SECTION 18
STORM DRAINS

18-1 TRENCHING

18-1.1 General - For the purpose of shoring or bracing, a trench is defined as an excavation in which the depth is greater than the width of the bottom of the excavation.

Excavations for appurtenant structures, such as but not limited to manholes, transition structures, junction structures, vaults, valve boxes, catch basins, thrust blocks, and boring planting hole shall, for the purpose of shoring and bracing, be deemed to be in the category of trench excavation.

Excavation shall include the removal of all water and materials of any nature that interfere with construction. Removal of groundwater to a level below the structure subgrade shall be mandatory and considered incidental to the installation of storm drains. .

Excavation for conduits shall be by open trench unless otherwise specified or shown on the Contract Plans. However, should the Contractor elect to tunnel or jack any portion not so specified, the Contractor shall first obtain approval from the Engineer. Payment for such work will be made as though the specified methods of construction had been used.

When necessary to protect existing trees the Engineer may require the Contractor to modify his trenching methods, such modifications may include the use of smaller equipment, including hand operated tools. Existing trees within the limits of construction not to be removed shall be protected and treated in accordance with Section 22-3, "Tree and Plant Protection," of these Technical Provisions.

18-1.2 Maximum Length of Open Trench - Except by permission of the Engineer, the maximum length of open trench where prefabricated pipe is used shall be no more than the amount of pipe that can be installed and backfilled in a single day.

Except by permission of the Engineer, the maximum length of open trench in any one location where concrete structures are cast in place will be that which is necessary to permit uninterrupted progress. Construction shall be pursued as follows: excavation, setting of reinforcing steel, placing of floor slab, walls, and covers slab or arch.

Failure by the Contractor to comply with the limitations specified herein may result in an order to halt the work until such time as compliance has been achieved.

18-1.3 Trench Width - The width of trench shall be as shown the Contract Plans or as specified in the Special Provisions. If no minimum width or maximum width of trench is specified the trench width shall be as approved by the Engineer. When pipe trenching and/or backfill is paid on a volume bases the maximum width, for the purpose of calculating the volume of trench excavation or backfill, shall be the outside diameter of the pipe, measured between joins plus one foot.

If the maximum trench width specified is exceeded, the Contractor shall provide additional bedding, another type of bedding, or a higher strength of pipe, as approved by the Engineer, at the Contractor's expense.

18-1.4 Access to Trenches - Safe and suitable ladders which project 2 feet (0.6m) above the top of the trench shall be provided for all trenches over 4 feet (1.2m) in depth. One ladder shall be provided for each 50 feet (156m) of open trench, or fraction thereof, and be so located that workers in the trench need not move more than 25 feet (7.5m) to a ladder.

18-1.5 Removal and Replacement of Surface Improvements - Asphalt pavement, concrete pavement, curbs, sidewalks or driveways removed in connection with construction shall be removed and replaced in accordance with the other provisions of these Standard Specifications, the Special Provisions and Contract Plans.

18-1.6 Bracing/Shoring Excavations - The Contractor shall furnish, install, and maintain sheeting and shoring for the protection of workers and the public from movement of the ground and any element of danger to life, property, or existing improvements. Additional supports requested by the Engineer shall in no way relieve the Contractor of his responsibility for the sufficiency of necessary precautions.

The Contractor shall comply with the California Occupational Safety and Health Administration (CAL/OSHA) requirements pertaining to trench safety and trench shoring. Excavation shall be adequately shored and braced so that the earth will not slide, move or settle, and so that all existing improvements of any kind will be fully protected from damage. Attention is called to Article 6 of "Construction Safety Orders" of the California Division of Industrial Safety, which applies to all open excavations made in the earth's surface, including trenches. In no case shall slope height, inclination, and excavation depths exceed those specified in local, state, or federal safety regulations. Specifically, Contractor shall be aware of the current OSHA Health and Safety Standards for Excavation, 29CFR Part 1926. All trenches and exposed excavations shall be evaluated by the Contractor's "Responsible Person," as defined in 29CFR Part 1926, as part of his safety procedures and prior to personnel entering any excavation.

Prior to commencing the excavation of a trench five-foot (5')(1.5m) in depth or greater and into which a person will be required to descend, the Contractor shall first obtain a permit to do so from the State of California Division of Industrial Safety. The Contractor shall submit a copy of his excavation permit to the Engineer at the preconstruction meeting.

Should the bracing system utilize steel H-beams or piles or other similar vertical supports, driving of said vertical supports will not be permitted except for the last four-foot (4')(1.2m). The vertical supports shall be placed in holes drilled to a depth of four-foot (4')(1.2m) above the proposed bottom of pile, except where this procedure is impractical. The vertical support may then be driven to the required depth, not to exceed four-foot (4')(1.2m). During the drilling and driving operations the Contractor shall take care to avoid damage to utilities.

At locations where the drilling of such holes is impractical because of the existence of rocks, running sand, or other similar conditions, and provided said impracticability is demonstrated to the satisfaction of the Engineer by actual drilling operations by the Contractor, the Engineer may, upon request of the Contractor, approve the use of means other than drilling for the purpose of placing the vertical support. Such other means, however, must be of a nature which will accomplish, as nearly as possible, the purpose of the drilling, namely, the prevention of damage to existing surface or sub surface improvements, both public and private. All costs for this work shall be included in the various Contract Bid Prices for the items of work involved.

If sheeting is used to support the excavated trench, the Contractor shall remove the sheeting, and no such sheeting will be permitted to remain in the trench.

Any damage resulting from the Contractor's shoring operations shall be repaired or replaced at the Contractor's expense. All repairs shall be completed within two (2) working days of the damage occurring.

18-2 BEDDING - Unless shown otherwise in the Contract Plans, bedding shall be defined as that material supporting, surrounding and extending to above the top of the pipe. Where it becomes necessary to remove boulders or other interfering objects at subgrade for bedding, any void below such subgrade shall be filled with the bedding material designated on the Contract Plans. Where concrete is specified to cover the pipe, the top of the concrete shall be considered as the top of the bedding.

If soft, spongy, unstable, or other similar material is encountered upon which the bedding material or pipe is to be placed, this unsuitable material shall be removed to a depth beneath the bottom of the pipe, or as approved by the Engineer, and replaced with bedding material suitably densified. Additional bedding so ordered, over the amount required by the Contract Plans or Special Provisions, shall be paid as "Extra Work" conforming to Section 9-3 of the General Provisions of the Standard Specifications. If the necessity for such additional bedding material has been caused by an act or failure to act on the part of the Contractor, or is required for the control of groundwater, the Contractor shall bear all expenses for the additional excavation and bedding.

Bedding material for pipe shall first be placed to a depth of 6-inches below the pipe. Bedding shall be compacted by hand or mechanical tamper prior to backfilling. All bedding material shall be placed carefully to achieve uniform contact with the pipe and a minimum relative compaction of 90 percent, as determined by ASTM D-1557 laboratory density. Unless the sheeting or shoring is to be cut off and left in place, compaction of bedding for pipe shall be accomplished after the sheeting or shoring has been removed from the bedding zone in the area to be compacted.

Bedding material for pipe shall be ¾-inch maximum-sized crushed drain rock meeting the requirements presented in the following Table.

Bedding Gradation	
Sieve Size	Percentage Passing
1"	100
3/4"	90 – 100
1/2"	30 - 60
3/8"	0 - 20
No. 4	0 – 5

Concrete used for bedding shall be one of the classes of concrete specified herein for the indicated time periods before backfill. Where shown on the Plans, a filter fabric lining shall be installed prior to placing the bedding material. Filter fabric shall be permeable, non-woven Class A conforming to Section 88-1.02B of the State Specifications.

When required by the Engineer, in wet trench conditions the continuity of bedding material shall be interrupted by low permeability groundwater barrier to impede passage of water through the embedment. Barrier material shall be low permeability clay material and shall be compacted to 95 percent of maximum density. Material may be finely divided suitable job excavated material, free from stones, organic matter, and debris.

18-3 PIPE MATERIALS

18-3.1 General - Pipe will be inspected in the field before and after laying. If any cause for rejection is discovered in the pipe before or after it has been laid, it shall be subject to rejection. Any corrective work shall be approved by the Engineer and shall be at the Contractor's expense.

Pipe not installed within 120 days of issuance of its certificate of compliance shall not be used without prior approval of the Engineer.

18-3.2 Identification and Markings - Each length of pipe, fitting or coupler shall be marked by the manufacturer with the manufactures name or logo, trade name, nominal size, date of manufacture and lot number. A lot is defined as 100 lengths of pipe, or a fraction thereof. Additionally, the following information shall be clearly marked for specific type of pipe.

Pipe shall have a home mark to indicate full penetration of the spigot when the joint is made

RCP shall be marked in accordance with AASHTO Designation: M 170. The D-load and lot number designations shall be marked on the inside of the pipe. Each coupling shall be marked with the nominal size and D-load for the pipe with which it shall be used.

Plastic pipe markings shall include the following:

1) Nominal pipe diameter.
2) PVC cell classification.
3) ASTM, SDR, and date designation.
4) Service designation or legend.

18-3.3 Acceptance and Testing - The basis for acceptance shall be the inspection of pipe, fittings and couplings; the tests specified herein, and compliance with all specifications. When the pipe is delivered to the work site, the Engineer may require additional testing to determine conformance with the specifications.

18-3.4 Causes for Rejection - The following defects are cause for rejection of individual pipe lengths:

1) Any crack extending through the wall of the pipe.
2) Any continuous surface crack having surface width of 0.01 inch or more and extending for a length of 12 inches or more, regardless of depth or position in the wall of the pipe.
3) Any shattering or flaking of concrete.
4) Any piece broken from the pipe.
5) A deficiency in wall thickness equal to or greater than ¼ inch from the specified thickness, for pipes 30 inches or smaller in diameter.

6) A deficiency in wall thickness equal to or greater than 6% of the specified thickness, for pipes larger than 30 inches in diameter.
7) Irregularities that indicate imperfect mixing or molding.
8) Improper machining of ends of pipe.
9) For circular pipe any variation from a true circle of the specific diameter by more than 1 percent.
10) Rock pockets.
11) Exposed Reinforcing.
12) Evidence of twisting or misplacement of reinforcing.
13) Failure to pass any required test.

When a pipe contains localized defects but is otherwise acceptable, the pipe may be accepted when the defective portion is cut off and the end or ends satisfactorily re-machined. If such pipe is accepted by the Engineer the unit price for such pipe shall be subject to a reasonable reduction in price as determined by the Engineer.

18-3.5 Reinforced Concrete Pipe (RCP) - These specifications apply to reinforced concrete pipe intended to be used for the construction of storm drains and related structures. Reinforced concrete pipe shall be circular, oval or arch. The size, type, and D-load of the concrete pipe to be furnished shall be as shown on the Contract Plans, specified in the Special Provisions or as indicated in the Contract Bid Proposal. Pipe stronger than that specified maybe furnished at the Contractor's option at no additional expense to the City, provided such pipe conforms in all other respects to the applicable provisions of these specifications.

Pipes shall conform to Section 65-2, "Reinforced Concrete Pipe," of the State Specifications. Where installation specifications conflict with these Technical Provisions, the requirements that result in a higher degree of quality shall govern. The judgment of quality shall be at the sole discretion of the Engineer.

The interior surface of the pipe shall be smooth and well finished. Joints shall be of such type and design and so constructed as to be adequate for the purpose intended, and so that when laid, the pipe will form a continuous conduit with a smooth and uniform interior surface. Sockets and spigots shall be free from any deleterious substance or condition, which might prevent a satisfactory joint from being formed.

The Contractor shall furnish, install and maintain supports inside and/or outside the pipe as may be necessary to prevent cracking and damage throughout pipe handling, transportation, and field installation.

Joints shall be self-centering, rubber gasket type in accordance with ASTM C 443 and shall be flexible and able to withstand expansion, contraction and settlement. All rubber gaskets shall be stored at 70°F (20°C) or less, and in no case shall the rubber gaskets be exposed to the rays of the sun for more than 72 hours. Rubber gaskets shall be of the O-ring type requiring lubrication and shall be lubricated with the lubricant recommended and supplied by the manufacturer.

Fittings and Special Connections required as indicated on the Contract Plans shall be constructed to the standards of the pipe manufacturer. Details of fittings and special connections shall be submitted for Engineer's acceptance before fabrication.

18-3.6 Plastic Pipe - All plastic pipe in the Work shall conform to Section 64, "Plastic Pipe," of the State Specifications. Unless otherwise specified on the Plans or in the Special Provisions, plastic pipe shall be smooth-interior, Type "S" corrugated High Density Polyethylene Pipe (HDPE), having a bell-and-spigot design with rubber gasket conforming to ASTM F477. Where installation specifications conflict with these Technical Provisions, the requirements that result in a higher degree of quality shall govern. The judgment of quality shall be at the sole discretion of the Engineer.

18-3.7 Corrugated Metal Pipe (CMP) - Corrugated steel pipe shall be used only when shown specifically on the Contract Plans. When specified, corrugated steel pipe shall be zinc or aluminum coated conforming to Section 66, "Corrugated Metal Pipe," of the State Specifications. Where installation specifications conflict with these Technical Provisions, the requirements that result in a higher degree of quality shall govern. The judgment of quality shall be at the sole discretion of the Engineer. .

18-4 PIPE INSTALLATION

18-4.1 General - The ends of the pipe shall be so formed that, when the pipes are laid together and joined, they shall make a continuous and uniform line of pipe with a smooth and regular surface. The length and cross sectional diameter

of the gasket, the annular space provided for the gasket, and all other joint details shall be such as to produce a watertight joint.

Under ordinary laying conditions, the work shall be scheduled so that the socket end of the pipe faces in the direction the pipe is laid.

Pipe shall be laid to plan alignment and grade, with uniform bearing under the full length of the barrel of the pipe. Suitable excavation shall be made to receive the bell, coupling, or collar, which shall not bear upon the sub grade or bedding. Any pipe that is not in true alignment or shows any undue settlement after laying shall be taken up and relayed at the Contractor's expense.

For pipe in which the inside joints are to be pointed, suitable spacers shall be placed against the inside shoulder of the socket to provide the proper space between abutting ends of the pipe.

The interior of the pipe shall be clean and free from dirt and debris of any kind as the work proceeds. Failure to meet this requirement shall result in the requirement for the Contractor to flush and clean the pipe at the completion of installation. In that case, Contractor shall install a water and debris trap at the most downstream structure of the pipe run being installed and flush the entire length of pipe until all debris are collected in the trap. The wash water, along with any silt and debris, shall be placed into a suitable container and legally disposed of by the Contractor outside of the project limits. Contractor shall provide proof of said legal disposal.

At the close of work each day, or whenever the work ceases for any reason, the end of the pipe shall be securely closed.

18-4.2 Rubber Gasket Joints for RCP - Prior to placing the spigot into the socket of the pipe previously laid, the spigot groove, the gasket and the inside of the socket shall be thoroughly cleaned.

Then the spigot groove, the gasket and the first 2 inches (50mm) of the inside surface of the socket shall be lubricated with a soft vegetable soap compound

Pipe sections shall be laid and jointed in such a manner that the offset of the inside of the pipe at any joint will be held to a minimum at the invert. The maximum offset at the invert of pipe shall be one-percent (1%) of the inside diameter of the pipe or 3/8 inch (10mm), whichever is smaller.

The gasket after lubrication shall be uniformly stretched when placing it in the spigot groove so that the gasket is distributed evenly around the circumference.

After the joint is assembled, a thin metal feeler gage shall be inserted between the socket and the spigot and the position of the gasket checked around the complete circumference of the pipe. If the gasket is not in the proper position, the pipe shall be withdrawn, the gasket checked to see that it is not cut or damaged, the pipe re-laid, and the gasket position again checked.

18-4.3 Mortar Joints - When non-rubber gasket concrete pipe is installed the joints shall be filled with a joint mortar. The mortar shall consist of one (1) part Portland cement conforming to the requirements of ASTM Designation C150 for Type II cement with two (2) parts of mortar sand by volume. Sand shall be well graded and of such size that it will pass a No. 8 sieve.

In joining socket and spigot pipe, the spigot of each pipe shall be so seated in the socket of the adjacent pipe as to provide a 3/8± inch (10mm) annular space all around the pipe in the socket. Unavailable offsets shall be distributed around the circumference of the pipe in such a manner that the minimum offset occurs at the invert.

Admixtures shall not be added to mortar without the prior approval of the Engineer.

18-4.4 Horizontal or Vertical Curves - In general, horizontal or vertical curves shall be made by using pipe with beveled ends or by slight deflections in the joints of straight pipe. If necessary, short length pipe shall be made for curve of shorter radius than can be made with beveled pipe of usual length. Detailed layouts of curves shall be submitted to the Engineer by the pipe manufacturer for review and acceptance before fabrication of the beveled pipe. Curves may be made by use of angle bands at joints in lieu of beveled ends. Not more than 15 degrees of deflection angle shall be made in any one joint. Each angle joint shall fall upon the curve of the radius as indicated on the Contract Plans.

18-4.5 Connections to Existing Pipe or other Appurtenances - When connections are to be made to any existing pipe, conduit, or other appurtenances, the actual elevation or position of which cannot be determined without excavation, the Contractor shall excavate for, and expose, the existing improvement before laying any pipe or conduit. The Engineer shall be given the opportunity to inspect the existing pipe or conduit before connection is made. The Engineer will make any adjustments in line or grade that may be necessary to accomplish the intent of the Contract Plans.

18-4.6 Pipe Laid in Sheeted Trench - When pipe is laid in a sheeted trench, all sheeting against which concrete cradle is to be placed shall be faced with at least one thickness of building paper and the sheeting shall be withdrawn without displacing or damaging the cradle. The provisions of Section 17-6.3 "Forms" of these Technical Provisions, shall apply.

18-5 BACKFILL

18-5.1 General - Backfill shall be considered as starting above the pipe or at the top of concrete bedding over the pipe. All materials below this point shall be considered as bedding.

Backfill, or fill, as the case may be, for cast-in-place structures such as, but not limited to, manholes, transition structures, junction structures, vaults, valve boxes and reinforced concrete box conduits, shall start at the subgrade for the structure.

All backfill shall be placed as specified herein to match existing adjacent grades. Backfill must be in place at the end of each work day, or the excavation shall be covered with steel trench plates secured in place and conforming to Section 6-11.2, "Trenching," of the General Provisions.

Contractor shall proceed as soon as possible with backfilling operations. Care shall be exercised so that the conduit will not be damaged or displaced. If concrete bedding placed between the trench wall and the pipe supports the pipe, the remainder of any bedding material shall be placed to sufficiently cover the top of the conduit. The backfill above the concrete bedding shall not be placed nor sheeting pulled until at least the minimum time after the placement provided by the optional classes of concrete designated in Section 17, "Concrete Construction," of these Technical Provisions for such concrete bedding.

Unless otherwise specified, the periods of time set forth in the following table after which the Contractor may place fill or backfill against or over the top of any cast-in-place structures are predicated on the use of concrete to which no admixture has been added for the purpose of obtaining a high early strength:

Operation	Location	
	Against Sides Of Structures	Over Top of Structures
Placement of Loose Backfill	5 days	21 days
Compaction of Backfill	7 days	28 days

The Engineer may permit the use of admixtures or the use of additional cement in various parts of the structure in accordance with Section 17 "Concrete Construction" of these Technical Provisions.

Unless otherwise authorized by the Engineer, rocks greater than two (2) inches (50mm) in any dimension shall not be permitted in backfill. Where rocks are included in the backfill, they shall be mixed with suitable excavated materials so as to eliminate voids.

Subject to the provisions specified herein, the material obtained from project excavations may be used as backfill provided that all organic material, rubbish, debris, and other objectionable materials are first removed. Broken Portland Cement concrete and bituminous type pavement obtained from the project excavations will be permitted in the backfill subject to the same limitations as rocks, or provided they are processed to meet all requirements of backfill materials.

Where it becomes necessary to excavate beyond the limits of normal excavation lines in order to remove boulders or other interfering objects, the voids remaining after the removal of the boulders shall be backfilled with suitable material and densified as approved by the Engineer.

The removal of all boulders or other interfering objects and the backfilling of voids left by such removals shall be at the expense of the Contractor and no payment for the cost of such work will be made therefor. The costs of such work shall be included in the prices paid for the various bid items of work.

Voids left by the removal of sheeting, piles and similar sheeting supports shall be promptly backfilled with clean sand, which shall be jetted into place to ensure dense and complete filling of the voids. Removal of sheeting shall also conform to the provisions of Section 17-6.3 "Forms" of these Technical Provisions.

After the placing of backfill has been started, the Contractor shall proceed as soon as practicable with compaction.

18-5.2 Mechanically Compacted - Backfill shall be mechanically compacted by means of tamping rollers, sheep's foot rollers, pneumatic tire roller, vibrating rollers, or other mechanical tampers. All such equipment shall be of a size and type approved by the Engineer. Impact-type pavement breakers (stompers) will not be permitted over pipes constructed of brittle materials and/or incapable of supporting the expected loads, including but not limited to trancite, clay, asbestos, plastic, cast iron, and non-reinforced concrete pipe.

Permission to use specific compaction equipment shall not be construed as guaranteeing or implying that the use of such equipment will not result in damage to adjacent ground, existing improvements, or improvements installed under the Contract. The Contractor shall make its own determination in this regard.

Material for mechanically compacted backfill shall be placed in lifts no greater than eight (8) inches in compacted thickness. Mechanically compacted backfill shall be placed in horizontal layers of thickness compatible to the material being placed and the type of equipment being used. Each layer shall be evenly spread, moistened (or dried, if necessary), and then tamped or rolled until the specified relative compaction has been attained.

18-5.3 (Blank)

18-5.4 Imported - If the Contractor is permitted, or required, to import material from a source outside the project limits for use as backfill, said materials shall be clean soil, free from organic material, trash, debris, rubbish, or other objectionable substances.

Whenever the Special Provisions or Contract Plans permit the use of imported material for backfill, the Contractor shall deliver, not less than 10 days prior to intended use, a sample of the material to the Engineer. The sample shall have a minimum dry weight of 100 pounds (45 kg) and shall be clearly identified as to source, including street address and community of origin. The Engineer will determine the suitability, the minimum relative compaction to be attained, and the placement method.

Should the imported material not be substantially the same as the approved sample, it shall not be used for backfill and shall be removed from the site at the Contractor's expense.

Testing of import material shall be at the Contractor's expense.

18-5.5 Compaction Requirements - Except as specified otherwise, trench backfill shall be compacted to the following minimum relative compaction:

90 percent Relative Compaction:

1) Between the pipe zone and the upper 3 feet (0.9m), measured from the pavement surface (or finish grade where there is no pavement), or within native material.
2) Outside the traveled way, shoulders and other paved areas (or areas to receive pavement).

95 percent Relative Compaction:

1) In the upper 3 feet (0.9m), measured from the pavement surface (or finish grade where there is no pavement), within the existing or future traveled way, shoulders, and other paved areas (or areas to receive pavement).
2) Within engineered fill.
3) Where lateral support is required for existing or proposed structures.

4) Under Sidewalks.

18-5.6 Testing Backfill Compaction

Laboratory Maximum Density - The following method shall be used for compaction tests unless otherwise specified. Compaction tests will be performed in accordance with ASTM D 1557 method "C" modified to use a 4-inch (100mm) diameter mold. If the material contains more than 10 percent of particles which are retained on a ¾ inch (19mm) sieve, use ASTM D 1557 method "D" modified to use a 40 inch (100mm) diameter mold.

Field Density - Field density of soil shall be determined by any method, approved by the Engineer, which will accurately and consistently determine the density and moisture content of the soil.

Relative Compaction - The words Relative Compaction (Relative Density) shall mean the ratio of the field dry or wet density to the laboratory maximum dry or adjusted wet density, respectively, expressed as a percentage.

18-5.7 Slurry Cement Backfill - With prior approval by the Engineer, Contractor has the option of using cement slurry backfill. Storm drain pipes shall be placed on the specified bedding, then encased and backfilled with a cement slurry conform to Section 17-1 of these Technical Provisions. The use of slurry cement backfill shall be considered to be for Contractor's convenience, and shall be at no additional Contract cost to the City.

18-6 (BLANK)

18-7 MANHOLES

18-7.1 General - These specifications apply to manholes and appurtenance materials.

The quality of all materials, the process of manufacture, and the finished sections shall be subject to inspection and approval by the Engineer. Such inspection may be made at the place of manufacture, or on the job site after delivery, or at both places, and the materials shall be subject to rejection at any time on account of failure to meet any of the specified requirements, even though samples may have been accepted as satisfactory at the place of manufacture.

Materials rejected after delivery to the job site shall be marked for identification and shall be removed from the job site at once. All materials, which have been damaged after delivery, and prior to project acceptance by the City, shall be rejected, even if installed. The Engineer's judgement shall be final on the condition of the material. Contractor may attempt to make acceptable repairs on installed material(s), if the Engineer so agrees; however, Engineer's judgment on the acceptability of the repairs will be final, and if not satisfactory, the material shall be removed and replaced with satisfactory material entirely at the Contractor's expense.

18-7.2 Precast Manhole Sections - Unless provided for otherwise by the Special Provisions, or shown otherwise on the Contract Plans, manhole bases shall be cast in place. All other parts of the manhole may be pre-cast. Precast manhole sections, where not otherwise modified in the Contract Plans, shall conform to ASTM C478 and meet the following requirements:

1) The wall thickness shall not be less than 5 inches for 48-inch diameter barrel sections and 6 inches for 60-inch diameter barrel sections.
2) All sections shall be fully cured and shall not be shipped nor subjected to loading until the design compressive strength has been reached.
3) Pre-cast base sections shall have the base slab integral with the sidewalls. Pre-cast base sections shall be used only if the invert plan and alignment of the pipe connections in the base exactly match the field measured angles between the connecting pipes.
4) Manholes shall have ladder type, epoxy coated steps as approved by the Engineer.

18-7.3 Placing Precast Manhole Sections - Pre-cast manhole sections shall be carefully inspected prior to installation. Sections with chips or cracks in the tongue shall not be used. Ends of pre-cast manhole sections shall be cleared of foreign materials.

The pre-cast sections shall be installed in a manner that will result in a watertight joint. Rubber "O"-Ring gaskets or preformed flexible joint sealant shall be installed in strict conformance with the manufacturer's recommendations. Only

pipe primer furnished by the gasket manufacturer will be approved. If leaks appear in the manholes, the inside joint shall be caulked with non-shrink epoxy mortar to the satisfaction of the Engineer.

18-7.4 Manhole Bases - Unless provided for otherwise by the Special Provisions, or shown otherwise on the Contract Plans, manhole bases shall be cast in place. Materials used in cast-in-place concrete manhole bases shall be in accordance with the applicable requirements of Section 17-6 "Concrete Structures" of these Technical Provisions. At the option of the Contractor and with the approval of the Engineer, pre-cast base sections with integral floor conforming to ATM C 478 may be used.

18-7.5 Manhole Extensions - In general, manhole extensions will be used on all manholes in roads or streets or in other locations where a subsequent change in existing grade may be likely. Extensions will be limited to a total maximum height of 12 inches. Concrete grade rings for extensions shall be a minimum of 4 inches thick and a maximum of 6 inches thick.

18-7.6 Jointing Manhole Sections - Male and female joints of manhole sections shall be sealed with either a round rubber "O"-Ring gasket or a preformed flexible joint sealant. The "O"-Ring shall conform to ASTM C-443. The preformed flexible joint sealant shall conform to Federal Specification SS-S-00210, and be Kent Seal No. 2 as manufactured by Hamilton-Kent, Ram-Nek as manufactured by K.T. Snyder Company, or approved equal. The size of the preformed joint sealant shall be as recommended by the manufacturer of the pre-cast manhole sections.

18-7.7 Manhole Base Channels - Concrete channels in the base of the manhole shall be constructed in the invert of the manhole. The channel shall provide smooth transitions to ensure an unobstructed flow through manhole. All sharp edges or rough sections that tend to obstruct flow shall be removed. Where a full section of pipe is laid through a manhole, a neatly cut half pipe shall be laid to form the channel. The exposed edge of the pipe shall be completely covered with mortar. All mortar surfaces shall be troweled smooth. Breaking out the top half section of pipe after installation will not be allowed. The depth of channel shall be equal to one-half the depth of the outfall pipe.

18-7.8 Manhole Over Existing Pipe - Manholes shall be constructed over existing operating pipe lines at locations shown. Excavation shall be as specified in applicable sections of these Technical Provisions.

Flow through existing pipelines shall be maintained at all times and shall be controlled. New concrete and mortar work shall be protected for a period of one day after concrete has been placed.

The new base shall be constructed under and around the existing pipe as specified herein. The top half of the existing pipe shall be neatly removed within the new manhole, the edges covered with mortar, and troweled smooth.

18-7.9 Connection to Existing Manholes - The Contractor shall provide all diversion facilities and perform all work necessary to maintain flow in existing pipes during connection to the existing manhole. After connection to the existing manhole, manhole bases shall be grouted as necessary to provide smooth flow into and through existing manholes. The connection shall be made with a reinforced concrete collar conforming to details shown on the Plans. Concrete shall be as specified in Section 17-1.1.3 of these Technical Provisions.

18-7.10 Frames and Covers - Work shall conform to applicable details shown in the Contra Costa County Standard Plans. Castings shall conform to ASTM A 48, Class 35. The bearing surfaces of the frames and covers shall be machined and the cover shall seat firmly into the frame without rocking. Set frames so tops of covers are flush with surface of adjoining pavement or ground surface, unless otherwise shown or directed. Manhole covers shall be stamped "Storm Drain."

18-8 CONTROL OF EXISTING FLOWS

Flow in the existing pipes shall not be restricted or dammed for any period of time without the approval of the Engineer. All manhole connections shall be constructed while water is flowing in the existing pipe. All rerouting and/or bypass pumping of existing flows necessary to make the required modifications shall be made at the Contractor's expense. The Contractor must advise the Engineer of plans for diverting flow in conformance with current stormwater pollution prevention regulations and obtain Engineer's approval before starting. Engineer's approval shall not relieve Contractor of the responsibility for maintaining adequate capacity for flow at all times and adequately protecting new and existing work.

Where temporary pumps are required to bypass any water flow across traffic lanes, the discharge lines crossing the traffic lanes shall be buried a minimum of 4 inches below the pavement surface and backfilled with temporary asphalt concrete surfacing.

18-9 TRENCH RESURFACING

18-9.1 Temporary - Unless permanent pavement is specified or allowed to be placed promptly, or shown otherwise in the Contract Plans, or specified differently by the Special Provisions, temporary bituminous resurfacing shall be placed in trenches at locations open to pedestrian or vehicular traffic. Placement of temporary resurfacing shall promptly follow completion of the trench backfill.

In sidewalk areas the temporary bituminous resurfacing shall be at least 1 inch (25mm) thick; in all other areas it shall be at least 2 inches (50mm) thick. At major intersections and other critical locations, a greater thickness may be ordered.

Temporary resurfacing shall be placed as soon as the condition of the backfill is suitable to receive it and shall remain in place until the condition of the backfill is suitable for permanent resurfacing. The Contractor shall maintain temporary surfacing until it is removed. Temporary trench surface shall be paved with a commercial grade pre-mix, or "cutback," using grade SC-800 asphalt binder, or an equivalent product approved by the Engineer. The mixture may be furnished from stockpiles or directly from the production plant and may be laid cold, at the option of the Contractor. The resurfacing shall be placed, rolled, maintained until it may be removed and disposed of by the Contractor just prior to permanent resurfacing.

18-9.2 Permanent Resurfacing - Unless otherwise shown on the Contract Plans or indicated differently in the Special Provisions, all surface improvements damaged or removed as a result of the Contractor's operations shall be reconstructed by the Contractor to the same dimensions, except for pavement thickness, and with the same type materials used in the original work. Trench resurfacing shall be 1 inch (25mm) greater in thickness than existing pavement, or 3 inches, whichever is greater.

18-10 MEASUREMENT - Pipe and conduit shall be measured along the longitudinal axis between the ends as laid and shall include the actual pipe in place, rounded up to the nearest foot, measured to the inside face of walls of structures and shall not include the inside dimensions of structures.

18-11 PAYMENT - The price per linear foot (m) for pipe and conduit in place shall be considered full compensation for all labor, materials, tools, equipment, and incidentals, to do all the work, including but not limited to- the excavations of the trench; the control of ground and surface waters; the preparation of subgrade; the removal of interfering portions of existing storm drains and other improvements; the closing or removing of abandoned conduit and structures; placing and joining pipe; backfilling the trench; placing, maintaining, and removing temporary surfacing; permanent resurfacing; and all other work necessary to install the pipe system complete in place as shown on the Contract Plans, as specified in the Contract Specifications, and as directed by the Engineer.

No adjustment in the contract unit price shall be made for raising the pipe grade by any amount or lowering of the pipe grade by twelve (12) inches or less.

Payment for structures such as manholes, clean outs, junction structures, and catch basins shall be made at the Contract Bid Price for each structure and shall be full payment for each structure complete in place, including excavation, backfill, constructing inverts, furnishing and installing castings, restoration of the street surface and all other work, including temporary resurfacing, necessary to complete the Work.