

SECTION 31 30 00 - EARTHWORK**PART 1 -- GENERAL**

1.1 THE REQUIREMENT

- A. The CONTRACTOR shall perform earthwork as indicated and required for construction of the WORK, complete and in place, in accordance with the Contract Documents.

1.2 CONTRACTOR SUBMITTALS

A. Samples

1. The CONTRACTOR shall submit samples of materials proposed for the WORK in conformance with the requirements of Section 01 33 00 – Contractor Submittals.
2. Sample sizes shall be as determined by the testing laboratory.

PART 2 -- PRODUCTS

2.1 FILL AND BACKFILL MATERIAL REQUIREMENTS

A. General

1. Fill, backfill, and embankment materials shall be selected or shall be processed and clean fine earth, rock, gravel, or sand, free from grass, roots, brush, other vegetation and organic matter.
2. Fill and backfill materials that are to be placed within 6 inches of any structure or pipe shall be free of rocks or unbroken masses of earth materials having a maximum dimension larger than 3 inches.

B. Suitable Materials

1. Materials not defined below as unsuitable will be considered as suitable materials and may be used in fills, backfilling, and embankment construction, subject to the indicated requirements.
2. If acceptable to the ENGINEER, some of the material listed as unsuitable may be used when thoroughly mixed with suitable material to form a stable composite.
3. Mixing or blending of materials to obtain a suitable composite is the CONTRACTOR's option but is subject to the approval of the ENGINEER.
4. The CONTRACTOR shall submit certification to the ENGINEER that the chloride concentration in imported materials within the pipe zone does not exceed 100 ppm, when tested in accordance with the requirements of AASHTO T291-94 – Standard Method of Test for determining Water-Soluble Chloride Ion Content in Soil.
5. Suitable materials may be obtained from on-Site excavations, may be processed on-Site materials, or may be imported.

6. If imported materials are required by this Section or are required in order to meet the quantity requirements of the WORK, the CONTRACTOR shall provide the imported materials as part of the WORK, unless a unit price item is included for imported materials in the Bidding Schedule.

C. The following types of materials are defined:

1. Type A (three-quarters inch minus granular backfill): Crushed rock or gravel, and sand with the gradation requirements below. The material shall have a minimum sand equivalent value of 28 and a minimum R-value of 78. If the sand equivalent value exceeds 35 the R-value requirement is waived.

Sieve Size	Percentage Passing
3/4-inch	100
No. 4	30 - 50
No. 200	0 - 12

2. Type B (Class I crushed stone): Manufactured angular, crushed stone, crushed rock, or crushed slag with the following gradation requirements. The material shall have a minimum sand equivalent value of 75.

Sieve Size	Percentage Passing
1/2-inch	100
No. 4	30 - 50
No. 200	0 - 5

3. Type C (sand backfill): Sand with 100 percent passing a 3/8-inch sieve, at least 90 percent passing a Number 4 sieve, and a sand equivalent value not less than 30.
4. Type D: (Imported Fill Material): Material shall be angular gravel material with no more than 15 percent passing a No. 200 sieve and a maximum particle size of 4 inches.
5. Type E (pea gravel backfill): Crushed rock or gravel with 100 percent passing a 1/2-inch sieve and not more than 10 percent passing a Number 4 sieve.
6. Type F (coarse drainrock): Crushed rock or gravel meeting the following gradation requirements:

Sieve Size	Percentage Passing
2-inch	100
1-1/2 inch	90 - 100

1-inch	20 - 55
3/4-inch	1 - 15
No. 200	0 - 3

7. Type G (aggregate base): Crushed rock aggregate base material of such nature that it can be compacted readily by watering and rolling to form a firm, stable base for pavements. At the option of the CONTRACTOR, the grading for either the 1-1/2 inch maximum size or 3/4-inch maximum size gradation shall be used. The sand equivalent value shall be not less than 22, and the material shall meet the following gradation requirements:

Sieve Size	Percentage Passing	
	1-1/2 inch Max Gradation	3/4-inch Max Gradation
2-inch	100	-
1-1/2-inch	90 - 100	-
1-inch	-	100
3/4-inch	50 - 85	90 - 100
No. 4	25 - 45	35 - 55
No. 30	10 - 25	10 - 30
No. 200	2 - 9	1 - 9

8. Type H (graded drainrock): Drainrock shall be crushed rock or gravel, durable and free from slaking or decomposition under the action of alternate wetting or drying. The material shall be uniformly graded and shall meet the following gradation requirements:

Sieve Size	Percentage Passing
1-inch	100
3/4-inch	90 - 100
3/8-inch	40 - 100
No. 4	25 - 40
No. 8	18 - 33
No. 30	5 - 15
No. 50	0 - 7
No. 200	0 - 3

The drainrock shall have a sand equivalent value not less than 75. The finish graded surface of the drainrock immediately beneath hydraulic structures shall

be stabilized to provide a firm, smooth surface upon which to construct reinforced concrete floor slabs. The CONTRACTOR shall use, at its option, one of the asphalt types listed below:

	Type 1	Type 2	Type 3
Designation	SC-800	SC-250	RS-1
Spray Temperature, deg F	175-255	165-200	70-120
Coverage, gal/sq yd	0.50	0.50	0.50

If the surface remains tacky, sufficient sand shall be applied to absorb the excess asphalt.

9. Type I: Any other suitable material as defined herein.
10. Type J (cement-treated backfill): Material which consists of Type H material, or any mixture of Types B, C, G, and H materials which has been cement-treated so that the cement content of the material is not less than 5 percent by weight when tested in accordance with ASTM D 2901 - Standard Test Method for Cement Content of Freshly Mixed Soil Cement. The ultimate compressive strength at 28 days shall be not less than 400 psi when tested in accordance with ASTM D 1633 - Standard Test Method for Compressive Strength of Molded Soil - Cement Cylinders.
11. Type K (topsoil): Stockpiled topsoil material which has been obtained at the Site by removing soil to a depth not exceeding 2 feet. Removal of the topsoil shall be done after the area has been stripped of vegetation and debris.
12. Type L (controlled low strength material): Controlled low strength material shall be in accordance with Section 033400 - Controlled Low Strength Material.
13. Type M (aggregate subbase): Crushed rock aggregate subbase material that can be compacted readily by watering and rolling to form a firm stable base. The sand equivalent value shall be not less than 18 and the material shall meet the following gradation requirements:

Sieve Size	Percentage Passing
3-inch	100
2-1/2 inch	87 - 100
No. 4	35 - 95
No. 200	0 - 29

14. Type N (trench plug): Low permeable fill material, a non-dispersible clay material having a minimum plasticity index of 10.
15. Type O (impervious trench soil cover): Low permeable compacted soil, low-plasticity clay or nonplastic silt compacted to a minimum 85 percent density and an in-place permeability of 10^{-6} cm/sec or lower.

16. Soils which, when classified under ASTM D 2487 - Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System), fall in the classifications of Pt, OH, CH, MH, or OL shall be classified as unsuitable.
17. Schedule: Materials shall be used as indicated below:

Embankment Fills	I or mixture of I and A through H
Pipe	
Mortar coated, concrete, uncoated DIP	A, B
Dielectrically coated steel, polyethylene encased, non-mortar (rockshield) coated	C
PVC, VCP, HDPE	C
Pipes on grades >4% where backfills are graded with <10% passing No. 4 sieve	Trench plugs of types J, L, or N at intervals of 200 feet or less.
Trench zone backfill except as identified below	I, A through H or mixture thereof.
Trench zone in agriculture areas	I, A through H or mixture thereof or K
Final backfill under paved areas	G
Final backfill unpaved areas	K
Trench and final backfill under structures	Same as pipe zone except where concrete encasement is required
Replace pipeline trench over excavation	F with 6-inch top layer of E, or non-woven filter fabric, or same as pipe zone backfill if trench is above water table.
Trench impervious soil cover	O
Aggregate base materials	G
Aggregate subbase	M
Backfill around structures	I, A through H or mixture thereof
Under hydraulic or water retaining structures with underdrains	H
Under hydraulic or water retaining structures without underdrains	G,H
Under structures where ground water is removed to allow placement of concrete	F, underlain by non-woven filter fabric
All other structures	G,H
Top 6-inches of reservoir roofs, embankment fills, or backfills around structures	K

2.2 MATERIALS TESTING

A. Samples

1. Soils testing of samples submitted by the CONTRACTOR will be performed by a testing laboratory of the OWNER's choice and at the CONTRACTOR's expense.
2. The ENGINEER may direct the CONTRACTOR to supply samples for testing of any material used in the WORK.

B. Particle size analysis of soils and aggregates will be performed using ASTM D 422 - Standard Test Method for Particle-Size Analysis of Soils.

C. Determination of sand equivalent value will be performed using ASTM D 2419 - Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate.

D. Unified Soil Classification System

1. References in this Section to soil classification types and standards shall have the meanings and definitions indicated in ASTM D 2487.
2. The CONTRACTOR shall be bound by applicable provisions of ASTM D 2487 in the interpretation of soil classifications.

E. Testing for sulfate shall be performed in accordance with AASHTO T-290.

F. Testing for resistivity shall be performed in accordance with AASHTO T-288.

G. Testing for pH shall be performed in accordance with AASHTO T-289.

H. Testing for chloride shall be performed in accordance with AASHTO T291.

2.3 IDENTIFICATION TAPE

A. Unless otherwise indicated, identification tape shall be placed above buried pipelines.

B. Identification tape shall be 6-inches wide, blue in color for potable water and green (or yellow) in color for drains, composed of polyethylene with solid foil core.

C. Tape shall be labeled with similar wording as shown below:

Potable Water Pipes	Caution Buried Water Line Below
Drain Pipes	Caution Buried Pipe (or Drain) Line Below
Electrical	Caution Buried Electrical Line Below

PART 3 -- EXECUTION**3.1 EXCAVATION AND BACKFILLING - GENERAL****A. General**

1. Except when specifically provided to the contrary, excavation shall include the removal of materials, including obstructions that would interfere with the proper execution and completion of the WORK.
2. The removal of such materials shall conform to the lines and grades indicated or ordered.
3. Unless otherwise indicated, the entire Site shall be stripped of vegetation and debris and shall be grubbed, and such material shall be removed from the Site prior to performing any excavation or placing any fill.
4. The CONTRACTOR shall furnish, place, and maintain supports and shoring that may be required for the sides of excavations.
5. Excavations shall be sloped or otherwise supported in a safe manner in accordance with applicable state safety requirements and the requirements of OSHA Safety and Health Standards for Construction (29CFR1926).
6. The CONTRACTOR shall provide quantity surveys where so required to verify quantities for Unit Price Contracts.
7. Surveys shall be performed prior to beginning WORK and upon completion by a surveyor licensed in the state where the Site is located.

B. Water Tank – The water tank shall be supported on at least 12 inches of Type B Material.**C. Removal and Exclusion of Water**

1. The CONTRACTOR shall remove and exclude water, including stormwater, groundwater, irrigation water, and wastewater, from excavations.
2. Dewatering wells, wellpoints, sump pumps, or other means shall be used to remove water and continuously maintain groundwater at a level at least 2 feet below the bottom of excavations before the excavation WORK begins at each location.
3. Water shall be removed and excluded until backfilling is complete and field soils testing has been completed.

3.2 OVER-EXCAVATION

A. Indicated

1. Where areas are indicated to be over-excavated, excavation shall be to the depth indicated, and backfill shall be installed to the grade indicated.

B. Not Indicated

1. When ordered to over-excavate areas deeper and/or wider than required by the Contract Documents, the CONTRACTOR shall over-excavate to the dimensions ordered and backfill to the indicated grade.

C. Neither Indicated nor Ordered

1. Any over-excavation carried below the grade that is neither ordered or nor indicated shall be backfilled and compacted to the required grade with the indicated material as part of the WORK

3.3 EXCAVATION IN LAWN AREAS

- A. Where excavation occurs in lawn areas, the sod shall be carefully removed, dampened, and stockpiled in order to preserve it for replacement.

- B. Excavated material may be placed on the lawn, provided that a drop cloth or other suitable method is employed to protect the lawn from damage, but the lawn shall not remain covered for more than 72 hours.

- C. Immediately after completion of backfilling and testing of the pipeline, the sod shall be replaced and lightly rolled in a manner as to restore the lawn as near as possible to its original condition.

- D. The CONTRACTOR shall provide new sod if the stockpiled sod has not been replaced within 72 hours.

3.4 EXCAVATION IN VICINITY OF TREES

- A. Except where trees are indicated to be removed, trees shall be protected from injury during construction operations.

- B. No tree roots larger than 2 inches in diameter shall be cut without the express permission of the ENGINEER.

- C. Trees shall be supported during excavation by any means previously reviewed and accepted by the ENGINEER.

3.5 ROCK EXCAVATION

- A. Rock excavation shall include removal and disposal of the following items:

1. boulders measuring 1/3 of a cubic yard or more in volume;

2. rock material in ledges, bedding deposits, and un-stratified masses that cannot be removed using conventional equipment as defined herein and which require systematic drilling and blasting for removal;
3. concrete or masonry structures that have been abandoned; and,
4. conglomerate deposits that are so firmly cemented that they possess the characteristics of solid rock and cannot be removed using conventional equipment as herein defined and require systematic drilling and blasting for removal.

B. Scope and Payment

1. Rock excavation shall be performed by the CONTRACTOR, provided that if the quantity of rock excavation is affected by any change in the scope of the WORK an appropriate adjustment of the Contract Price will be made under a separate Bid Item if such Bid Item has been established.
2. Otherwise, payment will be made in accordance with a negotiated price.

C. Explosives and Blasting: Blasting will not be permitted.

3.6 DISPOSAL OF EXCESS EXCAVATED MATERIAL

- A. Unless otherwise indicated, excess excavated material shall be the property of the CONTRACTOR.
- B. The CONTRACTOR shall be responsible for the removal and disposal of excess excavated material.
- C. Material shall be disposed of at an approved on-Site disposal area or off-Site at a location arranged by the CONTRACTOR in accordance with laws and regulations regarding the disposal of such material.

3.7 BACKFILL

A. General

1. Backfill shall not be dropped directly upon any structure or pipe.
 2. Backfill shall not be placed around or upon any structure until the concrete has attained sufficient strength to withstand the loads imposed.
 3. Backfill around water-retaining structures shall not be placed until the structures have been tested, and the structures shall be full of water while backfill is being placed.
- B. Except for drainrock materials being placed in over-excavated areas or trenches, backfill shall be placed after water is removed from the excavation and the trench sidewalls and bottom have been dried to a moisture content suitable for compaction.

C. Pre-Placement Conditions

1. Immediately prior to placement of backfill materials, the bottoms and sidewalls of trenches and structure excavations shall have any loose, sloughing, or caving soil and rock materials removed.
2. Trench sidewalls shall consist of excavated surfaces that are in a relatively undisturbed condition before placement of backfill materials.

D. Layering

1. Backfill materials shall be placed and spread evenly in layers.
2. When compaction is achieved using mechanical equipment, the layers shall be evenly spread such that when compacted each layer shall not exceed 6 inches in thickness.

E. Compaction shall not be achieved using flooding and jetting methods.

F. During spreading, each layer shall be thoroughly mixed as necessary in order to promote uniformity of material in each layer.

G. Moisture Content

1. Where the backfill material moisture content is below the optimum moisture content, water shall be added before or during spreading until the proper moisture content is achieved.
2. Where the backfill material moisture content is too high to permit the indicated degree of compaction, the material shall be dried until the moisture content is satisfactory.

3.8 STRUCTURE, ROADWAY, AND EMBANKMENT EXCAVATION AND BACKFILL

A. Excavation Beneath Structures and Embankments

1. Except where indicated otherwise for a particular structure or where ordered by the ENGINEER, excavation shall be carried to an elevation 6 inches below the bottom of the footing or slab and brought back to grade with compacted materials acceptable for placement beneath structures.
2. The area where a fill or embankment is to be constructed shall be cleared of vegetation, roots, and foreign material.
3. Where indicated or ordered, areas beneath structures or fills shall be over-excavated.
4. The subgrade areas beneath embankments shall be excavated to remove not less than the top 12 inches of native material and where such subgrade is sloped, the native material shall be benched.

5. When such over-excavation is indicated, both the over-excavation and the subsequent backfill to the required grade shall be performed by the CONTRACTOR.
6. After the required excavation or over-excavation for fills and embankments has been completed, the exposed surface shall be scarified to a depth of 6 inches, brought to optimum moisture content, and rolled with heavy compaction equipment to obtain 95 percent of maximum density.

B. Excavation Beneath Reservoirs

1. Excavation under reservoirs shall extend to the bottom of the drainrock layer.
2. After such excavation has been completed, the exposed surface shall be rolled with heavy compaction equipment to 95 percent of maximum density and then graded to provide a reasonably smooth surface for placement of the drainrock.
3. Areas under the reservoir upon which fill, not drain rock, is to be placed, shall be scarified to a depth of 6 inches, brought to optimum moisture content, and compacted to obtain 95 percent of maximum density.

C. Excavation Beneath Paved Areas

1. Excavation under areas to be paved shall extend to the bottom of the aggregate base or subbase, if such base is called for; otherwise it shall extend to the paving thickness.
2. After the required excavation has been completed, the top 12 inches of exposed surface shall be scarified, brought to optimum moisture content, and rolled with heavy compaction equipment to obtain 95 percent of maximum density.
3. The finished subgrade shall be even, self-draining, and in conformance with the slope of the finished pavement.
4. Areas that could accumulate standing water shall be regraded to provide a self-draining subgrade.

D. Notification of ENGINEER

1. The CONTRACTOR shall notify the ENGINEER at least 3 Days in advance of completion of any structure or roadway excavation and shall allow the ENGINEER a review period of at least one day before the exposed foundation is scarified and compacted or is covered with backfill or with any construction materials.

E. Compaction of Fill, Backfill, and Embankment Materials

1. Each layer of backfill materials as defined herein, where the material is graded such that 10 percent or more passes a No. 4 sieve, shall be mechanically compacted to the indicated percentage of density.

2. Equipment that is consistently capable of achieving the required degree of compaction shall be used, and each layer shall be compacted over its entire area while the material is at the required moisture content.
3. Each layer of coarse granular backfill materials with less than 10 percent passing the No. 4 sieve shall be compacted by means of at least 2 passes from a vibratory compactor that is capable of obtaining the required density in 2 passes.

F. Roofs

1. Fill on reservoir and structure roofs shall be deposited not sooner than 30 Days after the concrete roof slab has been placed.
2. Equipment weighing more than 10,000 pounds when loaded shall not be used on a roof.
3. A roller weighing not more than 8,000 pounds shall be used to compact fill on a roof.

G. Flooding, ponding, and jetting shall not be used for fill on roofs, backfill around structures, backfill around reservoir walls, for final backfill materials, or aggregate base materials.

H. Heavy Equipment

1. Equipment weighing more than 10,000 pounds shall not be used closer to walls than a horizontal distance equal to the vertical depth of the fill above undisturbed soil at that time.
2. Hand-operated power compaction equipment shall be used where the use of heavier equipment is impractical or restricted due to weight limitations.

I. Layering

1. Embankment and fill material shall be placed and spread evenly in approximately horizontal layers.
2. Each layer shall be moistened and aerated as necessary.
3. Unless otherwise approved by the ENGINEER, no layer shall exceed 6 inches of compacted thickness.
4. The embankment and fill shall be compacted in conformance with Paragraph K, below.

J. Embankments and Fills

1. When an embankment or fill is to be constructed and compacted against hillsides or fill slopes steeper than 4:1, the slopes of the hillsides or fills shall be horizontally benched in order to key the embankment or fill to the underlying ground.
2. A minimum of 12 inches perpendicular to the slope of the hillside or fill shall be removed and re-compacted as the embankment or fill is brought up in layers.

3. Material thus cut shall be re-compacted along with the new material.
4. Hillside or fill slopes 4:1 or flatter shall be prepared in accordance with Paragraph A, above.

K. Compaction Requirements

1. The following compaction requirements shall be in accordance with ASTM D 1557 - Test Method for Laboratory Compaction Characteristics of Soils Using Modified Effort (56,000 ft - lbf/ft³) (2,700 kN-m/m³) where the material is graded such that 10 percent or more passes a No. 4 sieve and in accordance with ASTM D 4253 - Test Method for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table, and D 4254 - Test Method for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density, where the material is coarse granular backfill materials with less than 10 percent passing the No. 4 sieve:

Location or Use of Fill or Backfill	Percentage of Maximum Dry Density	Percentage of Relative Density
Embankments and fills not identified otherwise	90	55
Embankments and fills beneath paved areas or structures	95	80
Backfill beneath structures and hydraulic structures	95	70
Backfill on reservoir of structure roof	90	55
Topsoil	80	NA
Aggregate base or subbase	95	NA
Concrete Flatwork	90	70
Landscaping	85	60
Wall Backfill	85-90	60-70

3.9 PIPELINE AND UTILITY TRENCH EXCAVATION AND BACKFILL

A. Exploratory Excavations

1. The CONTRACTOR shall excavate and expose buried points of connection to existing utilities as indicated.
2. Excavation shall be performed prior to the preparation of Shop Drawings for connections and before the fabrication of the pipe
3. The data obtained from exploratory excavations shall be used in preparing the Shop Drawings.

4. Data, including dates, locations excavated, and dimensioned sketches, shall be submitted to the ENGINEER within one week of excavation.
5. Damage to utilities from excavation activities shall be repaired by the CONTRACTOR in accordance with the General Conditions.

B. General

1. Unless otherwise indicated or ordered, excavation for pipelines and utilities shall be open-cut trenches with minimum widths as indicated.

C. Trench Bottom

1. Except where pipe bedding is required, the bottom of the trench shall be excavated uniformly to the grade of the bottom of the pipe.
2. Excavations for pipe bells and welding shall be made as required.
3. Where pipe bedding is required, the bottom of the trench shall be excavated uniformly to the grade of the bottom of the pipe bedding.

D. Open Trenches

1. The maximum amount of open trench permitted in any one location shall be 500 feet or the length necessary to accommodate the amount of pipe installed in a single Day, whichever is greater.
2. Trenches shall be fully backfilled at the end of each Day or, in lieu thereof, shall be covered by heavy steel plates adequately braced and capable of supporting vehicular traffic in those locations where it is impractical to backfill at the end of each Day.
3. These requirements for backfilling or use of steel plate will be waived in cases where the trench is located further than 100 feet from any traveled roadway or occupied structure; in such cases, however, barricades and warning lights meeting appropriate safety requirements shall be provided and maintained.

E. Embankments, Fills and Structural Backfills

1. Where pipelines are to be installed in embankments, fills, or structure backfills, the fill shall be constructed to a level at least one foot above the top of the pipe before the trench is excavated.
2. Upon completion of the embankment or structural backfill, a trench conforming to the appropriate detail may be excavated and the pipe may be installed.

F. Trench Shield

1. If a moveable trench shield is used during excavation operations, the trench width shall be wider than the shield such that the shield is free to be lifted and then moved horizontally without binding against the trench sidewalls and causing sloughing or caving of the trench walls.

2. If the trench walls cave or slough, the trench shall be excavated as an open excavation with sloped sidewalls or with trench shoring, as indicated and as required by the pipe structural design.
3. If a moveable trench shield is used during excavation, pipe installation, and backfill operations, the shield shall be moved by lifting the shield free of the trench bottom or backfill and then moving the shield horizontally.
4. The CONTRACTOR shall not drag trench shields along the trench causing damage or displacement to the trench sidewalls, the pipe, or the bedding and backfill.

G. Placing and Spreading Of Backfill Materials

1. Each layer of coarse granular backfill materials with less than 10 percent passing the No. 4 sieve shall be compacted by means of at least 2 passes from a vibratory compactor that is capable of achieving the required density in 2 passes and that is acceptable to the ENGINEER.
2. Where such materials are used for pipe zone backfill, vibratory compaction shall be used at vertical intervals of the lesser of:
 - a. one-half the diameter of the pipe; or
 - b. 24 inches, measured in the uncompacted state.
3. In addition, these materials shall be subjected to vibratory compaction at the springline of the pipe and the top of the pipe zone backfill, regardless of whether that dimension is less than 24 inches or not.
4. Each layer of backfill material with greater than 10 percent passing the No. 4 sieve shall be compacted using mechanical compactors suitable for the WORK.
5. The material shall be placed and compacted under the haunch of the pipe and up each side evenly so as not to move the pipe during the placement of the backfill.
6. The material shall be placed in lifts that will not exceed 6 inches when compacted to the required density.

H. Mechanical Compaction

1. Backfill around and over pipelines that is mechanically compacted shall be compacted using light, hand-operated vibratory compactors and rollers that do not damage the pipe.
2. After completion of at least 2 feet of compacted backfill over the top of pipeline, compaction equipment weighing no more than 8,000 pounds may be used to complete the trench backfill.

I. Pipe And Utility Trench Backfill

1. Pipe Zone Backfill

a. Definitions

- 1) The pipe zone is defined as that portion of the vertical trench cross-section lying between a plane below the bottom surface of the pipe and a plane at a point above the top surface of the pipe as indicated.
- 2) The bedding is defined as that portion of pipe zone backfill material between the trench subgrade and the bottom of the pipe.
- 3) The embedment is defined as that portion of the pipe zone backfill material between the bedding and a level line as indicated.

b. Final Trim

- 1) After compacting the bedding, the CONTRACTOR shall perform a final trim using a stringline for establishing grade, such that each pipe section when first laid will be continually in contact with the bedding along the extreme bottom of the pipe.
- 2) Excavation for pipe bells and welding shall be made as required.

c. The pipe zone shall be backfilled with the indicated backfill material.

d. Pipe zone backfill materials shall be manually spread evenly around the pipe, maintaining the same height on both sides of the pipe such that when compacted the pipe zone backfill will provide uniform bearing and side support.

e. The CONTRACTOR shall exercise care in order to prevent damage to the pipeline coating, cathodic bonds, and the pipe itself during the installation and backfill operations.

2. Trench Zone Backfill

a. After the pipe zone backfill has been placed, backfilling of the trench zone may proceed.

b. The trench zone is defined as that portion of the vertical trench cross-section lying as indicated between a plane above the top surface of the pipe and a plane at a point 18 inches below the finished surface grade, or if the trench is under pavement, 18 inches below the roadway subgrade.

3. Final Backfill

a. Final backfill is defined as backfill in the trench cross-sectional area within 18 inches of finished grade, or if the trench is under pavement, backfill within 18 inches of the roadway subgrade.

J. Identification Tape

1. Install identification tape as indicated.

2. Terminate the tape in a precast concrete box either adjacent to or part of the valve box, manhole, vault, or other structure into which the non-metallic pipe enters or at the end of the non-metallic pipeline.
3. The termination box shall be covered with a cast iron lid.
4. The box shall be located at grade in paved areas or 6 inches above grade in unpaved areas.

K. Trench Shield

1. If a moveable trench shield is used during backfill operations, the shield shall be lifted to a location above each layer of backfill material prior to compaction of the layer.
2. The CONTRACTOR shall not displace the pipe or backfill while the shield is being moved.

L. Compaction Requirements

1. The following compaction test requirements shall be in accordance with ASTM D 1557 - Test Method for Laboratory Compaction Characteristics of Soils Using Modified Effort (56,000 ft - lbf/ft³) (2,700 kN-m/m³) where the material is graded such that 10 percent or more passes a No. 4 sieve, and in accordance with ASTM D 4253 - Standard Test Method for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table, and D 4254 - Standard Test Method for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density where the material is coarse granular backfill materials with less than 10 percent passing the No. 4 sieve.

Location or Use of Fill or Backfill	Percentage of Maximum Dry Density	Percentage of Relative Density
Pipe embedment backfill for flexible pipe.	95	70
Pipe bedding and over-excavated zones under bedding for flexible pipe, including trench plugs.	95	70
Pipe zone backfill portion above embedment for flexible pipe	95	70
Final backfill, beneath paved areas or structures.	95	70
Final backfill, not beneath paved areas or structures.	85	50
Trench zone backfill, beneath paved areas, gravel roads, and structures, including trench plugs.	95	70
Trench zone backfill, impervious soil cover	80-85	NA
Trench zone backfill, not beneath paved areas or structures, including trench plugs.	85	50

3.10 FIELD TESTING

A. General:

1. Field soils testing will be performed by a testing laboratory of the CONTRACTOR's choice at the CONTRACTOR's expense, except as indicated below.

B. Density

1. Where soil material is required to be compacted to a percentage of maximum density, the maximum density at optimum moisture content will be determined in accordance with Method C of ASTM D 1557.
2. Where cohesionless, free draining soil material is required to be compacted to a percentage of relative density, the calculation of relative density will be determined in accordance with ASTM D 4253 and D 4254.
3. Field density in-place tests will be performed in accordance with ASTM D 1556 - Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method, ASTM D 2922 - Standard Test Methods for Density of Soil and Soil-Aggregate in Place By Nuclear Methods (Shallow Depth), or by such other means acceptable to the ENGINEER.

C. Remediation

1. In case the test of the fill or backfill shows non-compliance with the required density, the CONTRACTOR shall accomplish such remedy as may be required to ensure compliance.
2. Subsequent testing to show compliance shall be by a testing laboratory selected by the OWNER and paid by the CONTRACTOR.

D. CONTRACTOR's Responsibilities

1. The CONTRACTOR shall provide test trenches and excavations, including excavation, trench support and groundwater removal for the OWNER's field soils testing operations.
2. The trenches and excavations shall be provided at the locations and to the depths as required by the OWNER.
3. Lawn areas destroyed by test trenching and excavation shall be regraded and relandscaped with sod.

- END OF SECTION -

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