09 Maintaining Drainage.** The flow of all sewers, drains, streets, gutters, field tiles and watercourses encountered shall be provided for by and at the Contractor's own expense and wherever such watercourses and drains are disturbed or destroyed during the prosecution of the work, they shall be restored by and at the Contractor's own cost and expense to a condition satisfactory to the Engineer.

**901.10 Maintenance of Service in Existing Structures.** All existing overhead, surface or subsurface structures, together with all appurtenances and service connections, except those otherwise provided for herein, encountered or affected in any way during the construction of any of the work under this contract, shall be maintained in service by the Contractor at all times unless other arrangements, satisfactory to the authority responsible for their operation, are made with such authority.

Where connections are to be made to existing sewers, the Contractor shall make suitable provisions for maintaining the flow in the existing sewer until the completion of the connection.

The cost of this work shall be included in the prices bid for all the various items of the contract.

**901.11 Bedding and Embedment.** The Contractor shall place cutoff trench dams of native clay or impervious soil across and along the trench at 150 foot (45.7 m) intervals to retard and resist the movement of groundwater through the trench. There shall be at least 1 trench dam between adjacent manholes regardless of spacing. The trench dams shall be carefully compacted and shall be 6 feet (1.8 m) in length, as measured along the sewer centerline and shall be benched into the undisturbed trench sides from the subgrade or top of cradle, to within 5 feet (1.5 m) of the existing surface, or if in rock or hardpan, shall extend to the top thereof whichever is greater. Where pipe cover is less than 5 feet (1.5 m) the dam shall extend to within 1 foot (0.3 m) of the existing surface. The trench dam installation shall have as a minimum 3 feet (0.9 m) of compacted material above the crown of the pipe.

#### **Type I.**

1. Flexible sanitary and storm sewers *6 inches (152 mm)* in diameter *up to and including 60 inches (1524 mm)* in diameter shall have a bedding of No. 57 or No. 8 stone or compacted granular material Section 912.02 extending from a point 4 inches (101 mm) below the bottom of the pipe to a point 12 inches (305 mm) above the outside top of pipe as shown on the standard drawings.
2. Rigid sanitary and storm sewers *6 inches (152 mm)* in diameter to and including *27 inches (685 mm)* in diameter shall have a bedding of No. 57 or No. 8 stone or compacted granular material Section 912.02 extending from a point 4 inches (102 mm) below the bottom of the pipe to *spring line of the pipe* as shown on the standard drawings.
3. Rigid sanitary and storm sewers *30 inches (762 mm)* in diameter to and including *108 inches (2743 mm)* in diameter shall have a bedding of No. 57 or No. 8 stone or compacted granular material 912.02 extending from a point 6 inches (152 mm) below the bottom of the pipe to the spring line of the pipe as shown on the standard drawings.
4. When Type I bedding is used, the cost of all bedding as described above shall be included in the price bid for the various pipe items. When compacted granular material fails to meet the compaction required under Section 912.03, under pipe haunches and around the pipe, the Engineer will order stone bedding, No. 57 or No. 8, in lieu of compacted granular material at no additional cost.

Where thermoplastic pipe is utilized in areas where lateral soil support is negligible or questionable the embedment shall be in accordance with the recommendations of ASTM D2321 Appendix XI. COMMENTARY.

5. All sanitary and storm sewers to be constructed with flexible conduits (thermoplastic pipe) shall have bedding of No. 57 or No. 8 stone as shown on the standard drawing, extending from a point not less than 4 inches (102 mm) below the bottom of the pipe to a point not less than 12 inches (305 mm) above the crown of the pipe.

### **Type II.**

Sanitary and storm sewers shall be set to line and grade on Class "C" CONCRETE BLOCKING meeting the following minimum requirements:

1. The concrete blocking must have a horizontal bearing area in contact with the subgrade such that the bearing load does not exceed 3,000 pounds per square foot (14,646 kg/m<sup>2</sup>).
2. The concrete blocking shall support the pipe at least 6 inches (152 mm) above the subgrade.
3. *Concrete shall remain exposed until initial set has been completed.*

Class "A" CONCRETE CRADLE shall fill all the space around the concrete blocking and below the pipe as shown on the standard drawings and all concrete placed outside the limiting lines for trench width and elevation will be deemed unauthorized and will not be included for payment.

Backing shall be accomplished with stone bedding or compacted granular material unless Class A, Concrete is specified, or shown on the drawings.

When Type II bedding is used, the cost of all bedding as described above shall be included in the price bid for the various pipe items.

All the space within the width of the trench excavation, inside or outside the authorized limits, shall be filled, between the elevation limits and with the same material, as specified on the applicable standard drawing.

**901.12 Laying Pipe.** *Each pipe shall be carefully examined before being laid, and defective or damaged pipe shall not be used. Pipelines shall be laid to the grades and alignment indicated. Proper facilities shall be provided for lowering sections of pipe into trenches. Under no circumstances shall pipe be laid in water, and no pipe shall be laid when trench conditions or weather are unsuitable for such work. Diversion of drainage or dewatering of trenches during construction shall be provided as necessary.*

*All pipe in place shall be inspected before backfilling, and those pipes damaged during placement shall be removed and replaced.*

The laying of pipes in finished trenches shall be commenced at the lowest point so that the spigot ends point in the direction of flow. All pipes shall be laid with ends abutting and true to line and grade.

Where necessary with bell end pipe, suitable bell-holes shall be excavated in the bedding material for the bell of each pipe so that the weight of the pipe will not be supported by the bells only. The pipes shall be fitted and matched so that when laid in the work, they will form a conduit with a smooth and uniform invert. All possible care shall be used when shoving the pipe together so that the joints will not be unnecessarily large and pipe ends shall be carefully cleaned before pipes are laid. Gaskets shall be installed in accordance with the manufacturer's recommendations.

Class A concrete encasement, according to the dimensional standard drawing, shall be required within the limits of existing or proposed paved areas inside right-of-way where minimum cover during construction or proposed cover over the outside top of the pipe to top of subgrade is 30 inches (762 mm) or less.

All connections shall be made with existing structures after the structures have been cleaned in a thorough, first class, neat and workmanlike manner acceptable to the Engineer. The cost of this work shall be included in the price bid for the various pipe items.

**901.13 Bulkheads.** The Contractor shall construct a bulkhead at the start of construction of Sanitary Sewers, remove same bulkhead after all pipes and manholes are placed, all water removed and the sewer has been tested and approved.

All concrete, brick or clay pipe stubs shall have the outer end sealed with a brick masonry bulkhead. Bulkheads shall be 8 inches (203 mm) thick for stubs 21 inches (533 mm) and larger in diameter, and 4 inches (102 mm) thick for stubs smaller than 21 inches (533 mm) in diameter. Plaster all bulkheads with a 1/2 inch (13 mm) coat of mortar. Cost of this work shall be included in the price bid for various pipe items.

All thermoplastic pipe stubs shall be plugged or capped with a plug or cap in a manner acceptable to the Engineer.

**901.14 Sanitary Sewers.** Roof drains, foundation drains and other clean water connections to sanitary sewers are prohibited.

**901.15 Pipe Joints.**

## Sanitary Sewers

**Concrete.** Pipe joints shall conform to the requirements of ASTM C 443 and as specified herein. *The gaskets shall be solid gaskets of circular cross section and shall be confined in an annular space formed by shoulder on the bell and spigot or in the groove in the spigot of the pipe so that movement of the pipe or hydrostatic and hydrodynamic pressure cannot displace the gasket. When the joint is assembled, the gasket shall be compressed to form a watertight seal.*

*All elliptical reinforced concrete pipe for sanitary sewers shall have Type B - mortar joints with ASTM C 877 rubber and mastic sealing band.*

**Vitrified Clay.** Pipe joints shall conform to the requirements of ASTM C 425 Compression Joints for Vitrified Clay Bell and Spigot Pipe.

**Type PSM Poly Vinyl Chloride (PVC) Sewer Pipe.** Pipe joints shall conform to the requirements of ASTM D 3212.

**Ductile Iron.** Mechanical or push on joints meeting AWWA C111 *or restrained joints meeting AWWA C110 or C153.*

## Storm Sewers

**Concrete.** Pipe joints shall conform to one of the following:

Type A Rubber Gasket. Meeting the requirements of ASTM C 443.

Type B Mortar. On sewers 30 inches (762 mm) in diameter and larger the groove end of the pipe, laid to line and grade, shall be carefully washed with a wet brush and the bottom half of the groove buttered with 1 to 2 Portland Cement mortar. The tongue of the next section of pipe shall be cleaned with a wet brush and a layer of 1 to 2 Portland Cement mortar shall be applied to the top half of it. The tongue end of the second pipe shall then be fitted into the groove end of the first pipe until the mortar is squeezed out onto the inner and outer surfaces. The inner surface of the pipe at the joint shall then be pointed up smooth with a long handled brush, and the outside pointed up with a bead of mortar. If the joint opening on the bottom half of the pipe exceeds 1/2 inch (13 mm), it shall be filled with 1 to 2 Portland Cement mortar.

Type C Bituminous pipe joint filler. Meeting the requirements of 706.10.

Type D Preformed butyl rubber material. Meeting the requirements of 706.14. For concrete pipe 78 inch (2.0 m) diameter and over, the annular mating surfaces shall be primed.

**Vitrified Clay.** Pipe joints shall conform to one of the following:

Type A Compression. Meeting the requirements for vitrified clay pipe joints used in sanitary sewers as specified herein.

Type C Bituminous filler. Meeting the requirements of 706.10.

Type D Preformed butyl rubber material. Meeting the requirements of 706.14.

**High Density Polyethylene.** Pipe joints shall conform to one of the following:

Type A. Pipe joints shall meet the requirements of ASTM D 3212.

Type B. Pipe joints shall meet the requirements of AASHTO *M-252, M-294, and Section 23 of the Standard Specification for Highway Bridges, Division II*. Joints shall be "*silt tight*" with bell and spigot connection. Bells shall be either integrally joined to the pipe, or may be separate sleeves (*double-belled*) designed to join the pipe in the field. *Split couplings or separate sleeves may be used to make field repairs.*

All elliptical reinforced concrete pipe for storm sewers shall have Type B - mortar or, Type C Bituminous pipe joint filler. Where conditions dictate the use of other types of joints, such will be noted on the plans.

**901.16 Removal and Disposal of Water.** The Contractor shall, at all times, during construction, provide proper and satisfactory means and devices for the removal and disposal of all water entering the excavations and shall remove all such water as fast as it may collect in such manner as shall not interfere with the prosecution of the work or the proper placing of masonry or other work. Disposal shall be in accordance with applicable erosion and sediment control requirements.

**901.17 Backfilling.** All trenches and excavations shall, in general, be backfilled from 12 inches (305 mm) above the top of the pipe, as hereinafter specified, as soon after the sewers or other structures built therein are completed and as the particular type of construction and the circumstances will, in the opinion of the Engineer, permit.

For rigid pipe sizes 6 inches (152 mm) to and including 108 inches (2743 mm) in diameter, a carefully selected and placed backfill, using finely divided job excavated earth that is free from debris, organic or frozen material and stones larger than 2 inches (50 mm) in their greatest dimension, shall be placed from the top of the granular bedding or concrete backing, as shown on the standard drawing, to a level not lower than 12 inches (305 mm) above the outside top of the pipe. The selected backfill layer above the crown of the pipe shall be placed in lifts of 6 inches (152 mm) or less, carefully tamped, in order to produce a cushion over the pipe to prevent its breakage during the placing of the remaining trench backfill material. The selected backfill layer may be composed entirely of the granular bedding material, if the Contractor so elects, but without extra compensation therefore.

Earth backfilling of open trench excavations shall be done with the best of excavated earth, which shall be free from rubbish, or excessive frozen material, provided, however, that occasional boulders or stones not larger than 1 cubic foot (cubic meter) may be deposited at least 2 feet (0.6 m) above the top of the sewer and subject to the approval of the Engineer.

Where concrete cradle, encasement or backing, are required, at least 2 hours *or sufficient time for initial set* shall elapse before granular backing, pipe protection or backfill is placed. The method employed in depositing the backfill shall be as to prevent damage to the sewer or other structures. Concrete structures built in place shall not be backfilled until permitted by the Engineer.

*Where the proposed sewer pipe material is ductile iron to be cradled, encased or backed, the pipe shall be wrapped the length of the encasement and at least 30 feet beyond both ends of the concrete applied.*

Except where other requirements are noted on the plans, or provided for in the specifications or are ordered by the Engineer, all open trench backfill above the elevation of the bedding material of the sewer shall be done with materials that, subject to other provisions of the specifications for compaction or special fill have the same as or better soils characteristics than the adjacent undisturbed soil or materials and in a manner satisfactory to the Engineer. All backfilling operations and placement of the backfill material shall be conducted by such means as to eliminate damage to the sewer, its appurtenant structures and other adjacent structures.

Where settlement of the backfill is to be done by flushing or ponding, it shall be so shown by notes on the plans or as otherwise may be approved in writing by the Engineer.

All trenches, except those for plastic pipe systems that cross existing or proposed pavement or where the front face of trenches, paralleling the pavement, is within 36 inches (0.9 m) of the face of curb or edge of pavement within public right-of-way shall be backfilled with compacted granular material as per Item 912. The material shall extend laterally 36 inches (0.9 m) beyond the face of curb or edge of pavement. Other areas outside the above requirement but inside the right-of-way shall be compacted as per Item 911.

For all plastic pipe systems under pavement in the right-of-way or paralleling the pavement within 36 inches (0.9 m) of the face of the curb or edge of pavement, the first 36 inches (0.9 m) of backfill above the top of bedding shall be filled with a material meeting the following gradation:

<b>Sieve</b>	<b>Total Passing % by Weight</b>
1 inch (25 mm)	100
No. 8 (2.36 mm)	3-5

or controlled density fill per Item 636 The material shall extend laterally 36 inches (0.9 m) beyond the face of curb or edge of pavement.

Balance of trench shall be compacted aggregate backfill or controlled density fill as per Item 912.02. Other areas outside the above requirement but inside the right-of-way shall be compacted as per Item 911.

The above backfill requirements within public rights-of-way shall be considered minimum requirements. City standard drawings promulgating more stringent requirements will prevail where applicable.

Where sewer construction is in existing lawn areas outside proposed or existing right-of-way, the backfill shall be compacted to a minimum 90 percent maximum dry density.

*All trenches within the road right of way shall be backfilled or securely plated during non-working hours.*

*Care shall be taken during backfilling and compaction to avoid displacement of or injury to pipe. Movement of construction machinery over a pipe at any stage of construction shall be at the Contractor's own risk. Any damaged pipe shall be repaired or replaced at the Contractor's expense.*

Any settlement in the open trench backfill taking place within the guarantee period shall be refilled with satisfactory materials and the affected surface properly repaired by the Contractor all at his own cost and expense and no extra payment will be made therefore.

**901.18 Surface Soil and Restoration of Surface.** Except where otherwise specifically exempted or provided, the Contractor shall, before starting trench excavation, remove the surface soil to a depth of not less than that of the topsoil material to a maximum of 12 inches (305 mm) below the original surface of the ground within the limits to be excavated and then segregate and store it separately from the remaining stored excavated material. In cultivated areas the entire work area, including storage areas for backfill, shall be stripped up to 12 inches (305 mm) deep and stored for reuse. If necessary, he shall acquire additional area to provide for such separate storage of surface soil. After the completion of sewer construction and basic trench backfill, the Contractor shall *place a minimum of 4 inches (102 mm) of suitable surface soil within the construction limits up to a depth of not less than that of the original topsoil, or a maximum of 12 inches (305 mm), to allow for proper leveling and for preparation of an adequate seed bed to support growth and the Contractor shall make due allowance where embankment is required and shall re-excavate the basic trench backfill where necessary to allow for the surface soil fill. Final grades shall conform to those shown on the plans. The surface soil for this requirement shall be as obtained during initial trench excavation*

*or as furnished by the Contractor at the Contractor's expense and no extra payment will be made therefor.*

When directed by the Engineer, the Contractor shall perform restoration of all surfaces as the work progresses and will be directed to cease excavation and pipe laying until such restoration work is accomplished. Where surface soil is replaced, any settlement below the original ground surface occurring within the guarantee period shall be refilled with surface soil equivalent to the original material. The cost of all work and other expenses connected with the surface soil operation shall be included in the price bid for the various sewer items and no extra payment will be made therefor.

All surfaces, including grass or lawn, pavement, sidewalk, curbing and other surfaces disturbed or destroyed during and as a result of the construction of the work, shall be replaced by the Contractor.

The Contractor will be required under this provision to seed all areas disturbed *unless otherwise stated on the plans*. The seeding operation shall be done in conformity with the requirements set forth under Item 659 of these specifications, and shall be performed within 30 days weather permitting.

All fences damaged or removed in connection with the construction of the sewer shall be repaired or replaced by the Contractor to the satisfaction of the Engineer. If necessary temporary fencing shall be provided by the Contractor.

The Contractor shall include in the prices bid for the sewer items, the cost of all such restoration in all areas involved above and adjacent to the work and no separate or additional payment shall be made therefor unless specifically provided for under other items.

**901.19 Trees.** All branches or growth from trees that is to be saved and which are interfering with the free construction of the pipe sewer may be removed by the use of pruning tools. All pruning tools used and methods employed shall meet with the approval of the Engineer. The branches shall be removed with a good clean cut made flush with the parent trunk or if having a good healthy lateral branch the cut shall be a good clean slanting cut close to and beyond the healthy branch. All pruning cuts shall be painted with an accepted pruning preservative. All branches removed shall be at the direction of the Engineer. The cost of all work and expenses connected with the removal of branches shall be included in the price bid for the various sewer items and no extra payment shall be made therefore.

**901.20 Leakage Tests.** Leakage through the joints of all sewer pipe, sanitary and storm, shall not exceed the following allowable limits:

Sanitary Sewers: 100 gallons per inch (378.5 L/mm) of tributary pipe diameter per 24 hours per mile (km) of length or the computed equivalent for shorter lengths and shorter periods of time. All sanitary sewers shall be tested.

Storm Sewers: 1,000 gallons per inch (3785 L/mm) of tributary pipe diameter per 24 hours per mile (km) of length or the computed equivalent for shorter lengths and shorter periods of time. Tests on storm sewers will only be performed when indicated on the plans, and shall be performed by the infiltration method only.

Leakage tests shall be performed after all installed pipe and manholes have been cleaned and obstructions removed:

1. **Infiltration Test.** This test is to be conducted when the height of ground water table is two feet or more above the elevation of the inside crown of pipe at the upstream limit of the section being tested. The infiltration test shall be made by installing a weir or other measuring device approved by the Engineer in the lower end of the sewer section to be tested. The quantity of ground water infiltration into the sewer shall be measured and shall not exceed the allowable leakage.
2. **Exfiltration Test.** This test is to be conducted when the height of the ground water table is less than two feet above the elevation of the inside crown of pipe at the upstream limit of the section being tested.

The entire sanitary sewer system installed shall be tested. Unless otherwise directed by the Engineer or indicated on the plans, testing shall be done section by section where a section consists of the distance between the successive manholes. The inlet end of the upstream and downstream manholes shall be closed with a watertight bulkhead and the sewer, along with the upstream manhole, shall be filled with water until the elevation of the water in the upstream manhole is two feet higher than the inside crown of the pipe in the section being tested, or two feet above the existing ground water in the trench whichever is the higher elevation. The length of section to be tested may be filled and maintained full of water for a period of approximately 24 hours prior to the start of the test. If the water level in the upper manhole has dropped during this 24 hour period the level shall be raised to the test elevation mark prior to the measurement of leakage. If the Contractor elects to test at any time during the 24 hour period, the water shall be set at the test elevation mark and the test made.

The exfiltration will be determined by measuring the volume of water that is required to be added to return the surface of the water in the upstream manhole to the test elevation mark. The test period shall be a minimum of 1 hour duration from the start of the test.

The Engineer, because of adjacent trench material consideration, may order that after the completion of the exfiltration test the test section of line shall be drained and the infiltration, under existing ground conditions, shall be measured within three hours by means of a weir located in the downstream manhole.

The allowable leakage is based on a maximum difference in elevation of 8 feet (2.4 m) between the level of water in the upper manhole and the invert of the bulkheaded pipe at the downstream manhole. If the difference in elevation exceeds 8 feet (2.4 m), the allowable leakage shall be increased five percent for each 1 foot (0.3 m) in excess of 8 feet (2.4 m).

3. ***Manhole Test.*** *Manholes shall be tested by plugging connecting pipes and filling with water to 2 feet (0.6 m) above the crown of the highest entering pipe. After the filled manhole has been allowed to stand for 24 hours, no loss of water will be permitted in a 4 hour period. As an alternative to this test procedure, and subject to approval of the Engineer, the Contractor may perform a vacuum test in accordance with the procedures set forth in ASTM-C-1244.*
4. ***Air Test.*** *In lieu of exfiltration tests required for pipe sizes 8 inches (203 mm) through 24 inches (610 mm) under Section 901.20 (b) and subject to approval of the Engineer on a job to job basis, the Contractor may request an air test for checking tightness of sanitary sewer pipe construction. All sections of pipe between manholes shall be tested.*

Air testing of pipes will be accomplished only by use of equipment that has been approved by the Engineer and in accordance with the following steps:

1. Plug all pipe outlets with suitable test plugs. Brace each plug securely.
2. Add air slowly to the portion of the pipe installation under test until the internal air pressure is raised to 4.0 psig.
3. After an internal pressure of 4.0 psig is obtained, allow at least 2 minutes for air temperature to stabilize, adding only the amount of air required to maintain pressure.
4. When pressure decreases to 3.5 psig, start stop-watch. Determine the time in seconds that is required for the internal air pressure to reach 2.5 psig. Minimum permissible pressure holding times for runs of single pipe diameter and for systems of 6 inches or 8 inches (152 or 203 mm) laterals in combination with trunk lines shall be as published in tables by the National Clay Pipe Institute for vitrified clay pipe, ASTM C-924 for

concrete pipe, and Table 1 in UNI-B-690 by Uni-Bell PVC Pipe Association for PVC pipe.

In the event the allowable leakage limits are not met, the Contractor shall determine the location where excess water is entering or leaving the sewer. The sewer and/or manholes shall be *replaced or repaired as directed by the Engineer* and retested until the leakage is within the allowable limits. The Contractor shall include, in the price bid per linear foot (meter) of sewer, the cost of all bulkheads, plugs, pipe stopper, pumps, compressors, water, weirs, labor, delay, and any other items of cost necessary for the performance and completion of the required leakage test and for the cost of any repairs or adjustments which may be necessary to make the project conform to the required allowable leakage limits.

All leakage tests shall be conducted under the supervision of the Engineer or Engineer's representative.

**901.21 Deflection.** Prior to final acceptance of completed *flexible* sewer lines, the Contractor shall, at his expense, perform a pipe deflection test on all main line sanitary sewers and storm sewers *where required*.

All lines shall be measured for vertical ring deflection no sooner than 30 days after completion of backfilling operations, provided in the judgment of the engineer, sufficient settlement of the backfill has occurred. The Engineer shall be the sole judge as to when sufficient settlement has occurred.

The maximum limit of vertical deflection shall not exceed 5 percent. *The 5 percent shall be calculated using the applicable ASTM or AASHTO procedures.*

The test shall be accomplished by manually pulling a City of Columbus approved "go, no-go" mandrel with 9 arms.

The Contractor shall be responsible to provide all equipment and labor, including mandrel, to perform and conduct the required test. The Contractor shall also be responsible to notify the *Engineer* at least 48 hours in advance of the anticipated date of the testing for scheduling of personnel needed to monitor the testing operations.

In areas where deflections exceeds the 5 percent limit, the Contractor, at no additional expense to the City, will correct the problem area(s) as directed by the Engineer by one of the following procedures:

1. Trench shall be re-excavated, the backfill and pipe removed and replaced in accordance with the original plans and specifications. If in the opinion of the Engineer or his representative the pipe has been damaged the pipe shall be replaced with new pipe and installed per the plans and specifications. The failed sections of pipe corrected by this method shall be retested in

accordance with 901.21 no sooner than 30 days after the correction is made or as otherwise directed by the Engineer.

2. The failed section(s) will be rerounded by an approved company providing this service. Methods, types of equipment, and company to provide service shall be submitted in writing to the *Engineer* for approval at 5 working days in advance of performing this procedure. This method may only be used if approved by the Engineer and it is determined that the deflection has not exceeded 10 percent of the base inside diameter of the pipe, by pulling a 9 arm "go, no-go" mandrel having a diameter equal to 90 percent of the base inside diameter of the pipe.

After either procedure 1 or 2 is completed, the repaired area(s) will be retested according to Sections 901.20 and 901.21 prior to final acceptance.

**901.22 Method of Measurement.** The length of pipe to be paid for will be the actual number of linear feet (meters) accepted, as measured along the centerline of the sewer, complete in place, including lengths through manholes and inlets and to the center of manholes and inlets in the case of sewer size change thereat. In the case of an extended stub or branch stub at a manhole, should more than one length of pipe extend beyond the wall of a manhole, the measurement will be from the center of the manhole to the end of the stub unless the payment for such stub is otherwise provided for. No length deduction will be made at manholes or tunnel shafts since the basis of bids for manholes or tunnel shafts is to be the difference between the price of the affected length of sewer at manholes or tunnel shafts and the price of a similar length of sewer not affected by a manhole or tunnel shaft.

**901.23 Basis of Payment.** The accepted quantities of sewer of the sizes and types specified will be paid for at the contract unit prices per linear foot (meter), complete in place.

Payment will be made under:

<b>Item</b>	<b>Unit</b>	<b>Description</b>
901	Linear Foot (Meter)	___ Pipe, with Type ___ Bedding
901	<i>Linear Foot (Meter)</i>	___ <i>Pipe, with Type ___ Bedding, with Item 911 Compacted Backfill</i>
901	<i>Linear Foot (Meter)</i>	___ <i>Pipe, with Type ___ Bedding, with Item 912 Compacted Granular Material</i>