CHAPTER 4

STORM SEWERS AND DRAINS

STANDARD CONSTRUCTION SPECIFICATIONS

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STANDARD CONSTRUCTION SPECIFICATIONS

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401 - Tunneling, Boring, and Jacking

401.01.00 Description

401.01.01 Tunneling

Tunneling shall include all methods by which the underground passageway is first excavated and then pipe or conduit is either brought in and placed or cast into place.

401.01.02 Boring

Boring shall include all methods by which a pipe or conduit is pushed or pulled into place and by which the excavation method precludes the stationing of workers within the pipe or conduit without stopping or removing the excavation equipment.

401.01.03 Jacking

Jacking shall include all methods by which a pipe or conduit is pushed or pulled into place and one or more workers inside the conduit to excavate and assist in keeping the conduit on a straight and true grade and alignment.

401.01.04 Permitter

Within this Section, permitter shall mean the owner of railroad tracks or other facilities with prior rights, under which a pipe or conduit must be tunneled, bored, or jacked.

401.02.00 Materials

401.02.01 Pipe Bedding and Pipe Zone Material

Conform to the requirements of **Section 204 - Excavation, Embankment, Bedding, and Backfill.**

401.02.02 Pipe

Conform to **Section 402 - Pipe and Fittings (Storm Drain)** for the strength, class, and type as shown or specified.

401.02.03 Casing

Corrugated metal pipe may be used for casing in tunneled, bored, or jacked applications where specified and approved. Give coupling bands a protective coating similar to pipes. Provide galvanized bolts for connection. Corrugated metal pipe shall conform to the requirement in **Section 402 - Pipe and Fittings (Storm Drain)**.

Provide casing of size to permit proper construction to the required lines and grades. Casing shall be the type shown in the table below.

Use a minimum gauge or wall thickness corresponding to the size of casing selected from the following: however, be responsible for selecting the gauge consistent with the operations and the specified requirements of the permitter.

Diameter (Inches)	AASHTO M36 Corrugated Metal Pipe U.S. Standard Gauge	Smooth Steel Pipe Minimum Thickness
15-24 (381.00-609.60mm)	12	1/4 (6.35mm) ASTM A 53
30-36 (762.00-914.40mm)	10	5/16 (7.9375mm) AWWA C 201
48-78 (1219.20-1981.20mm)	8	Not Allowable

Equip jacked casings with nipples at the spring line and crown at 10-foot (3.048 m) centers when pressure grouting is specified.

Optionally construct the casing of galvanized standard, offset tunnel liner plate with gauge and section modulus per inch (25.40 mm) of width, as approved. Nipples for pressure grouting, when specified, shall be installed at the spring line and crown at 10-foot (3.0480 m) centers.

401.03.00 Construction

401.03.01 General

Conform to all Federal, State, and local laws and regulations pertaining to tunneling and specifically to the standards set forth in the Oregon Safety Code for Places of Employment, Chapter 24, Safety Code for Mining, Tunneling, and Quarrying published by the Oregon Industrial Accident Commission, latest revision.

Before the start of the work, submit satisfactory evidence to the Engineer that all insurance coverage requirements called for by the permitter have been complied with. All proposed construction methods and materials shall be approved by the Engineer and permitter before the start of construction. Written approval to proceed from the permitter shall be submitted to the Engineer before the start of construction.

401.03.02 Excavation

Excavation shall be unclassified and shall include whatever materials are encountered to the depths as shown or as required.

401.03.03 Tunneling Details Required

Submit details of the following to the Engineer for approval before beginning the tunnel construction:

1. Tunnel shaft bracing and dimensions.
2. Tunnel supports.
3. Method of backpacking tunnel supports.
4. Bracing to prevent pipe or conduit shifting and flotation.
5. Backfill material or pressure grout mix, placement method and equipment.

401.03.04 Jacking and Boring Details Required

Submit details of the following to the Engineer for approval before beginning the jacking or boring construction:

1. Jacking pit bracing.

2. Casing, pipe or conduit.

3. Jacking head.

4. Excavation method.

5. Tee or wye installation.

6. A substitute design for any part of the system that must be changed as a result of the jacking or boring operation (manhole, headwall, etc.).

7. Any structure that is required because of the particular method or procedure used by the Contractor.

8. If placed in a casing, bracing to prevent pipe shifting and flotation, backfilling material, method, and equipment.

9. Backfill material or pressure grout mix, placement method, and equipment.

401.03.05 Tunneling

Tunneling will be permitted only where shown, specified or approved.

Make the subgrade, upon which the pipe is to be placed or constructed, firm, thoroughly compacted, and true to grade. Pipe bedding shall conform to the standard plans for the type of bedding specified. Restore to grade by backfilling with approved bedding material, at no expense to the City, all excavation below grade, which is made inadvertently or without authority.

401.03.06 Alternate of Jacking or Boring

Jacking or boring may be allowed in lieu of the open trench method or tunneling. However, written approval by the Engineer must first be obtained. The Engineer retains the right to reject either the jacking or boring method without rejecting the other. Approval by the Engineer shall in no way relieve the Contractor of the responsibility for making a satisfactory installation meeting the requirements set forth herein.

401.03.07 Jacking and Boring

Equip the leading section of pipe or conduit with a jacking head securely anchored thereto to prevent any wobble or alignment variation during the jacking or boring operation. For jacking, all excavation shall be carried out entirely within the jacking head, and no excavation in advance thereof shall be permitted. For jacking, every effort shall be made to avoid any loss of earth outside the jacking head. Remove excavated material from the pipe or conduit as excavation progresses, and do not allow such material to accumulate within the pipe or conduit.

Once the jacking operation has commenced, it shall be continued uninterrupted around the clock until the conduit has been jacked between the specified limits.

Jack or bore all pipes or conduits to true line and grade. Should any deviation from true line and grade be considered excessive, in the judgment of the Engineer, take up and relay that portion of the pipe or conduit at no expense to the City.

Should appreciable loss of ground occur during the jacking or boring operations, backpack all voids promptly. Fill all remaining voids upon completion of the operations; such filling or backpacking shall be with grout or approved granular material.

The design of all pipe or conduit is based upon the superimposed loads and not upon the loads resulting from the jacking or boring operations. Be responsible for any increase in pipe strength necessary to withstand jacking or boring loads.

401.03.08 Concrete Pipe and Box Section

Protect the driving ends of concrete pipe or conduit against spalling and other damage. Intermediate joints shall be similarly protected by the installation of sufficient bearing shims to properly distribute the bearing stresses. Remove any section of pipe or conduit showing signs of failure and replace with a new section or with a cast-in-place section which, in the judgment of the Engineer, is adequate to carry the loads imposed upon it.

401.03.09 Smooth Steel Casing

Join sections of smooth steel casing to be jacked or bored by welding the joints with a continuous weld for full circumference or by other approved means. Provide joints which are capable of resisting the jacking and boring forces without failure.

Brace pipe or conduit installed in a casing to prevent shifting and flotation. Fill the void between the casing and the pipe or conduit with grout, or other material as specified or approved.

If not shown or specified, the casing diameter shall be the option of the Contractor. Provide casing of such strength as to withstand the jacking or boring loads and of such diameter to allow filling the void between the pipe or conduit and casing with the approved material.

401.03.10 Grouting Voids Outside Casing or Tunnel Liner

When grouting is specified, after the casing has been jacked into position or the liner plates have been placed in the tunnel, pressure grout to fill all voids outside the casing or liner plates through the grout holes provided. Start grouting at the spring line hole at one end and pump grout until grout appears in the grout hole at the crown, then start grouting through the opposite spring line hole until grout appears at the hole in the crown. Next grout through the hole at the crown until grout appears in the next set of holes along the pipe. Plug the holes at the

starting point and move to the next set of holes and repeat grouting sequence until full length of jacked, bored, or tunneled pipe has been grouted. Grouting once commenced at any one point shall be completed without stopping.

401.03.11 Cased or Tunneled Pipe

Where timber cradles are shown, provide strapped timber cradle under barrel of pipe, join pipe, and slide into casing. Pipe barrel shall bear continuously on cradles. Pipe installation shall conform to applicable requirements in **Section 402 - Pipe and Fittings (Storm Drain)**, including hydrostatic or air testing and line and grade.

401.03.12 Placing Backfill Outside Carrier Pipe

Where shown or when directed, completely fill the annular space between the casing or tunnel liner and the carrier pipe or conduit with specified or approved backfill material. Accomplish backfilling by pumping material from the two ends at such intermediate points as may be necessary in a manner which will ensure all voids are filled. When grouting use approved low pressure grouting equipment.

401.03.13 Railroad Crossings

The right is reserved by the City to require tunneling, jacking, or boring under any or all crossing.

Should open trench construction be required by the City at a railroad crossing, the railroad will take up and relay the tracks at no expense to the Contractor. Submit a schedule of operations to the railroad company and to the City 72 hours before trenching within 20 feet (6.096 m) of the railroad tracks. Construct the pipe crossing and compact backfill through the track location within 72 hours after the tracks have been removed by the railroad unless otherwise specified.

When a tunneling alternate is chosen, special attention shall be given to the backfill. Backfill as required in **Section 204 - Excavation, Embankment, Bedding, and Backfill.**

401.04.00 Measurement and Payment

401.04.01 Tunneling, Boring, and Jacking

Measurement and payment for tunneled, bored, and jacked pipe or conduit will be made on a linear foot (meter) basis. Payment will include full compensation for all excavation, shafts, portals, jacking pits, tunnel stabilization, backfill, lubricant,

grouting pipe, casing, and all appurtenances as approved, complete, except for tees and wyes.

Where casing is used at the option of the Contractor, the casing and the backfill between the pipe or conduit and the casing shall be included in the pay item for tunneling, boring, or jacking as applicable, and no separate payment will be made therefor.

Measurement for tunneling, jacking and boring will be made on a linear foot (meter) basis along the centerline of the pipe or conduit between portals. Tunneling, jacking, and boring extensions beyond the limits shown shall be considered to be for the Contractor's convenience, unless ordered in writing, and measurement and payment for said extension shall be made as if the open trench method of construction had been used.

401.04.02 Jacking or Boring in Lieu or Tunneling

Where jacking or boring of a pipe or conduit is approved in lieu of tunneling, measurement and payment will be made as though the tunneling method had been used and payment shall be made at the bid price for tunneling.

401.04.03 Tunneling, Jacking, or Boring in Lieu of Open Trench

Where tunneling, jacking, or boring of a conduit is approved in lieu of open trench construction, measurement and payment will be made as though the open trench method had been used and will include all the pay items that would have been applicable if the open trench construction method had been used.

401.04.04 Tunneling in Lieu of Jacking or Boring

Where tunneling of a pipe or conduit is approved in lieu of jacking or boring, measurement and payment will be made as though the jacking or boring method had been used and payment shall be made at the bid price for jacking or boring as applicable.

401.04.05 Railroad Track Crossings

Alternate bids for tunneling, jacking, or boring track crossings, if in the proposal, are add or deduct adjustments per linear foot (meter) to the computed open trench cost. The computed open trench cost shall be based on the standard pay width, the depth as shown, the length as actually tunneled, portal to portal (except that it shall not exceed the maximum length as shown), and the following assumed pay items:

1. Trench excavation and granular backfill.

2. Pipe or conduit of the size and strength shown.

3. Surfacing material of the same type and thickness as exists within the track section.

4. Pavement base courses when required.

5. Crushed Aggregate for Class "B" pipe bedding, see **Subsection 204.03.17A**.

401.04.06 Tees and Wyes

Measurement and payment for tees and wyes in the tunneled, jacked, or bored pipe or conduit will be made at the contract unit price for tees and wyes installed in an open trench as provided for in **Section 402 - Pipe and Fittings (Storm Drain)**.

402 - Pipe and Fittings (Storm Drain)

402.01.00 Description

This Section covers the following work:

1. Gravity storm sewer pipe
2. Culverts
3. Perforated pipe underdrains
4. Fittings

402.02.00 Materials

The following solid pipe materials are acceptable, when installed according to manufacturer's specifications:

Non Reinforced Concrete Pipe	ASTM C 14
Reinforced Concrete Pipe	ASTM C 76
Polyvinyl Chloride (PVC)	ASTM D 3034
Corrugated High Density Polyethylene Pipe (N-12)	AASHTO M 294 Type C
Corregated High Density Polyethylene Pipe (N-12), smooth inside	AASHTO M 294 Type S
Ductile Iron Pipe	AWWA C 151

The following perforated pipe materials are acceptable, when installed according to manufacturer's specifications:

Pipe and Fitting Material	Specifications
Unreinforced Concrete Pipe	ASTM C 14
Reinforced Concrete Pipe	ASTM C 76
PVC (SDR 35 minimum)	ASTM D 3034
Perforated Concrete Pipe	ASTM C 444
Perforated PVC Pipe	ASTM D 3034

(See Standard Plans for perforated pipe details)

Other pipe materials for storm drains, culverts, pipe arches, elliptical pipe and other special purposes may be considered on a case by case basis, but will require the specific written approval of the Director of Public Works.

402.02.01 General

Use all storm pipe and fittings of the size, strength, material, and joint type specified on the plans and/or in the proposal. Use jointing material as hereinafter specified for each pipe material. Each piece of pipe shall be clearly identified as to strength, class, and date of manufacture. The manufacturer or fabricator shall furnish appropriate certification, based on manufacturer's routine quality control tests, that the materials in the pipe and fittings meet the requirements specified herein. Strength, permeability, hydrostatic tests, and pipe joints will be used as the basis of acceptance as described under proof tests herein. Minimum length of pipe shall be 3.5 feet (1.0668 m).

402.02.02 - 402.02.15 Reserved

402.02.16 Jointing Materials

Use only lubricants for jointing materials approved by the manufacturer.

402.02.16A - Concrete Pipe

Use rubber gaskets for bell and spigot pipe conforming to ASTM C 443. Use captive gasket in groove design for pipe 24 inch (609.60 mm) diameter and larger. Mortar for tongue and groove pipe shall conform to **Section 205 - Materials.**

402.02.16B - Reserved

402.02.16C - Reserved.

402.02.16D - Cast Iron and Ductile Iron Pipe

Use rubber gaskets conforming to ANSI A21.11.

402.02.16E - Reserved

402.02.16F - PVC Pipe

Use rubber gaskets for PVC pipe conforming to ASTM F 477.

402.02.16G - High Density Polyethylene Pipe (HDPE)

For Corrugated High Density Polyethylene (CHDPE) pipe use only lubricants and joining materials as approved by the manufacturer.

402.02.17 - 402.02.19 Reserved

402.02.20 Fittings

402.02.20A - General

Provide tee or wye fittings in storm lines, catch basin or inlet connections. All fittings shall be of sufficient strength to withstand all handling and load stresses encountered. All fittings shall be of the same materials as the pipe unless otherwise specified. Material joining the fittings to the pipe shall be free from cracks and shall adhere tightly to each joining surface. Use the same type of joints on all fittings that are used on the main line pipe. Tee or wye fittings shall

not be closer than 12 inches (304.80 mm) to any joint or bell of main line which is 12 inches (304.80) or less in diameter.

402.02.20B - Concrete Pipe

Use shop fabricated fittings on 12 inch (304.80 mm) and smaller concrete pipe. Fittings on pipe 15 inches (381.00) and larger may be field or shop fabricated.

Submit and obtain approval of fabrication details for shop fabricated fittings prior to delivery of fittings to the job site.

402.02.20C - Reserved

402.02.20D - Reserved

402.02.20E - Cast Iron and Ductile Pipe

Use mechanical joint cast iron fittings conforming to ANSI A21.10 and AWWA C 110, and of a class at least equal to that of the adjacent pipe. Use push-on fittings of gray cast iron with body thickness and radii of curvature conforming to ANSI A21.10 and joints conforming to ANSI A21.11 and AWWA C 111 or Federal Specification WW-P-421C.

402.02.20F - PVC Pipe

Use push-on type fittings for joints conforming to the same standards as the pipe.

402.02.20G - Reserved

402.02.20H - HDPE Pipe

Use fittings which conform to ASTM D 3350. Pressure testable fittings shall meet the requirements of ASTM F 1336. O-Ring gaskets shall meet the requirements of ASTM F 477. Installation shall be per ASTM D 2321.

402.02.21 Couplings, Bands, and Fittings for Corrugated Metal and Polyethylene Pipe

Use couplings, bands, and fittings as specified by the pipe manufacturer and approved by the Engineer.

402.03.00 Construction

Trench Excavation and Backfill.

1) Excavate to grades staked in field, allowing for 4 inches (101.60 mm) of bedding material beneath pipe.
2) Sheet, shore and brace as required.
3) Place pipe bedding material and shape to receive pipe circle.
4) Backfill with care, protecting pipe from damage, movement, etc.
5) Place and compact backfill in conformance with the appropriate standard plan. Resurfacing shall be as specified in **Section 405** or as shown.
6) Restore surface features to original conditions as set forth in **Subsection 405.01.00**.

The following Standard Plans, included in these specifications, may be applicable in whole or in part to the work:

Plan Number	Title
ST-30	TYPE 1 CATCH BASIN
ST-31	TYPE 2 CATCH BASIN
ST-32	TYPE 3 CATCH BASIN
ST-33	CATCH BASIN GRATES AND FRAMES
ST-40	STORM DRAIN STD. MANHOLE
ST-41	LARGE DIAMETER STD. MANHOLE
ST-42, 43 and 44	SHALLOW MANHOLE
ST-45	MANHOLE FRAMES, COVERS & RISER RINGS
ST-50 through 54	TYPICAL TRENCH DETAILS

Pipe Work.

1) Handle pipe to avoid damage.
2) Lay pipe to within 1/2 inch (12.70 mm) of line and 1/4 inch (6.35 mm) of grade as line and grade are established in the field.

402.03.01 Line and Grade for Storm Sewers

Do not deviate from line or grade, as established by the Engineer, more than ½ inch (12.70) for line and 1/4 inch (6.35 mm) for grade, provided that such variation does not result in a level or reverse sloping invert. Measure for grade at the pipe invert, not at the top of the pipe, because of permissible variation in pipe wall thickness. Establish line and grade for pipe by the use of approved lasers or by transferring the cut from the offset stakes to batter boards at maximum

intervals of 25 feet (7.62 m). If batter boards prove impractical because of trench conditions, submit other methods of grade and alignment control for approval.

402.03.02 Pipe Distribution and Handling

Distribute material on the job no faster than it can be used to good advantage. Unload pipe only by approved means. Do not unload pipe of any size by dropping to the ground. Do not distribute more than one week's supply of material in advance of laying, unless approved.

Inspect all pipe and fittings prior to lowering into trench to ensure no cracked, broken, or otherwise defective materials are used. Clean ends of pipe thoroughly. Remove foreign matter and dirt from inside of pipe and keep clean during and after laying.

Use approved implements, tools, and facilities for the safe and proper protection of the work. Lower pipe into the trench in such a manner as to avoid any physical damage to the pipe. Remove all damaged pipe from the jobsite. Do not drop or dump pipe into trenches.

402.03.03 Pipe Laying and Jointing of Pipe and Fittings

402.03.03A - General

Proceed with pipe laying upgrade with spigot or tongue ends pointing in direction of flow. Place pipe in such a manner as to ensure solid bearing between the pipe and the full cross sectional accordance with the recommendations of the manufacturer. Take care to properly align the pipe before joints are forced entirely home. Upon completion of pipe laying all pipe joints shall be in the "Home" position, which is defined as the position where the least gap (if any) exists, when the pipe components that comprise the joint are fitted together as tightly as the approved joint design will permit. Gaps at pipe joints shall not exceed that allowed by the manufacturer's recommendations. For curved lines the normal gap will be the gap existing when the pipe joints are in the home position as described above, for the pipe in the specified deflected position. After installation prevent movement from any cause including uplift or floating.

Take special care to prevent movement of the pipe after installation when laid within a movable trench shield.

When laying operations are not in progress, protect the open end of the pipe from entry of foreign material and block the pipe to prevent movement or creep of gasketed joints.

Plug or close off pipes which are stubbed out for manhole construction or for connection by others.

Provide all pipes, 36 inches (914.40 mm) or smaller in diameter, entering or leaving manholes or other structures, with flexible joints within 18 inches (457.20 mm) of the exterior wall. Pipes larger than 36 inches (914.40 mm) in diameter shall have this flexible joint within a distance from the exterior wall equal to one-half the inside pipe diameter.

When cutting and/or machining the pipe is necessary, use only tools and methods recommended by pipe manufacturer.

When shown or approved to deflect pipe from a straight line, either in the vertical or horizontal plane, or when long-radius curves are shown, the amount of deflection allowed shall not exceed that specified or approved by the Engineer.

The pipe manufacturer's recommendations will serve as a guide but the decision of the Engineer shall be final.

Under normal conditions minimum cover shall be 24 inches (609.60 mm) above the top of the pipe in paved areas and 30 inches (762.00 mm) at all other locations.

402.03.03B - Concrete Pipe

Use rubber ring gasket joints unless mortar joints are specifically specified. When mortared joints are used, the entire joint for the full circumference of the pipe shall be completely filled with mortar. The surfaces of the pipe joint shall be brushed clean prior to mortaring. Fill the exterior of the joint with mortar and in the case of bell and spigot joints, fill to an angle of 45 degrees.

Lay elliptical reinforced pipe so that the top or bottom marks are not more than 5 degrees from a vertical plane.

402.03.03C - Corrugated Metal Pipe

Repair all damaged areas of the protective coating with material similar to the original as approved and permit to dry or solidify before backfilling.

402.03.04 Perforated Pipe Underdrains

402.03.04A - Trench Excavation and Backfill

Conform to applicable requirements in **Section 204 - Excavation, Embankment, Bedding, and Backfill.**

402.03.04B - Pipe Bedding

Provide filter fabric as shown. Provide a minimum 4 inch (101.60 mm) bedding of special filter material under perforated drain pipe, or as shown. Hand grade the bedding to proper grade ahead of pipe laying. Provide a firm, unyielding support along the entire pipe length.

402.03.04C - Backfill at the Pipe Zone

Backfill the pipe zone with special filter material, hand placed simultaneously on both sides of the pipe for the full trench width.

402.03.04D - Backfill Above the Pipe Zone

Use special filter material for backfill above the pipe zone, unless otherwise specified.

402.03.04E - Laying and Jointing Perforated Pipe

Securely fasten together perforated pipe with couplings, fittings, or bands as specified by the manufacturer for the type of pipe used. Close upgrade ends of all subsurface drain pipe with approved plugs to prevent entry of soil materials.

Begin pipe laying normally at the outlet end of the pipe line. The lower segment of pipe shall be in contact with the shaped bedding throughout its full length. Bell or groove ends of rigid pipe and outside circumferential laps of flexible pipe shall be placed facing the upgrade end.

Inspect all pipe prior to lowering into the trench and, if necessary, clean off any material tending to plug the perforations of the pipe. Have available the proper tools, labor, and equipment for efficient execution of the work. Carefully lower all pipe and fittings into the trench to avoid any contamination of the filter bedding material.

402.03.05 - 402.03.10 Reserved

402.03.11 Culverts

Remove and replace culverts in conformance to all applicable requirements of this Section and **Section - 204 Excavation, Embankment, Bedding, and Backfill.**

402.03.12 - 402.03.14 Reserved

402.03.15 Deflection Test for PVC and HDPE Pipe

A deflection test may be required of all storm drains and culverts constructed of PVC, or CHDPE pipe after the trench backfill and compaction has been completed. If required, deflection test will be performed by the City in conjunction with the television inspection as stated in **Subsection 402.03.16 Television Inspection of Storm Drains.** The test shall be conducted by puling an approved solid pointed mandrel or a variable deflection measuring gauge through the completed pipeline. The diameter of the mandrel shall be 95 percent of the pipe diameter unless otherwise specified by the Engineer. Testing will be conducted by the City on a manhole-to-manhole basis and only after the line has been completely cleaned by the Contractor. Locate and repair any sections failing to pass the test and to retest the section, at no expense to the City. Do not use the solid pointed mandrel on the 11th month inspection due to live services.

402.03.16 Television Inspection of Storm Drains

The City may require a televised inspection of the storm drain pipe. If the televised inspection reveals defects, the Contractor will reimburse the City for the costs of the television inspection. Any defects in material or workmanship shall be satisfactorily corrected prior to final acceptance of the work.

When the quality of materials used or workmanship performed during the construction of storm drains is in doubt for any reason, the Engineer may require the storm drain and all applicable appurtenances to be tested. When so ordered, the storm drain shall be required to pass an air test as specified by the Engineer.

Prior to a television inspection the contractor shall clean all parts of the system. Remove all accumulated construction debris, rocks, gravel, sand, silt and other foreign material from the system. Upon the Engineer's television inspection, if any foreign matter is still present, the Contractor will re-clean the system.

Findings will be recorded. All deficiencies will be corrected at no expense to the City. Upon correction of deficiencies revealed by televiewing, notify the Engineer; the same steps listed above may be repeated until all work is acceptable.

402.03.17 Mandrel Deflection Test

The City may, at its own option, perform the mandrel deflection test at the same time it performs its television inspection.

402.04.00 Measurement and Payment

Payment indicated to include complete compensation for all labor, equipment, materials and incidentals involved in the construction of the storm drainage facilities.

402.04.01 Storm Drain Pipe

Measurement and payment for conduits and storm drain pipe, including culverts, and pipe stubouts from manholes, will be made on a linear foot (meter) basis for the type and class of storm pipe the Contractor selects from acceptable pipes shown on the plans for the sizes and bedding classes of pipe listed in the proposal and as actually installed. All pipe will be measured horizontally from center-to-center of manholes or to the ends of the pipe, whichever is applicable. No deductions will be made for fittings or for structures.

Payment shall constitute full compensation for the pipe in place, including connection of new pipe to new manholes, testing, and plugs.

Payment for new tees, wyes, field taps, and permanent plugs will be made separately under the respective items shown in the proposal. There will be no separate payment for pipe and fittings used by the Contractor to facilitate the air test or for concrete closure collars and connections to existing pipes using "Calder" coupling, or equal, in conformance with material and construction Subsections of this Section, it being understood that the costs thereof are included in and incidental to the contracted prices for the applicable fitting or pipe work items listed in the proposal.

402.04.02 Perforated Pipe Underdrains

Measurement and payment for perforated drain pipe will be made on a linear foot (meter) basis for the type and size of pipe installed as shown in the proposal. Length will be measured as total length of pipe installed, including fittings measured along the pipe centerline. Payment shall constitute full compensation for trench excavation, special filter material for pipe bedding and trench backfill, and all other work specified to complete the installation of the perforated drain pipe complete in place.

402.04.03 - 402.04.04 Reserved

402.04.05 Concrete Closure Collars and Reconnections

Measurement and payment for concrete closure collars and/or reconnections will be made at the unit price each as shown in the proposal and actually constructed. Payment shall include full compensation for all materials, equipment, and labor necessary to complete the work.

402.04.06 Reserved

402.04.07 Field Fabricated Connections

Measurement and payment for field fabricated connections will be made at the unit price each for the type and size as shown in the proposal. Payment shall include full compensation for all materials, equipment, and labor necessary to complete the work.

403 - Manholes, Inlets, and Concrete Structures

403.01.00 Description

This Section covers the work necessary for the construction of the following items:

1. Manholes
2. Drop Assemblies
3. Sumps
4. Inlets and Catch Basins
5. Anchor Walls
6. Special Concrete Structures
7. Concrete Encasement

403.02.00 Materials

403.02.01 Base Rock and Drain Gravel

One inch (25.40 mm) minus base rock, conforming to the requirements for aggregate base material in **Section 303 - Aggregate Bases.** Drain gravel shall conform to **Subsection 204.02.06B - Bank-run and River-run Gravel.**

403.02.02 Forms

Forms for exposed surfaces shall be steel or plywood. Others shall be matched boards, plywood, or other approved material. Form all vertical surfaces. Trench walls, large rock, or earth will not be approved form material.

403.02.03 Manholes

403.02.03A - Standard Precast Manhole Sections

Furnish sections as specified conforming to the details on the standard plans and to ASTM C 478. Manhole cone sections shall have the same wall thickness as barrel sections and conform to all the requirements of ASTM C 478 with the exception of the steel reinforcement requirement. The steel reinforcement may be replaced with Fibermesh I as manufactured by the Fibermesh Company or approved equal. The minimum length of the fibers shall be 2 inches (50.80 mm) with a minimum of 1.6 pounds (0.72576 kg) of fiber per cubic yard (0.7646 m^3) of concrete. Top and bottom of all sections shall be parallel.

Prior to the delivery of any size of precast manhole section on the job site, yard permeability tests will be conducted at the point of manufacture. The precast sections to be tested will be selected at random from the stockpiled material which is to be supplied for the job. All test specimens will be material tested, and shall meet the permeability test requirements of ASTM C 14 and ASTM C 497.

403.02.03B - Standard Monolithic Manhole

Conform to details on the standard plans.

403.02.03C - Precast Concrete Bases

When shown or specified, precast base sections may be used provided all details of construction are approved prior to fabrication. They may be used only with Portland Cement concrete manholes. The Contractor must obtain the Engineer's written approval of his/her submitted shop drawings prior to shipment. In the event construction details are shown on the project plans and the Contractor does not intend to deviate therefrom, the shop drawing requirement may be waived by the Engineer.

403.02.03D - Manhole Grade Rings

Concrete grade rings for extensions shall be a maximum of 6 inches (152.40 mm) high and shall be approved before installation.

403.02.03E - Jointing Materials

Mortar shall conform to the requirements of ASTM C 387, or be proportioned one part Portland Cement to two parts clean, well-graded sand which will pass a 1/8 inch (3.175 mm) screen. Admixtures may be used not exceeding the following percentages of weight of cement: hydrated lime, 10 percent; diatomaceous earth, or other inert materials, 5 percent. The consistency of the mortar shall be such that it will readily adhere to the precast concrete if using the standard tongue-and-groove type joint. Mortar mixed for longer than 30 minutes shall not be used.

Nonshrink grout shall be Sika 212, Euco N-S, Five-Star, or approved equal nonmetallic cementitious commercial grout exhibiting zero shrinkage per ASTM C 827 and CRD-C-621. Grout shall not be amended with cement or sand and shall not be reconditioned with water after initial mixing. Unused grout shall be discarded after 20 minutes and shall not be used.

Nonshrink grouts shall be placed or packed only with the use of an approved commercial concrete bonding agent applied to all cured concrete surfaces being grouted. The bonding agent shall be compatible with the brand of grout used. Water shall not be used as a substitute for the commercial bonding agent.

Preformed plastic gaskets shall meet all the requirements of Federal Specification SS-S-00210.

Rubber gasket materials shall conform to ASTM C 443.

403.02.03F - Metal Manholes

Where corrugated metal manholes are shown or specified, submit shop drawing by the manufacturer for approval prior to shipment.

403.02.03G - Manhole Steps

Manhole steps shall be a minimum of 11 inches (279.40 mm) wide by 9 inches (228.60 mm) deep by ½ inch (12.70 mm) diameter, safety type, using ASTM A 36 structural steel or ASTM 615 grade 40, rebar completely encapsulated in a corrosion-resistant, resilient compound, pressure molded to the steel. Finished steps shall be nonsparking and nonconductive and shall meet current O.S.H.A., and ASTM C 478 requirements. They shall be driven 2½ inches (63.50 mm) into predrilled holes in the manhole wall providing a compression fit that will resist a pullout force of at least 300 pounds (136.08 kg) per leg.

Steps that are not encased in a resilient compound shall be 3/4 inch (19.05 mm) diameter and shall be galvanized in accordance with ASTM A 123. Steps for installation during casting of manhole barrel sections shall have a lip of at least 1 inch (25.40 mm) at the embedded end thereof.

403.02.04 Pipe and Fittings

Conform to requirements of **Section 402 - Pipe and Fittings (Storm Drain).**

403.02.05 Precast Inlets and Catch Basins

Precast units may be used in lieu of cast in place units when approved by the Engineer. Details of proposed units shall be submitted for approval. Concrete risers for extensions shall be a maximum of 6 inches (152.40 mm) in height and of the same quality as the main section. Risers shall only be used where approved.

403.02.06 Precast Sump

Conform to requirements shown on the applicable plans and the applicable requirements herein for precast units and drain gravel.

403.02.07 Manhole Frames and Covers

403.02.07A - General

All castings shall be true to size, weight and tolerances shown on the applicable plans. Delivered weight shall be plus or minus 5 percent of the specified weight. The bearing seat shall not rock when checked by the test jig. The foundry shall supply all test gauges and shall not subcontract any of the work other than testing procedure, patterns, machining, and cartage. The casting shall not be made by the open mold method and shall be free of porosity, shrink cavities, cold shuts, or cracks, or any defects which would impair serviceability. Repair of defects by welding, or by the use of smooth-on or similar material will not be permitted. All casting shall be shot or sandblasted, and the application of paint or other coating will not be permitted. Each casting shall have distinctly cast upon it the initials of the manufacturer and the year of the cast. These characters shall be minimum 1 1/4 inch (31.75 mm) in height and 1/8 inch (3.175 mm) in relief.

403.02.07B - Materials

Conform to ASTM A 48, Class 30B, with the following revisions:

Tensile Strength	30,000 psi (206.85 MPa)
Traverse Strength: ½" (12.70 mm) dia. bar--18" (457.20 mm) centers	
Load - Pounds (kg)	2,600-3,000 (1179.36-1360.80 kg)
Deflection - Inches (mm)	0.22 - 0.34 (5.59-8.84 mm)
Brinell Hardness (as cast)	173 - 200

The foundry shall certify as to the tensile and traverse properties and the Brinell Hardness. The City reserves the right to require a rough transverse bar (size of bar 1.2 inch (30.84 mm) diameter by 20 inches (508.00 mm) long) and/or a tensile bar as per ASTM A 48 for each 20 castings or heat when less than 20 castings are made.

403.02.07C - Inspection

Notify the City at least 24 hours in advance of casting the units or bars. At least 24 hours' notice shall also be given prior to final gauging and inspection. When directed, the following strength test shall be made on the manhole cover. The cover, while resting in its frame, shall sustain a concentrated load of 40,000 pounds (18 144 kg) applied at its center through a 2½ inch (63.50 mm) plug. The Engineer may, at any time, require up to 5 percent of the job and/or order and in no case less than one cover to be tested in this manner. In case of failure during the test, additional covers shall be furnished until the tests prove satisfactory. All covers that pass this test will be returned. The City will not be responsible for those that fail the test.

403.02.07D - Cap Screws

Cap screws and washers for tamperproof and watertight manhole covers shall be stainless steel with 60,000 psi (413.70 MPa) minimum tensile strength conforming to ASTM A 453.

403.02.08 Standard Frames and Grates for Inlets and Catch Basins

Frames and grates for catch basins and storm drain inlets shall be fabricated of steel conforming to ASTM A 7, A 36, or A 373 in accordance with the details shown on the standard plans. All connections shall be welded. Welding shall conform to requirements of current code for welding in building construction of the American Welding Society. Frames and gratings shall be tested one within the other and there shall be no more than 1/16 inch (1.5875 mm) rock. When

checked by a test jig, the bearing seat of either component shall have no more than 1/16 inch (1.5875) rock. Test jigs shall be furnished by the manufacturer.

403.03.00 Construction

403.03.01 General

Catch basins shall conform to standard plans.

Manholes shall conform to standard plans.

403.03.01A - Excavation and Backfill

Conform to applicable provision in **Section 204 - Excavation, Embankment, Bedding, and Backfill**. Backfill around manholes and other appurtenances shall be of the same quality as the trench backfill immediately adjacent.

403.03.01B - Base Rock

When specified or directed, place crushed aggregate base rock thoroughly compacted to the required thickness and density.

403.03.01C - Foundation Stabilization

If material in bottom of excavation is unsuitable for supporting manholes and other appurtenances, excavate below subgrade as directed and backfill to required grade with rock conforming to Foundation Stabilization in **Section 204 - Excavation, Embankment, Bedding, and Backfill.**

403.03.02 Manholes

403.03.02A - Base and Sections

Construct manholes as shown on the detail drawings or standard plans. Densify the concrete base by vibrating or working as approved and screed to provide a level, uniform bearing for precast sections or formed wall extensions.

Deposit sufficient mortar on base to assure watertight seal between base and manhole wall or place the first precast section of manhole in concrete base before concrete has set, if preferred. First section shall be properly located and plumb. When installing a precast base, assembling precast manhole sections or elsewhere, when cured concrete is joined to cured concrete, use neoprene or mastic at the

joint to provide a compression seal which will be watertight when complete. Grout the joint at the inside surface to provide a smooth wall surface.

All lift holes shall be thoroughly wetted, then completely filled with mortar, and smoothed and pointed both inside and out to ensure water tightness.

Preformed plastic or rubber gaskets shall be used on manholes. Mortar will be allowed on storm manholes, and on 24 inch (609.60 mm) extension rings above the cone. All mortar joints between precast elements shall be thoroughly wetted, then completely filled with mortar. On proposed street grades, a minimum of one 24 inch (609.60 mm) precast riser will be required between the cone and manhole cover frame.

When the keylock joint is used, it is the intent that the void between the tongue-and-groove be completely filled with mortar and that the interior and exterior end faces of the section to be placed seat fully on the previously placed section.

Prevent mortar from drying out and cure by applying an approved curing compound or comparable approved method. Chip out and replace all cracked or defective mortar. Other types of jointing materials may be used in lieu of mortar only when approved by the Engineer. Preformed plastic gaskets shall be installed in strict accordance with the manufacturer's recommendations. Only pipe primer furnished by the gasket manufacturer will be approved. When using preformed plastic gaskets, manhole sections with chips or cracks in the jointing surfaces shall not be used. Completed manholes shall be rigid. Construct manhole inverts in conformance with the standard plans with smooth transitions to ensure an unobstructed flow through manhole. Where a full section of pipe is laid through a manhole, break out the top section to the full width of pipe and diameter of the manhole. Cover exposed edges of pipe completely with mortar. Trowel all mortar surfaces smooth.

403.03.02B - Pipe Connections

Special care shall be taken to see the opening through which pipes enter the structure are completely watertight. All pipe shall be connected to manholes according to the manufacturer's recommendations. All rigid nonreinforced pipe entering or leaving the manhole shall be provided with flexible joints within 1 foot (0.3048 m) of the manhole structure and shall be placed on firmly compacted bedding.

Concrete pipe connections to sanitary manholes shall be grouted watertight with nonshrink grout conforming with **Subsection 403.02.03E - Jointing Materials.**

403.03.03 Drop Assemblies

Construct drop assemblies at locations indicated and as shown on the standard plans.

403.03.04 Pipe Stubouts from Manholes

Install stubouts from manholes as shown or directed. Grout pipes into manhole walls or manhole base to provide watertight seal around pipes.

403.03.05 Manhole Grade Rings

Manhole grade rings shall be installed in such a manner as to prevent infiltration of surface or ground water between the grade ring(s) and the concrete of the manhole section.

Install grade rings as shown on standard plans to the height directed. Lay grade rings in mortar with sides plumb and tops level. Seal joints with mortar as specified for manhole section. Extensions shall be watertight.

In general, manhole grade rings will be used on all manholes in streets or roads or in other locations where a subsequent change in existing grade may be likely. Extensions will be limited to a maximum height of 12 inches (304.80 mm). Finish grade for manhole covers shall conform to finished ground or street surface unless otherwise directed.

403.03.06 Manhole Frame and Covers

Manhole frames and covers shall be installed in such a manner as to prevent infiltration of surface or ground water between the frame and the concrete of the manhole section.

Set frames in a bed of mortar with the mortar carried over the flange of the frame as shown on the standard plans. Set frames so tops of covers are flush with surface of adjoining pavement or ground surface, unless otherwise shown or directed.

403.03.07 - 403.03.09 Reserved

403.03.10 Concrete Encasement for Storm Drain Pipe

Conform to the requirement shown on the standard plans and to applicable requirements of **Section 204 - Excavation, Embankment, Bedding, and Backfill.**

Foundation stabilization, if required, shall be completed and the bottom of the trench compacted, as approved. Sides of encasement shall be formed, not poured against soil or rock, unless directed or approved by the Engineer.

Support pipe true to line and grade as approved before and during placement of concrete. Encasement may be placed in two lifts only with prior approval. If concrete is approved to be placed in two lifts provide a keyway on both sides of the encased pipe and vertical reinforcing bond steel as shown or a directed. Place concrete starting at the lower end of the encasement.

After concrete encasement has been placed and taken an initial set, cure by covering with well-moistened earth or backfill material for five days before conducting hydrostatic or air tests.

403.03.11 Anchor Walls

Conform to details shown on the appropriate plan. Do not overexcavate in the areas where anchor walls are to be poured. Construct suitable forms that will allow the downhill wall to have a full bearing surface against undisturbed earth. Cure concrete for five days before conducting hydrostatic or air tests.

403.03.12 Special Concrete Structures

Conform to the details as shown and to the applicable provisions for monolithic concrete construction specified herein.

403.03.13 Placing Precast Units

When precast units are approved, if material in bottom of trench is unsuitable for supporting unit, excavate as directed and backfill to required grade with foundation stabilization material in conformance with **Section 204 - Excavation, Embankment, Bedding, and Backfill**. Set units to grade at locations shown or as directed.

403.03.14 Inlet and Catch Basin Extensions and Catch Basins

When approved, install extensions to height as directed. Lay risers in mortar with sides plumb and tops to grade. Joints shall be sealed with mortar, with interior and exterior troweled smooth. Prevent mortar from drying out and cure by applying an approved curing compound or other approved method. Extensions shall be watertight.

403.03.15 Installation of Inlet and Catch Basin Frames and Grates

Set frames and grates at elevations shown or as directed. Frames may be cast in, or shall be set in mortar. Bearing surfaces shall be clean and provide uniform contact. Anchor bolts and other fastenings shall be firmly bedded in concrete or otherwise secured as approved.

403.03.16 Precast Sump

Construct precast sump in conformance with the standard plan.

403.03.17 Cleaning

Upon completion, clean each structure of all silt, debris, and foreign matter.

403.04.00 Measurement and Payment

403.04.01 Manholes

Measurement and payment for manholes, including standard precast concrete or monolithic concrete manholes will be made on a unit price basis for each type shown in the proposal for manholes 8 feet (2.4384 m) deep, plus the unit price per foot (meter) shown in the proposal for extra depth of manholes over 8 feet (2.4384 m). No deduction will be made for depths less than 8 feet (2.4384 m). Measurement of manhole depth will be from the top of the manhole frame and cover to the manhole invert at the center of the manhole to the nearest one-tenth of a foot (30.84 mm). There will be no separate payment for pavement removal and replacement, excavations, including removal of an existing manhole or lamphole, and backfill, foundation stabilization and/or baserock and any materials, equipment and labor necessary to reconnect all existing pipes when constructing manholes, it being understood that the cost thereof is incidental to and included in the contracted price for "Standard Manhole" or "Manhole Drop Assembly", work items.

403.04.02 Drop Assemblies

Measurement and payment for drop assemblies, regardless of size, will be made on a unit price basis as shown in the proposal for drop assemblies 0-6 feet (0-1.8288 m) in depth, plus the unit price per foot (0.3048 m) shown in the proposal for extra depth over 6 feet (1.8288 m). No deduction will be made for depths less than 6 feet (1.8288 m). Drop assemblies will be vertically measured from the invert of the pipe at the top of the assembly to the invert of the pipe into the manhole base at the bottom of the assembly to the nearest one-tenth of a foot

(30.48 mm). Payment shall include full compensation for all materials, labor, and equipment required to construct the work complete in place.

403.04.03 Pipe Stubouts from Manholes

Measurement and payment for pipe stubouts from manholes shall be made on a linear foot (meter) basis in accordance to **Section 402 - Pipe and Fittings (Storm Drain)**.

403.04.04 Tamperproof and Watertight Manhole Frame and Covers

Measurement and payment for tamperproof and watertight manhole frame and covers will be made on a unit price basis for each type installed. Since payment for furnishing and installing standard frame and covers is already included in the bid price for manholes, this unit price will include only the additional compensation for providing the watertight frame and cover complete in place.

403.04.05 Concrete Encasement

Measurement and payment for concrete encasement will be made on a linear foot (meter) basis as shown in the proposal for the size pipe to be encased. Length shall be measured along the centerline of the pipe and shall be the total length of encasement actually constructed. Payment shall include full compensation for all materials, equipment, and labor required to construct the work complete in place.

403.04.06 Anchor Walls

Measurement and payment for anchor walls will be made on a unit price basis for each unit installed. Payment shall include full compensation for all materials, equipment, and labor required to construct the work complete in place.

403.04.07 Special Concrete Structures

Measurement and payment for special concrete structures will be made on a lump sum each basis. Payment shall constitute full compensation for materials, equipment, and labor required to construct the work complete in place.

403.04.08 Catch Basins and Inlets

Measurement and payment for catch basins and inlets will be made on a unit price basis per each catch basin or inlet for the number and type actually constructed. Payment shall include full compensation for all materials, equipment, and labor required to construct the work complete in place.

403.04.09 Precast Sump

Measurement and payment for precast sump will be made on a unit price basis for each unit installed. Payment for pipe stubouts, if required, will be made as provided for in **Section 402 - Pipe and Fitting (Storm Drain).** Payment shall include full compensation for all materials, equipment, and labor required to construct the work complete in place.

404 - Work on Existing Storm Sewers and Drain Structures

404.01.00 Description

This Section covers the work necessary for joining new work to existing, the abandoning of storm drains and structures, and adjusting of existing utility structures to finished grades, complete.

404.02.00 Materials

Conform to the requirement of **Section 205 - Materials** and to the requirements for related work referred to herein.

404.03.00 Construction

404.03.01 Excavation and Backfill

Conform to requirements of **Section 204 - Excavation, Embankment, Bedding, and Backfill.** Excavation shall be classified as either common or rock excavation.

404.03.01A - Screening Manholes

Prior to excavation, the Contractor shall install a 1.5 inch (38.10 mm) x 14 Ga. expanded metal screen, or equal, on the outlet of a manhole downstream of the construction work to prevent debris and other foreign objects from entering the storm sewer system. The screen shall remain in-place as long as any excavation is not yet backfilled and when work is being done in an upstream manhole.

Prior to the end of the work day, the Contractor shall enter, inspect, and clean the screening manhole. Additionally, the screen shall be maintained by the Contractor in such a way the drain flow is accommodated at all times.

The Contractor will be charged for all maintenance expenses and/or damage resulting from entry of debris or foreign objects into the storm sewer facilities of the City.

404.03.02 Manholes Over Existing Storm Sewers

Advise Engineer of plans for diverting flow and obtain approval before starting. Approval will not relieve Contractor of responsibility for maintaining adequate capacity for flow at all times and adequately protecting new and existing work.

Construct manholes over existing operating lines at locations show. Perform necessary excavation and construct new manholes in conformance with applicable requirements of **Section 403 - Manholes, Inlets, and Concrete Structures.**

Manholes shall be constructed over existing concrete sewers after first cleaning and applying approved commercial concrete bonding agent to all surfaces of the pipe that will be in contact with the manhole. Manholes shall be constructed over existing PVC sewers after first applying a dense coating of clean mortar sand to all pipe surfaces that will be in contact with the manhole, using PVC solvent cement. After the cement has cured, commercial concrete bonding agent shall be applied to the sand prior to placement of concrete.

Prevent broken material or debris from entering sewer flow. Maintain flow through existing sewer lines at all times. Protect new concrete and mortar for a period of seven days after placing.

404.03.02A - Manhole Sealing

This Subsection covers the rehabilitation of existing manholes via interior repair and sealing using a compound that reacts chemically with the salts in the concrete or mortar to form a waterproof crystalline barrier yet allowing the concrete to breathe. The rehabilitated manhole shall have all holes, cracks, and joints, including those in the manhole base, plugged in accordance with the manufacturer's recommendations and the total interior surface coated with the appropriate sealant. A minimum of two coats is required. Extra coats shall be applied if the Engineer determines it necessary to stop infiltration under severe groundwater pressure situations or extremely deteriorated manholes.

Manhole rehabilitation shall consist of the following steps performed in strict accordance with the manufacturer's recommendations: (1) high pressure water wash; (2) plug holes; (3) patch cracks, joints; and, (4) seal the concrete using materials in conformance with the minimum structural standards listed below.

Materials Test	Standard	Result
Tensile Strength	ASTM C 190	325 psi (2.2409 MPa) at 59% R.H.
Flexural Strength	ASTM C 580	675 psi (4.65413 MPa)
Compressive Strength	ASTM C 109	5,000 psi (34.475 MPa)
Permeability	ARMY CRD-C48-55	8.1×10^{-10} cm/sec
Adhesion	ASTM E 149	40 psi (.2758 MPa)

Repair and sealing compound shall be HEY'DI K-11 as manufactured by HEY'DI American Corporation or approved equal.

404.03.03 Connection to Existing Manholes

The Contractor shall construct openings in the existing manhole base or sections as required and construct connections that are watertight and will provide a smooth flow into and through the manhole. The Contractor shall provide all diversion facilities and perform all work necessary to maintain flow in existing lines during the connection to the manhole.

Provide all diversion facilities and perform all work necessary to maintain flow in existing storm sewers during connection to the manhole. Break out existing manhole base for new flow channel as specified or directed. Core drill existing manhole wall as necessary to accept new pipe as specified or directed. Grout in new pipe to provide watertight seal, and when applicable, smooth flow into and through existing manhole as specified in **Subsection 404.03.09 - Reconstruct Manhole Base.** All pipe connections to the manhole shall be watertight and shall preclude infiltration by inclusion of an elastomeric seal/waterstop unit grouted to or into the manhole. Repair any damage to existing base and channels as required.

404.03.04 Removal of Existing Pipes, Manholes, and Appurtenances

Existing pipelines, manholes, and appurtenances which lie in the line of and are to be replaced by the new construction shall be removed from the site and disposed of as provided for in **Section 203 - Clearing and Grubbing.**

404.03.05 Filling Abandoned Manholes

Existing manholes shown to be abandoned shall be filled with granular material as specified in **Section 204 - Excavation, Embankment, Bedding, and Backfill.**

Compact to 95 percent optimum density as determined by ASTM D 698. Remove manhole frame and cover and plug all pipes with permanent plugs as specified herein. Break or perforate the bottom to prevent the entrapment of water. Remove the manhole cone to facilitate specified compaction of fill material. Construct the granular base and pavement or gravel or sod surfacing to render the work site compatible with the surrounding area.

404.03.06 Existing Manhole Frames and Covers

Manhole frames and covers removed by the Contractor and not to be reused on the project shall become the property of the City. Deliver these in accordance with **Subsection 206.03.02.**

404.03.07 Permanent Plugs

Clean interior contact surfaces of all pipes to be cut off or abandoned as approved. Construct concrete plug in end of all pipe 18 inches (457.20 mm) or less in diameter. Minimum length of concrete plugs shall be 8 inches (203.20 mm). For pipe 21 inches (533.40 mm) and larger, the plugs may be constructed of common brick or concrete block. Plaster the exposed face or block or brick plugs with mortar. All plugs shall be watertight and capable of withstanding all internal and external pressures without leakage.

404.03.08 Adjust Structures to Grade

Manholes, inlets, catch basins, and similar structures shall be brought to the specified finished grade by methods of construction as required in **Section 403 - Manholes, Inlets, and Concrete Structures**, and **Section 206 - Adjustment of Incidental Structures to Grade.**

Excavation necessary for bringing structures to grade shall center about the structure and be held to the minimum area as approved. At the completion of the structure adjustment, the void around the structure shall be backfilled with crushed aggregate and thoroughly compacted.

404.03.09 Reconstruct Manhole Base

Conform to applicable requirements of **Section 403 - Manholes, Inlets, and Concrete Structures**. Exercise caution in chipping out existing concrete base so as to prevent cracking of manhole walls. Prevent all material from entering the flow area. Pour new base to a minimum of 6 inches (152.40 mm) below the lowest projection of the pipe. Construct new channels to the elevations shown. Conform to details for channel construction in the standard plans. Repair any cracks which

occur as a result of work operations with new grout to form a watertight seal, as approved.

404.03.10 Connect Pipe to Existing Inlets

Conform to applicable requirements of **Section 403 - Manholes, Inlets, and Concrete Structures.** Break into existing inlet and grout in a watertight seal between the new pipe and inlet wall. Plaster mortar smooth inside pipe opening. Alignment, slope of pipe, and other construction details shall be as approved.

404.03.11 - 404.03.12 Reserved

404.03.13 Safety

The Contractor is hereby alerted to the dangers of working in sewers and manholes where the organic material present could result in the formation of hydrogen sulfide gases. Hydrogen sulfide gas can be toxic in high concentrations. Also, in high concentrations, hydrogen sulfide gas is odorless; therefore, it is not detectable without specialized equipment. The Contractor should provide gas detection equipment that would detect the presence of hydrogen sulfide gas and/or the lack of oxygen. The Contractor shall also provide ventilation equipment to insure that hazardous gases or conditions are eliminated prior to workers entering existing sewer manholes or sewer lines. The Contractor shall ensure that all personnel entering manholes wear a harness with attached safety line so that said personnel can be removed from the manhole if he/she is unable to climb out unassisted.

404.04.00 Measurement and Payment

404.04.01 Manholes Over Existing Storm Sewers and Drains

Measurement and payment for manholes over existing storm sewers or drains will be made in accordance to **Subsection 403 - Manholes, Inlets, and Concrete Structures.**

404.04.02 Removal of Existing Pipes, Manholes, and Appurtenance

Payment for removal and disposal of existing pipes, manholes, and appurtenances will be considered as incidental to the work and included in the bid item for excavation and backfill as specified in **Section 204 - Excavation, Embankment, Bedding, and Backfill** or included in the bid item for "Standard Manhole" as specified in **Subsection 403.04.01.**

When listed separately in the proposal, payment for "Remove Manhole" shall be at the contracted unit price each. A bid item for this work will generally be added only when the manhole to be removed lies outside of and distant from the mainline trench.

404.04.03 Connection to Existing Manholes

Measurement and payment for connection to existing manholes will be made on a unit price each basis. There will be no separate payment for modifying the manhole base or channel, it being understood that the cost thereof is included in and incidental to the contracted prices for "Connection to Existing Manhole", "Polyethylene Liner Pipe", or "Insituform Liner" work items.

404.04.04 Filling Abandoned Manholes

Measurement and payment to filling abandoned manholes will be made on a unit price each basis. There will be no separate payment for work necessary to reconstruct the ground surface after removing the manhole cone consistent with adjoining materials, including but not limited to, pavement, curb, driveway, sidewalk, or sod or for replacement of landscape or improvements removed during construction it being understood that payment therefore is included in and incidental to the contracted price for the "Fill Abandon Manhole" work item.

404.04.05 Adjust Structures to Grade

Measurement and payment for adjusting manholes, catch basins, inlets, and similar structures will be made on a unit price each basis for the type and size as shown in the proposal.

404.04.06 Reconstruct Manhole Base

Measurement and payment for reconstructing manhole base will be made on a unit price each basis.

404.04.07 Connect Pipe to Existing Catch Basin

Measurement and payment for connecting new pipe to existing catch basins will be made on a unit price each basis.

404.04.08 Reserved

404.04.09 Safety

No separate payment will be made for providing safety equipment as required by **Subsection 404.03.13**, it being understood that the cost thereof is included in the contracted prices for the various items or work, and is therefore a cost to be borne solely by the Contractor incidental to performance of the work.

405 - Resurfacing

405.01.00 Description

This Section covers the work necessary to replace all pavement, pavement base, curbs, sidewalks, rock surfacing, and other surface features damaged either directly or indirectly by the operations incidental too the construction of sewers, water mains, and conduits. Such surface areas shall be brought to an equal or better condition than prior to the beginning of construction.

405.02.00 Materials

405.02.01 Hot Mix Asphalt Concrete

Use Class C asphalt concrete hot mix. Conform to the requirements for hot mix asphalt concrete in **Subsection 306.02.00 Materials.**

405.02.02 Cold Mix Asphalt Concrete

Use cold mix asphalt concrete and 1/2 inch-0 (12.70 mm-0) gradation with either MC 250 liquid asphalt of CRS-2 cationic emulsified asphalt. Conform to the requirements of cold mix asphalt concrete in **Section 304 - Asphalt Treated Bases.**

405.02.03 Asphalt Prime

Tack coat shall be AR 4000 or PBA-2 asphalt cement.

405.02.04 Reserved

405.01.05 Pavement Base

Use pavement base material for resurfacing trenches which conform to **Section 303 - Aggregate Bases.**

405.02.06 Forms

All forms shall be approved by the Engineer and shall conform to requirements for forms in **Section 602 - Concrete Structures.**

405.03.00 Construction

405.03.01 Street Maintenance

Maintain all trenches as specified under **Section 204 - Excavation, Embankment, Bedding, and Backfill.**

405.03.02 Temporary Cold Mix Asphalt

When shown or directed, place and compact temporary cold mix asphalt over the approved trench areas to the depth shown or approved. Spread with an approved mechanical spreading machine, or in areas inaccessible to the spreading and finishing machine, place by hand methods. Immediately after each load is dumped, distribute into place by means of hot shovels or suitable forks and spread with hot rakes in a loose layer of uniform density.

After spreading, the mixture shall be thoroughly and uniformly compacted with an approved power-driven roller as soon after being raked as it will bear the roller without undue displacement. Roll longitudinally at the sides and proceed toward the center of the pavement overlapping on successive trips by at least one-half the width of the roller. Alternate trips of the roller shall be of slightly different lengths. The speed of the roller shall at all times be slow enough to avoid displacement of the mixture, and any displacements occurring from any cause shall at once be corrected by the use of rakes and of fresh mixture where required. Roll continuously until all roller marks are eliminated and no further compaction is possible. Compact areas inaccessible to the roller by tamping with hot iron tampers. After compaction, the temporary cold mix asphalt shall have the thickness shown or approved and conform to the grade as directed.

Remove cold patch prior to final paving.

405.03.03 Asphalt Concrete Pavement

405.03.03A - Prime Coat

Tack coat all edges of existing pavement, manhole, and cleanout frames, inlet boxes and like items with 100 percent coverage using materials specified in **Subsection 405.02.03.**

405.03.03B - Asphalt Concrete Placement

Trim existing pavement to a straight line to remove any pavement which has been damaged or which is broken and unsound. Provide a smooth, sound edge for joining the new pavement. All final pavement sawcuts shall be to the dimensions shown on the applicable plan. Resaw as necessary just prior to repaving trench so no loose or jagged edges remain. Final sawing shall be substantially parallel to the trench centerline with angle points not to exceed 45 degrees. Any angle points shall be at least five feet (1.524 m) apart.

Place the asphalt concrete on the prepared subgrade over the trench to the specified depth, and when not specified, to a depth of not less than 4 inches (101.60 mm) or the depth of the adjacent pavement, whichever is greater. When a prime coat is specified, place asphalt concrete after the prime coat has set. Maximum thickness for any one lift of pavement shall normally not exceed 2 inches (50.80 mm), and in no case shall it exceed 2 ½ inches (63.50 mm). Spread and level the asphalt concrete with hand tools or by use of a mechanical spreader, as approved, depending upon the area to be paved. Bring the asphalt concrete to the proper grade and compact by rolling or the use of hand tampers where rolling is impossible or impractical. When it is necessary to place asphalt concrete in successive lifts to achieve the required thickness, use tack coat applied at a rate within a range of 0.05 to 0.10 gallons (.189 25 L to 0.3785 L) per square yard (0.8361 m^2) between each successive lift. In areas where successive lifts are placed in the same day and the previous lift of asphalt concrete has remained clean, tack coat will not be required between successive lifts.

Use tack coat applied at a rate of 0.05 to 0.10 gallons (.189 25 L to 0.3785 L) per square yard (0.8361 m^2) on surfaces which are to be overlaid with asphalt concrete.

Roll with power rollers capable of providing compression of 200 to 300 pounds (90.72 kg to 136.08 kg) per linear inch (25.40 mm). Begin the rolling from the outside edge of the replacement progressing toward the existing surfacing, lapping the existing surface at least one-half the width of the roller. If existing surfacing bounds both edges of the replacement, begin rolling at the edges of the replacement, applying the existing surfacing at least one-half the width of the roller, and progress toward the center of the replacement area. Overlap each preceding track by at least one-half the width of the roller and make sufficient passes over the entire area to remove all roller marks and to produce a smooth, uniform surface as directed.

Make the finished surface of the new compacted paving flush with the existing surface and conform to the grade and crown of the adjacent pavement, as directed.

Immediately after the new paving is compacted paint all joints between new and original asphalt pavement with tack coat and cover with dry paving sand before the asphalt solidifies to prevent pick up by traffic.

405.03.03C - Application, Quantity, and Temperature of Tack Coat

The Engineer may vary the amount of tack coat to be applied within rates specified elsewhere in this Section as in his/her judgement will give the best results. AR 4000 or PBA-2 tack coat shall be spray-applied unless otherwise approved, and applied at a temperature between 290 degrees and 350 degrees Fahrenheit (143.33°C -176.67°C).

405.03.03D - Surface Smoothness

The surface smoothness of the replaced pavement shall be such that when a straightedge is laid across the patched area between the edges of the old surfacing and the surface of the new pavement, the new pavement shall not deviate from the straightedge more than 1/4 inch (6.35 mm) provided surface drainage is maintained. Areas which contain depressions that impound water shall be replaced.

405.03.03E - Weather Conditions

Do not apply asphalt during rainfall, sand or dust storms, or before imminent storms that might adversely affect the construction. The Engineer will determine when surfaces and material are dry enough to proceed with construction. Asphalt concrete shall not be placed when the atmospheric temperature is lower than 40 degrees Fahrenheit (4.44°C), or when the surface upon which it is to be placed is frozen.

405.03.03F - Protection of Structures

Provide whatever protective covering may be necessary to protect the exposed portions of bridges, culverts, curbs, gutters, posts, guard fences, road signs, and any other structures from splashing oil and asphalt from the paving operations. Remove any oil, asphalt, dirt, or any other undesirable matter that may come upon these structures by reason of the paving operations, as approved.

Where water valve boxes, manholes, catch basins, or other underground utility appurtenances are within the area to be surfaced, make the resurfacing level with the top of the existing finished elevation of these facilities. If it is evident that these facilities are not in accordance with the proposed finished surface, notify the Engineer to have the proper authority contacted in order to have the facility altered before proceeding with the resurfacing around the obstruction, unless otherwise approved. Consider any delays experienced from such obstructions as incidental to the paving operation. No additional payment will be made. Protect all covers during asphalt application.

405.03.03G - Excess Materials

Dispose of all excess materials as approved. Make arrangements for the disposal and bear all costs or retain any profit incidental to such disposal.

405.03.03H - Resealing Cracks and Over-saw

Where asphalt concrete is to be removed and replaced over-sawing shall be held to a minimum. Where over-sawing does occur, the kerf shall be filled with a mixture of tack coat and fine sand. Over filling of the kerf shall be held to a minimum, however, if it does occur, sprinkle with dry sand to prevent pick up by traffic.

If a crack between the new paving and old pavement appears, or the filler placed in a saw kerf settles during the warranty period, clean out void with compressed air and reseal with AR 4000 asphalt cement. Overfilling shall be held to a minimum, however, if it does occur, sprinkle with dry sand to prevent pick up by traffic.

Temperature requirements for asphalt materials shall be between 270 degrees and 300 degrees Fahrenheit (132.22°C -148.89°C). Use of material shall be limited by minimum air temperatures specified in **Subsection 405.03.03E**.

405.03.04 Portland Cement Concrete Pavement

Pavement replaced shall be the same thickness as that removed, or a minimum of 6 inches (152.40 mm). Protect the newly placed concrete from traffic for a period of 7 days.

Handle, place, finish and cure concrete pavement in conformance with the applicable provisions of **Section 307 - Portland Cement Concrete Pavement.**

405.03.05 Pavement Base

Place pavement base to the specified depth. When not specified, place to a compacted depth of 12 inches (304.80 mm). Bring the top of the pavement base to a smooth, even grade at a distance below finished grade equivalent to the required pavement depth.

Compact the pavement base with mechanical vibratory or impact tampers to a density of not less than 95 percent of the maximum density as determined by AASHTO T 99.

405.03.06 Rock Surfacing

Place rock surfacing only where shown or directed on streets, driveways, parking areas, street shoulders, and to other areas disturbed by the construction. Rock surfacing shall be 1 1/2 inch (38.10 mm) or 3/4 inch (19.05 mm) minus crushed aggregate, as directed. Spread the rock by tailgating and supplement by hand labor where necessary. Level and grade the rock surfacing to conform to adjacent existing grades and surfaces as directed.

405.03.07 Concrete Driveways, Sidewalks, and Curbs

Replace concrete driveways, sidewalks, and curbs to the same section, width depth, line, and grade as that removed or damaged. Saw broken or jagged ends of existing concrete on a straight line and to a vertical plane. Place new concrete only on approved compacted trench.

When directed, replace concrete driveways and sidewalks between scored joints. Make replacement to prevent a patched appearance. Provide a minimum 2 inch (50.80 mm) thick compacted leveling course of clean 3/4 inch (19.05 mm) minus crushed aggregate.

Construct forms to match existing. Place concrete and finish exposed surfaces similar to adjacent surface in conformance with **Section 308 - Curbs, Gutters, Driveways, Sidewalks, and Pathways.**

405.04.00 Measurement and Payment

405.04.01 Temporary Cold Mix Asphalt

No separate payment will be made for furnishing and placing temporary cold mix asphalt pavement when directed by the Engineer to be maintained over trench backfill, it being understood that the cost thereof is included in and incidental to

the contracted prices of the associated permanent pavement replacement items of work.

405.04.02 Rock Surfacing

Payment for rock surfacing will be made on a cubic yard (m^3) basis. The volume for payment shall be computed on the following measurements for length, width, and depth of rock surfacing.

Length. The actual horizontal length of trench where rock was specified or directed to be placed.

Width. The pay width of trench excavation as specified in **Section 204 - Excavation, Embankment, Bedding, and Backfill**, plus 12 inches (304.80 mm).

Depth. The actual depth of the thickness of rock surfacing specified or directed to be placed in the trench.

Payment for this item shall constitute full compensation for furnishing all materials, labor, and equipment necessary to complete the work in place.

405.04.03 Pavement Base

Payment for pavement base will be made on a cubic yard basis (m^3). The volume will be computed on the following measurements for length, width, and depth:

Length. Actual horizontal length of trench where rock was specified or directed to be placed.

Width. Trench pay width as specified in **Section 204 - Excavation, Embankment, Bedding, and Backfill**, plus 12 inches (304.80 mm).

Depth. Depth of pavement base specified for the particular project. When not specified, depth shall be 12 inches (304.80 mm).

Payment for this item shall constitute full payment for furnishing all material, labor, and equipment necessary to complete the work in place.

405.04.04 Asphalt Concrete and Portland Cement Concrete Pavement Replacement

Payment for replacement of asphalt concrete or Portland Cement concrete pavement will be made on a square yard (m^2) basis. Payment will be limited to

pavement actually replaced within the pay width specified for trench excavation in **Section 204 - Excavation, Embankment, Bedding, and Backfill,** plus 6 inches (152.40 mm) additional width on each side of the trench excavation pay width. The area for payment shall be computed on the following measurements for length and width:

Length. The actual horizontal length of trench where pavement was specified or directed to be replaced.

Width. A variable width, being the width of pavement actually replaced within the limits specified. All pavement damaged as a result of the Contractor's operations lying outside the above-stated pay limits will be removed and replaced at the Contractor's expense.

On roadways or streets that do not have curbs, when the cut in asphalt concrete pavement falls 2 feet (0.6096 m) or less from the edge of the existing pavement, remove and replace the remaining strip at the Contractor's expense. When the same situation occurs where lifted or damaged during construction operations, remove and replace the remaining strip at the Contractor's expense.

Payment shall include full compensation for all excavation and disposal of temporary cold mix asphalt required to provide space for the pavement, and all materials, labor, and equipment necessary to complete the work in place.

On Portland Cement concrete streets, when the pavement cut falls one foot (0.3048 m) or less from an expansion or contraction joint, remove and replace the remaining strip and restore said joint. There will be no separate payment for removal and replacement of this extra width, it being understood that the cost thereof is included in and incidental to the contracted prices for "Pavement Removal and Replacement".

405.04.05 Sidewalk Replacement

Payment for sidewalk replacement will be made on a square foot (m^2) basis. Payment will be limited to sidewalk actually replaced within the pay width specified for trench excavation in **Section 204 - Excavation, Embankment, Bedding, and Backfill,** plus 6 inches (152.40 mm) additional width on each side of the trench excavation pay width. The area for payment shall be computed on the following measurements for length and width:

Length. The actual horizontal length of sidewalk specified or directed to be replaced.

Width. A variable width, being the width of sidewalk actually replaced within the limits specified. All sidewalk damaged as a result of the Contractor's operations lying outside the above-stated pay limits will be removed and replaced at the Contractor's expense.

Payment shall include full compensation for all materials, labor, and equipment necessary to complete the work in place.

There will be no separate payment for replacement of roof drains damaged or removed during excavation or for constructing bicycle and wheelchair ramps at locations shown on the plans and in conformance with standard plans, it being understood that the cost thereof is included in and incidental to the contracted prices for the "Sidewalk Removal and Replacement" work item.

405.04.06 Driveway Replacement

Payment for driveway replacement will be made on a square yard (m^2) basis. Payment will be limited to driveway actually replaced within the pay width specified for trench excavation in **Section 204 - Excavation, Embankment, Bedding, and Backfill**, plus 6 inches (152.40 mm) additional width on each side of the trench excavation pay width. The area for payment shall be computed on the following measurements for length and width:

Length. The actual horizontal length of driveway specified or directed to be replaced.

Width. A variable width, being the width of driveway actually replaced within the limits specified. All driveway damaged as a result of the Contractor's operations lying outside the above-stated pay limits will be removed and replaced at the Contractor's expense.

Payment shall include full compensation for all materials, labor, and equipment necessary to complete the work in place.

405.04.07 Curb Replacement

Payment for replacement of curb will be made on a linear foot (meter) basis. Payment will be limited to curb actually replaced within the pay width specified for trench excavation in **Section 204 - Excavation, Embankment, Bedding, and Backfill**, plus 6 inches (152.40 mm) additional width on each side of the trench excavation pay width. Measurement for payment will be the actual horizontal length of curb specified or directed to be replaced. All curb damaged as a result

of the Contractor's operations lying outside the above-stated pay limits will be removed and replaced at the Contractor's expense.

Payment shall include full compensation for all materials, labor, and equipment necessary to complete the work in place.

There will be no separate payment for constructing weep holes in curbs at locations directed by the Engineer or for constructing depressed curbs or dropped curbs for bicycle and wheelchair ramps and driveways, in conformance with standard plans, where shown on the plans or as otherwise directed, it being understood that the cost thereof is included in and incidental to the contracted prices for the "Curb Removal and Replacement" work item.

405.04.08 Payment

Payment will be made for any or all of the following items when listed as pay items in the proposal for any particular contract:

	Pay Item	Unit of Measure
1.	Temporary Cold Mix Asphalt	S.Y. (m^2)
2.	Rock Surfacing	C.Y. (m^3)
3.	Pavement Base	C.Y. (m^3)
4.	Asphalt Concrete Pavement Removal and Replacement	L.F. (m)
5.	Portland Cement Concrete Pavement Removal and Replacement	L.F. (m)
6.	Portland Cement Concrete Pavement With Asphalt Concrete Pavement Overlay Removal and Replacement	L.F. (m)
7.	Sidewalk Removal and Replacement	S.F. (m^2)
8.	Driveway Removal and Replacement	S.Y. (m^2)
9.	Curb Removal and Replacement	L.F. (m)

405.04.09 Alternate Method

Should the Contractor choose to bore, jack, or tunnel to avoid cutting pavement, sidewalk, driveway, or curb, which would otherwise require removal and replacement had the open trench type of construction taken place, and the Engineer concurs with said choice, the Contractor will be paid as if work had been done by conventional removal and replacement methods of construction and at the contracted prices for the work as set forth in the proposal.