550 PIPE CULVERTS, SEWERS AND DRAINS

551 GENERAL

551.01 Description. This work shall consist of the construction or reconstruction of pipe culverts, sewers and drains (referred to below as Type A, Type B, Type C, and Type D pipe), complete in place as specified, using pipe of sizes and types called for by the plans, proposal, or these specifications, and in conformity with lines and grades shown on the plans and profiles, or as established by the Engineer. This work shall include all excavating and the removal of all materials necessary for placing the pipe, manholes, inlets and other appurtenances; maintaining flow in existing culverts, sewers or drains; furnishing, mixing, placing or removing materials, including lining materials; furnishing and placing bedding and backfilling materials as specified; furnishing, setting and removing of forms; pointing or plastering of surfaces; joining to existing and proposed appurtenances as required; performing low pressure air test and deflection test as specified; protecting existing utilities, structures or other improvements in the vicinity of the proposed pipe culverts, sewers and drains; and cleaning up and restoring disturbed facilities and streets and other surfaces.

551.02 Materials. Pipe shall be of the size and kind specified in the proposal and meet the requirements of pertinent sections of 706 and 707. When the kind of pipe is not specifically itemized, any of the kinds listed herein under the specified pipe type may be used. Higher strength concrete or plastic pipe of the same type may be furnished where lower strength pipe is specified. A thicker metal pipe of the same corrugation profile and type may be furnished where a lesser thickness is permitted or specified.

Other materials shall be as follows:

Concrete ..... 499 and 511

Reinforcing Steel	509.02
Special Fittings	561
Brick Masonry	602
Slag and Limestone Bedding	703.02
Crushed Gravel for Bedding	703.04
Material for Backfill	604.02
Cement for Mortar	701.07
Sand for Mortar	703.03

Unless otherwise specified, all reinforced concrete circular pipe shall comply with the requirements of 706.02 and 706.11 and shall comply with the standard specifications of ASTM C76 Class IV, Wall B or Wall C, unless otherwise specified on the plans. All reinforced concrete pipe shall be manufactured using Type II cement.

Only Vitrified Clay Pipe and Reinforced Concrete Pipe shall be considered as rigid pipe materials. All other pipe materials listed herein shall be considered non-rigid pipe materials.

Type A Pipe - Storm Sewers Under Pavement

Vitrified Clay Pipe	706.08 with 706.12
Reinforced Concrete Pipe, Class IV	706.02 with 706.11
Reinforced Concrete Elliptical Pipe	706.04 with 706.15
Corrugated Polyethylene Watertight Smooth Lined Pipe	707.23
Glass Fiber Reinforced Pipe	707.25

Type B Pipe - Storm Sewers Not Under Pavement

Vitrified Clay Pipe	706.08 with 706.12
Reinforced Concrete Pipe, Class IV	706.02 with 706.11
Reinforced Concrete Elliptical Pipe	706.04 with 706.15
PVC Composite Sewer Pipe	707.18
PVC Gravity Sewer Pipe	707.20
Corrugated Polyethylene Watertight Smooth Lined Pipe	707.23
PVC Smooth Interior Pipe	707.24
Glass Fiber Reinforced Pipe	707.25

Type C Pipe - Sanitary / Combined Sewers

Vitrified Clay Pipe	706.08 with 706.12
Reinforced Concrete Pipe, Class IV (30" Diameter and Over)	706.03 with 706.11
Reinforced Concrete Elliptical Pipe	706.04 with 706.15
PVC Composite Pipe	707.18
PVC Gravity Sewer Pipe	707.20
Glass Fiber Reinforced Pipe	707.25

Type D Pipe - Steep Slopes / Special Conditions

High Density Polyethylene Pipe (HDPE), Solid Wall	707.26

551.03 Excavation. Excavation shall include the removal and disposal of all material, including concrete, masonry and rock which may be removed with commonly used excavation equipment necessary for the construction and completion of work under this item. Excavation operations shall be conducted from the surface, except where tunneling is required on the plans or permitted by the Engineer. Tunnel openings shall be made subject to the approval of the Engineer.

Except in rock, water-bearing earth, or where a granular or concrete base is to be used, mechanical excavation of trenches shall be stopped above the final invert elevation so that the pipe may be laid on undisturbed soil. If overdigging occurs, all loosened earth shall be removed and the trench bottom brought back to grade, at the Contractor's expense, with granular material which may be fortified with cement, if so directed by the Engineer.

Width of trenches, except for pipe underdrains, in which pipe is to be installed shall be such as to provide adequate space for workmen to place and joint the pipe properly, but in every case the trench shall be kept to a minimum width. For all rigid pipe installations, the width of the trench at the top of the pipe shall not exceed the outside pipe diameter, including bells, plus the clear width on each side of the pipe as listed in the following table:

Pipe Size	Maximum Clear Width
6 inch to 24 inch	12 inches
27 inch to 54 inch	15 inches
60 inch and over	24 inches

For all non-rigid pipe installations, the minimum trench width shall be per the pipe manufacturer’s recommendations, but at no time shall the width be less than that specified in ASTM D2321.

The length of trench or tunnel open at any one time shall conform to the limits approved by the Engineer. In general, not more than 100 feet of trench shall be opened in advance of the completed work.

Excavation shall be of sufficient depth and width to permit the installation of the work to the lines, grades, and dimensions called for by the plans, and for all sheeting, pumping, and draining. In general, the sides of the trench or other excavation shall be vertical and the walls properly supported with sheeting, bracing or other approved method where necessary for the protection of workmen, adjacent property, structures, utilities or existing improvements. The width at the top of the excavation shall be the minimum width that will permit the proper construction of the sewer or other structures, or the placing of sheeting. Should two sets of wood sheeting be used, the top width shall exceed the bottom width only by the thickness of the necessary rangers and planking plus one inch on each side for additional clearance of lower sheeting past upper rangers.

Trenches in rock shall be excavated to a depth not less than 6 inches below the bottom of the pipe by any acceptable method, including use of explosives, with the approval of the Engineer. Where blasting is permitted, it shall be done by persons experienced in such work and in accordance with 107.09. All blasts shall be well covered, and provisions made to protect pipes, conduits, sewers, structures, persons, and any property adjacent to the site of the work. No blasting shall be permitted within twenty-five feet of the completed pipe culvert, sewer or drain.

The Contractor shall provide proper and satisfactory means and devices for the removal of all groundwater entering the trench excavation and remove such groundwater as fast as it may collect in such matter as to not interfere with the prosecution of the work. The Contractor shall submit a dewatering plan to the Engineer for review prior to commencing work. The groundwater level must be lowered enough to allow a workable trench. Dewatering shall be continued until backfilling is completed in any manhole-to-manhole span. Cost of dewatering shall be included in the price bid for the item requiring the dewatering.

Should the Contractor excavate outside the limits as specified, or should he carry the excavation below or beyond the lines and grades given by the Engineer, or wherever material is loosened sufficiently, in the opinion of the Engineer, to endanger the bearing or foundation of the sewer or other structure to be built, the Contractor shall at his own expense remove all such loosened material and refill all such excavated space with suitable material as directed by the Engineer.

Where the soils encountered are not suitable for foundation, the excavation shall be carried to such additional depths or widths as directed by the Engineer.

Payment for excavation shall be included in the price bid for the item requiring the excavation. Payment for additional excavation, required by the Engineer because of unsuitable material encountered at the elevation of the pipe or appurtenance, shall be included in the unit price submitted for the material used to refill the area of unsuitable material. If there is no item in the contract, payment shall be as provided for in 104.03.

Where the pipe culverts, sewers, or drains are built upon the surface of the ground, the surface shall be grubbed and cleared of all stumps, grass, muck, or other vegetable matter. If 201 Clearing and Grubbing is not included in the contract**,** the cost of this work shall be included in the price bid for the item requiring the work. Pipe culverts, sewers, or drains shall not be constructed on frozen ground.

Unless otherwise indicated in the contract or permitted by the Engineer, the Contractor will not be permitted to store excavated materials along the line of the work.

551.04 Protection of Excavation. When excavating, the Contractor shall provide, place, and adequately maintain sheeting, bracing, cribbing or other trench

support for the safety of workmen or the adequate protection of adjacent property, structures, utilities or existing improvements.

The Engineer may order the Contractor to prepare and submit a trench protection plan. The required plan must identify how the Contractor will comply with specific plan notes requiring trench protection as well as identify methods to be used throughout the work.

No excavation work will be permitted within the limits of the work identified in the Engineer's request for a plan until that plan is approved in writing by the Engineer. Any deviation from the approved plan must also be approved by the Engineer.

Approval of a plan, failure to request a plan, or failure to request additional trench protection by the Engineer shall not be construed as relieving the Contractor from full responsibility for damages or injuries resulting from weak or insufficient trench protection or a lack of trench protection.

When wood sheeting is used and driven below the invert of a pipe culvert, sewer, or drain, it must be cut off and the portion below the pipe not disturbed. Any sheet piling or wood sheeting left in place shall be set or cut-off a minimum of two feet below the finished grade or bottom of pavement unless otherwise noted on the plans.

The cost of sheeting, bracing, cribbing, or other trench protection shall be included in the price bid for the items requiring the protection unless expressly noted in the proposal and/or the plans. Where sheeting, bracing or cribbing is a separate pay item, the work shall be paid for as 503 Cofferdams, Cribs and Sheeting or as 504 Temporary Sheet Piling.

551.05 (a) Bedding for Rigid Pipe. Class "A" bedding shall consist of a continuous concrete encasement or concrete cradle conforming to the dimensions given herein unless otherwise called for on the plans. Trenches in which continuous monolithic and integral concrete cradles or encasements are to be placed may be excavated completely with mechanical equipment. Prior to formation of the cradle or encasement, temporary supports consisting of timber wedges or pieces of brick shall be used to support the pipe in place. Temporary supports shall have minimum dimensions and shall support the pipe at not more than two locations, one adjacent to the shoulder of the socket and the other near the spigot end. After jointing of the pipe has been completed, concrete for cradle or encasement shall be uniformly placed beneath and on both sides of the pipe.

Concrete cradles shall have vertical sides and the bottom shall be a plane surface parallel to the invert of the pipe. Standard cradles shall encase the pipe to the level of the horizontal centerline of the pipe, and shall extend a minimum of six (6) inches to each side of the pipe, and six (6) inches below the outside of the pipe. Concrete for cradles shall be Class "C". Full encasement shall completely envelop the pipe. The

minimum thickness of concrete for full encasement shall be (six) 6 inches, measured from the outside wall of the pipe. Concrete for full encasement shall be Class "F".

Extreme care shall be exercised in the placing of concrete encasement to prevent the displacement of the pipe from proposed line or grade.

Class "B" bedding shall consist of crushed limestone, crushed air cooled blast furnace slag or crushed gravel. The aggregate size shall be No. 5, No. 6, No. 56, or No. 57 as defined by AASHTO M43, unless otherwise approved by the Engineer. Bedding materials shall be placed in the trench bottom to a depth of not less than 6" below the pipe bottom. The layer of bedding material shall be shaped to receive the pipe for a depth approximately 10 percent of the diameter or rise of the pipe and shall have recesses shaped to receive the bell of bell and spigot pipe.

After the pipe is placed and line and grade verified, the bedding material shall be extended up around the sides of the pipe to the horizontal center line. The material shall be placed under the pipe haunch, taking care to not disturb the line and grade of the pipe and to insure sufficient material has been placed and compacted along the sides of the pipe to provide adequate side support. Granular bedding material shall be compacted to 95 percent of the maximum laboratory dry weight as determined by AASHTO T99.

Flooding or puddling shall not be used to compact embedment materials for any pipe, whether rigid or flexible. Preparation of the trench bottoms and placement of all pipe shall be carefully made so that when in final position, the pipe is true to line and grade and supported throughout its length. Blocking will not be permitted to bring pipe to grade.

Trenches shall be dry when trench bottom is prepared.

The cost of furnishing and placing materials to achieve the required class of bedding shall be included in the item requiring the bedding.

551.05 (b) Bedding for Non-Rigid Pipe. Class “NR” Bedding for installation of non-rigid pipe shall be in an envelope consisting of bedding, haunching, and initial backfill extending from a depth of 6 inches below the bottom of the pipe to 12 inches above the top of the pipe. Material for the envelope shall meet the requirements for Class “B” Bedding materials, except only No. 56 and No. 57 size material shall be used. Slag shall only be permitted for use with 707.23 pipe material.

The bedding shall be placed and shaped to fit the pipe. After installation of the pipe, bedding material shall be placed and compacted under the haunches and along the sides of the pipe up to the horizontal centerline to provide adequate side support, taking care to not disturb the line and grade of the pipe.

The initial backfill shall then be placed uniformly across the trench to a minimum depth of 12 inches above the top of the pipe.

Flooding or puddling shall not be used to compact embedment materials for any pipe. Preparation of the trench bottoms and placement of all pipe shall be carefully made so that when in the final position, the pipe is true to line and grade and supported throughout its length. Blocking will not be permitted to bring the pipe to grade. Trenches shall be dry when the trench bottom is prepared.

Cost of furnishing and placing of bedding materials to achieve the required class of bedding shall be included in the item requiring the bedding.

551.06 Storing and Laying Pipe. Pipe shall be stored at the job site in such a manner as to protect the pipe from damage. Non-rigid pipe must be stored to prevent bowing. Pipes having deviations from straight greater than 1/16-inch per foot of length shall not be used. Pipe, fittings and specials with visible breakage or other defects shall not be used, or repaired and used, unless specifically approved by the Engineer in writing. Pipe shall be kept clean at all times.

Pipe shall be laid accurately to the line and grade designated on the plans. Pipe shall be carefully centered so that when laid it will form a sewer with close fitting joints and a uniform invert.

All pipe shall begin and end with pipe ends as normally fabricated by the manufacturers. If field cutting of 707 pipe is required, cutting shall be performed by the use of tools or equipment that will provide a neat perpendicular cut without structural damage to the pipe wall or damage to coatings or fillers.

Metal pipe shall be placed with any longitudinal laps or seams at the side and shall be placed with circumferential seams lapping on the inside in the direction of flow.

706.02 reinforced concrete pipe with elliptical reinforcement and 706.04 reinforced concrete horizontal elliptical pipe with single cage reinforcement shall be handled and placed with the reinforcement markings along a vertical plane. 706.02 reinforced concrete pipe with auxiliary supports shall be handled and placed with the centerline of the auxiliary support system in a vertical plane.

Care shall be taken with all precut holes, fittings, specials, etc. to insure that they are placed at the location and elevation indicated on the plans.

It is intended that curves in 30 inch or larger diameter 706.02 reinforced concrete pipe sewers be truly circular. This work shall be monolithic construction of brick and/or concrete unless otherwise specified on the plans. However, the use of 706.02 radius pipe or 706.02 cut curves may be permitted where the alignment shown on the plans can be maintained, and a shop drawing of the cut curves or radius pipe illustrating the layout and geometry is approved by the Engineer.

Bedding provided for rigid pipe shall be as called for on the plans but in no case will a bedding providing a load factor less than a Class "B" bedding be permitted.

Bedding for non-rigid pipe shall be as called for on the plans, or shall conform to Section 551.05(b). If directed by the engineer, the contractor shall provide additional bedding material or pipe foundation not required by the plans or specifications, in order to adequately support the pipe. Payment for furnishing and placing the additional bedding and/or foundation shall be in accordance with item 603 or section 109.04, as appropriate.

Where bracing plates or a trench box is used for the installation of flexible pipe, all voids caused by the withdrawal of the bracing plates or the trench box shall be completely filled.

All lifting holes in 706.02 and 706.04 pipe shall be grouted with cement mortar or other approved material after the pipe has been placed.

551.07 Joining Pipe. Before joining pipe with a coupling or bell end, all surfaces of the portions of the pipe to be joined and all surfaces of factory made jointing materials shall be clean and dry. Lubricants, primers, adhesives, solvents, bolts, etc. shall have been manufactured specifically for their intended use and shall be used as recommended by the pipe and/or pipe joint manufacturer. The jointing materials shall be fitted and adjusted or applied in such a manner as to obtain a close fitting joint and to obtain the degree of water tightness required.

For elliptical reinforced concrete pipe preformed butyl rubber material 706.15 shall be used. The butyl material shall be of sufficient quantity to seal the joint but not necessarily fill the joint when the pipe is placed in its final position. Both sides of the joint shall be primed with an asphalt based primer as recommended by the manufacturer.

For corrugated metal pipe requiring banded joints, the pipe lengths shall be joined with coupling bands which have at least one circumferential corrugation that indexes into the inboard corrugation of each pipe. Bands with projections shall not be permitted. If coated pipe is used, coated coupling bands must also be used.

For Corrugated Polyethylene Smooth Lined Pipe, joints shall conform to the most current edition of AASHTO M294 for watertight requirements including continuously extruded bell and spigot without welds. If deemed necessary by the Engineer, water-tightness of joints shall be field-tested per ASTM F1417 or C969. Any testing shall be performed by the Contractor, with the cost to be included in the unit price bid for the pipe.

Where the joining of pipes of different materials is required or approved, this work shall be done utilizing special adapters and couplers manufactured specifically for this purpose. The adapters and couplers shall be installed and securely attached to both pipe barrels according to manufacturers recommendations.

As soon as possible after a joint is made, sufficient backfill materials shall be placed along each side of the pipe to support the pipe in its final position.

Where a pipe stub or run of pipe is to be temporarily terminated for future extension, the end of the pipe shall be sealed using an approved removable plug. Masonry bulkheads, if required, shall be constructed in such manner as to allow for their removal in the future without damaging the bell of the pipe. Masonry for bulkheads shall be per 602. Cost of this work to be included in the unit price bid for the pipe.

Where a pipe enters or exits a proposed or reconstructed manhole, the method of connection to the manhole shall be per the pipe manufacturer's recommendations, and shall form a watertight connection.

When pipe having exterior corrugations is being connected to a proposed or reconstructed manhole, the connection shall be made using a boot-type seal with stainless steel clamping band. The boot-type seal may be either cast into the manhole wall, or may be the field-placed expanding ring type. The use of manhole sleeves is not permitted.

551.08 Shop Strutting. Where required by the plans, flexible pipe shall be elongated by increasing its vertical diameter 5 percent. The vertical elongation shall be maintained by horizontal wire struts that shall be left in place until the embankment is completed. The struts shall be removed as directed by the Engineer.

The completed installation shall at no point have out-of-round pipe deflections greater than 5 percent whether or not shop strutting is required. The Engineer may require a deflector meter or a "go, no-go" gauging test run prior to acceptance.

551.09 Backfilling. All trenches and excavations shall be backfilled as soon as practicable after the pipe has been installed unless other protection of the pipe is directed or shown on the plans. The backfill material, which is placed at the sides of the pipe and 2 feet over the pipe or other structure, shall be bank run gravel meeting the requirements of 604.02. Backfill material beyond 2 feet above the top of pipe shall be suitable material removed from the trench or other parts of the project or bank run gravel meeting the requirements of 604.02 as approved or directed by the Engineer. The material shall be moistened or dried, if necessary, to its optimum moisture content for compaction.

The backfill around the pipe up to the top of the pipe shall be placed in loose layers not exceeding 6 inches per layer and thoroughly compacted by hand or power tampers approved by the Engineer. Great care shall be used to obtain thorough compaction under the haunches and along the sides of the pipe. Over the top of the pipe, backfill layers of approximately 8 inch depth shall be added with each layer compacted separately and thoroughly until the trench is completely and uniformly filled to a depth of two feet above the top of the pipe. Backfilling operations shall be done in such a manner as to avoid movement or damage to the pipe.

If specified on the plans, the Contractor shall construct bulkheads using the approved soil at 100 foot intervals. The bulkheads shall be constructed in layers and

thoroughly compacted. They shall extend the full width of the trench, approximately 3 feet in length and brought up to a minimum of 2 feet above the top of the pipe.

Above this point backfill material shall be brought up evenly by depositing the material in layers approximately nine inches in loose depth and without injuring the pipe by shock, jar or excessive free fall. Each layer shall be thoroughly compacted by power tampers operated with care so as not to injure the underlying pipe or appurtenances or by water if proper drainage is provided for the free water. However, flooding or puddling shall not be used without written approval of the Engineer. If the Contractor intends to compact backfill with water he shall submit details of the proposed method for approval before beginning backfilling operations. Hand tampers may be used in corners or narrow places inaccessible to power tampers. Payment for the fill or backfill, including bulkheads, to two feet above the top of the pipe or appurtenances, shall be included in the unit price bid for the pipe or appurtenance being constructed. Payment for backfill obtained from the excavation or other parts of the project shall be included in the price bid for the item requiring the backfill.

If compaction is done using hydraulically-operated backhoe-mounted compactors, such as Ho-Pac Model 8700C or equal, the backfill material may be deposited in layers not more than 2 feet in loose depth. Layers in excess of 2 feet may be deposited only if tests, conducted at the contractor's expense, show, to the satisfaction of the Engineer, that the specified degree of compaction is being achieved. There shall be at least 3 feet of compacted backfill over the pipe before this method of compaction may be employed.

When required by the Engineer to use bank run gravel (604.02) for backfill, payment shall be made at the unit price bid for Item 604 - Bank Run Gravel. The limits for payment of bank run gravel fill shall be the widths as specified in 551.03, the depth shall be from top of subgrade or finished elevation, whichever is lower, to a point two feet above top of pipe and the length shall be measured horizontally from start of fill to end of fill.

For areas outside the street R/W the backfill shall be compacted to not less than 90% of the maximum dry density at $\pm$2% of optimum moisture content as determined by tests approved or conducted by the Engineer. Backfill shall be compacted to not less than 95% of the maximum dry density at $\pm$2% of optimum moisture content for areas within the street R/W.

Backfilling shall be kept completed up to a point within 100 feet of the end of the newly laid pipe unless otherwise directed by the Engineer. During backfilling operations, no sheeting or bracing shall be removed without permission of the Engineer.

551.10 Restoration of Streets and Cleaning Up. All surfaces affected by the construction work shall be permanently restored according to 104.07. The cost of all restoration made necessary by the construction of pipe culverts, sewers and drains,

unless otherwise provided for on the plans, in the proposal, or in the specifications, shall be included and paid for in the price bid for the pipe items or appurtenances as appropriate.

Before final acceptance the Contractor shall clean up the work area in accordance with 104.06.

551.11 Reconstructed Pipe. Where so required by the plans, existing pipe culverts, sewers and drains shall be reconstructed with materials of the types and at the locations specified for new pipe culverts, sewers or drains. All of the provisions of these specifications shall govern the reconstructing of existing pipe culverts, sewers and drains with the same materials and by the same methods as new construction of the same. Cost of connecting sewer pipe to existing manhole and restoring manhole wall shall be included in the cost of the pipe.

551.12(a) Low Pressure Air Test. All sewers, manholes or other structures and appurtenances which are to be used for sanitary sewage shall at all times be water tight and not permit the infiltration of water into, or the exfiltration of sewage therefrom. All such sewers shall be subject to an air leakage test to be performed by the Contractor, under the direct supervision of the Engineer. No request by the Contractor for waiver of the test will be considered. The cost of all air-leakage testing shall be included in the unit price bid for the pipe.

The air test shall be performed within a reasonable time after completion of the sewer, or sections of a larger installation, before the subfinal acceptance. The Contractor shall verify that the sewers, manholes, etc. are substantially complete and reasonably clean prior to performing the test.

The testing procedure and criteria shall be in accordance with ASTM C 828 (clay pipe), C 924 (concrete pipe), or F 1417 (plastic pipe), as applicable, and Table 551.12(a) which shows the required test time in minutes per 100 feet of pipe for each nominal pipe size for a 1.0 psi pressure drop from 3.5 to 2.5 psi. Testing procedures and criteria for PVC pipe (707.20) shall be in accordance with ASTM D3212. All sanitary sewer manholes shall be tested in accordance with ASTM C1244.

TABLE 551.12(a) Minimum Test Time for Various Pipe Sizes			
Nominal Pipe Size, in.	T (time) min/100 ft.	Nominal Pipe Size, in.	T (time) min/100 ft.
3	0.2	21	3.0
4	0.3	24	3.6
6	0.7	27	4.2
8	1.2	30	4.8
10	1.5	33	5.4
12	1.8	36	6.0
15	2.1	39	6.6
18	2.4	42	7.3

If the sewer fails to meet the minimum test times shown in Table 551.12(a) the Engineer may order the Contractor to expose and repair as required joints or any section in the test, backfill, and restore the surface. Such additional work shall be at the Contractor's expense. Following the repairs, the sewer shall be retested until the minimum test time is equaled or exceeded.

In the event that the pipe fails to meet the test requirements,

No payment to exceed 75% of the price bid for the pipe items shall be made until the sewer(s) satisfactorily passes the low pressure air test. Passing an air test or making repairs and passing an air test does not release the Contractor from the responsibility of repair or replacement of sewers and appurtenances during the guarantee period.

551.12(b) Deflection Test. All sewers constructed using non-rigid pipe materials shall be subject to a pipe deflection test, regardless of the pipe stiffness, to be performed by the Contractor, under the direct supervision of the Engineer. No request by the Contractor for waiver of the test will be considered. The cost of performing the deflection testing shall be included in the unit price bid for the pipe.

The deflection test will be performed at the end of the guarantee period before release of the retainer or bond.

The test shall consist of pulling a mandrel (Go/No Go) device through the sewer by hand. No mechanical pulling devices shall be used. The mandrel shall be either the full circle or 9-arm type and conform to the dimensions noted in Table 551.12(b). No sewer will be accepted if the pipe deflection at any point is in excess of 5% of its average inside diameter as noted in Table 551.12(b).

TABLE 551.12(b) Average Inside Diameters & 5% Deflection Mandrel Dimensions						
	ASTM D-3034		ASTM D-2680		ASTM F-679	
Minimal Pipe Size Inches	Average I.D. Inches	5% Deflection Mandrel Inches	Average I.D. Inches	5% Deflection Mandrel Inches	Average I.D. Inches	5% Deflection Mandrel Inches
6	5.893	5.598				
8	7.891	7.496	7.75	7.35		
10	9.864	9.371	9.75	9.25		
12	11.737	11.150	11.75	11.16		
15	14.374	13.655	14.75	14.01		
					T-1*	
18					18.165	17.257
21					21.415	20.344
24					24.092	22.887
27					27.152	25.794
					T-2*	
18					18.202	17.292
21					21.459	20.386
24					24.142	22.935
27					27.208	25.848

*T-1 = Cell Classification 12454C
*T-2 = Cell Classification 12364C

All portions of sewer found to exceed this limit shall be replaced or repaired by the Contractor promptly in a manner satisfactory to the Engineer. After a period of at least 30 days after backfilling the repaired area(s), the sewer shall again be tested for deflection. This procedure shall be repeated as necessary until the maximum pipe deflection is 5% or less. The Contractor shall bear the total cost of all repairs or replacement, including surface restoration in accordance with 104.07.

551.12(c) T.V. Inspection. All sewers, manholes, inlets and other appurtenances shall be subject to T.V. and visual inspections, to be performed by the Contractor, prior to subfinal acceptance of the sewer items. No request by the Contractor for waiver of the inspections will be considered. Costs associated with the T.V. inspection shall be included in the unit price bid for the pipe.

The T.V. inspections shall be performed after completion of the sewer items, before the subfinal acceptance and release of the retainer or bond. The Contractor shall verify that the sewers, manholes, inlets, etc. are substantially complete and reasonably clean prior to performing the inspection.

All pipe, manholes, inlets and appurtenances found to be defective shall be replaced or repaired by the Contractor promptly in a manner satisfactory to the Engineer. The Contractor shall bear the total cost of all repairs or replacement, including surface restoration in accordance with 104.07.

Passing the T.V. inspection or making repairs and passing the T.V. inspection does not release the Contractor from the responsibility of repair or replacement of sewers and appurtenances during the guarantee period.

551.13 Method of Measurement. The quantities to be paid for shall be the actual number of linear feet of pipe culverts, sewers and drains, constructed and accepted. Measurements shall be horizontal centerline measurements of the length of actual pipe in place. The length of fittings shall not be deducted from the gross length of the sewer even if paid separately under item 561. The interior dimension(s) of manholes or junction chambers will be deducted from the gross length of the sewer.

However, if the sewer pipe is 42 inches or more in inside diameter the deduction for manholes shall not be made. If monolithic brick and/or concrete curves, cut curves, or radius pipe are part of the construction, the quantity to be paid shall be measured horizontally along the centerline and payment made under the equivalent diameter pipe item. In the instance where a constructed in place or factory built transition section is used to change pipe size it shall be measured as above and included in the quantity to be paid for the larger adjacent pipe size. The quantities of items 503 Cofferdams, cribs and sheeting and 504 Temporary sheet piling or Sheet piling left in place to be measured for payment shall be the actual quantity measured in place and accepted. Payment for these items shall be made only within the limits specifically shown on the plan or noted in the proposal.

ITEM 552 STORM SEWERS

552.01 Description. This work shall consist of the construction or reconstruction of pipe storm sewers in accordance with 551.

552.02 Materials. Material shall be as specified in the proposal and/or the plans. When the pipe material is not specifically itemized, any of the pipe materials listed herein under the specified pipe type may be used. Higher strength non-rigid pipe of the same type may be furnished where lower strength pipe is specified. A thicker wall pipe of the same type may be furnished where lesser thickness is permitted or specified. Any concrete pipe used for storm sewers shall be manufactured using Type II cement.

Type A Pipe - Storm Sewers under Pavement

Reinforced Concrete Pipe, Class IV ..... 706.02 with 706.11
Vitrified Clay Pipe, Extra Strength ..... 706.08 with 706.12
Reinforced Concrete Elliptical Pipe..... 706.04 with 706.15

Corrugated Polyethylene
Watertight Smooth Lined Pipe 707.23
Glass Fiber Reinforced Pipe 707.25

Type B Pipe - Storm Sewers Not under Pavement
Reinforced Concrete Pipe, Class IV ..... 706.02 with 706.11
Vitrified Clay Pipe, Extra Strength ..... 706.08 with 706.12
Reinforced Concrete Elliptical Pipe..... 706.04 with 706.15
PVC Composite Sewer Pipe 707.18
PVC Gravity Sewer Pipe 707.20
Corrugated Polyethylene
Watertight Smooth Lined Pipe 707.23
PVC Smooth Interior Pipe 707.24
Glass Fiber Reinforced Pipe 707.25

552.03 Method of Measurement. The quantity to be paid under this item shall be measured as provided in 551.13.

552.04 Basis of Payment. Payment for accepted quantities complete in place will be made at the contract prices for:

Item	Unit	Description
552	Linear Foot	____ inch Storm sewer, Type ____, Class ____ bedding
552	Linear Foot	____ x ____ Storm sewer, ____, Class ____ bedding

ITEM 553 INLET CONNECTIONS

553.01 Description. This work shall consist of the construction or reconstruction of pipe from inlets or catch basins to manholes, sewers or other inlets as shown on the plans and in accordance with 551.

553.02 Materials. Materials shall be as specified in the proposal and/or the plans. Where the kind of inlet connection pipe is not specifically itemized, any of the kinds listed hereunder may be used.

Reinforced Concrete Pipe, Class IV ..... 706.02 with 706.11
Vitrified Clay Pipe, Extra Strength..... 706.08 with 706.12

However, in the case of extensions, repair or adjustment of existing inlet connections and where directed by the engineer, the contractor must use pipe material that is most similar to the existing pipe. Under no circumstances will non-rigid pipe be permitted for use as inlet connection pipe.

All inlet connections for modified inlets shall be RCP ASTM C76 Class IV Wall B or C, 706.02 with 706.11. Remove or abandon existing inlet connections as directed by the Engineer.

The standard pipe size for inlet connections shall be 12 inches, unless otherwise shown on the plans. If the inlet connection is to drain a sump or sag area, the size shall be a minimum of 15" diameter unless otherwise directed by the Engineer**.**

553.03 Construction. The pipe shall be laid and joints made according to 551. Junctions with existing sewers shall be made as per plan or as directed by the Engineer. Where sufficient manhole depth exists and unless directed otherwise by the Engineer, connections from inlets to manholes shall be laid straight on a line and grade, with a minimum grade of two percent, from a point in the manhole wall above the bench to the lowest part of the inlet.

When a connection runs directly from the sewer, it shall be laid straight from the horizontal centerline of the sewer to the lowest part of the inlet, unless otherwise directed by the Engineer.

Connections shall be constructed so as to form neat and tight junctions with the sewer or manhole, with slants, Y-branches or T-branches being used when connecting directly with sewers or stubs being used at manholes.

Portions of existing inlet connections, which will not be utilized, and fall within the trench excavation limits of the new inlet connection shall be removed. Cost to be included in the price bid for the new inlet connection.

Portions of existing inlet connections, which will not be utilized, and fall outside the trench excavation limits of the new inlet connection shall be removed or abandoned. Payment for the abandonment or removal shall be made under the appropriate 202 bid item.

553.04 Method of Measurement. The quantity to be paid under this item shall be measured as provided in 551.13.

553.05 Basis of Payment. Payment for accepted quantities complete in place will be made at the contract price for:

Item	**Unit**	**Description**
553	Linear Foot	_____ inch Inlet connection, _____, Class ____ bedding

ITEM 554 DRIVEWAY, ROADWAY AND DITCH CULVERTS

554.01 Description. This work shall consist of the construction and reconstruction of pipe for the purpose of enclosing roadside ditches under driveways or through intersections, enclosing ditches crossing the roadway or any ditch requiring pipe less than 30 inches in diameter. Construction shall be as specified in 551.

554.02 Materials. Material shall be as specified in the proposal and/or the plans. Where the kind of pipe is not specifically itemized any of the kinds listed hereunder may be used. Higher strength concrete or plastic pipe of the same type may be furnished where lower strength pipe is specified. A thicker wall pipe of the same type may be furnished where lesser thickness is permitted or specified.

Reinforced Concrete Pipe 706.02
Vitrified Clay Pipe, Extra Strength 706.08
Galvanized Corrugated Steel Pipe 707.01
Bituminous Coated Corrugated Steel Pipe (2-2/3" x 1/2") 707.04
Paved Bituminous Coated Corrugated (2-2/3" x 1/2") Steel Pipe.....707.05
Corrugated Aluminum Alloy Pipe 707.12
Bituminous Lined Corrugated (2-2/3 x 1/2") Steel Pipe.....707.13
Fiber Bonded Corrugated Steel Pipe 707.16

554.03 Method of Measurement. The quantity to be paid under this item shall be measured as provided in 551.13.

554.04 Basis of Payment. Payment for accepted quantities complete in place, including coupling bands and bolts on corrugated metal pipe, will be made at the contract price for:

Item	Unit	Description
554	Linear Foot	____ inch Ditch culverts, ____, Class ____ bedding
554	Linear Foot	____ inch Driveway culverts, ____, Class ____ bedding
554	Linear Foot	____ inch Roadway culverts, ____, Class ____ bedding

ITEM 555 DRAINAGE CULVERTS

555.01 Description. This work shall consist of the construction or reconstruction of pipe or pipe arches 30 inches or greater in equivalent diameter for the purpose of enclosing water courses. This work may be connected to headwalls, end walls, stilling basins, other end structures or have plain open ends. Construction shall be as specified in 551.

555.02 Materials. Materials shall be as specified in the proposal and/or the plans. Where the kind of pipe is not specifically itemized any of the kinds listed hereunder may be used. Higher strength concrete or plastic pipe of the same type may be furnished where lower strength pipe is specified. A thicker wall pipe of the same type may be furnished where lesser thickness is permitted or specified.

Reinforced Concrete Pipe ..... 706.02 with 706.11
Galvanized Corrugated Steel Pipe 707.01
Galvanized Corrugated (3" x 1") Steel Pipe 707.02
Structural Plate Corrugated Steel Structures 707.03
Bituminous Coated Corrugated (2-2/3" x 1/2")
Steel Pipe and Pipe Arches 707.04
Paved Bituminous Coated Corrugated (2-2/3" x 1/2")
Steel Pipe and Pipe Arches 707.05
Bituminous Coated Corrugated (3" x 1")
Steel Pipe and Pipe Arches 707.06
Paved Bituminous Coated Corrugated (3" x 1")
Steel Pipe and Pipe Arches 707.07
Corrugated Aluminum Alloy Pipe 707.12
Bituminous Lined Corrugated (2-2/3" x 1/2")
Steel Pipe 707.13
Bituminous Lined Corrugated (3" x 1")
Steel Pipe 707.14
Fiber Bonded Corrugated Steel Pipe 707.16
Fiber Bonded Corrugated Steel Pipe Arches 707.17

555.03 Method of Measurement. The quantity to be paid for under this item shall be measured as provided in 551.13.

555.04 Basis of Payment. Payment for accepted quantities, complete in place, including coupling bands and bolts on corrugated metal pipe, will be made at the contract pipe for:

Item	Unit	Description
555	Linear Foot	____ inch Drainage culvert, _____ , Class ____ bedding
555	Linear Foot	____ x ____ inch Drainage culvert, ____ , Class ____ bedding

ITEM 556 HOUSE DRAIN PIPE

556.01 Description. This work shall consist of furnishing and installing drain pipe for the purpose of conveying roof water to the street gutter or ditch.

When payment is made under 556 House Drain Pipe, Complete, this work shall consist of furnishing and installing drain pipe through the curb, under the lawn strip and/or sidewalk, and within private property to a maximum of three feet behind the R/W line, and shall include drilling the necessary holes through stone or concrete curbing, and where applicable, making the necessary tie-ins to existing or proposed drain pipe.

When payment is made under 556 House Drain Pipe, Type A, this work shall consist of furnishing and installing drain pipe within private property from three feet behind the R/W line to a convenient and suitable point of tie-in and shall include making the necessary tie-ins to existing drain pipe.

When payment is made under 556 House Drain Pipe, Type B, this work shall consist of furnishing and installing drain pipe within the street R/W from the face of the curbing to a convenient and suitable point of tie-in under the lawn strip, and shall include drilling the necessary holes through stone or concrete curbing and making the necessary tie-ins to existing drain pipe.

556.02 Materials. Pipe shall be 3 inch diameter unless otherwise shown on the plans or directed by the Engineer.

Schedule 40 PVC Pipe and Fittings 707.27

556.03 Length of Pipe. House Drain Pipe, Complete. Where there is curbing, the pipe shall extend from the face of the curbing to a maximum of three feet behind the R/W line. Where there is no curbing, the pipe shall extend from the roadway ditch line to a maximum of three feet behind the R/W line. Where the pipe is being installed under new sidewalk that does not abut the curb, a coupling shall be provided at each side of the walk. In lieu of a coupling, bell type pipe may be installed with the bell at the uphill side of the walk. In some cases the pipe shall be laid only under the sidewalk and shall have a suitable cap or plug installed at both ends. In instances where the pipe is to be capped behind the R/W line, the pipe shall extend a minimum of 12 inches beyond the back edge of the walk.

House Drain Pipe, Type A and B. The length of pipe furnished and installed shall be as required to make a convenient and suitable tie-in to the existing drain pipe as directed by the Engineer.

556.04 Construction Methods. The holes shall be provided through the curbing by drilling, using a method approved by the Engineer. The pipe shall be laid on a straight grade from the R/W line through the hole in the curbing. The pipe shall be laid under the walk in the subbase when the walk and lawn strip are of sufficient cross slope to allow the pipe to flow. The pipe shall be laid within the walk between the forms when the walk and lawn strip are not of sufficient cross slope. Standard manufactured fittings shall be used to connect new pipe to existing pipes.

House drain installations under existing sidewalk shall be installed by open-cutting. No jacking or tunneling under existing sidewalk shall be permitted. The affected sidewalk slab(s) shall be reconstructed back to the nearest existing construction, expansion or contraction joint per 456. Payment for the replacement of the sidewalk shall be considered incidental to this work unless payment is provided for in the contract under the appropriate sidewalk pay item.

Lawn areas on private property disturbed solely by the installation of house drain pipes shall be restored per 653 and 659. Cost of the lawn restoration shall be considered incidental to this item.

556.05 Method of Measurement. The quantity of House Drain Pipe, Complete, to be paid shall be the actual number of pipes in place and accepted including holes in curbs, couplings and fittings.

The quantity of House Drain Pipe Type A and B to be paid under this item shall be the actual number of linear feet of pipe in place, completed and accepted including couplings and fittings. Couplings and fittings shall be measured in place as straight lengths of pipe, and paid for in the linear foot measurement.

556.06 Basis of Payment. Payment for accepted quantities complete in place will be made at the contract price for:

Item	Unit	Description
556	Each	House drain pipe, complete,
556	Linear Foot	House drain pipe, Type A,
556	Linear Foot	House drain pipe, Type B,

ITEM 557 SANITARY SEWERS

557.01 Description
557.02 Materials
557.03 Method of Measurement

557.04 Basis of Payment

557.01 Description. This work shall consist of the construction or reconstruction of pipe for sanitary sewers and combination sewers in accordance with 551.

557.02 Materials. Materials shall be as specified in the proposal and/or the plans. Where the kind of pipe is not specifically itemized any of the kinds listed hereunder may be used. Higher strength non-rigid pipe of the same type may be furnished where lower strength pipe is specified. A thicker wall pipe of the same type may be furnished where lesser thickness is permitted or specified. Sewers serving any industrial or commercial properties shall be constructed of a pipe material other than PVC. Any concrete pipe used for sanitary sewers shall be manufactured using Type II cement. All reinforced concrete pipe used for sanitary or combined sewers shall be epoxy coated per 706.03, if called for on the plans.

For 8" to 15" Diameter

Vitrified Clay Pipe, Extra Strength	706.08 with 706.12
PVC Composite Sewer Pipe	707.18
PVC Gravity Sewer Pipe	707.20

For 18" Diameter to 27" Diameter

Vitrified Clay Pipe, Extra Strength	706.08 with 706.12
Glass Fiber Reinforced Pipe	707.25

For 30" Diameter and Over

Reinforced Concrete Circular Pipe	706.03 with 706.11
Reinforced Concrete Elliptical Pipe*	706.04 with 706.15
Glass Fiber Reinforced Pipe	707.25

* Epoxy coated as per 706.03, if called for on the plans.

557.03 Method of Measurement. The quantity to be paid under this item shall be measured as provided in 551.13.

557.04 Basis of Payment. Payment for accepted quantities, complete in place**,** including all T-branches and Y-branches for existing or proposed lateral connections, will be made at the contract price for:

Item	Unit	Description
557	Linear Foot	_____inch Sanitary sewer, _____, Class _____ bedding

ITEM 558 FORCE MAINS AND SYPHONS

558.01 Description

558.01 Description. This work shall consist of the construction or reconstruction of pipe for the purpose of conveying sewage or other waste liquids under pressure in accordance with 551 except 551.12 shall not be required.

558.02 Materials. Materials shall be as specified in the proposal and/or the plans. Where the kind of pipe is not specifically itemized any of the kinds listed hereunder may be used. Higher strength pipe of the same type may be furnished where lower strength pipe is specified. A thicker wall pipe of the same type may be furnished where lesser thickness is permitted or specified.

Ductile Iron Pipe (minimum class 53)..... 715.02 and 254.04
PVC pressure pipe (minimum class 100) 707.19

558.03 Testing. After the pipe has been laid and backfilled, the pipe will be filled with water for a leakage test. The pipe shall be tested under a pressure of 50 pounds per square inch greater than the working pressure that the pipe will experience in service, as determined by the Engineer. The pipe shall be tested in lengths of not more than 2,000 feet when possible. The duration of the test shall be two hours, unless directed otherwise by the Engineer, and the leakage during the test shall not exceed 50 gallons per inch of diameter per mile of pipe per 24 hours.

The test shall be made by pumping the pipe to the test pressure and measuring the quantity of water required to pump the pipe back up to test pressure at the end of the test period. The Contractor shall furnish the necessary pumps, pipe, bulkheads, connections, gauges and measuring devices for making the test.

In the event that the pipe fails to meet the test requirements, the Engineer may order the Contractor to expose and repair as required joints or any section in the test, backfill, and restore the surface. Such additional work shall be at the Contractor's expense.

The Contractor shall be responsible for any damage to the trench, piping or appurtenances which may arise from, or in connection with, the tests, and all damaged pipe or appurtenances shall be replaced by the Contractor immediately.

Where testing would be expedited by access to open ends of pipe and where approved by the Engineer, the Contractor may test the pipe prior to installing the last final lengths(s) of pipe and/or connecting the pipe to pump station piping or appurtenances. This shall not be construed, however, as relieving the Contractor from responsibility for defects in the completed work which may appear during the maintenance period. This leakage test may be waived in its entirety, if so determined by the Engineer or if noted on the plans.

558.04 Method of Measurement. The quantity to be paid under this item shall be as provided in 551.13.

558.05 Basis of Payment. Payment for accepted quantities complete in place will be made at the contract price for:

Item	Unit	Description
558	Linear Foot	____inch Force main,
558	Linear Foot	____inch Syphon,

ITEM 559 PIPE RECONNECTIONS

559.01 Description
559.02 Materials
559.03 Construction
559.04 Method of Measurement
559.05 Basis of Payment

559.01 Description. This work shall consist of the extension of existing sanitary sewer laterals, the reconnection of existing sanitary sewer laterals as part of sanitary sewer reconstruction, adjustment of existing sewer laterals to provide clearance for storm sewer or utilities or the reconstruction of damaged sections of existing laterals.

559.02 Materials. Materials shall be as specified in the proposal and/or the plans. Where the kind of pipe is not specifically itemized any of the kinds listed hereunder may be used. Higher strength pipe of the same type may be furnished where lower strength pipe is specified. A thicker wall pipe of the same type may be furnished where lesser thickness is permitted or specified.

Vitrified Clay Pipe, Extra Strength ..... 706.08 with 706.12
PVC Gravity Sewer Pipe 707.20

However, where the Engineer so directs, the Contractor must use that pipe material listed above that is most similar to the existing material.

559.03 Construction. The pipe shall be laid and joints made in accordance with 551. Junctions with existing laterals or sewers shall be made as conditions require and at the direction of the Engineer. When necessary to connect new sewer pipes to existing lines, the Engineer may waive the requirement for the so-called "premium" joint materials to permit proper connections with existing lines. Such waiver is not to be interpreted to include any more pipe than is required to make the necessary connections with existing lines or to lay pipe around obstacles where the premium joints may not be workable.

Existing lateral and Y-branch locations are approximate. Before making a reconnection and where directed by the engineer, the contractor shall perform a dye test or utilize other appropriate means to determine the origin of a lateral and/or an active or unused status. The decision to reconnect or abandon any unused laterals shall be made by engineer. The cost of dye tests or other investigation shall be included in the unit price bid for item 559.

559.04 Method of Measurement. The quantities to be paid for under these items shall be the actual linear feet of pipe sewer and the number of bends. The number of bends shall be determined by actual count of those used. Payment for bends shall be based upon the number of short bends placed. Long bends shall be paid for as two short bends. Bends shall be considered "short bends" when the centerline length and radius are approximately two feet.

There shall be no special payment for stacks or chimneys. The pipe and bends, used for stack construction, shall be measured and paid for as described above.

Brick or concrete masonry used for stack or chimney construction shall be measured and paid for as provided in 602.

559.05 Basis of Payment. Payment for accepted quantities, complete in place, will be made at the contract price for:

Item	Unit	Description
559	Linear Foot	_____ inch Pipe reconnections, _____, Class ____ bedding
559	Each	____ inch Pipe bends, ____, Class _____ bedding

ITEM 560 LATERALS AND STACKS

560.01 Description. This work shall consist of the construction of complete lateral sewer connections, using pipe of the sizes and types specified, from the street sewer to the property line in accordance with the plans or as directed by the Engineer. This work includes tee or wye connections to existing and new sanitary or storm sewers and all stack or chimney construction when required.

560.02 Materials. Materials shall be as specified in the proposal and/or the plans. Where the kind of pipe is not specifically itemized any of the kinds listed hereunder may be used. Higher strength pipe of the same type may be furnished

where lower strength pipe is specified. A thicker wall pipe of the same type may be furnished where lesser thickness is permitted or specified.

Sanitary Laterals

Vitrified Clay Pipe, Extra Strength ..... 706.08 with 706.12
..... Concrete and masonry items shall be as specified in 602.02.
PVC Gravity Sewer Pipe 707.20
Special fittings 707.18, 707.20

Storm Laterals

Vitrified Clay Pipe, Extra Strength ..... 706.08 with 706.12
..... Concrete and masonry items shall be as specified in 602.02.
Reinforced Concrete Pipe, Class V ..... 706.02 with 706.11
PVC Gravity Sewer Pipe 707.20
Special fittings 707.18, 707.20

560.03 Construction. The pipe shall be laid and joints made in accordance with 551. Junctions with existing laterals or sewers shall be made as conditions require, and at the direction of the Engineer, as specified in 559.03.

The minimum grade for laterals shall be one percent. Unless otherwise specified or directed by the Engineer, all sanitary laterals shall be laid to a depth of eight feet below ordinance street grade at the property line. All storm laterals shall be laid to match the horizontal centerline of the mainline storm sewer, and be laid to match the slopes and inverts shown on the plans, unless otherwise directed by the Engineer.

Where the end of a lateral has been laid, before or after the contract was awarded, and is at or outside of the property line, the street lateral shall be laid to the end of the existing lateral and the same connected to the new work by the Contractor without additional cost.

Where the ends of lateral connections are left unconnected, they shall be tightly sealed with stoppers of the same material as the lateral, using the same joint materials specified for the lateral. The unconnected ends of all laterals shall be marked with a 1 x 2 inch wooden strip extending from the top of the pipe to the surface of the ground, and a section of drain pipe 2 inch in diameter inserted over the top of the wooden strip.

560.04 Stacks. Vertical stacks for laterals shall be constructed of 6 inch pipe. Rigid pipe used for stacks shall be encased in concrete with a minimum thickness of 6 inches outside the barrel of the pipe. Non-rigid pipe used for stacks shall be completely encased in No. 57 stone, with a minimum encasement thickness of 6 inches, within a Sonotube. The connection to the sewer and details of the encasement shall be as shown on the plans or as directed by the Engineer.

560.05 Method of Measurement. The quantity to be paid for under these items shall be the actual linear feet of encased Stack and the number of House Laterals

completed and accepted including stubs, slants, bends or special fittings. House laterals shall be classified by length as follows:

Length	Description
Less than 19 feet	_____ inch short house lateral
19 to 31 feet inclusive	_____ inch house lateral
More than 31 feet	_____ inch long

*For the purpose of classification the length shall be determined by the distance measured in a straight line horizontally from the end of the lateral at the property line to the center line of the sewer at the point of connection.

560.06 Basis of Payment. Payment for accepted quantities complete in place will be made at the contract price for:

Item	Unit	Description
560	Each	____ inch short house lateral,
560	Each	____ inch house lateral,
560	Each	____ inch long house lateral,
560	Linear Foot	____ inch house lateral,
560	Linear Foot	Stack ____ inch encased
560	Linear Foot	____ inch storm lateral
560	Each	____ inch storm lateral

ITEM 561 SPECIAL FITTINGS

561.01 Description. This work shall consist of furnishing and installing special fittings on culverts, sewers, drains, force mains, manholes, inlets, junction chambers or such other places as may be directed. Special fittings shall include Y-branches, T-branches, stubs, slants, bends, flap gates, frames and covers, special adapters and couplers. These fittings shall not be paid for separately, unless specifically itemized in the proposal, but shall be included in the price bid for the respective item requiring the fittings.

561.02 Materials. Items under this section which are related to pipe, or could be considered as pipe, shall be of the same kind and quality as specified or approved for the pipe. The joints shall also be of the same kind and quality unless otherwise specified or approved.

Materials for Cast Iron Special Fittings shall be:

Cast Iron 711.12

Each casting shall have the cast mark of the foundry and shall be painted with two coats of painted with two coats of a waterbased bituminous or black epoxy paint approved by the Engineer.

561.03 Construction. Special fittings shall be handled and laid as specified for pipe of the same kind.

Pipe with Y-branches or T-branches shall be laid and inclined sufficiently to bring the tops of the branches level with the top of the sewer pipe. The ends of the branches shall be tightly sealed with stoppers of similar material using the same joints as specified for the sewer unless the lateral branches are to be laid immediately. The location of each branch shall be marked with a 1 x 2 inch vertical wood strip, reaching from the end of the branch to the bottom of the pavement, or to within one foot of the surface of the ground.

Stubs or slants shall be neatly installed in the sides of sewers or manholes or other places as directed, with the bell end outward. Stubs or slants shall be set while the masonry is being constructed. They shall be securely placed, and the juncture with the sewer barrel or manhole neatly grouted with cement mortar without projections or voids, and the inner end of the stub or slant flush with the inside surface or the sewer, manhole, or other structure. Unless otherwise required, they shall be installed just above the spring line of the sewer. The bell end of the stubs or slants shall be sealed with stoppers of similar material and the locations marked as specified above.

Flap gates shall be installed in new or existing structures in accordance with Standard Drawing MH-7 or as directed by the Engineer.

New castings, including frames and covers for manholes and inlets, shall be set upon existing, or newly rebuilt, or newly adjusted masonry to grades designated by the plans or directed by the Engineer. Cost of rebuilding or adjusting the existing masonry shall be included under the respective items as specified in 562 or 563. Mortar required for setting, bedding, or filling the webs of special fittings shall be included in the price bid for the fitting.

561.04 Method of Measurement. The quantities to be paid for under these items shall be the number of Y-branches, T-branches, stubs, slants, bends, flap gates, frames and covers, special adapters, or couplers of each size and type furnished and installed as specified. The number shall be determined by the Engineer's count of them complete in place. Six inch bends used for reconnections shall be paid for under 559.

561.05 Basis of Payment. Payment for accepted quantities, complete in place including marking, will be made at the contract price for:

Item	Unit	Description
561	Each	_____inch T or Y Branch on _____ inch sewer
561	Each	_____inch Stub
561	Each	_____inch Slant
561	Each	_____inch Bend
561	Each	_____inch Special adapter
561	Each	_____inch Coupler
561	Each	_____inch Flap gate, standard
561	Each	Manhole frame and cover
561	Each	Inlet casting, No. _____

ITEM 562 MANHOLES

562.01 Description. This work shall consist of excavating for, constructing, adjusting, rebuilding or reconstructing manholes of the type and size as indicated on the plans, or as ordered by the Engineer, complete with standard casting, backfilling, rechanneling inverts, and placing steps. Concrete, gravel, limestone, or slag required for bedding shall be included in the price bid for the respective item requiring the bedding material.

562.02 Materials. Materials shall be:

Structural concrete (Class C) ..... 499 and 511
Brick masonry units 704.01
Granular material for backfill 604.02
Precast concrete riser sections, cones, grade rings and flat slabs 706.13
Preformed expansion joint fillers 705.03
Reinforcing steel 509.02
Cast frames, grates, covers ..... 711.12 and 711.13

Welded frames and grates	513.17, 711.01
Steps	711.13 or 711.31
Resilient and flexible gasket joints	706.11
Resilient connectors between reinforced concrete manhole structures and pipes	706.14
Curing materials	705.05, 705.07, 705.08
Slag or limestone	703.02
Crushed gravel	703.04

Unless otherwise noted on the plans or in the proposal, the Contractor may use either brick or precast reinforced concrete manholes for new or reconstructed manholes on storm sewers. All new or reconstructed manholes on sanitary or combination sewers shall be precast reinforced concrete. All precast reinforced concrete manholes shall be manufactured using Type II cement.

When precast manholes are proposed to be incorporated into the work, the Contractor shall submit to the Engineer the following:

a. Manufacturer's name and address
b. Detailed shop drawings
c. Material specifications

Approval will be based on complete inspection of manufacturer's plant, method of manufacture, samples of materials to be used and inspection and testing of actual units to be used.

562.03 Manhole on Sanitary Sewer or Storm Sewer; Drop Manhole. The Contractor shall construct manholes complete, in accordance with the plans, including castings, covers, slab tops, steps, plastering, pointing, interior coating, joint sealing and all incidentals. The inlet and outlet treatment of pipe at manholes shall be in accordance with the plans and shall be included in the price bid per linear feet of the appropriate pipe item. Pipe, fittings, concrete or masonry required for drop connections shall be included in the price bid for drop manholes complete. Sanitary, Combined or Storm manhole types shall be as designated on the plans. Excavation and backfill shall be in accordance with section 551.

The manhole bottom shall have a uniform bearing on a minimum of three inches of compacted #57 stone. Unsuitable material shall be removed and replaced as specified in Section 551.03.

Adequate precautions shall be taken to prevent concrete and/or mortar from freezing. Any material incorporated in these items having a temperature of 40°F or less shall not be placed until heated for a period sufficient to insure a temperature of 50°F to 80°F throughout the entire mass of the material.

All manholes shall be thoroughly bonded or securely connected to the barrel of the sewer, and all connections with pipes neatly made without projections or voids. Unless otherwise noted on the plans, all pipe connected to precast concrete manholes

shall be sealed by use of a resilient manhole connector meeting the requirements of 706.14.

Brick manholes shall be built of common brick with the channel lined with vitrified brick. The brick shall be laid in a full bed of mortar with interior joints not more than 1/4 inch wide. Whole brick shall be used, except to effect closures and to "chink in" the exterior radial joints. Each seventh course shall be laid as "stretchers", the intervening courses being composed of "headers". The upper part of the manhole shall be "domed", starting at the elevation indicated on the plans and "drawing-in" evenly and equally on all sides to such diameter as will receive the casting. The interior joints shall be pointed and the exterior surface plastered with 1/2 inch portland cement mortar. No backfill shall be placed against masonry within 24 hours after construction.

Precast concrete manholes on sanitary and combination sewers shall be epoxy coated (if called for on the plans) and shall be installed with a full depth channel constructed of precast concrete (using Type II cement), pour in place concrete (using Type II cement), or vitrified brick with mortar joints not more than 1/4 inch wide. Slab top manholes shall be constructed in accordance with standard drawing MH-6.

Standard manhole steps shall be set in the masonry of brick manholes and the manhole riser sections and cones of precast manholes as indicated on the drawings. Where the ordinance grade is below the grade of an unimproved street, the brick work or last precast section shall be built to correspond with the ordinance grade, and the manhole casting and cover set to existing grade by use of a brick chimney and/or grade rings. The inside diameter of the brick masonry, grade ring, brick chimney or precast section shall be not less than 26 inches nor more than 28 inches.

The manhole frame shall be set in a full bed of mortar and, if appropriate, adjusted to conform to the surface of the roadway. Care shall be taken with setting and adjusting the frame in order to maintain a full and firm bearing on the mortar bed.

When directed by the Engineer or noted on the plans, manholes shall have locking covers.

When manholes are completed, they shall be cleared of scaffolding, centering or forms and cleaned of surplus mortar or other foreign materials.

All new and reconstructed manholes on sanitary or combined sewers shall be tested by the Contractor. Testing shall be performed in accordance with ASTM C-1244, and all costs associated with the testing considered incidental to the manhole item.

When a manhole is described in the proposal and plans by the word "modified", the item shall be constructed to conform to the details and intent of the appropriate standard drawing and in accordance with these specifications, with the exception of those modifications specifically detailed or called for by the plans or addendum specifications.

562.04 Manhole Adjusted. Existing brick manholes shall be adjusted to grade when it is necessary to raise or lower the manhole casting and it is not necessary to rebrick any portion of the dome of the manhole. The Contractor shall carefully remove and clean the existing casting. Existing brick masonry shall be removed, if necessary, and new brick masonry constructed to proper elevation. The upper surface of the finished brickwork and casting shall conform to the new elevation and contour of the surface. The existing casting shall be reset in a bed of mortar.

Precast manholes shall be adjusted as above, providing the cone must not be cut or the combined vertical height of the brick and grade rings above the cone section does not form a chimney more than 12 inches in height. If it is not possible to adjust the manhole to the required elevation without cutting the cone section or exceeding a chimney height of more than 12 inches, the work shall be performed and paid for as specified in 562.06 Precast manhole rebuilt.

Adjustment of a manhole to grade by adding an adjusting ring shall be paid for as "Manhole Adjusted by Adding Adjusting Ring." The ring shall be the expanding steel ring type, which mechanically locks into the manhole casting. The ring shall be furnished by the Contractor.

Adjustment of a manhole to grade by removing an existing adjusting ring shall not be a pay item. The removed ring shall be stored for pickup by the City if it is salvageable.

562.05 Brick Manhole Rebuilt. Existing brick manholes shall be rebuilt when it is necessary to rebrick any portion of the dome of the manhole. The Contractor shall carefully remove and clean the existing casting. The existing manhole wall shall be removed as far down as necessary to permit reconstruction of a new standard dome. The upper surface of the casting shall conform to the new elevation and contour of the surface. The existing casting shall be reset in a bed of mortar. Any steps encountered within the area of rebuild shall be reset.

562.06 Precast Manhole Rebuilt. When existing precast manholes can not be adjusted as described in 562.04, they shall be rebuilt. When rebuilding an existing precast concrete manhole for purposes of raising or lowering the casting elevation, the necessary cone and/or riser sections shall be removed, appropriate substitutions or additions made, and the manhole reassembled. The change in manhole casting elevation shall be accomplished such that the combined height of new brick and/or concrete grade rings on top of the cone section shall not exceed 12 inches, of which the brick height shall not exceed two courses.

562.07 Manhole Reconstructed. When a manhole is to be completely replaced or must be relocated, the work shall be done under this item. The Contractor shall carefully remove and clean the existing manhole casting for reuse. The cost of the removal and the disposal of any materials in the existing manhole not suitable or required to be reused, and all pipe reconnections, shall be included in the

price paid for work under this item and description. The work under this item shall be done as required in section 562.03. If the Engineer deems necessary a new manhole frame and cover, payment for the frame and cover will be made under item 561 Manhole Frame and Cover.

562.08 Manhole Rechanneled. Under this item the existing manhole invert shall be altered as shown on the plans or as directed by the Engineer. The existing invert shall be removed as required, and new masonry constructed in accordance with 562.03.

562.09 Manhole Steps Replaced. When manhole steps are to be replaced or added to an existing manhole, the work shall be done as shown on plan or as directed by the Engineer. The steps shall be of size and shape shown on the standard drawings and conforming to 711.13 or 711.31. The Contractor shall carefully remove deteriorated existing steps by core drilling around it and clean the surface before placing new steps and grouting with quick set grout or as directed by the Engineer.

562.10 Method of Measurement. The quantity to be paid for shall be the number of manholes constructed, adjusted, rebuilt, reconstructed or rechanneled as specified and accepted. The quantity of brick manholes rebuilt shall be the number of feet as determined by the difference in elevation in feet and fractions thereof between the top and bottom of the new masonry. Manhole steps replaced shall be the actual number of steps placed or replaced in existing manholes.

562.11 Basis of Payment. Payment for accepted quantities, complete in place, will be made at the contract price for:

Item	Unit	Description
562	Each	Manhole _____ on _____" Sanitary Sewer
562	Each	Manhole _____ Slab Top on _____" Sanitary Sewer
562	Each	Manhole _____on _____" Storm Sewer
562	Each	Manhole _____Slab Top on _____" Storm Sewer
562	Each	Drop Manhole on _____" Sanitary Sewer
562	Each	Manhole Adjusted by Adding Adjustment Ring
562	Each	Brick Manhole Adjusted
562	Each	Precast Manhole Adjusted
562	Linear Foot	Brick Manhole Rebuilt
562	Each	Precast Manhole Rebuilt
562	Each	Manhole Reconstructed _____on _____" Sanitary Sewer
562	Each	Manhole Reconstructed _____on _____" Storm Sewer
562	Each	Drop Manhole Reconstructed on _____" Sanitary Sewer
562	Each	Manhole Rechanneled
562	Each	Manhole Steps Replaced

Note: Where a specific item in the proposal is modified by the word brick it shall mean exclusively a manhole constructed predominantly of brick and conforming to these specifications and the appropriate standard drawing.

When a specific item in the proposal is modified by the word precast, it shall mean exclusively a manhole constructed of precast reinforced concrete sections conforming to these specifications and the appropriate standard drawing.

ITEM 563 INLETS

563.01 Description. This work shall consist of constructing, adjusting, or reconstructing inlets of the type and size indicated on the plans or as directed by the Engineer. Payment for concrete, gravel, or slag required for bedding shall be included in the price bid for the respective item requiring the bedding material.

563.02 Materials. Specific materials shall be those listed in 562.02.

563.03 Inlets, Wingwall Inlets, Junctions Boxes. All inlets, wingwall inlets and junction boxes shall be constructed in accordance with the plan and construction standard drawings, complete with standard casting, and inlet approach where applicable. Excavation and backfill shall be in accordance with 551. Note that the depth of inlets may vary due to the necessity of raising or lowering inlet connections to pass over or under other underground lines.

All brick work shall be pointed on the inside and finished smooth and a 1/2 inch mortar coat applied to the exterior. The top castings shall be set in a full bed of mortar and shall conform to the curb grade and shall be sloped to form a smooth junction with the sidewalk, if any. When castings are set in notches in the curbing, premolded bituminous expansion joint material shall be inserted between the ends of the castings and the notches in the curbing. The joint material shall be at least 1/2 inch thick and shall completely separate the mortar fill of the inlet castings from the concrete or stone curbing. No backfill shall be placed against masonry within 24 hours after construction.

Wingwall inlet dimensions shall be determined by the size of the pipe leading from the wingwall inlet as detailed in the plans. Except for gratings, wingwall inlets shall be constructed of concrete. However, brick masonry may be used with written

approval of the Engineer. Gratings shall meet the requirements shown on the appropriate standard drawing. If brick masonry is used, the tops of the walls shall be finished with a coping of concrete not less than 4 inches in thickness.

Where an inlet, wingwall inlet or junction box is described in the proposal and plans by the word "modified", the item shall be constructed to conform to the details and intent of the appropriate standard drawing and in accordance with these specifications, with the exception of those modifications specifically detailed or called for by the plans.

New and reconstructed inlets shall include the reconnection of any existing underdrain pipes.

563.04 Inlets Adjusted. Existing inlets shall be adjusted to grade when it is necessary to raise, lower or alter existing inlets and a portion of the inlet masonry, including the base, is to be reused. The Contractor shall carefully remove the existing inlet casting, and when applicable, remove all the existing concrete from the wells on top of the existing casting, or replace with a new casting. The Contractor shall then fill the wells on top of the casting with class “C” concrete. Existing brick masonry shall be removed, if necessary, and new brick masonry constructed to proper elevation. The Contractor, when directed by the Engineer, shall remove as much of the old masonry as required to make the adjusted inlet structurally sound. The upper surface of the finished brick work and casting shall conform to the new line and grade. The existing casting shall be reset and adjusted as specified in 563.03 for new inlets, including the use of premolded bituminous expansion strips at the casting ends. When necessary, the top of the inlet casting shall be filled with class "C" concrete.

563.05 Inlets Reconstructed. Existing inlets shall be reconstructed when it is necessary to alter existing inlets and no portion of the inlet masonry, including the base, is to be reused. The Contractor shall carefully remove the existing inlet casting, and when applicable, remove all the existing concrete from the wells on top of the existing casting, or replace with a new casting. The Contractor shall then fill the wells on top of the casting with class “C” concrete. The Contractor shall also carefully remove and clean the existing cast iron support bar (T-bar). This may require the complete removal of all old masonry and the reconstruction of the inlet in a new location. Workmanship, methods and materials shall be the same as specified for a new inlet of the same type. The finished brick work and casting shall conform to the new line and grade.

The old casting shall be set in mortar upon the new masonry and adjusted to line and grade.

563.06 Method of Measurement. The quantity to be paid for under this item shall be the actual number of inlets constructed, adjusted or reconstructed and the number of wingwall inlets or junction boxes constructed as specified and accepted.

Adjustments made on new inlets, such as the readjusting of castings to conform to the new pavement, are included in the price bid for the inlets.

563.07 Basis of Payment. Payment for accepted quantities, complete in place including the removal of all old masonry, will be made at the contract price for:

Item	Unit	Description
563	Each	No. _____Inlet
563	Each	Type _____ Inlet
563	Each	Wingwall inlet
563	Each	Junction box
563	Each	Inlet box
563	Each	Inlet reconstructed
563	Each	Inlet adjusted

ITEM 564 UNDERDRAINS

564.01 Description. This work shall consist of constructing pipe underdrains with granular filter, in accordance with these specifications and in reasonably close conformity with lines, grades and locations shown on the plans or established by the Engineer. The item shall include: all necessary excavations and backfill, furnishing and placing pipe, furnishing and installing all necessary pipe bends and branches of a type at least equal to the pipe of which they become a part, connection to inlets or other drainage structures, granular filter material, and all other materials necessary to complete the designated drains, and removal and disposal of all surplus excavation and discarded materials in accordance with 203.

564.02 Materials. Pipe shall be of the size and kind listed in the proposal. When the kind of pipe is not specifically itemized in the proposal, any of the following types may be used:

Perforated Concrete Pipe 706.06
Concrete Drain Tile, extra quality 706.07
Perforated Vitrified Clay Pipe 706.08
Galvanized Corrugated Steel Pipe 707.01
Corrugated Aluminum Alloy Pipe 707.12
Perforated Plastic and Polyethylene Corrugated
Drainage Pipe or tubing, heavy duty 707.15

Other materials shall be as follows:

Reinforcing steel.....509.02
Concrete (Class C)..... 499 and 511

564.03 Pipe Underdrains. Construction sequence for placing pipe underdrains shall be in accordance with 310.03.

Construction shall be as follows: (a) Excavation. Trench excavation shall be of such dimensions in all cases as will give ample room for construction. The trench shall be excavated to a minimum width of 12 inches to permit proper placing of the pipe. The excavation for the underdrains shall include the removal of any obstructions encountered.

Where pipe underdrains are to be placed within or beneath an embankment, the embankment shall be constructed to the elevation of the top of the subgrade before trenching for the pipe.

(b) Laying Pipe. The pipe shall be laid true to line and grade with close fitting joints. When bell and spigot pipe is used, it shall be laid with the bell end up grade. The pipe shall rest on a solid bed shaped to fit the pipe throughout its entire length. Lateral connections shall be made with suitable branches and bends. The upper ends of pipe underdrains shall be closed with suitable plugs. Connection of the underdrain to existing or proposed inlets or other drainage structures shall be included in this item.

Perforated pipe shall be so laid that the perforations are in the bottom half of the pipe.

(c) Backfilling. The underdrains shall be inspected before any granular filter material is placed. The granular filter materials shall be made from durable natural aggregates, No. 8 or No. 9, Table 703-1. It shall be placed around the pipe for the full width and depth of the trench and shall extend to the bottom of the pavement or subbase as shown on the plans. When underdrains are placed outside of the pavement or subbase area, the granular filter shall extend to within 4 inches of the finished grade. The remainder of the trench shall be backfilled with soil, placed in accordance with 203.

564.04 Method of Measurement. The footage of pipe underdrains to be paid for will be the actual number of linear feet of pipe with granular filter complete in place, measured as provided in 551.13.

564.05 Basis of Payment. The accepted quantities of pipe underdrains, measured as provided above, will be paid for under:

Item	**Unit**	**Description**
564	Linear Foot	_____ inch Pipe underdrains

ITEM 565 DROP CONNECTION ON EXISTING MANHOLE

565.01 Description. This item shall consist of construction of a drop connection on an existing sanitary manhole.

565.02 Materials. Materials used for construction of the drop connection shall be of the same kind and quality as specified for Item 562 - Drop Manhole on Pipe Sewer.

565.03 Construction Methods. Under this item, the Contractor shall construct an 8" drop connection on an existing brick manhole where none exists in accordance with the location and elevations shown on the plans and according to Construction Standard Drawing No. MH-9.

565.04 Method of Measurement. The quantity to be paid for shall be the number of drop connections as described above, complete and accepted by the Engineer.

565.05 Basis of Payment. Payment for the complete work will be made at the contract price for:

Item	Unit	Description
565	Each	Drop Connection on Existing Manhole

This price shall constitute full compensation for all labor, materials, equipment, tools and incidentals required to complete the work as specified herein, including all excavation, brick or concrete masonry, mortar and vitrified pipe bends, tees and stacks.

ITEM 566 - TRENCH DRAINS

566.04 Method of Measurement
566.05 Basis of Payment

566.01 Description. This item shall consist of the construction or reconstruction of a trench drain according to the lines and grades shown on the plans or as directed by the Engineer.

566.02 Materials. Materials shall be:

Concrete, Class 'C'	511
Slag or Limestone	703.02 or 703.08
Cast Frames, Grates and Covers	711.12 and 711.13
Expansion Joint Material	705.03

566.03 Construction Methods. Unless otherwise shown on the plans, trench drains shall be constructed as per Standard Drawing No. S-2.

566.04 Method of Measurement. The quantity shall be the total number of linear feet of trench drain constructed and accepted as determined by the Engineer's final measurement. Measurements shall be horizontal centerline measurements of the end-to-end length of covers or grates in place.

566.05 Basis of Payment. Payment for accepted quantities, complete in place, shall be made at the contract price for:

Item	Unit	Description
566	L.F.	Trench Drain

This price shall constitute full compensation for all labor, materials, equipment, tools and incidentals required to complete the work as specified herein, including excavation, furnishing and placing slag or limestone bedding, furnishing and installing frames, grates and covers, and furnishing and placing concrete and expansion joint material, and backfilling.