

## SECTION 31 23 34.01

### EXCAVATING, TRENCHING, DEWATERING AND BACKFILLING FOR UTILITY WORK

#### PART 1 GENERAL

##### 1.1 SUMMARY

- A. Furnish all labor, equipment, supplies and materials, and perform all operations in connection with the following:
  - 1. Clearing, grubbing, and preparation of the site; removal and disposal of all debris.
  - 2. Pipeline and utility structure excavations including trenching, subgrade preparation, embedment, backfilling, pumping, and dewatering
  - 3. Tunneled (trenchless construction) crossings.
  - 4. Sheet piling, shoring, and protection of work.
  - 5. Borrow, transportation, handling, storage, and disposal of suitable and unsuitable materials for pipelines, utility structures, site fills, curb and gutters, sidewalks, driveways, and pavements
  - 6. Subgrade preparation, grading, wetting, rolling, surfacing and other operations pertaining to the site work
  - 7. Protection of adjacent property.
  
- B. No classification of excavated materials will be made. Excavation includes all materials regardless of type, character, composition, moisture, or condition thereof.
  
- C. Related Requirements:
  - 1. Section 03 05 00 - Concrete
  - 2. Section 32 92 01 - Seeding and Sodding
  - 3. Section 33 14 13 - Water Distribution Piping, Valves, Hydrants, and Appurtenances
  - 4. Section 31 31 11 - Sanitary Sewer Gravity Mains
  - 5. Section 33 31 23 - Sanitary Sewer Force Mains, Valves, and Appurtenances
  - 6. Section 33 32 11 - Wastewater Pumping Stations

##### 1.2 REFERENCES

- A. Definitions:
  - 1. "Subgrade" is the uppermost surface of native soil material unmoved from cuts, the bottom of excavation.
  
- B. Reference Standards:
  - 1. OSHA - Safety and Health Regulations for Construction, Chapter XVII of Title 29, CFR, Part 126
  - 2. NCDOT Positive Shoring Plan - issued with Right-of-Way Encroachment Agreement
  - 3. AASHTO T99/T180 - Standard Method of Test for Moisture-Density Relations of Soils.
  - 4. ASTM C136 - Sieve analysis of fine and coarse aggregates.
  - 5. ASTM D448 - Standard Classification for Sizes of Aggregate for Road and Bridge Construction.

6. ASTM D698 - Tests for moisture-density relations of soils and soil-aggregate mixture using 5.5 lb (2.49 kg) rammer and 12 inch (305 mm) drop.
7. ASTM D2321 – Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.
8. ASTM D2487 - Classification of Soils for Engineering Purposes.
9. ASTM D4253 - Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
10. ASTM D4254 - Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.
11. ASTM D4318 - Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
12. ASTM D4832 - Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders.
13. ASTM D6023 - Test Method for Density (Unit Weight), Yield, Cement Content, and Air Content (Gravimetric) of Controlled Low-Strength Material (CLSM).
14. ASTM D6938 - Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

### 1.3 SUBMITTALS

- A. Contractor Excavation Protection Plans or NCDOT Positive Shoring Plans:
  1. Provide sheeting, shoring, and bracing materials and installation required to protect excavations and adjacent structures and property.
  2. At least 30 days before starting construction on sheeting and shoring, and in accordance with the OSHA and NCDOT requirements, the Contractor shall ensure the sheeting and shoring design engineer complete and submit the Protective System Design Certificate(s) for the sheeting and shoring systems that the Contractor will install.
  3. If required by the OSHA regulations to protect existing facilities, the Contractor shall submit separate certificates for each unique design. The certificate(s) shall be signed and sealed by the registered professional engineer that designed the protection system.
- B. Geotextile Fabrics: Samples, manufacturer's product data, installation instructions
- C. Embedment and Backfills Materials:
  1. Name and location of proposed material suppliers.
  2. Standard test results for materials proposed by independent materials testing firm.
- D. Trench Shields: Fabricator/manufacturer certifications

### 1.4 QUALITY ASSURANCE

- A. Contractor to provide experienced on-site Safety Officer and Superintendent to comply with OSHA regulations for site excavations and engineered shoring plans.
- B. Safety Officer and Superintendent shall hold OSHA 30-Hour Construction Certifications and classified as the competent person.

## 1.5 EXISTING SITE CONDITIONS

- A. Every reasonable effort has been made to provide accurate information on existing site conditions. The Contractor should become familiar with the site and satisfy himself as to the scope of the work involved and the materials to be encountered. Any significant change in conditions should be immediately brought to the attention of the Engineer.

## PART 2 PRODUCTS

### 2.1 MATERIALS

- A. Geotextile Fabric. The fabric shall be provided in rolls wrapped with covering for protection from mud, dirt, dust, and debris.
1. Geotextile Fabric Type A. Geotextile fabric Type A shall be provided for installation at locations indicated on the Drawings and as specified herein. Geotextile Fabric Type A shall be a nonwoven fabric consisting of only continuous chains of polymeric filaments or yarns of polyester formed into a stable network by needle punching. The fabric shall be inert to commonly encountered chemicals; shall be resistant to mildew, rot, ultraviolet light, insects, and rodents; and shall have the indicated properties:

<u>Property</u>	<u>Test Method</u>	<u>Unit</u>	<u>Minimum Average Roll Value *</u>
Fabric Weight	ASTM D3776	oz/yd <sup>2</sup>	5.7
Grab Strength	ASTM D4632	lb	155
Grab Elongation	ASTM D4632	percent	50
Mullen Burst Strength	ASTM D3786	psi	190
Apparent Opening Size	CW-02215	U.S. Std. Sieve Size	70

\* Minimum average roll value in weakest principal direction.

- B. Polyethylene Film: Polyethylene film beneath concrete slabs or slab base course material shall be Product Standard PS17, 6 mil minimum thickness.
- C. Granular Materials and Soils: Five classes defined according to properties and characteristics as follows.
- Class I** - Angular, 25 mm (1-in.) to No.4 (3/16 in.) in size, #57 or #67 graded stone or equivalent regional material from crushed rock, slag, and/or coral.
  - Class II** - Coarse sands and gravels with maximum size of 25 mm (1-in.), including variously graded sands and gravels containing small percentages of fines, generally granular and non-cohesive, either wet or dry. Soil Types GW, GP, SW, and SP are included in this class.
  - Class III** - Fine sand and clayey gravels, including fine sands, sand-clay mixtures, and gravel-clay mixtures. Soil Types GM, GC, SM, and SC are included in this class.

- d. **Class IV** - Silt, silty clays, and clays, including inorganic clays and silts of medium to high plasticity and liquid limits. Soil Types MH, ML, CH, and CL are included in this class. These materials are not acceptable for bedding, haunching, or initial backfill.
  - e. **Class V** - This class includes the organic soil, OL, OH, PT as well as soils containing frozen earth, debris, rocks, larger than 37.5 mm (1-1/2 in.) in diameter, and other foreign materials. These materials are not acceptable for bedding, haunching, initial backfill, or final backfill.
- D. General Fill:
- 1. Use soils free of organic matter, refuse, rocks and lumps greater than 4 inches in diameter and other deleterious matter.
  - 2. Fill shall have a liquid limit not greater than 45, and plasticity index not greater than 25.
  - 3. Previously excavated materials complying with the Contract Documents requirements for general fill may be used for general fill.
  - 4. When on-site materials are found unsuitable for use as general fill, provide approved off-site general fill materials. Prior to using off-site material as general fill, furnish submittal for and obtain Engineer's approval of the material proposed for use.
  - 5. General fill material not otherwise specified shall be Class II or III.
- E. Granular Fill: Granular fill under floor slabs shall be Class I material.
- F. Structural Fill: Fill material placed inside the line of the building foundation or slab shall be Class I or II.
- G. Fill Under Pavement: Fill material used beneath pavement and for road shoulders shall be Class II or III.
- H. Topsoil: Natural, friable soil free of subsoil, stumps, rocks larger than 2 inches in diameter, weeds, and other material detrimental to plant growth.
- I. Concrete: Concrete placed for cradles, thrust blocks, or encasement shall be Class B concrete as specified in Section 03 05 00 - Concrete.
- J. Subbase Material:
- 1. Material shall be naturally- or artificially graded mixture of natural or crushed gravel, crushed stone, or natural or crushed sand. Crushed slag is unacceptable.
- K. Drainage Fill:
- 1. Material shall be washed, uniformly graded mixture of crushed stone, or crushed or uncrushed gravel, with 100 percent passing 1-1/2-inch sieve and not more than 10 percent passing a No. 4 sieve (#57 or #67 stone).
- L. Controlled Low Strength Material (CLSM):
- 1. CLSM shall be self-leveling and self-compacting cementitious material.
    - a. Cement: Type I or Type II Portland cement complying with ASTM C150/C150M.
    - b. Fly Ash Mineral Admixture: Comply with ASTM C618, Class F.

- c. Water: Clean, potable.
  - d. Admixtures: Provide admixtures in accordance with product manufacturer's published instructions. Admixtures shall be compatible with each other. Do not use calcium chloride or admixtures containing chloride ions. Use only admixtures that have been tested and approved in the mix designs.
  - e. Fine Aggregates: ASTM C33/C33M.
2. CLSM Mix:
- a. Cement Content: 50 pounds per cubic yard.
  - b. Fly Ash Mineral Admixture: 250 pounds per cubic yard.
  - c. Fine Aggregate Content: 2910 pounds per cubic yard.
  - d. Water Content: 500 pounds per cubic yard.
  - e. Admixtures shall comply with manufacturer's recommendations for use with CLSM.
  - f. Unconfined compressive strength shall be not more than 100 psi.
  - g. Adjustment of Mixes.
    - 1) Mix design adjustments may be requested by Contractor when warranted by characteristics of materials, Site conditions, weather, test results, or other, similar circumstances.
    - 2) Submit for Engineer's approval laboratory test data for adjusted mix designs, including compressive strength test results.
    - 3) Implement adjusted mix designs only after Engineer's approval.
    - 4) Adjustments to mix designs shall not result in additional costs to Owner.

## 2.2 SOURCE QUALITY CONTROL

- A. Perform quality assurance testing, and submit results to Engineer, in accordance with the "Submittals" Article in Part 1 of this Section.

## PART 3 EXECUTION

### 3.1 INSPECTION

- A. Familiarization: Prior to commencement of the Work, become thoroughly familiar with the site, the site conditions, and all portions of the work specified in this Section.
- B. Provide Engineer with sufficient notice and with means to examine areas and conditions under which excavating, filling, and grading will be performed. Do not proceed with the Work until unsatisfactory conditions are corrected.
- C. Approvals: Backfilling and grading operations near foundations, walls, pipes and other portions of the work to be covered shall not commence until the Engineer has completed all required inspections, tests and approvals. Work covered prior to inspection shall be uncovered for inspection purposes and backfilled.

### 3.2 SUBSURFACE UTILITY LOCATION AND EXPLORATION

- A. Existing Utilities Location:

1. Prior to excavation, Contractor shall contact local underground alert hotlines, "North Carolina 811" and/or individual utility owners for marking underground utilities. A survey shall be made of the utility size, material, location, and elevation prior to trench excavation and information shall be recorded on the record Drawings maintained by the Contractor.
2. Once utilities are marked and recorded, Contractor shall excavate to expose the existing utilities in advance of the construction.
3. Perform all work required in connection with excavating, stockpiling, maintaining, sheeting, shoring, filling, and replacing pavement for utility location pits.
4. Contractor shall be responsible for the definite location of each existing underground utility involved within the area of excavation for the Work and exercise care during such location work to avoid damaging and disrupting the affected underground facilities or structures. Contractor shall be responsible for repairing, at his expense, damage to underground facility or structures caused during exploratory Work.

### 3.3 PREPARATION

#### A. Surface Preparation

1. Clearing: Areas designated for clearing and required for construction operations shall be cleared of trees, brush, structures and other materials within the defined rights-of-way, easements, and limits of disturbance indicated. Trees which are to remain shall be protected during clearing operations and subsequent work.
2. Grubbing: Roots, stumps and other materials shall be grubbed from the cleared areas to a depth of at least 18 inches. Tree stumps shall be grubbed in their entirety, including tap roots where applicable.
3. Topsoil: Strip existing topsoil to a depth of 4 inches from areas to be excavated or graded. Stockpile the topsoil in a suitable area for use during final grading operations. Protect the topsoil from excessive erosion.
4. Unsuitable Material: Remove sod, muck, or other unsuitable material to firm subsoil in areas designated for filling or grading operations.
5. Disposal: Trees, stumps, roots, rubbish, unsuitable soil, or other material resulting from surface preparation shall be removed from the site by the Contractor and disposed of.

#### B. Prohibited Work:

1. Burning or blasting and use of explosives is not allowed.

#### C. Dust Control:

1. Control objectionable dust caused by Contractor's operation of vehicles and equipment, clearing and other actions. To minimize airborne dust, apply water or use methods subject to approval of authorities having jurisdiction.

### 3.4 EXCESS WATER CONTROL

#### A. General Dewatering:

1. Grade and maintain all areas of the site to preclude surface runoff into excavations and prevent ponding of water.
2. Remove all soil softened or eroded by the presence of water and replace with suitable backfill material.

3. Provide and maintain drainage and dewatering equipment to remove and dispose of all surface water and ground water entering excavations, or other parts of the Work areas. Keep excavations dry during execution of Work, subgrade preparation, and continually thereafter until the pipeline or structure to be built therein is acceptable to Engineer and backfilling operations are completed and acceptable to Engineer.
4. Provide temporary drainage ditches and temporary dikes and provide required temporary pumping and other work necessary for diverting or removing rainfall and all other accumulations of surface water from excavations and fill areas. Perform diversion and removal of surface water in manner that prevents accumulation of water behind permanent or temporary structures and at any other locations in the construction area where such accumulations may be detrimental.
5. Water used for working or processing, resulting from dewatering operations, or containing oils or sediments that will reduce the quality of the surface water or groundwater downstream of the point of discharge, shall not be directly discharged. Divert such waters through temporary settling basin or filter before discharging to surface water, groundwater, or drainage routes.
6. Contractor shall be responsible for condition of piping, conduits, and channels used for drainage and such piping, conduits, and channels shall be clean and free of sediment.

B. Temporary Dewatering Systems:

1. Contractor shall design, provide, and operate dewatering system to include sufficient trenches, sumps, pumps, hose, piping, well points, deep wells, and similar facilities, necessary to depress and maintain groundwater level below the base of each excavation during all stages of construction operations.
2. Design and operate dewatering system to avoid settlement and damage to existing structures and underground facilities.
3. Groundwater table shall be lowered in advance of excavation for a sufficient period of time to allow dewatering of fine grain soils.
4. Maintain groundwater level at excavations 2-feet below lowest subgrade excavation until the structure has sufficient strength and weight to withstand horizontal and vertical soil and water pressures from natural groundwater.
5. Operate dewatering system continuously, 24-hours per day, 7-days per week. Provide standby pumping facilities and personnel to maintain the continued effectiveness of the system. Do not discontinue dewatering operations without first obtaining Engineer's acceptance for such discontinuation.
6. Locate elements of temporary dewatering system to allow continuous dewatering operation without interfering with the Work to the extent practicable.
7. Where portions of dewatering system are located in the area of permanent construction, submit to and obtain Engineer's acceptance of details of proposed methods of constructing the Work at such location. Control of ground water shall continue until the permanent construction provides sufficient dead load to withstand hydrostatic uplift of the normal groundwater, until concrete has attained sufficient strength to withstand earth and hydrostatic loads, and until waterproofing Work is completed.
8. Perform pumping of water from excavations in a manner that prevents carrying away of unconsolidated concrete materials, and that avoids damaging the subgrade.

C. Disposal of Water Removed by Dewatering System:

1. Contractor's dewatering system shall discharge to in accordance with the NC Sedimentation Pollution Control Act, NCDEQ Erosion Control Permit, and NC Stormwater Permit for Construction Activities.
2. Convey water from excavations in closed conduits. Do not use trench excavations as temporary drainage ditches.
3. Dispose of water removed from excavations in a manner that does not endanger health and safety, property, the Work, and other portions of the Project.
4. Dispose of water in manner that causes no inconvenience to Owner, others involved in the Project, and adjacent and downstream properties.

### 3.5 SHEETING, SHORING AND BRACING

#### A. General:

1. Design and provide sheeting, shoring, bracing, cofferdams, and similar excavation supports as shown, specified, and required for the Work. Where sheeting, shoring, bracing, or trench boxes are used, they must be designed and sealed by a professional engineer licensed to practice in the State of North Carolina.
2. Clearances and types of temporary sheeting, shoring, bracing, and similar excavation supports, insofar as they may affect the finished character of the Work and the design of sheeting to be left in place, will be subject to the Engineer's approval; but Contractor is responsible for adequacy of all sheeting, shoring, bracing, cofferdams, and similar excavation supports.
3. Materials:
  - a. Previously used materials shall be in good condition and shall not be damaged or excessively pitted. All steel or wood sheeting designated to remain in place shall be new. New or used sheeting may be used for temporary sheeting, shoring, and bracing.
  - b. All steel work for sheeting, shoring, bracing, cofferdams, and other excavation supports, shall be in accordance with ANSI/AISC 360, except that field welding will be allowed.
  - c. When required, provide permanent steel sheet piling or treated timber sheet piling where subsequent removal of sheet piling might allow lateral movement of soil under adjacent structures
4. As excavation progresses, carry down shoring, bracing, cofferdams, and similar excavation supports to required elevation at bottom of excavation.
5. Maintain sheeting, shoring, bracing, bracing, and other excavation supports in excavations regardless of time-period excavations will be open.
6. Unless otherwise shown, specified, or directed, remove materials used for temporary construction when the Work is completed. Perform such removal in manner not injurious to the structures and underground facilities, their appearance, and adjacent construction.

#### B. Removal of Shoring, Sheeting and Bracing:

1. Remove sheeting and bracing from excavations, unless otherwise directed by Engineer in writing. Perform removal to avoid damaging the Work and adjacent construction. Removal shall be equal on both sides of excavation to ensure no unequal loads on structures and underground facilities.
2. Defer removal of sheeting and bracing, where removal may cause soil to come into contact with concrete, until the following conditions are satisfied:
  - a. Concrete has cured for not less than 7 days.



- b. Wall and floor framing, up to and including grade level floors, is in place.
  - 3. When shoring is installed that does not extend below the invert of the underground structure, the shoring shall be removed. Backfill and compaction shall be executed in conformance with the specifications.
- C. Shoring Left in Place:
  - 1. Only shoring authorized by the Engineer and approved by the Engineer shall be left in place.
  - 2. When shoring is installed to extend below the underground structure, the shoring shall remain with the top edge 4-feet below the finished grade.
- D. Sheeting Left in Place:
  - 1. Materials: Steel sheeting shown or indicated to be left in place shall consist of rolled sections of continuous interlocking type. Steel sheeting material designated to be left in place shall be new. Type and design of the sheeting and bracing shall comply with the above requirements for steel work for all sheeting and bracing.
  - 2. Installation:
    - a. Steel sheeting to be left in place shall be driven straight to lines and grades as shown, indicated, or directed. Piles shall penetrate into firm materials with secure interlocking throughout pile's entire length. Damaged piling having faulty alignment shall be pulled and replaced by new piling.
    - b. Type of guide structure used and method of driving steel sheeting to be left in place shall be determined by Contractor's professional engineer.
  - 3. Cut off at elevations shown, indicated, or directed by Engineer sheeting left in place and remove cut off pilings from the Site.
  - 4. Clean wales, braces, and all other items to be embedded in the permanent structure and ensure that concrete surrounding the embedded element is sound and free of air pockets and harmful inclusions. Provisions shall include the cutting of holes in the webs and flanges of wale and bracing members, and welding of steel diaphragm water stops perpendicular to the centerline of brace ends that are to be embedded.

### 3.6 TRENCH EXCAVATION

- A. Cutting Existing Surface Pavements.
  - 1. Cuts in concrete pavement and concrete base pavements shall be no larger than necessary to provide adequate working space for proper installation of pipe and appurtenances.
  - 2. Cutting shall be started with a concrete saw in a manner which will provide a clean groove at least 1-½ inches deep along each side of the trench and along the perimeter of cuts for structures.
  - 3. Concrete pavement and concrete base pavement over trenches excavated for pipelines shall be removed so that a shoulder not less than 12-inches in width at any point is left between the cut edge of the pavement and the top edge of the trench.
  - 4. Pavement cuts shall be made to and between straight or accurately marked curved lines which, unless otherwise required, shall be parallel to the center line of the trench.
  - 5. Pavement removal for connections to existing lines or structures shall not exceed the extent necessary for the installation.

6. Where the trench parallels the length of concrete walks, and the trench location is all or partially under the walk, the entire walk shall be removed and replaced.
  7. Where the trench crosses drives, walks, curbs, or other surface construction, the surface construction shall be removed and subsequently replaced between existing joints or between saw cuts as specified for pavement.
- B. Trench Width: Trenches shall be excavated to a width which will provide adequate working space and sidewall clearance for proper installation, jointing, and embedment haunching. Trench banks from the top of the pipe to trench bottom shall be as vertical as practicable.
  - C. Over-Excavation: Over-depth excavation carried below required grade, unless authorized by the Engineer, shall be backfilled with Class I material, and compacted as embedment at no additional cost to Owner.
  - D. Alignment and Depth: Trench to the lines and grades shown on the drawings. Where elevations are not shown, trench to a depth sufficient to provide at least 36-inches of cover above the top of pipe, unless otherwise specified. Grade trenches to provide a constant slope free of sags and high spots.
  - E. Dewatering: Keep trenches free of water.
  - F. Trench Bracing: Properly brace, sheet and support trench walls as soil conditions indicate and in conformance OSHA regulations. Provide adequate bracing and shoring to protect adjacent improvements according to contractor submitted excavation plan or NCDOT positive shoring plan. Contractor shall provide certification for all premanufactured trench bracing devices prior to any excavation activities.
  - G. Bedding, Haunching and Backfill: Tamp to provide firm, even bedding. Excavate bedding material to match the shape of the bottom of the pipe and bell, as detailed in the drawings. Shovel slice haunching material to provide full bearing around the bottom of the pipe.
  - H. Method of Compaction Density Testing: ASTM D698 Standard Proctor
  - I. Pipe Trench Construction: (Depth measured from top of pipe to final grade)
    1. Bedding requirements for sewer force mains and water mains listed in Section 3.6.I below shall be followed, if it has been determined that unsuitable soils exist within the excavated trench. Otherwise bedding for sewer force mains and water mains may be Class I or Class II. All other backfill for sewer force mains and water mains shall be as shown below.
    2. Type A – Sewer mains 12-feet and deeper
      - a. Bedding, Haunching, and Initial Backfill – Class I bedding material, 4-inch minimum depth or 1/8 pipe diameter from stable subgrade to pipe invert; Class I haunching and initial backfill from invert to 6-inches above top of pipe; compact all zones to 95% standard density.
      - b. Final Backfill – Class II material from top of initial backfill to ground surface; compact to 95% standard density.
    3. Type B – Sewer mains between 6-feet and 12-feet deep (occasional water and sewer force mains)

- a. Bedding and Haunching – Class I bedding material, 4-inch minimum depth or 1/8 pipe diameter from stable subgrade to pipe invert; Class I haunching to spring-line of pipe; compact both zones to 95% standard density.
  - b. Initial Backfill – Class II material from spring-line of pipe to 6-inches above top of pipe; compact to 95% standard density.
  - c. Final Backfill – Class II or III material from top of initial backfill to ground surface; compact to 95% standard density.
4. Type C – Sewer, water, and sewer force mains 3-feet to 6-feet deep
- a. Bedding and Haunching – Class I material 4-inch minimum depth or 1/8 pipe diameter from stable subgrade to 1/6 pipe outside diameter above invert; compact to 95% standard density.
  - b. Initial Backfill – Class II or III material from top of pipe to a minimum of 6-inches above top of pipe; compact to 95 standard density.
  - c. Final Backfill – Class II or III material from top of initial backfill to ground surface; compact to 95% standard density.
5. Type S – Water and sewer service lines 3-feet to 6-feet deep
- a. Bedding, Haunching, and Initial Backfill – Class I or II material 3-inch minimum depth from stable subgrade to 3-inch minimum above top of pipe; compact to 95% standard density.
  - b. Final Backfill – Class II or III material from top of initial backfill to ground surface; compact to 95 percent standard density.
- J. Trench Compaction Lifts:
- 1. Embedment and initial backfill zones – 6-inch lifts
  - 2. Final backfill zone – 8-inch lifts
- K. Subgrade Stabilization: Wet, yielding, and mucky trench bottoms shall be stabilized by removal of the material and replacement with sufficient Class I embedment material to correct the instability.
- L. Backfilling Under NCDOT or City Pavements
- 1. As indicated on standard detail drawings
    - a. Top 12-inches of final backfill for road or street subbase shall be compacted to 98% standard density.
    - b. CLSM trench embedment and backfill.
- M. Trench Shields:
- 1. When using a shield for installing pipe, bottom of the shield shall not extend below pipe spring-line and haunching embedment.
  - 2. When using a shield for installing structures, bottom of the shield shall not extend below the top of the bedding for the structures.
  - 3. When removing the shield or moving the shield ahead, exercise extreme care to prevent moving piping, structures, and other underground facilities, and prevent disturbance of bedding material for piping, structures, and other underground facilities. When piping, structures, or underground facilities are disturbed, remove, and reinstall the disturbed items.

### 3.7 SITE AND STRUCTURE EXCAVATION

- A. Perform all excavation required to complete the Work as shown, specified, and required. Excavation shall include the removal and replacement of all asphalt, concrete, curb, rock, earth, fences, trees, shrubs, and other materials as applicable within the defined rights-of-way, easements, and limits of disturbance indicated.
- B. Excavation Protection:
  - 1. Under all other conditions, excavations shall be sloped and benched, shielded, or shored and braced.
  - 2. Provide and maintain excavation protection system(s) in accordance with submittals accepted by Engineer.
- C. All areas of the site shall be graded and maintained at all times to prevent surface runoff from draining into the excavations, and to prevent ponding of water therein.
- D. Excavation shall be accomplished in accordance with the grades and lines as established by the Engineer and as required by the work to be performed. Exercise care to prevent undercutting lower than the required subgrades. When excavations are made below required grades without written order of Engineer, fill such excavations with compacted select fill material, as directed by Engineer, at Contractor's expense.
- E. Extend excavations sufficiently on each side of foundation slabs, wet wells, manholes, valve vaults, and similar construction to allow setting of forms, installation of shoring and bracing, and the safe sloping of banks, as necessary.
- F. General Site Subgrades:
  - 1. Subgrades shall be firm, dense, and thoroughly compacted and consolidated; shall be free from mud, muck, and other soft or unsuitable materials; and shall remain firm and intact under all construction operations. Subgrades that are otherwise solid but become soft or mucky on top due to construction operations shall be reinforced with select fill. Finished elevation of stabilized subgrades shall not be above subgrade elevations shown.
  - 2. If, in Engineer's opinion, subgrade becomes softened or mucky because of construction delays, failure to dewater properly, or other cause within Contractor's control, subgrade shall be excavated to firm material, trimmed, and backfilled with select fill material at Contractor's expense.
  - 3. Upon completion of site preparation and excavation, scarify to a depth of 12-inches and compact as specified. For areas to receive fill, the compacted subgrade shall be scarified to a depth of 4-inches prior to placing the fill.
- G. Proof-rolling Subgrades:
  - 1. Prior to placing fill or constructing pavements or slabs-on-grade, proof-roll the subgrade surface with sufficient proof-rolling apparatus. Before starting proof-rolling, submit to and obtain acceptance from Engineer of proof-rolling apparatus and procedure to be used.
  - 2. Proof-rolling operations shall be made in the presence of Engineer. Notify Engineer in advance of start of proof-rolling operations.
  - 3. Subgrades displaying pronounced elasticity or deformation, deflection, cracking, or rutting shall be stabilized as directed by Engineer. Unsuitable materials shall be undercut to the depth directed by Engineer and replaced with select fill material. Other suitable stabilization methods may be directed by Engineer.

- H. Excavated Materials to be Used as Fill:
1. All materials from excavation, considered as suitable by the Engineer, shall be used as fill wherever required, and the Contractor shall arrange his work so that this usage of excavated materials will be possible.
  2. Stockpile excavated materials that are acceptable for use as fill.
  3. As excavation proceeds, keep stockpiles of excavated materials suitable for use as fill separate from unsuitable materials and waste materials.
  4. Place, grade, and shape stockpiles for proper drainage.
  5. Locate and retain soil materials away from edge of excavations.
  6. Dispose of excess soil material and waste materials.
  7. Stockpiled excavated soils for use as select fill or general fill shall be tested and classified by laboratory as on-Site select fill or on-Site general fill. Perform required quality assurance testing for material verification on stockpiled materials as soon as possible to demonstrate compliance of excavated materials.

### 3.8 SITE AND STRUCTURE FILL AND COMPACTION

- A. Provide and compact all fill required for the finished grades as shown on the drawings.
- B. Place fill in excavations as promptly as progress of the Work allows, but not until completing the following:
1. Engineer's authorization after observation of construction below finish grade, including damp-proofing, waterproofing, perimeter insulation, and similar Work.
  2. Inspection, testing, approval and recording of locations of underground facilities.
  3. Removal of concrete formwork.
  4. Removal of shoring and bracing, and filling of voids with satisfactory materials.
  5. Removal of trash and debris.
  6. Permanent or temporary horizontal bracing is in place on horizontally supported walls.
  7. Field testing of tanks, underground facilities including piping and conduits, and water-retaining structures.
- C. Fill that includes organic materials, debris, roots, trash, stones, or other unacceptable material shall be removed and replaced with approved fill material.
- D. Borrow: The Contractor will supply all borrow necessary and will provide all labor and equipment necessary to dig and haul such borrow.
- E. Placement:
1. Place fill to the grades shown or indicated. Bring up evenly on all sides fill around structures and underground facilities.
  2. Fill shall be spread in successive layers of loose material not more than 8 inches in depth. Each layer shall be spread uniformly by motor grader or other approved device and rolled with an approved tamping or 3-wheeled power roller until thoroughly compacted to 90 percent of maximum density obtained at optimum moisture content, as determined by the AASHTO Standard Method T-180.
  3. Fill areas shall be undercut, and proof rolled as directed by Engineer.
  4. Place fill materials at moisture content and density as specified in Table 31 23 34-A of this Section and this Article's requirements on compaction density. Furnish and use equipment capable of adding measured amounts of water to the fill

materials to bring fill materials to a condition within required moisture content range. Furnish and use equipment capable of disking, aerating, and mixing the fill materials to ensure reasonable uniformity of moisture content throughout the fill materials, and to reduce moisture content of borrow materials by air drying, when necessary. When subgrade or lift of fill materials requires moisture-conditioning before compaction, fill material shall be sufficiently mixed or worked on the subgrade to ensure uniform moisture content throughout the lift of material to be compacted. Materials at moisture content in excess of specified limit shall be dried by aeration or stockpiled for drying.

5. Perform compaction with equipment suitable for the type of fill material placed. Select and use equipment capable of providing the minimum density required. Use lightweight or hand operated compaction equipment within horizontal distance of 10 feet from the wall of completed, below-grade structures. Furnish and use equipment capable of compacting in restricted areas next to structures and around piping and underground facilities. Effectiveness of the equipment selected by Contractor shall be tested at start of compacted fill Work by constructing a small section of fill within the area where fill will be placed. If tests on the test section of fill indicate that required compaction is not obtained, do one or more of the following: increase the amount of coverage, decrease the lift thicknesses, or use different compactor equipment.
6. Place fill materials in horizontal, loose lifts, not exceeding specified uncompacted thickness. Place fill in a manner ensuring uniform lift thickness after placing. Mechanically compact each lift, by not less than two complete coverages of the compactor. One coverage is defined as the conditions reached when all portions of the fill lift have been subjected to the direct contact of compactor's compacting surface. Compaction of fill materials by inundation with water is unacceptable.
7. Do not place fill materials when standing water is present on surface of the area where fill will be placed. Do not compact fill when standing water is present on the fill to be compacted. Do not place or compact fill in a frozen condition or on top of frozen material. Fill containing organic materials or other unacceptable material previously described shall be removed and replaced prior to compaction.
8. If required densities are not obtained because of improper control of placement or compaction procedures, or because of inadequate or improperly-functioning compaction equipment, Contractor shall perform all work required to provide the required densities. Such work shall include, at no additional cost to Owner, complete removal of unacceptable fill areas and replacement and re-compaction until acceptable fill is provided.
9. Repair, at Contractor's expense, observed or measured settlement. Make repairs and replacements as required within 30 days after being so advised by Engineer.
10. When any portion of the fill is constructed on an old roadbed, the existing surfaces shall be scarified and manipulated as directed by the Engineer in order that, when compacted, it shall have a uniform density. Fills shall be shaped and maintained at all times during their construction to prevent an accumulation of standing water in the event of rain.

F. Fill Against Concrete:

1. Placing fill against concrete below finished grade is not allowed until the concrete has attained its specified strength, as determined by duration of concrete curing and testing of field-cured concrete cylinders. Requirements for strength and curing time are in Section 03 05 00 – Concrete.

2. Backfill structural foundation units as soon as practicable, after concrete has gained sufficient strength to avoid damage, to avoid ponding of surface water and accumulation of debris.
  3. Where fill is placed against waterproofed surface, exercise care that waterproofing material is not damaged.
- G. Fill in Electrical Ductbank Trenches:
1. Provide general fill for full depth of electrical ductbank trench, below and above electrical ductbank.
  2. Where one ductbank passes beneath another pipe or ductbank, provide select fill to the elevation of the bottom of upper ductbank or pipe, as applicable.
  3. Placing and compacting fill in electrical ductbank trenches shall comply with Type S trench construction requirements.
- H. Pavement:
1. Compact the subgrade and fill material beneath paved areas and shoulders to a minimum 98 percent ASTM D698 maximum density at optimum moisture content.
  2. Place 1-½ inches of temporary asphalt concrete pavement immediately after filling excavations in paved roadways and other paved areas that will remain for permanent use.
  3. Maintain surface of paved area over the fill in good and safe condition during progress of the Work, and promptly fill depressions over and adjacent to the fill area caused by settlement of fill.
  4. Permanent replacement pavement shall be equal to that of the existing roadways, unless otherwise shown or specified.
- I. Subbase Placement:
1. Provide subbase material where shown to the limits shown or indicated.
  2. Place subbase material in compacted lifts not exceeding depth of 6-inches each.
- J. Drainage Fill Placement:
1. Provide drainage fill material where shown to the limits shown or indicated.
  2. Place drainage fill material in compacted layers of uniform thickness not exceeding depth of 6-inches each. Compact lifts of drainage fill using suitable compaction equipment.
- K. Granular Fill Placement
1. Place granular fill on compacted subgrade.
- L. Compaction Density Requirements:
1. Compaction required for all types of fills shall be in accordance with Table 31 23 34-A of this Section. Moisten material or aerate the material as necessary to provide the moisture content that will facilitate obtaining the required compaction.
  2. Fill shall be wetted and thoroughly mixed to achieve optimum moisture content plus-or-minus 3-percent, with the following exceptions:
    - a. On-site clayey soils: Optimum to plus 3-percent.
  3. Replace natural, undisturbed soils or compacted soil subsequently disturbed or removed by construction operations with materials compacted as indicated in Table 31 23 34-A.

**TABLE 31 23 34-A  
REQUIRED MINIMUM DENSITY**

<b>Material</b>	<b>Percent Compaction (ASTM D698)</b>	<b>Uncompacted Lift (inches)</b>
General Fill		
More than 5-feet below final grade	100	8
Less than 5-feet below final grade	95	8
Select Fill		
Below concrete slabs or mats	100	8
Below pavement and sidewalks	100	12
Behind concrete walls	95	8
Subbase Material		
Below pavement and sidewalks	100	12
All other locations	100	8
Drainage Fill	N/A	6
Structural Fill	98	-
Granular Fill	100	-
Landscaped Areas		
Subgrade	98	-
Topsoil	85	

4. Field quality control testing for density; to verify that specified density was obtained, will be performed during each day of compaction Work. Responsibility for field quality control testing is specified in the “Field Quality Control” Article in Part 3.
5. When field quality control testing indicates unsatisfactory compaction, provide additional compaction necessary to obtain the specified compaction. Perform additional compaction Work at no additional cost to Owner until specified compaction is obtained. Such work includes complete removal of unacceptable (as determined by Engineer) fill areas and replacement and re-compaction until acceptable fill is provided in accordance with the Contract Documents.

M. Replacement of Unacceptable Excavated Materials: In cases where over-excavation to replace unacceptable soil materials is required, backfill the excavation to required subgrade with select fill material and thoroughly compact in accordance with Table 31 23 34-A and the associated “Compaction Density Requirements” in this Article. Slope the sides of excavation in accordance with the maximum inclinations specified for each structure location

### 3.9 SITE GRADING

A. General:

1. Uniformly grade areas within limits of grading under this Section, including adjacent transition areas. Finished grades should be smooth and provide positive drainage.
  - a. Rough Grade Plus or minus 0.1 foot
  - b. Finish Grade Plus or minus 0.1 foot



2. Smooth subgrade surfaces within specified tolerances, compact with uniform levels or slopes between points where elevations are shown, or between such points and existing grades.
- B. Topsoil: The top 4-inches of soil in landscaped areas shall be topsoil.
  - C. Protection: Protect areas which have been graded from equipment traffic.
  - D. Grading Outside Building Lines: Grade areas adjacent to building lines to drain away from structures and to prevent ponding. Finish surfaces free of irregular surface changes, and shall comply with the following:
  - E. Grassed Areas or Areas Covered with Gravel, Stone, Wood Chips, or Other Special Cover: Finish areas to receive topsoil or special cover to within not more than one inch above or below the required subgrade elevations.
  - F. Sidewalks: Shape surface of areas under sidewalks to line, grade, and cross section, with finish surface not more than 1-inch above or below the required subgrade elevation.
  - G. Pavements: Shape surface of areas under pavement to line, grade, and cross section, with finish surface not more than ½-inch above or below the required subgrade elevation.
  - H. Grading Surface of Fill Under Concrete Slabs: Grade smooth and even, free of voids, compacted as specified, and to required elevation. Provide final grades within a tolerance of ½-inch when tested with a 10-foot straight edge.
  - I. Compaction: After grading, compact subgrade surfaces to the depth and percentage of maximum density for each area classification.

### 3.10 CONTROLLED LOW STRENGTH MATERIAL (CLSM)

- A. Controlled Low Strength Materials Placement:
  1. Discharge CLSM from the mixer by reasonable means into the space to be filled.
  2. Bring the fill material uniformly up to the fill line indicated on drawings.
  3. Placement of fill over the CLSM may proceed after a curing period of not less than 3-days.

### 3.11 SITE PAVEMENT SUBBASE COURSE

- A. General:
  1. Place subbase material, in layers of specified thickness, over ground surface to support pavement base course.
  2. After completing filling and grading, shape, and compact pavement subgrade to an even, firm foundation in accordance with this Section. Remove unsuitable subgrade materials, including soft materials, boulders, vegetation, and loose stones, and replace with compacted fill material as directed by Engineer.

- B. Undercutting: Undercutting, unless authorized by the Engineer, shall be replaced, and compacted at the Contractor's expense. If the material, after excavation to subgrade, is found to be soft, spongy, or unfit for use as subgrade, such unsuitable material shall be removed to a depth as directed by the Engineer and the subgrade shall be brought to proper elevation by filling with suitable material from excavation or from an approved borrow site.
- C. Grade Control:
  - 1. During construction, maintain lines and grades including crown and cross-slope of subbase course.
- D. Placing of Pavement Subbase Course:
  - 1. Place subbase course material on prepared subgrade in layers of uniform thickness, in accordance with indicated cross-section and thickness. Maintain optimum moisture content for compacting subbase material during placing operations.
  - 2. When indicated on the drawings, provide geotextile separation fabric over the prepared subgrade
- E. Compaction and Grade Control: Comply with compaction requirements for excavation and fill in this Section, and the following requirements:
  - a. Compaction with roller shall begin at the sides of the area to be paved and continue toward the center. Continue compaction until there is no movement of the course ahead of the roller.
  - b. After compaction of top lift of pavement subbase, provide and uniformly spread pipe bedding material and screenings compacted, on the surface, and sweep using gang-dragged broom, followed by compaction.
  - c. After rolling, check for grade with a line not less than 40-feet in length; depression over ½-inch deep shall be filled to satisfaction of Engineer.
  - d. After completing compaction, other than that necessary for bringing material for the next course, do not haul or drive over the compacted subbase.
  - e. Do not install pavement subbase in excess of 500-feet in length without compacting to prevent softening of the subgrade.
  - f. If subgrade material becomes churned up into or mixed with the subbase material, remove the mixed material, and replace with clean, compacted subbase material.

### 3.12 DISPOSAL OF EXCAVATED MATERIALS

- A. Unsuitable materials encountered in an excavation shall be removed by the Contractor and backfilled with suitable material and compacted. Unsuitable materials include organic soils, muck, soft and compressible silts, and clays and running sands.
- B. Excavated materials not required for topsoil, fill, or backfill shall be removed from the site of the work by the Contractor, but none shall be deposited on private property without written consent of the property owner.

### 3.13 TEMPORARY BARRIERS

- A. Provide temporary barrier surrounding excavations and excavation work areas to provide temporary protection to persons and property. Barrier shall have openings only at vehicular, equipment, and worker access points.
- B. Minimum Material Requirements for Temporary Barriers:
  - 1. Temporary barrier shall not be less snow fence-type fencing, 4-feet high.
  - 2. Fence shall be constructed of vertical hardwood slats measuring not less than 1-1/2 inches by 1/4 inch interwoven with strands of horizontal wire or shall be of equivalent plastic construction.
  - 3. Posts:
    - a. Posts shall be steel, either "U"-, "Y"-, "T"-shaped, or channel section.
    - b. Posts shall have a nominal weight of not less than 0.33-pound per linear foot, exclusive of the anchor.
    - c. Posts shall have tapered anchors weighing not less than 0.67 pounds, each firmly attached by means of welding, riveting, or clamping.
    - d. Posts shall have corrugations, knobs, notches, or studs placed and constructed to engage a substantial number of fence line wire in the proper position.
    - e. Provide each post with sufficient quantity of galvanized wire fasteners or clamps, of not less than 0.120-inch diameter, for attaching fence wire to post.

### 3.14 FIELD QUALITY CONTROL

- A. Field inspection, sampling and testing shall be performed.
- B. Site Tests: Owner will employ an independent testing laboratory to perform field quality control testing.
  - 1. Testing Laboratory Scope:
    - a. Perform field moisture content and density tests to ensure that the specified compaction of embedment and fill materials has been obtained.
    - b. Perform tests of actual unconfined compressive strength or bearing tests on structure subgrades.
    - c. Report results of each test to CFPUA, Engineer, and Contractor.
  - 2. Authority and Duties of Testing Laboratory:
    - a. Technicians representing the testing laboratory shall inspect the materials in the field, perform testing, and report findings. When materials furnished or the Work performed does not comply, technician will direct attention of CFPUA, Engineer, and Contractor to such failure.
    - b. Technician will not act as foreman or perform other duties for Contractor. Work will be checked as it progresses, but failure to detect defective Work or non-complying materials shall not in any way prevent later rejection when defect is discovered. Technicians are not authorized to revoke, alter, relax, enlarge, or release requirements, or to approve any portion of the Work.
  - 3. Responsibilities and Duties of Contractor:
    - a. To facilitate testing laboratory, Contractor shall advise testing laboratory at least 2-days in advance of excavating filling operations to allow for assignment of personnel for field quality control testing.

- b. It shall be Contractor's responsibility to control construction operations to accomplish the specified compaction for fill and trench construction and confirm tests verify that Contractor has complied and is complying relative to compaction control.
  - c. Contractor shall demonstrate adequacy of compaction equipment and procedures before exceeding one or more of the following quantities of earthwork:
    - 1) 200 linear feet of trench embedment and backfill.
    - 2) 10 cubic yards of select fill.
    - 3) 100 cubic yards of general fill.
    - 4) 50 cubic yards of subbase material.
  - d. Each test location shall include tests for each layer, type, or class of fill to finish grade.
4. Testing laboratory will inspect and indicate acceptable subgrades and fill layers using the interval/units listed below as a guide. Actual inspection and testing interval/units will vary based on specific project conditions.
- a. Trenches for pipelines and underground facilities (including buried ductbanks):
    - 1) In Open Fields: Two locations every 1,000 linear feet.
    - 2) Along Dirt or Gravel Roads or Off Traveled Right-of-Way: Two locations every 500 linear feet.
    - 3) Crossing Paved Roads: Two locations along each crossing.
    - 4) Under Pavement Cuts or Within Two Feet of Pavement Edges: One location every 400 linear feet.
  - b. Footing Subgrade: For each stratum of soil on which footings will be placed, perform not less than one test to verify required design bearing capacities. Subsequent verification and approval of each footing subgrade may be based on a visual comparison of each subgrade with related tested strata, when acceptable to Engineer.
  - c. For Select Fill: On 30-foot intervals on all sides of the structure for every compacted lift, but not less than one per lift on each side of the structure for structures less than 60 feet long on a side.
  - d. For General Fill: One per 1,000 square feet on every compacted lift.
  - e. Subbase Material: One per 1,000 square feet on every compacted lift.
5. Test reports shall be provided to Owner, Engineer and Contractor.
6. If testing laboratory reports or inspections indicate subgrade, fills, or bedding compaction below specified density, Contractor shall remove unacceptable materials as necessary and replace with specified materials and provide additional compaction at Contractor's expense until subgrades, bedding, and fill are acceptable.

END OF SECTION

 **D 2321 – 05**

**TABLE 1 Classes of Embedment and Backfill Materials**

Class	Type	Soil Group Symbol D 2487	Description	Percentage Passing Sieve Sizes			Atterberg Limits		Coefficients	
				1 1/2 in. (40 mm)	No. 4 (4.75 mm)	No. 200 (0.075 mm)	LL	PI	Uniformity $C_u$	Curvature $C_c$
IA	Manufactured Aggregates; open-graded, clean.	None	Angular, crushed stone or rock, crushed gravel, broken coal, crushed slag, cinders or shells; large void content, contain little or no fines.	100 %	≤ 10 %	< 5 %	Non Plastic			
IB	Manufactured, Processed Aggregates; dense-graded, clean.	None	Angular, crushed stone (or other Class 1A materials) and stone/sand mixtures with gradations selected to minimize migration of adjacent soils; contain little or no fines (see XI.8).	100 %	≤ 50 %	< 5 %	Non Plastic			
II	Coarse-Grained Soils, clean	GW	Well-graded gravels and gravel-sand mixtures; little or no fines.	100 %	< 50% of "Coarse Fraction"	< 5 %	Non Plastic		> 4	1 to 3
		GP	Poorly-graded gravels and gravel-sand mixtures; little or no fines.						< 4	< 1 or > 3
		SW	Well-graded sands and gravelly sands; little or no fines.		> 50% of "Coarse Fraction"				> 6	1 to 3
		SP	Poorly-graded sands and gravelly sands; little or no fines.						< 6	< 1 or > 3
	Coarse-Grained Soils, borderline clean to w/fines	e.g. GW-GC, SP-SM.	Sands and gravels which are borderline between clean and w/fines.	100 %	Varies	5 % to 12 %	Non Plastic		Same as for GW, GP, SW and SP	
III	Coarse-Grained Soils With Fines	GM	Silty gravels, gravel-sand-silt mixtures.	100 %	< 50% of "Coarse Fraction"	12 % to 50 %		< 4 or < "A" Line		
		GC	Clayey gravels, gravel-sand-clay mixtures.					< 7 and > "A" Line		
		SM	Silty sands, sand-silt mixtures.		> 50% of "Coarse Fraction"			> 4 or < "A" Line		
		SC	Clayey sands, sand-clay mixtures.					> 7 and > "A" Line		
IVA <sup>A</sup>	Fine-Grained Soils (inorganic)	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, silts with slight plasticity.	100 %	100 %	> 50 %	< 50	< 4 or < "A" Line		
		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.					> 7 and > "A" Line		
IVB	Fine-Grained Soils (inorganic)	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.	100 %	100 %	> 50 %	> 50	< "A" Line		
		CH	Inorganic clays of high plasticity, fat clays.					> "A" Line		
V	Organic Soils	OL	Organic silts and organic silty clays of low plasticity.	100 %	100 %	> 50 %	< 50	< 4 or < "A" Line		
		OH	Organic clays of medium to high plasticity, organic silts.					> 50	< "A" Line	
	Highly Organic	PT	Peat and other high organic soils.							

<sup>A</sup>Includes Test Method D 2487 borderline classifications and dual symbols depending on plasticity index and liquid limits.  
 Note—"Coarse Fraction" as used in this table is defined as material retained on a No. 200 sieve.