

SECTION 02300

TRENCH EXCAVATION AND BACKFILL

PART 1 - GENERAL

1.1 Description

A. Description of Work

The work to be performed in accordance with this section includes the excavation, trenching, backfilling, and surface repair for all pipelines, pipe culverts, box culverts, accessories and lines connected thereto, complete including sheeting and shoring, dewatering, grading and cleanup.

Excavation for appurtenant structures such as manholes, inlets, transition structures, junction structures, vaults, valve boxes, catch basins, etc. shall be included in this section.

The work shall include the furnishing of all labor, tools, equipment, materials and performing all operations to provide a complete item in accordance with the project plans and these specifications.

B. Related Work Specified Elsewhere

Earthwork.....	Section 02200
Ductile Iron Pipe	Section 02648
Cement-Mortar Lined and Coated Steel Pipe and Fittings	Section 02651
General Piping Systems and Appurtenances.....	Section 15000
Valves and Appurtenances.....	Section 15020

C. Definitions

1. Trench

An excavation in which the depth is greater than the width of the bottom of the excavation.

2. Foundation

Material on which bedding is to be directly placed.

3. Bedding

Granular material on which pipe or structure is to be directly placed. The bedding extends from 6 inches below the pipe to 12 inches above the top of the pipe.

4. Select Backfill

Material placed from top of the bedding to finished subgrade.

1.2 Quality Assurance

A. Reference Test Standards and Specifications

ASTM C94, Standard Specification for Ready Mix Concrete.

ASTM C117, Standard Test Method for Materials Finer than No. 200 Sieve in Mineral Aggregates by Washing.

ASTM C131, Standard Test Method for Resistance to Degradation of Small Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.

ASTM C136, Standard Method for Sieve Analysis of Fine and Coarse Aggregate.

ASTM D1556, Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method.

ASTM D698, Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³).

ASTM D6938, Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

ASTM D4215, Standard Specification for Cold Mixed, Cold Laid Bituminous Paving Mixture.

ASTM D4318, Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

Rock Correction Procedure for Maximum Density Determination, ARIZ 227.

Moisture – Density Relationship Using Typical Moisture – Density Curves (One Point Proctor) Method A, ARIZ 232

B. Frequency of Testing

1. Maximum Dry Density and Optimum Moisture Content, ASTM D698.

- a. One test for each different class or type of material shall be provided by the **CONTRACTOR**.
- b. **CONTRACTOR** shall provide additional test when previous test is suspect, as determined by the **ENGINEER**.
- c. **The ENGINEER at the discretion of the OWNER may perform quality assurance testing for compaction, gradation and plasticity index of bedding sand and select backfill. If any test results show non-compliance with the project specifications, the non-complying materials shall be removed and replaced or reworked by the CONTRACTOR. The CONTRACTOR shall perform additional tests at his cost to verify an acceptable condition prior to acceptance by the ENGINEER.**

2. Density of Soil In-Place by Sand Cone or by Nuclear Methods

- a. **CONTRACTOR** shall perform a minimum of one test per lift per 500 linear feet of trench for each type of material.
- b. **CONTRACTOR** shall perform additional tests as required to ensure proper compaction.

3. Sieve Analysis of Aggregate, ASTM C136

- a. **CONTRACTOR** shall perform one test per 1,000 cy per material type of Bedding Sand Material incorporated into the **WORK**.
- b. **CONTRACTOR** shall perform one test per 1,000 cy per material type of Select Backfill Material incorporated into the **WORK**.

4. Plasticity Index of Soils, ASTM D4318

- a. CONTRACTOR shall perform one test per 1,000 cy per material type of Bedding Sand material incorporated into the WORK.
- b. CONTRACTOR shall perform one test per 1,000 cy per material type of Select Backfill material incorporated into the WORK.

5. Moisture – Density Relationship Using Typical Moisture – Density Curves (One Point Proctor) Method A, ARIZ 232

- a. CONTRACTOR shall perform this test any time the fill material appears to have changed or as directed by the ENGINEER or DESIGNEE to verify the appropriate proctor is being utilized.

C. Testing Tolerances

1. Percent Relative Compaction

Not less than as specified on plans or in these specifications.

2. In-Place Moisture Content

As required to achieve specified percent relative compaction.

3. Soft or Yielding Surfaces

Regardless of percent relative compaction obtained by test, areas which are soft and yield under the load of construction equipment are to be removed and replaced at no additional cost.

1.3 Submittals

A. Materials Test Reports

1. Report on maximum dry density and optimum moisture content prior to beginning of construction.
2. Report on bedding and backfill materials compliance tests as required. Compaction test reports shall be submitted to the ENGINEER within two (2) business days of completion of each test.

B. Spoil Disposal Area

Provide location and written approval for area to dispose of spoil from operation, as approved by ENGINEER.

C. Shoring Plan

Provide plans, details, and calculations by a professional **ENGINEER** registered in the State of Arizona if shoring or sheeting is required. See Section 02254

D. Dewatering Plan

Provide plans, details and calculations by a professional Engineer registered in the State of Arizona if dewatering is required.

1.4 Job Conditions

A. Dewatering

It is the **CONTRACTOR'S** responsibility to dewater if groundwater is encountered.

B. Protection of Existing Utilities

Maintain all utilities both underground and overhead in continuous service throughout the contract period. Liability for damages to, or interruption of services caused by the construction shall be borne by the **CONTRACTOR**.

PART 2 - MATERIALS

2.1 Soil and Soil Aggregate Materials

A. Unsuitable materials not to be incorporated in the work include:

1. Organic matter such as peat, mulch, organic silt or sod.
2. Soils containing expansive clays.
3. Material containing excessive moisture.
4. Poorly graded coarse material.
5. Particle size in excess of 6-inches.
6. Material which will not achieve density and/or bearing requirements.
7. Material containing asphalt concrete or Portland cement concrete.

B. Bedding

Bedding for all water, sewer, storm drain lines, and manholes specified in Sections 2500, 2551, 2550, 2560, and 2570 shall be bedded in bedding sand. Culverts, specified in Section 2520, shall be bedded on aggregate base course per subsection 2.1.E unless otherwise specified.

1. Bedding Sand

Bedding sand shall consist of non-plastic sandy material conforming to the following requirements:

Sand Equivalent (SE), 30 Minimum
PH 6.5 – 8.5
Resistivity 2,000 – 50,000 ohm-cm
Sulfate (optional) 1500 PPM or less

SIEVE SIZES	PERCENTAGE BY WEIGHT
3/8"	100
No. 4	90-100
No. 50	10-40
No. 100	3-20
No. 200	0-15

C. Granular Backfill

Native excavated or approved import granular material, free draining and free of unsuitable materials defined herein. Granular backfill shall be non-plastic, well graded and meet the following requirements:

Sieve Size	Percent by Weight Passing
4 inches	100
No. 4	30-75
No. 8	20-60
No. 30	10-40
No. 200	0-12

D. Aggregate Base Course

Crushed aggregate or processed natural material, clean, hard, sound, and free of any detrimental quantity of soft, friable, elongated, or laminated pieces, organic matter or other deleterious substances. Properties of which shall meet the following requirement:

- a. Grading, ASTM C136 and ASTM C117.

Sieve Size	Percent by Weight
1 1/2"	100
No. 4	30-70
No. 8	20-60
No. 30	10-40
No. 200	0-12

- b. Percentage of Wear, ASTM C131, maximum percentage of wear of 40 after 500 revolutions.

- c. Plasticity Index and Liquid Limit, ASTM D4318, maximum plasticity index of 5, maximum liquid limit of 25 percent.

2.2 Portland Cement Concrete

ASTM C94 and Specification Section 3300.

2.3 Asphalt Cement Concrete

As required in Specification Section 2630.

2.4 Cold Mix, Cold Laid Bituminous Paving Mixture

ASTM D4215.

2.5 Buried Warning and Identification Tape

Polyethylene plastic and metallic core or metallic-faced, acid- and alkali-resistant, polyethylene plastic warning tape manufactured specifically for locating, warning, and identification of buried utility lines. Provide tape on rolls, 3-inch minimum width, color coded as stated below for the intended utility with warning and identification imprinted in bold black letters continuously over the entire tape length. Warning and identification to read, "CAUTION, BURIED (intended service) LINE BELOW" or similar wording. Color and printing is to be permanent, unaffected by moisture or soil.

WARNING TAPE COLOR CODES	
RED	ELECTRIC
YELLOW	GAS, OIL, DANGEROUS MATERIALS
ORANGE	TELEPHONE AND OTHER COMMUNICATIONS
BLUE	WATER
GREEN	SEWER
WHITE	STEAM, AIR
PURPLE	REUSE

A. Warning Tape for Metallic Piping

Acid and alkali-resistant polyethylene plastic tape conforming to the width, color, and printing requirements indicated above. Minimum thickness of the tape shall be 0.003 inch. Tape shall have a minimum strength of 1500 psi lengthwise and 1250 psi crosswise with a maximum 350 percent elongation.

B. Detectable Warning Tape for Non-Metallic Piping

Polyethylene plastic tape to the width, color, and printing requirements indicated above. Minimum thickness of the tape shall be 0.004 inch. Tape shall have a minimum strength of 1500 psi lengthwise and 1250 psi crosswise.

PART 3 - EXECUTION

3.1 Preliminary Investigation of the Work

Verify that all of the preliminary work including construction staking has been performed in accordance with the plans and specifications prior to trenching and backfill operations.

3.2 Trenching in Fill Areas

Grade fill areas to within 1 foot of the finish grade prior to trenching and placement of the pipeline.

3.3 Excavation

A. General

Perform all excavations of every description and of whatever substances encountered to the depths indicated on the plans and including excavation ordered by the **ENGINEER** of compacted fill for the purpose of performing tests. Use open cut excavation methods unless otherwise indicated on the plans or approved by the **ENGINEER**.

B. Trench Widths

Trenches shall be excavated per LHC Standard Detail 200A

Maintain trench walls as vertical as possible except as required by safety standards and as required for sheeting and shoring.

If the maximum trench width is exceeded at the top of the pipe, the **CONTRACTOR** shall provide necessary additional load bearing capacity by means approved by the **ENGINEER** at no additional cost to the **OWNER**.

C. Over excavation

1. Unauthorized

Fill and compact unauthorized excavation beyond the specified grade line, at the **CONTRACTOR'S** expense, with bedding material, compact to 95 percent of the maximum density. No payment will be made for unauthorized over excavation.

2. Rock

Over excavate rock encountered in the trench to provide a minimum of six inches of bedding below the pipe and the minimum width at the springline.

3. Unsuitable Material

Over excavate unsuitable material to the depth necessary to provide the required support as determined by the **ENGINEER**. Backfill the over excavation with bedding material and compact to at least 95 percent of the maximum density.

D. Excavation for Manholes, Valves, Inlets, Catch Basins and Other Accessories

Provided the excavated surfaces are firm and unyielding, the **CONTRACTOR** may elect to cast concrete for the structure directly against excavated surfaces. Over excavate to provide bedding where shown on the plans.

E. Pavement and Concrete Cutting and Removal

Sawcut, remove and dispose of existing pavements and concrete per Specification Section 2110.

F. Grading and Stockpiling

1. Grading

Grade in the vicinity of the trench to prevent surface water from flowing into the trench. Remove any water accumulated in the trench by pumping or by other approved methods. Stockpile excavated material in an orderly manner a sufficient distance back from the edges of the trench to avoid overloading and to prevent slides or cave-ins.

2. Topsoil

Excavate topsoil and stockpile separately. Replace topsoil upon completion of backfill and grade to the elevations indicated on the plans.

G. Shoring and Sheeting

Shore, sheet and brace excavations as set forth in the rules, orders and regulations of the United States Department of Labor Occupational Health and Safety Administration (OSHA), and as specified in section 02254 of these specifications. Provide detailed plan and calculations as prepared by a registered professional **ENGINEER** for excavations 20 feet in depth or greater or when shoring, sheeting or bracing deviates from OSHA standards. Place and remove shoring, sheeting and bracing so as not to damage adjacent improvements, utilities or utility being placed. Costs for shoring, sheeting, and bracing is considered incidental.

H. Open Trench

1. Maximum Length

The maximum length of open trench within developed, dedicated right of way is not to exceed 500 feet per trench and pipeline crew, provided that all proper barricades and safety procedures have been addressed. The trench is considered to be open until backfill is completed to adjacent finish grade elevation.

2. Street Crossing

Complete backfill of trench across streets at the end of each work day. Use temporary patch material (cold mix asphalt concrete) or steel plates as required.

3. Temporary Provisions

Furnish and install trench bracing and steel plating required to provide safe and convenient vehicular and pedestrian passage across trenches where required. Maintain access to and from emergency facilities at all times.

3.4 Foundation, Bedding, Backfilling and Compaction

A. Foundation

Excavate trench bottom to the depth and width as shown. Remove all loose, disturbed material from the bottom of the trench such that the bedding shall rest on firm, undisturbed soil.

B. Bedding

Moisture condition and place bedding material to required thickness. Compact bedding material to the specified density.

C. Fine Grading

Accurately grade the bottom of the trench to provide uniform bearing and support for each section of pipe at every point along its entire length, except where it is necessary to excavate for joints.

D. Moisture Conditioning

Moisture condition all bedding and backfill materials by aerating or wetting to obtain the moisture content required to achieve specified percent relative compaction. Completely mix the material until the moisture content is uniform throughout the lift.

E. Lift Thickness

1. The following table applies when using mechanical compaction:

LIFT DESCRIPTION	MAXIMUM LOOSE LIFT THICKNESS, INCHES
Bedding	8-Inches in all cases
Backfill	
Aggregate Base Course	

Lift thickness may be increased if **CONTRACTOR** can prove, through a series of density tests, to be approved by the Engineer, that minimum density is achieved throughout the lift thickness.

F. Compaction

1. Compaction Methods

Construction shall be accomplished by mechanical methods. Rubber tire wheel rolling will not be allowed.

2. Pipe Haunch

When using mechanical methods, hand compact initial backfill in pipe haunch with a pipe haunch compactor (J-bar) or mechanical vibrator sized to fit the narrow width between the pipe and the trench. Give special attention to provide proper compactive effort in the pipe haunch zone.

3. Compaction Densities

Thoroughly compact trench bedding and backfill to not less than the percent relative compaction as presented in the following table, unless more stringent requirements are called for on the plans.

PERCENT RELATIVE COMPACTION MINIMUM DENSITY REQUIRED				
Backfill Type	Location	From Subgrade Surface To 2' Below Surface	From 2' Below Surface To 1' Above Top of Pipe	From 1' Above Top of Pipe To Bottom of Trench
I	Under any existing or proposed pavement, curb, gutter, sidewalk, or such construction included in the contract or when any part of the trench excavation is within 2' of the above.	95%	95%	95%
II	On any utility easement, street, road or alley right-of-way outside of (I).	95%	95%	95%
III	Around any structures or exposed utilities.	95% in all cases		
IV	Outside of right-of-way and not below any curb, gutter sidewalk or other structures.	90% in all cases		

3.5 Buried Warning and Identification Tape

Place warning and identification tape to the depth indicated on the plan. Center tape over pipeline.

3.6 Backfill for Manholes, Valves, Inlets, Catch Basins and Other Accessories

Backfill appurtenances and structures including bedding, backfill, lift thicknesses and compaction as indicated.

3.7 Pavement Replacement and Surface Restoration

A. Grading

Perform all grading adjacent to backfilled trenches and structures necessary to leave the area in a neat and satisfactory condition as approved by the **Engineer**.

B. Surface Restoration

Restore all streets, alleys, driveways, sidewalks, curbs or other surfaces which were broken or damaged by the installation of the new work, to a condition as good as or better than originally encountered in accordance with these specifications, accepted standards and as acceptable to the **ENGINEER**.

1. Landscape

Replace landscape rock, sod, shrubs, trees, grass, sprinkler systems as required to a condition as good as or better than originally encountered in accordance with these specifications, accepted standards and as acceptable to the Engineer.

2. Temporary Pavement

Place cold mix, cold laid bituminous paving mixture in accordance with ASTM D4215 immediately following backfilling and compaction of trenches through existing pavement. Maintain pavement in safe and smooth condition until final pavement can be placed.

3. Pavement Replacement

Replace permanent asphalt cement, concrete pavement per the requirements of Specification Section 2630, Asphalt Concrete Pavement.

4. Clean Up

Remove all excess soil, concrete, etc. from the premises. Leave job site in a neat and clean condition.

PART 4 - MEASUREMENT AND PAYMENT

4.1 Measurement

A. Trench Excavation and Backfill

No measurement will be made for trench excavation and backfill.

B. Over excavation

Over excavation of unsuitable material will be measured by the average end area method per Section 2200, Earthwork.

C. Surface Repair

Measure surface repair along the centerline of utility over which it occurs from junction center to center.

4.2 Payment

A. Trench Excavation and Backfill

No payment will be made for trench excavation and backfill. All trench excavation and backfill work including but not limited to excavation, material testing, disposal, backfill grading is incidental to the pipelines and appurtenant bid items.

B. Over excavation

Payment for over excavation will be made per Specification Section 2200, Earthwork.

****END OF SECTION 02300****