

**SECTION 02221
TRENCHING, BACKFILLING AND COMPACTION**

PART 1 - GENERAL

1.01 DESCRIPTION.

Requirements specified in Conditions of Contract and Division 1 form a part of this Section. The Work of this Section includes all labor, machinery, construction equipment, and appliances to perform in a good workmanlike manner all trench excavation and backfill work shown on the Drawings and herein specified.

A. Work Included In This Section. Principal items include:

1. Requirements
2. Materials
3. Trench Excavation
4. Bracing Trenches
5. Pipe Bedding
6. Backfilling Pipe Trenches
7. General Pipeline Installation Requirements
8. Clean-Up

B. Related Work Not Included In This Section.

1. Earthwork & Site Preparation
2. Asphalt Concrete Paving
3. Piping & Conduit Work specified in other Divisions.

1.02 GENERAL REQUIREMENTS.

Requirements of Section 02200 apply to this Section.

1.03 SAFETY.

The Contractor shall familiarize himself with, and shall at all times conform to all applicable regulations of Subpart "P" entitled, "Excavations" as mandated in the "Occupational Safety and Health Standards" (29CFR Part 1926) of OSHA Safety and Health Regulations for Construction. Contractor shall also comply with "Construction Safety Orders," Article 6 "Excavations, Trenches, Earthwork" of the State of California, Department of Industrial Relations, Division of Occupational Safety and Health (CAL/OSHA); the Owner's Plant Rules and Regulations; and applicable requirements specified in Section 01080.

1.04 INSPECTION AND CONTROL.

A Soils Engineer will be employed by the Contractor who shall act as the authority of the soils work, and shall perform inspection of the removal and replacement of unsuitable materials, and the placement and compaction of all backfills within the limits of trenching ensuring project specifications are being satisfied by the contractor. All work shall be done in accordance with these Specifications and as directed and approved by the Owner. Costs for all such inspections and tests will be paid by the Contractor. If retesting is required because the Contractor did not meet the Specification, all such costs shall be borne by the contractor.

1.05 REQUIREMENTS.

A. General.

1. The Work performed under this Specification shall be constructed to the lines, grades, and elevations, indicated on the Drawings, specified herein, and/or directed by the Owner in writing. Slopes, graded surfaces and drainage features shall present a neat, uniform appearance upon completion of the Work.
2. It shall be the Contractor's responsibility (1) to maintain adequate safety measures and working conditions; and (2) to take all measures necessary during the performance of the Work to protect the entire project area and adjacent properties which would be affected by this Work from storm damage, flood hazard, caving of trenches and embankments, and sloughing of material, until final acceptance by the Owner. It shall be the Contractor's responsibility to maintain completed areas until the entire project area is in satisfactory compliance with the project Specifications.
3. Contractor shall be responsible for the excavation and disposition of unsuitable or surplus material by approved means of conveyance away from the working area. Conform with applicable requirements for "Disposal of Surplus and/or Unsuitable Materials" as specified in Section 02200.

B. Utility Protection. Utility lines and structures indicated on the Drawings which are to remain in service shall be protected by the Contractor from any damage as a result of his operations. Where utility lines or structures not shown on the Drawings are encountered, the Contractor shall report them to the Owner before proceeding with the Work. The Contractor shall bear the cost of repair or replacement of any utility lines or structures which are broken or damaged by his operations.

1.06 GUARANTEE.

Work done under this Section shall in all respects come under the terms of the guarantee stated in the General Conditions.

PART 2 - PRODUCTS

2.01 MATERIAL.

A. Bedding. Bedding shall be defined as a layer of material immediately below the bottom of the pipe and extending over the full trench width in which the pipe is bedded. Thickness of pipe bedding shall a minimum of 6 inches compacted to 90% relative compaction.

1. Sand Bedding. Sand for bedding for all pipe shall be washed natural or manufactured granular material, or a combination thereof, free of deleterious substances such as organic material, mica, loam, or clay. The material must have been tested to a minimum Sand Equivalent of 30 within two (2) weeks of its use. Sand shall conform to the gradation listed below:

Sieve Size	Percent Passing	
	Minimum	Maximum
3/8"	100	-
No. 4	75	100
No. 30	12	50
No. 100	5	20
No. 200	0	15

B. Pipe Zone Material. Pipe zone material shall be defined as that material above the bedding and extending to the sides of trench and to one foot above the top of pipe. Use sand for the Pipe Zone. A native free-draining granular material having sand equivalent of not less than 30, or having coefficient of permeability greater than 1/4 inch per hour, or other material may be used with approved by the District Engineer. Cost of any sand equivalent tests shall be borne by the Contractor.

C. Trench Backfill shall consist of excavated onsite soils, except when unsuitable soils are encountered as determined by the Owner or his representative, sand or slurry backfill shall be used.

D. Slurry Backfill. When directed by the Owner, slurry backfill shall be used to provide a stable trench backfill in an otherwise incompressive trench zone. Use Trench Backfill Slurry of Concrete Class 100-E-100 as defined in Subsection 201-1.1.2 of the Standard Specifications for Public Works Construction "GREENBOOK 2018 Edition or latest edition.

E. Pipelines. Use materials shown on the Plans and as specified in other pertinent Sections of this Specification.

PART 3 - EXECUTION

3.01 TRENCH EXCAVATION.

A. Excavation for Trenches shall include the removal of all material of any nature for the installation of the pipe or facility and shall include the construction of trench shoring and stabilization measures, timbering and all necessary installations for dewatering.

B. Minimum Width of Trench. The minimum width of pipe trenches, measured at the crown of the pipe, shall not be less than 12 inches greater than the exterior diameter of the pipe, exclusive of bells and the minimum base width of such trench shall be not less than 12 inches greater than the exterior diameter of the pipe, exclusive of special structures or connections, and such minimum width shall be exclusive of all trench supports.

C. Maximum Width of Trench. The maximum allowable width of trench for all pipelines measured at the top of the pipe shall be the outside diameter of the pipe (exclusive of bells or collars) plus 24 inches, and such maximum shall be inclusive of all timbers. A trench wider than the outside diameter plus 24 inches may be used without special bedding if the Contractor, at his expense will furnish pipe of the required strength to carry the additional trench load. Such modifications shall be submitted to the Owner and approved in writing. Whenever such maximum allowable width of trench is exceeded for any reason, except as provided for on the Plans or in the Specifications, or by the written direction of the Owner, the Owner may, at his discretion, require that the Contractor, at his own expense for all labor and materials, cradle the pipe in 2000 psi compressive strength concrete, or other approved pipe bedding.

D. Pipe Trench widths in the pipe zone shall be limited as follows:

<u>Pipe Diameter</u>	<u>Minimum Trench Width</u>	<u>Maximum Trench Width</u>
4" through 12"	O.D. + 12"	O.D. + 16"
14" through 48"	O.D. + 16"	O.D. + 24"

E. Maximum Length of Open Trench. Except by special permission by the Owner, only that amount of pipe construction will be permitted, including excavation, construction of pipeline, and backfill in any one location, which can be completed in one day. This length includes open excavation, pipe laying and appurtenant construction and backfill which has not been temporarily resurfaced. The use of trench plates shall be use with the approval of the Owner.

F. Trench Side Slopes.

1. Temporary trench excavations shall at all times conform to the safety requirements hereinbefore specified in Paragraph entitled "Safety".
2. Loose cobbles or boulders shall be removed from the sides of the trenches before allowing workmen into the excavation, or the trench slopes must be protected with screening or other methods. Trench side slopes shall be kept moist during construction to prevent local sloughing and raveling. Surcharge loads due to construction equipment shall not be permitted within 5 feet of the top of any excavated slope.
3. If the Contractor elects to shore or otherwise stabilize the trench sides, he shall file with the Owner copies of drawings for same prepared and signed by a Civil Engineer duly registered in the State of California before commencing excavation.

G. Excess Trench Excavation. If any trench, through the neglect of the Contractor, be excavated below the bottom grade required, it shall be refilled to the bottom grade, at the Contractor's expense for all labor and material, with sand or D.G compacted to a firm stable foundation.

3.02 BRACING TRENCHES.

The sides of the trenches shall be supported with plank sheeting and bracing in such a manner as to prevent caving of the sides of the trench. Space left by withdrawal of sheeting or shoring shall be filled completely with dry granular material blown or rammed in place. All trenches shall be shored according to OSHA standards unless cut to the angle of repose of the excavated soils. All shoring must be submitted with engineered product specifications.

3.03 PIPING BEDDING.

A. The Contractor shall bed all pipe in crushed rock as hereinbefore specified, except as follows:

1. Where directed on the plans, or as determined by the Owner or Soils Engineer, pipe shall be bedded in concrete.
2. Plastic pipe shall be bedded in sand, unless otherwise required by the manufacturer.

B. The Contractor shall excavate to 6 inches below the bells or couplings for the full width of the trench and shall place 6 inches of bedding as specified upon which the pipe is to be laid. In cases, as determined by the Owner, where trench material is suitable for use as bedding, the trench may be excavated to a point above the invert grade, and the trench bottom shall be handshaped so that the bottom segment of the pipe is firmly supported on undisturbed material.

C. Where rock is encountered in the trench and the rock is deemed not rippable with a standard heavy-duty excavation equipment, Caterpillar 336 or equal, then this shall be considered a change in scope and contractor shall submit a change order request per the General conditions.

D. Before any pipe is lowered in place, the trench bottom shall be prepared so that each pipe shall be supported for the full length of the barrel. All adjustments in line and grade shall be made by scraping away or filling and tamping in under the barrel of the pipe. Wedging or blocking are not permitted.

E. The pipe bedding shall be compacted to a minimum of 90 percent relative compaction as hereinafter specified.

3.04 BACKFILLING PIPE TRENCHES.

A. Backfilling Pipe Zone. Selected backfill material for the pipe zone shall consist of hereinbefore specified material or imported granular material as approved by Soils Engineer in advance of placement. Place material in the trench simultaneously on each side of the pipe for the full width of the trench and the depth of the pipe zone in layers 6 inches in depth. Each layer shall be thoroughly compacted by tamping or, where the material is sufficiently granular in nature as determined by the Owner.

B. Particular attention shall be given to underside of the pipe and fittings to provide a firm support along the full length of the pipe. The pipe zone shall be considered to extend and compacted 12 inches minimum above the top of the pipe, and shall be compacted to a relative compaction of not less than 90 percent of maximum dry density at optimum moisture content as hereinafter specified. Care shall be taken not to damage pipe or special coatings on the pipe.

1. For PVC Pipe, use sand or other material and methods recommended in writing by the pipe manufacturer for pipe bedding and for backfill material within pipe zone.
2. Use of Materials other than those specified shall be approved by Owner prior to use. The Contractor shall bear all cost of removal of rejected material, its hauling to an authorized disposal site, and cost of providing required material to complete the bedding and backfilling.

C. Backfilling Pipe Trench. After the pipe has been laid in the trench and has been inspected and approved, and backfilling in the pipe zone is complete and compacted, the remainder of the trench may be backfilled. The backfill material shall be suitable material as hereinbefore specified or sand, free from all stones, clods or other deleterious material or trench slurry backfill. Care shall be taken to ensure that no voids remain under, around or near the pipes.

1. Whenever imported borrow for backfill is required, the Contractor shall furnish this borrow material and dispose of the excess trench excavation and shall include the expense of this work in his bid.
2. The imported material shall be select earth, sand, or gravel, free from clods, lumps or stones over 3 inches in diameter and shall not contain over 10 percent, by volume, of clay or adobe. The imported material must be submitted and approved by the Owner prior to use.

D. Compaction. The maximum dry density and optimum moisture content of each soil type used in the controlled compacted fill shall be determined by ASTM D1557 (Modified Proctor) compaction method. Field density tests shall be determined in accordance with ASTM D2922 (Nuclear) and ASTM D1556 (Sand Cone) as directed in Section 02200 "Earthwork and Site Preparation."

E. Placement and Compaction of Trench Backfill. The placement and compaction of all trench backfill shall conform to one of the following methods subject to the qualification specified therein:

1. Mechanically Compacted Backfill. With approval of Owner, backfill shall be mechanically compacted by means of tamping rollers, sheepsfoot rollers, vibrating rollers, or other mechanical tampers to 90 percent relative compaction except that backfill compaction for trenches above the pipe zone (Trench Zone) shall be to a minimum 95 percent in areas under buildings and pavements. Where the backfill soil has a clay-like behavior and has a plasticity index of at least 12, only the upper 3 feet of material placed will require minimum compaction of 95 percent. Mechanically compacted backfill shall be placed in horizontal layers not exceeding twelve inches, or the maximum thickness recommended by the Soils Engineer. Each layer shall be evenly spread, the moisture content brought to near optimum condition and then tamped or rolled until the specific relative compaction has been attained.
2. Water Densified Backfill. Densification by flooding or jetting shall not be permitted
3. Densification of Slurry Backfill. Trench backfill slurry shall be used when directed by the Owner or Soils Engineer to attain a stable trench backfill under a structure, or in a poor or otherwise incompressive trench zone. Trench backfill slurry shall be consolidated by vibration as described in Section 03300.

3.05 GENERAL PIPELINE INSTALLATION REQUIREMENTS.

A. Depth of Pipe. Install pipelines at the depths (elevations) shown on the Drawings. If elevations are not shown, piping shall be only installed with cover adequate to resist construction loads, but in no instance shall cover be less than three (3) feet.

B. Sewer Pipe. Unless otherwise shown on the Plans, all sewer force mains shall have a coverage of at least 30 inches between the top of the pipe and the finished surface. All gravity line invert elevations and locations shown are intended to be exact and any change in alignment and grade may only be made with approval of the Owner. All force and gravity mains shall have 1 foot vertical clearance between themselves and all other utilities. When clearance of 1 foot is not feasible, the contractor will be required to request direction from the owner before proceeding. Failure to notify the owner will result in correction action at contractor's expense. If a delay is encountered, at no time will the Owner be held financially responsible for the contractors lost time.

C. Changes in Line and Grade. In the event obstructions not shown on the Plans are encountered during the progress of the Work which will require alterations to the Plans, the Owner shall have the authority to change the Plans and order the necessary deviation from the line or grade. The Contractor shall not make any deviation from the specified line and grade without prior approval by the Owner. Should any deviations in line and grade be permitted by the Owner in order to reduce the amount of rock excavation or for other similar convenience to the Contractor, any additional costs for thrust blocks, valves, air and vacuum valve assemblies, blow-off assemblies, extra pipe footage, concrete, sewer structures, or other additional costs shall be borne by the Contractor.

1. Contractor shall include in his Bid provisions to cover any deviations from the line or grade shown on the Plans to facilitate extra trenching required to eliminate possible conflicts between culverts and other utilities with the pipe trench.

D. Installing Pipe. Contractor shall, after excavating the trench and preparing the proper bedding for the pipe, furnish all necessary facilities for properly lowering and placing sections of

the pipe in the trench without damage and shall properly install the pipe. The section of pipe shall be fitted together correctly and shall be laid true to line and grade in accordance with stakes established by the Owner. All pipe shall be installed per manufactures recommendations. The full length of the barrel of the pipe shall have a uniform bearing upon 6 inches of bedding material, but if the pipe has a projecting bell, suitable excavation shall be made to receive the bell which shall not bear on the subgrade. The requirements for closely fitting the bottom of the pipe to the bedding material for the width shown on the Drawings will be strictly enforced.

1. Pipe shall be laid up grade. Any pipe which is not in true alignment, both vertical and horizontal, or shows any undue settlement after laying shall be replaced when so ordered by the Owner. No pipe shall be laid which is damaged, cracked, checked or spalled has any other defect deemed by the Owner to make it unacceptable, and all such sections shall be permanently removed from the Work.
2. At all times when the Work of installing pipe is not in progress, all openings into the ends of the pipelines shall be kept tightly closed to prevent the entrance of animals and foreign materials and to prevent water from entering the pipe.
3. Keep the pipe trench free from water at all times and take all necessary precautions to prevent the pipe from floating due to water entering the trench from any source. Any damage is the Contractor's full responsibility. Restore and replace the pipe to its specified conditions and grade if it is displaced due to floating.

3.06 CLEAN-UP.

Immediately upon completion of Work of this Section, all rubbish and debris shall be removed from the job site. All construction equipment and implements of service shall be removed and the entire area involved shall be left in a neat, clean and acceptable condition.

END OF SECTION 02221