

SECTION 31 00 00.10 - SITE PREPARATION AND EARTHWORK FOR FUELING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following.
 - 1. Excavating and backfilling for underground fuel system utilities, structures and appurtenances.
 - 2. Aggregate base course for fueling structures.
 - 3. Pipe bedding

1.2 RELATED SECTIONS

- A. Section 01 33 29.06.01 Contaminated Media Management Plan
- B. Section 33 52 43.00 – Fuel System General Provisions
- C. Drawings and General Provisions of Contract, including General and Supplementary Conditions and DIVISION 1 Specification Sections.

1.3 REFERENCES

- A. American Society for Testing and Materials (ASTM):
 - 1. C31-12 – Making and Curing Concrete Test Specimens in the Field.
 - 2. C33-13 – Concrete Aggregates.
 - 3. C39-12a – Compressive Strength on Cylindrical Concrete Specimens.
 - 4. C88-05 – Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.
 - 5. C117-13 – Materials Finer than 75 mm (No. 200) Sieve in Mineral Aggregates by Washing.
 - 6. C131-06 – Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
 - 7. C136-06 – Sieve Analysis of Fine and Coarse Aggregates.
 - 8. C144-11 – Aggregate for Masonry Mortar.
 - 9. C150-12 – Portland Cement.
 - 10. C618-12a – Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
 - 11. D1241-07 – Materials for Soil-Aggregate Subbase, Base and Surface Courses.
 - 12. D1556-07 – Density and Unit Weight of Soil in Place by the Sand-Cone Method.
 - 13. D1557-12 – Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft. lbf/ft³ (2,700 kN-m/mm³).
 - 14. D1586-11 - Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils.
 - 15. D2487-11 – Classification of Soils for Engineering Purposes (Unified Soil Classification System).
 - 16. D4253-06 – Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
 - 17. D4254-06e1 – Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.
 - 18. D4318-10 – Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
 - 19. D4429-9a – CBR (California Bearing Ratio) of Soils in Place.
 - 20. D4546-08 – One-Dimensional Swell or Collapse of Cohesive Soils.

21. D4832-10 – Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders.
22. D6103-17 - Standard Test Method for Flow Consistency of Controlled Low Strength Material.
23. D6938-10 – Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

B. Occupational Safety and Health Administration (OSHA):

1. 29 CFR Part 1926-07 – Safety and Health Regulations for Construction.

1.4 SUBMITTALS

A. Submit as specified in DIVISION 1.

B. Includes, but not limited to, the following:

1. Test results from laboratory testing of proposed borrow materials.
2. Erosion and dust control plan.
3. Dewatering plan.
4. Compaction equipment to be used for fill, trench backfill, and other backfill operations (for information only and not for Engineer approval).
5. Warning tape and location wire data and sample.
6. Pipe bedding and aggregate materials data and tests.
7. Flowable fill.
8. Aggregate Base tests and sieve analysis.

C. Where selecting an option for excavation, trenching, and shoring design from “OSHA Part 1926,” submit (For information only and not for Engineer approval) copies of design calculations and notes for sloping, benching, support systems, shield systems, and other protective systems approved by the Responsible person or Contractors Registered Professional Engineer.

D. Photographs or Videotape as specified, sufficiently detailed, of existing conditions of adjoining construction and site infrastructure that might be construed or misconstrued as being damage by Contractor’s demolition or construction operations.

1.5 QUALITY ASSURANCE

A. Tests of all Contractor-secured materials and products being submitted for approval to determine conformance with these specifications, including borrow materials (both on-or off-site) proposed for use, shall be performed by an independent testing laboratory retained and compensated by the Contractor.

B. As materials are incorporated into the Project, on-site and off-site quality control tests will be performed during construction to determine conformance with Drawings and Specifications by an independent testing laboratory retained and compensated by the Contractor. Frequency of on-site and off-site testing is specified in PART 3.

1.6 PROJECT/SITE CONDITIONS

A. Lines and grades shall be as indicated. Owner will furnish reference points as necessary to permit the Contractor to lay out and construct the work properly.

- B. Carefully maintain all reference points and replace as directed by the Owner if disturbed or destroyed.
- C. Temporary Erosion, Dust and Sediment Controls: This work shall consist of furnishing, installing, and constructing temporary measures to control erosion and minimize the siltation of intermittent streams as well as prevent siltation of open trenches or other excavations.
 - 1. Temporary erosion and sediment control facilities (i.e., silt fences, sediment traps, or other measures) shall be constructed in compliance with local, state, federal, and jurisdictional agency regulations.
 - 2. Maintain all erosion control facilities and replace when damaged.
- D. Disposition of Utilities:
 - 1. Adequately protect from damage all active utilities and remove or relocate only as indicated, specified, or directed.
 - 2. Report inactive and abandoned utilities encountered in excavating and grading operations to the Engineer. Remove, plug, or cap as directed by the Engineer.
 - 3. Provide a minimum 48-hours' notice to the Engineer and receive written notice to proceed before interrupting any utility.
- E. New spot and contour elevations shown on the contract drawings are finish grade in unpaved areas and top of pavement in paved areas.
- F. Stockpiling of topsoil and other excavated materials will be permitted on airport property. The contractor shall coordinate with the Owner's Representative for stockpiling locations.

PART 2 - PRODUCTS

2.1 MATERIALS ENCOUNTERED

- A. Materials suitable for use in backfill and fill include material that is clean and free of contamination, debris, roots, organic matter, and frozen matter and which is free of stone having any dimension greater than $\frac{1}{2}$ the specified layer thickness. Materials shall not exhibit characteristics of high shrink-swell potential as determined from Atterberg limit tests (ASTM D4318) and/or swell/pressure tests (ASTM D4546). For soils used below structural elements, such as footings, slabs, pavements, and mats, that portion of material passing the No. 40 sieve shall have a liquid limit not exceeding 40 and a plasticity index not exceeding 25 when tested in accordance with ASTM D4318.
 - 1. When backfill and fill source material is stratified or exists as segregated deposits of material which individually are and are not suitable fill as specified, the contractor will be allowed to mechanically mix the soil material and use it as fill if the blended material meets the specified requirements for suitable fill and backfill material. Mixing or other conditioning of soil material necessary to make it conform to the specified requirements for fill shall be done at no additional cost to the Owner.
 - 2. Conforming to the following:
 - a. Soluble Chlorides < 0.02%
 - b. Sulfate Content < 0.2%
 - c. Sodium Sulfate Content < 0.2%
 - d. Percent Swell < 4%

- B. Materials unsuitable for use in backfill and fill include all material that contains debris, roots, organic matter, frozen matter, stone (with any dimension greater than $\frac{1}{2}$ the layer thickness), or other materials that are determined by Engineer as too wet or otherwise unsuitable for providing a stable fill, subgrade, or foundation for structures.
- C. Materials suitable for backfill of utility trenches and structures shall be as specified for backfill and fill except that no stones or particles may exceed 50 mm (2 inches).
- D. Cohesionless materials include gravels, gravel-sand mixtures, sands, and gravelly sands generally exclusive of clayey and silty material. Cohesionless materials are free-draining materials for which impact compaction will not produce a well defined moisture-density relationship curve and for which the maximum density by impact methods will generally be less than by vibratory methods. Generally less than 15% by dry weight of soil particles pass a No. 200 sieve. Cohesionless materials are typically classified by ASTM D2487 as GW, GP, SW, and SP. Materials classified as GM and SM will be identified as cohesionless when fines have a plasticity index of zero.
- E. Cohesive materials include silts and clays generally exclusive of sands and gravel and are materials for which impact compaction will produce a well-defined moisture-density relationship curve. Cohesive materials are typically classified by ASTM D2487 as GC, SC, ML, CL, MH, and CH. Material classified as GM and SM will be considered cohesive when the fines have a plasticity index greater than zero.
- F. Rock is defined as solid, homogeneous, interlocking crystalline material with firmly cemented, laminated, or foliated masses or conglomerate deposits, none of which can be removed without systematic drilling and blasting, or the use of machine mounted hydraulic or pneumatic rock breakers. Rock also includes large boulders, buried masonry, or concrete other than pavement, exceeding 1 cubic yard(s). Material indicated in the soil boring logs as having a standard penetration resistance as determined by ASTM D1586 greater than 600 blows per foot is arbitrarily defined herein as "Rock". Removal of "hard material" will not be considered rock excavation because of drilling and blasting that is performed merely to increase production.
- G. Hard material is defined as weathered rock, dense consolidated deposits or conglomerate materials, (excluding manmade materials such as concrete) which usually require the use of heavy excavation equipment with ripper teeth or large excavators for removal. [Material indicated in the soil boring logs as having a standard penetration resistance as determined by ASTM D1586 between 60 and 600 blows per foot is arbitrarily defined herein as "Hard Material".] Hard material shall not be considered as rock and excavation of hard material shall not be cause for a claim for additional compensation regardless of hardness or difficulty in removing.
- H. All materials encountered, regardless of type, character, composition and condition thereof shall be unclassified. Rock encountered shall be handled at no additional cost to Owner.
- I. Rock excavation shall be measured and paid for by the cubic yard quantity of acceptably excavated rock material using plan elevations and sections for utilities and structures.
- J. Waste material includes excess usable materials and materials unsuitable for use in the Work.
- K. Borrow materials includes the following:
 - 1. Acceptable fill materials, granular materials, and topsoil obtained from locations arranged for by Contractor and required when sufficient suitable materials are not obtained from excavation and trenching.
 - 2. Obtaining, excavating, handling, and final placement of materials.

2.2 GRANULAR MATERIAL

- A. Pipe Bedding Material for exterior coated steel pipe shall be clean, natural sand conforming to ASTM C144 (masonry aggregate), or ASTM C33 (fine concrete aggregate) with 100% passing the No. 4 sieve. Neither shall have more than 5% by weight passing the No. 200 sieve. The sand material shall have less than 300 ppm chlorides, less than 1000 ppm sulfates and have a PH of 6.5 to 9. The sand material shall have an electrical resistivity of 10,000 ohm-cm or greater.

	ASTM C33	ASTM C144
Sieve	Percent Passing	Percent Passing
3/8 in.	----	----
No. 4	95 to 100	100
No. 8	80 to 100	95 to 100
No. 16	50 to 85	70 to 100
No. 30	25 to 60	40 to 75
No. 50	10 to 30	10 to 35
No. 100	2 to 10	2 to 15
No. 200	----	0 to 5

2.3 CRUSHED ROCK BASE AND SUBBASE

- A. Aggregate shall be crushed stone or crushed gravel, free from lumps or balls of clay, dirt, or other objectionable matter and reasonably free from thin and elongated pieces or dirt. Aggregates shall consist of angular fragments, durable and sound, and shall be reasonably uniform in density and quality.
- B. Percentage of wear shall not exceed 50 after 500 revolutions as determined by ASTM C131.
- C. Aggregate shall contain 75% by weight of pieces with two or more fractured surfaces if material is crushed gravel.
- D. Portion of aggregate passing No. 40 sieve shall be as follows:
1. Liquid Limit: Not more than 25 determined by ASTM D4318.
 2. Plastic Index: Not more than 6 determined by ASTM D4318.
- E. Gradation shall not vary from the low limit on one sieve to high limit on an adjacent sieve. Test by ASTM C136 and C117, and conform to ASTM D1241, gradation A or B as follows:

Percent By Weight Passing Square-Mesh Sieve		
Sieve Designation	Gradation A	Gradation B
2-inch (50-millimeters)	100	100
1-inch (25-millimeters)	----	75 to 95
3/8-inch (9.5-millimeters)	30 to 65	40 to 75
No. 4 (4.75-millimeters)	25 to 55	30 to 60
No. 10 (2.0-millimeters)	15 to 40	20 to 45
No. 40 (425-micrometers)	8 to 20	15 to 30
No. 200 (75-micrometers)	2 to 8	5 to 15

1. Similar local or state DOT gradations may be substituted for the ASTM gradations listed above and used with the Engineer's approval.

2.4 FLOWABLE FILL

- A. Flowable fill, also known as Controlled Low Strength Materials (CLSM), may be used in place of backfill above the pipe bedding envelope with Engineer's approval.
- B. A flowable fill design mix shall be developed by an independent testing laboratory retained and paid by the Contractor. Mix shall consist of sand conforming to ASTM C33 or C144, fly ash conforming to ASTM C618, Portland cement conforming to ASTM C150 or other materials approved by the engineer and have a 28 day compressive strength of not less than 25 psi or more than 150 psi. The objective is to provide a flowable material that is self-leveling and completely fills spaces around pipe and structures and develops adequate strength to support loads while remaining easily excavatable. Mixes that produce 28 day compressive strengths consistently above 150 psi are unacceptable. In general, the water content in the mix should not be so high that it hydraulically inhibits consolidation of the material.
- C. Contractor may use a preexisting developed design mix conforming to the requirements of paragraph B above in lieu of developing a mix design specifically for this project.
- D. When specified for use in the project elsewhere, flowable fill material conforming to FAA P-153 Class 1 (50-150 psi) is acceptable in lieu of developing and producing a mix under this specification section, except that no aggregate material may be used that exceeds the gradations for sand and fine aggregate specified in the preceding paragraph B when the flowable fill is being placed within the bedding envelope for coated steel pipe. P-153 material may be used without restriction outside of the pipe bedding envelope and as bedding for other types of pipe without this fine aggregate restriction.

2.5 BACKFILL AND FILL MATERIAL

- A. Material shall be free of roots or other organic matter, refuse, debris, ashes, cinders, frozen earth, or other unsuitable material.
- B. Use suitable material sufficiently friable to provide a dense mass free of voids and capable of specified compaction.
- C. Do not use material containing gravel, stones, or shale particles greater in dimension than ½ the depth of the layer to be compacted.
- D. Moisture content shall be that required to obtain specified compaction of the soil.
- E. Perform any wetting or drying of the material as required to obtain the specified density when compacted.

2.6 WARNING TAPES FOR UNDERGROUND UTILITIES

- A. For the purposes of early warning and identification of buried pipes during future trenching and excavation.

- B. Tape shall be plastic, acid- and alkali-resistant polyethylene film, at least 6 inches in width and 4 mils thick, of the color indicated, and continuously inscribed with at least 1-inch-high, black lettering, indicating type of buried line installed:
 - 1. "BURIED JET FUEL LINE BELOW," yellow tape.
 - 2. "BURIED ELECTRIC LINE BELOW," red tape.
- C. Install warning tape above all piping as indicated.

PART 3 - EXECUTION

3.1 EXCAVATION AND TRENCHING

- A. Sheeting, Shoring and Sloping:
 - 1. Use when required for slope stability and where resulting slopes from excavation or trenching might endanger people or in-place or proposed structures or utilities.
 - 2. Provide materials on site prior to start of excavation. Adjust spacing and arrangement as required by conditions encountered.
 - 3. Remove sheeting and bracing as backfill progresses. Fill voids left after withdrawal with sand or other approved fill material.
 - 4. The contractor is entirely responsible for excavation means, methods and safety, including compliance with OSHA 29 CFR Part 1926 – Safety and Health Regulations for Construction. Excavation and trench details shown on the drawings have been provided for the sole purpose of addressing design issues related to the intended short and long term performance of the respective structures and utilities and conveying these requirements to the contractor. The presence of these details shall not be construed to mean or imply that site soils have been classified in accordance with OSHA safety requirements or that the engineer has designed or taken responsibility for design of systems related to excavation safety.
 - 5. Existing infrastructure, ongoing owner or tenant operations and project work limits may or will preclude some traditional trenching methods such as sloped sides and require others such as sheeting, shoring, trench boxes or others. The contractor is free to select and use any method or combination of methods that facilitate the work, and adequately protects workers and existing infrastructure to remain in service.
- B. Explosives: Blasting will not be permitted.
- C. Excavation for Structures:
 - 1. Excavate area adequate to permit efficient erection and removal of forms.
 - 2. Trim to neat lines where details call for concrete to be deposited against earth.
 - 3. Excavate by hand in areas where space and access will not permit use of machines.
 - 4. Notify Engineer immediately when excavation has reached the depth indicated.
 - 5. Restore bottom of excavation to proper elevation with compacted fill in areas overexcavated. If trench bottom is soft, replace overexcavated material with compacted crushed rock. Payment shall be negotiated with Owner for authorized replacement of unsuitable materials. Correct at no additional cost to Owner when trench is overexcavated without authority or to stabilize bottom rendered unsuitable through negligence or improper operations.
- D. Trenching for Underground Utilities:
 - 1. Side Walls:

- a. Make vertical or sloped within specified trench width limits below a plane 12 inches above top of pipe.
 - b. Make vertical, sloped or stepped as required for stability, above a plane 12 inches above top of pipe.
 - c. Excavate without undercutting.
2. Trench Depth:
 - a. Excavate to depth indicated on plans and sufficient to provide the minimum bedding requirements for the pipe being placed. If utility depth is not indicated on plans or profiles, the following depths shall be used as typical minimums from top-of-pipe to finish grade. If local codes require greater cover depths, the local code depth for the specific utility shall be used. Shallower depths may be use when required to match existing utilities at tie-ins or special conditions approved by the engineer.
 - 1) Fuel Lines48 inches
 - b. Do not exceed depth indicated where conditions of bottom are satisfactory.
 - c. Increase depth as necessary to remove unsuitable supporting materials as directed.
3. Trench Bottom:
 - a. Protect and maintain when suitable natural materials are encountered.
 - b. Remove rock fragments and materials when overexcavated. Payment shall be negotiated with Owner for authorized replacement of unsuitable materials. Correct at no additional cost to Owner when trench is overexcavated without authority or to stabilize bottom rendered unsuitable through negligence or improper operations.
4. Trench Width:
 - a. Excavate trench to a width, which will permit satisfactory jointing of the pipe and thorough tamping of bedding.
 - b. Unless indicated otherwise, do not exceed following trench widths:
 - 1) Below a plane 12 inches above top of pipe.

Nominal Pipe Size	Trench Width	
	Minimum	Maximum
Less than 24 inches	Pipe OD + 1.50 foot	Pipe OD + 2 feet
24 inches and larger	Pipe OD + 2 feet	Pipe OD + 3 feet
 - 2) Above plane defined in (1), as determined by Contractor means and methods.
 - 3) Maximum trench width limitations shall apply in all areas more than 5 feet from manhole or structure walls.
 - 4) Maximum width shall be as near the minimum specified as can be controlled by construction equipment and methods utilized.
5. Fill Areas: Perform trenching only after compacted fill has reached an elevation of not less than one foot above the top of the pipe.
6. Limit maximum length of open trench to 100 feet in advance and to 100 feet behind pipe installation.
7. Protect open trenches with movable concrete barriers, wood beam barricades, fencing or other approved method as specified in SECTION 01 56 00.00.

E. Dewatering:

1. Control grading around excavations to prevent surface water from flowing into excavations.

2. Drain or pump as required to continuously maintain all excavations and trenches free of water or mud from any source and discharge to approved drains or drainage channels. Commence when water first appears and continue until work is complete to the extent that no damage will result from hydrostatic pressure, flotation, or other causes.
3. Remove subgrade material rendered unsuitable by excessive wetting or siltation and replace with approved backfill material.

3.2 SUBGRADE PREPARATION

A. General:

1. Excavate or backfill as required to construct subgrades to the elevations and grades indicated.
2. Remove all unsuitable material and replace with acceptable fill material. Perform all wetting, drying, shaping, and compacting required to prepare subgrade.

B. Subgrade for Fills: Roughen by discing or scarifying and wet or dry top 6 inches as required to bond with fill.

C. Subgrade for areas to receive crushed rock base course, pavement, structures and concrete slabs:

1. Extend subgrade, where possible, the full width of the pavement, structure, or concrete slab, plus 1 foot in each direction.
2. Scarify the top 6 inches of subgrades in excavation areas and recompact.
 - a. Compact cohesive and cohesionless soil subgrades to a minimum of 95% of maximum density at optimum moisture content as determined by ASTM D1557.
 - b. Moisture content for cohesive and cohesionless materials shall not be more than 2% above or 2% below optimum during compaction. Stricter limits may be required to meet specified density. Less restrictive limits may be used when specified density requirements are achieved.

D. Subgrade for Structures:

1. For subgrades in fill, compact to density specified for fill.
2. For normal subgrades, not constructed in fill, above the water table and not subject to saturation, compact subgrade as specified for fill.
3. For saturated subgrades in well draining soil near or below the water table, dewater soil and compact top 6 inches as specified for fill, but not less than the density of undisturbed soil at the same location and depth.
4. For saturated subgrades in poor draining soil near or below the water table, dewater soil and compact to density of undisturbed soil at the same location and depth. If soil shows signs of liquefying or compaction efforts cause soil to loose density or bearing capacity as compared to in-situ material, notify engineer and proceed as directed.

E. Subgrade for Fuel Pipe:

1. Excavate to at least 6 inches below bottom of fuel pipe.
2. Smooth subgrade for fuel pipe in trenches using excavator bucket or other means and compact to minimum of 90% of ASTM D1557 maximum prior to placement of sand pipe bedding (or flowable fill when approved).
3. Subgrade for piping in larger areas with multiple pipes shall be graded smooth and compacted with appropriate equipment prior to placement of the initial sand bedding layer.

3.3 CRUSHED ROCK BASE AND SUBBASE

A. Cold Weather Limitations:

1. Base course construction shall be prohibited when atmospheric temperature is below 6°C (35°F).
2. Do not place base course on frozen subgrade.
3. Protect base course and subgrade in freezing weather and repair areas damaged by freezing, by reshaping, and recompacting.

B. Placement and Compaction:

1. Place material without segregation of sizes and spread from spreader boxes or moving vehicles equipped to spread material in layers of uniform thickness.
2. Compact in layers no less than 3 inches or more than 7 inches thick.
3. Roll to specified compaction requirements throughout full depth of layer with tamping rollers, power rollers, rubber-tired rollers, or combination.
4. Shape and smooth by blading.
5. Hand-tamp in places not accessible to rolling equipment.
6. Aerate by blade graders, harrows, or other approved equipment when mixture is excessively moistened by rain.

C. Degree of Compaction:

1. Base compaction on weight per cubic foot of material passing 3/4-inch sieve and compact to at least 95% of maximum dry density at optimum moisture.
2. Determine and control compaction in accordance with ASTM D1557.

D. Smoothness Test:

1. Surface shall show no deviation in excess of 3/8-inch in any 10 feet when tested with a 10-foot straightedge applied parallel with and at right angles to the centerlines of the paved area.
2. Correct any deviation in excess of this amount by loosening, adding or removing material, reshaping, watering, and compacting as directed by Engineer.

E. Maintain finished base course in a condition satisfactory to Engineer until pavement is placed upon it.

3.4 FILL AND BACKFILL

A. General Fill and Backfill:

1. Construct to the depths, contours, and elevations indicated and as specified, using suitable approved material from excavation and borrow areas.
 - a. Place materials in lifts not exceeding 8 inches (compacted).
 - b. Place only on subgrades approved by the Engineer.
 - c. Do not place snow, ice or frozen earth in fill and do not place fill on a frozen surface.
 - d. Remove all debris from excavation prior to placement.
 - e. Compact cohesive and cohesionless soil to a minimum of 95% of maximum density at optimum moisture content as determined by ASTM D1557 [ASTM D698].
 - f. Moisture content shall not be more than 2% above or 2% below optimum during compaction. Stricter limits may be required to meet specified density. Less

restrictive limits may be used when specified density requirements are achieved. Obtain compaction by the controlled movement of approved compaction equipment during the placing and grading of layers.

B. Backfilling: Backfill for structures and trenches shall be as specified for general fill and backfill with the following additional provisions.

1. Structures:

- a. Backfill only after concrete has attained 70% design strength.
- b. Backfill adjacent to structures only after a significant portion of the structure has been built to resist the imposed load.
- c. Perform backfilling simultaneously on all sides of structures.
- d. Exercise extreme care in the use of heavy equipment in areas adjacent to structures. Equipment operated within 10 feet of any wall shall not exceed 20,000 pounds gross weight.
- e. Material above a 45-degree plane intersecting the footing shall not include rock fragments incapable of passing a 2-inch screen, and no shale whether disintegrated or not.
- f. Compact backfill in lifts not exceeding 6 inches (compacted).

2. Trenches: Backfill for trenches shall be as specified for general fill and backfill and with the following additional provisions:

- a. Complete promptly upon completion of pipe embedment and approval to proceed.
- b. Use hand methods to a plane 12 inches above top of pipe.
- c. Mechanical methods shall be acceptable where hand backfill is not required.
- d. Compact backfill in lifts not exceeding 8 inches (compacted).
- e. Until compacted depth over utility exceeds 3 feet, do not drop fill material over 5 feet.

3. Compaction:

- a. Compact soil to 95% of maximum density at optimum moisture content as determined by ASTM D1557.
- b. Moisture content shall not be more than 2% above or 2% below optimum during compaction. Stricter limits may be required to meet specified density. Less restrictive limits may be used when specified density requirements are achieved.

C. Pipe Bedding Material:

1. Place pipe bedding as indicated using bedding material specified.
2. Place and bed pipe within 48 hours of holiday testing, unless longer periods are approved by the Owner's Representative or Resident Engineer.
3. Consolidation or compaction by flooding or jetting methods will not be permitted.
4. Place pipe bedding material as follows:
 - a. With level bottom layer at proper grade to receive and uniformly support pipe barrel throughout its length. Compact and test compaction of minimum 6 inch bedding layer prior to placement of fuel pipe. Placement of pipe on bags or block prior to placement of supporting bedding and dumping of sand bedding around, under or on fuel pipe in uncontrolled and non-uniform piles or layers prior to or without compaction is not acceptable. Reasonable gaps may be left in the supporting sand bedding layer when necessary for construction of pipe joints or other pipe discontinuities. Supporting fuel line with bags in congested piping areas where multiple fuel lines, fittings, directional changes and other complications exist may be permitted on a limited basis only when approved. Submit plan for approval when bag support is required.

- b. Following placement of the fuel pipe, add second layer not exceeding 8 inches loose simultaneously to both sides of the pipe with care to avoid displacement of the pipe.
 - c. Continue placement and compaction of sand bedding in 8 inch lifts until a minimum of 12 inches of sand bedding is placed above the top of pipe.
 - d. Complete promptly after placement of pipe.
- 5. Compact Pipe Bedding Material as follows:
 - a. In lifts not exceeding 8 inches of loose material.
 - b. Rod, spade, or use pneumatic or vibratory equipment.
 - c. Throughout depth of embedment.
 - d. Except sand bedding adjacent to or above coated steel fuel pipe, as required to obtain not less than 92% of maximum density as determined by ASTM D1557.
 - e. Pipe bedding adjacent to coated steel pipe shall be compacted using sound mechanical methods acceptable to the Engineer that thoroughly compact the bedding material to a condition that is firm and tight without damaging pipe coatings. Compaction acceptance of bedding adjacent to and above the fuel pipe will be based on observations/tests performed by an approved independent laboratory, consisting of continual visual observation of the bedding placement and compaction operation; and the ability of the procedure to provide in-place bedding that is tight and does not show signs of additional consolidation when walked on. Nuclear, sand cone and other traditional density testing is not an appropriate or accurate means of testing pipe bedding adjacent to coated steel fuel piping due to potential damage to the pipe coatings and inherent inaccuracy of the tests caused by the irregular and inconsistent material density conditions near and adjacent to the pipe (undisturbed trench wall, steel pipe, steel pipe void, and sand bedding materials).

D. Flowable Fill:

- 1. Place in trench after pipe or structure is installed and approved for backfill.
- 2. Place in manner that prevents lateral or vertical displacement of pipe or structures. Pipelines with exterior protective coating or which are protected by a cathodic protection system shall not be restrained by straps or wires which will damage coatings or concentrate corrosion.
- 3. Material shall be placed within 2 hours of mixing with water. Placement shall conform to ACI and other typical procedures and practices used to place concrete, including Cold and Hot weather practices.
- 4. Backfill may proceed on top of flowable fill after it is sufficiently set to support foot traffic without deformation.

3.5 SITE GRADING, SURFACE TOLERANCE

A. Excavate, fill, compact fill, and rough-grade to bring Project area to subgrades as follows:

- 1. For paved surface areas; to underside of respective surfacing or base course.
- 2. For seeded and landscaped areas; to a minimum of 4 inches below finished grade.

B. Finish Grading and Surface Tolerances

- 1. Grade and compact all areas within the project area, including excavated and filled sections and adjacent transition areas, reasonably smooth, and free from irregular surface changes.
- 2. Degree of finish shall be that ordinarily obtained from blade grader except as otherwise specified.

3. Finished subgrades which receive pavement shall not be more than 0.04-foot above or below subgrade elevations indicated.
4. Finished grades in unpaved areas shall not be more than 0.10-foot above or below those indicated.
5. Test all areas to receive pavement with 10-foot straightedge applied parallel and perpendicular to centerline. Deviation shall not exceed 0.04-foot.
6. Finish all areas of the project, including ditches and swales to drain readily. Water shall not pond on any part of the project when grading is completed except in areas specifically designed by the engineer for slowing or retaining storm runoff.
7. Unless shown, noted or directed otherwise, grades adjacent to paved areas such as sidewalks, slabs, roadways and aprons shall generally be 0.10 to 0.20 foot below the adjacent edges of the paved area and slope away from the pavement at 2% to 5%. Finished grade that causes water to pond on or near the paved areas is unacceptable.
8. Provide rounding at top and bottom of banks and at other breaks in grade.
9. Material: Use the most suitable material obtained from excavation and stripping operations and borrow when required.
10. Clear areas free of vegetation, rock, and other materials which would interfere with grading.

3.6 WASTE MATERIALS

- A. Remove unsuitable materials from Work area as excavated.
- B. Demolished or excavated materials such as asphalt, concrete, and others which are unsuitable for reuse in the Project (as determined by the Engineer) shall become property of Contractor and be disposed of off-site at locations arranged for and paid for by the Contractor (designated on-site by Owner).
- C. No contaminated waste/soil material is anticipated for this Project. If Contractor suspects contaminated soil has been encountered during the progress of Work by odor or other means, he shall notify the Owner immediately for directions on how to proceed. The Contractor shall dispose of material at a location and price approved by the Owner.
- D. If encountered, contaminated soils shall be disposed of as specified in Section 01 33 29.06.1 Contaminated Media Management Plan.
- E. Place excavated rock in interior of waste area fills so it will not be exposed to view.
- F. Grade waste areas and leave free-draining with an orderly, neat appearance.

3.7 ON-SITE TESTING

- A. Contractor shall retain and compensate an independent and qualified testing lab to perform the following tests. Where indicated on drawings or specified for test to be performed by a Geotechnical Engineer, tests may be performed by a qualified testing laboratory. However, if needed or required for work to proceed, any geotechnical interpretations or design recommendations based on the testing must come from a Geotechnical Engineer. Contractor shall provide testing laboratory access to work which is to be tested and include all costs for delays associated with the performance of the described testing by the owner's testing lab. Contractor is responsible for notifying the Owner's Representative no less than 24 hours before work is expected to be ready for testing.

- B. The method of in-place compaction testing including density and moisture content will be as follows:
 - 1. Density: ASTM D6938-10 (Nuclear Density) and ASTM D1556 (Sand Cone Density).
 - 2. Moisture Content: ASTM D6938-10 (Nuclear Moisture).
- C. A representative frequency of in-place compaction tests including density and moisture content shall be as follow:
 - 1. At least one test per lift for every 100 linear feet or less of backfill placed in trenches.
 - 2. At least one test for every 500 square feet where subgrade preparation for paved areas is being performed.
 - 3. At least one test for every 200 square feet but not less than one test per lift in fill around structures and tanks.
 - 4. At least one test when the Engineer suspects the moisture content or effectiveness of compaction is not acceptable.
 - 5. In place density may be tested by ASTM D6838-10 (nuclear) or by ASTM D1556 (sand cone), but at least one ASTM D1556 test shall be performed for every 10 ASTM D6838-10 tests or portion thereof.
 - 6. At least one DCP (Dynamic Cone Penetrometer) test in accordance with ASTM D6951/D6951M to verify soil bearing capacity below each building or significant concrete structure footing or foundation. If not indicated or directed otherwise, test subgrade and consider each structure weighing or to be loaded in excess 5000 pounds as significant.
- D. Fill failing to meet required densities or moisture contents shall be scarified and recompacted as necessary to achieve specified results at no additional cost to Owner.
- E. Removal of in-place material and replacement with approved new material will be required if scarifying and recompaction do not produce the required densities.
- F. Perform at least one ASTM D2487 (Classification of Soil) and one ASTM D1557 [ASTM D698] (Compaction) test on each soil type supporting pavement or structures, or used in fill or backfill operations during construction.
 - 1. Each sample shall be taken from subgrade material for structures and pavement, trenches or other excavations as directed by the Engineer and should be generally representative of distinguishably differing materials encountered and used (existing or placed) for subgrades, backfill or fill.
 - 2. Perform one set of tests at the beginning of excavation and one additional set of tests when material properties vary (wetter, dryer, more granular, or other conditions) from the material initially tested.
 - 3. Additional tests shall be performed when directed by the Engineer.
- G. Perform at least one ASTM D1557 [ASTM D698] (Compaction) test for every 2500 cubic yards of material placed.
- H. Sand Bedding for pipe.
 - 1. Sand material used for fuel pipe and tank bedding shall be stockpiled on site, tested and approved to assure conformance with this specification prior to placement, or placed and left accessible for sampling, testing and approval prior to backfilling and any related subsequent construction. Testing of sand for fuel pipe and tank bedding shall include representative sampling and sieve analysis of delivered, on-site materials, assuring conformance with ASTM C33 or C144 particle distributions and specified limits for chlorides, sulphates, PH, and resistivity. Testing shall include test required to assure conformance with ASTM C33 or C144, such as durability, fineness, percentage of coal and organic material. Perform at least 2 sets of tests using different, and randomly

collected field samples. Perform one additional set of tests for each additional 500 cubic yards of sand material, or portion thereof, placed in excess of 500 cubic yards. Perform pH, resistivity, sulfate and chloride tests in accordance with the following:

- a. ASTM G 51 - Standard Test Method for Measuring pH of Soil for Use in Corrosion Testing
- b. ASTM G 57 - Standard Test Method for Field Measurement of Soil Resistivity Using the Wenner Four-Electrode Method
- c. CRD C 403 - Method of Test for Determination of Sulfate Ion in Soils and Water
- d. AASHTO T291 - Standard Method of Test for Determining Water-Soluble Chloride Ion Content in Soil

2. Observation, Testing and Reporting for Sand Fuel Pipe Bedding Placement:

- a. Compact the bottom supporting 6 inch sand pipe bedding layer as previously specified. Test in place density and moisture in accordance with ASTM D6938-10 (Nuclear Density). Verify supporting bedding layer thickness. Perform at least one density, moisture and layer thickness test for each 200 foot of each lift placed in trenches; or 500 square feet of each bedding lift placed in open, non-trench locations.
- b. Perform visual observation and physical testing of sand pipe bedding placed adjacent to and up to 12 inches above fuel piping as previously specified. Provide written reports from an approved testing laboratory for each 200 foot of each lift placed in trenches; or 500 square feet of each bedding lift placed in open, non-trench locations. Observation/Test reports shall include the location of observation/test by pipe station or other meaningful means, lift number, estimated lift thickness, pass/fail notation, and general description of test results (additional "consolidation occurred" or "consolidation did not occur" when walked on). Superficial surface footprints not indicative of discernable consolidation is not to be construed as "Additional Consolidation."

I. Flowable Fill (CLSM):

1. Make and test one set of four cylinder specimens in accordance with ASTM D4832 for every 100 cubic yards of material placed but not less than one set for each day's pour.
2. For each set of cylinders made, perform one test for flowability of the material in accordance with ASTM D6130. The material shall form a patty with an average diameter of at least 8 inches, without segregation of constituents in the mixture.

3.8 MAINTENANCE AND CLEANUP

- A. Protect newly graded areas from actions of the elements.
- B. Settling or erosion occurring shall be filled and repaired and grades reestablished to the required elevations and slopes.
- C. Keep paved areas clean. Promptly remove rock or dirt dropped upon paved surfaces by sweeping, washing, or other methods acceptable to the Engineer.

END OF SECTION