

SECTION 31 23 00 – EXCAVATION AND FILL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to Work of this section.

1.2 STANDARDS

- A. The following Standards are listed in this specification:

ASTM C31	Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C33	Standard Specification for Concrete Aggregates
ASTM C150	Standard Specification for Portland Cement
ASTM D448	Standard Classification for Sizes of Aggregates for Road and Bridge Construction
ASTM D698	Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft)
ASTM D1557	Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft ³ (2,700 kN-m/m ³))
ASTM D1621	Standard Test Method for Compressive Properties of Rigid Cellular Plastics
ASTM D2487	Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D4253	Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table
ASTM D4254	Standard Test Method for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density
ASTM D4491	Standard Test Methods for Water Permeability of Geotextiles by Permittivity
ASTM D4533	Standard Test Method for Trapezoid Tearing Strength of Geotextiles
ASTM D4632	Standard Test Method for Grab Breaking Load and Elongation of Geotextiles
ASTM D4716	Standard Test Method for Constant Head Hydraulic Transmissivity (In-Plane Flow) of Geotextiles and Geotextile Related Products
ASTM D4751	Standard Test Method for Determining Apparent Opening Size of a Geotextile
ASTM D4759	Standard Practice for Determining the Specification Conformance of Geosynthetics
ASTM D4833	Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products

1.3 DESCRIPTION OF WORK

- A. Earthwork: The extent of earthwork is indicated on the drawings. The work, in general, includes the following items:
 - 1. Excavation and backfill for building structure and foundation.

2. Preparation of subgrade for building slabs, and walks.
 3. Excavation, backfill and related materials for perimeter and underfloor foundation drainage system.
 4. Excavation and backfill in conjunction with underground mechanical and electrical utilities under slabs on grade, and mechanical and electrical appurtenances that are buried under the building slab.
 5. Rough and finish grading adjacent to the building.
 6. Furnishing Unit Prices for additional earthwork.
- B. Excavation Definition: "Excavation" consists of removal of all material encountered to required subgrade elevations indicated and subsequent disposal of all materials removed.

1.4 QUALITY ASSURANCE

- A. Codes and Standards: Perform excavation work in compliance with all applicable requirements of governing authorities having jurisdiction.
- B. Testing and Inspection Services:
1. Owner's Testing Laboratory: The Owner will engage a soil testing and inspection service for quality control testing during earthwork operations. Reference Section entitled "Testing Laboratory Services".
- C. Depth of Bearing Strata: It is to be understood that site soil conditions are variable across the site. Footing design dimensions and bearing elevations shown are minimums. The design of the footings is based on the assumed strata bearing capacity at the elevation shown on the drawings and as indicated in the General Notes. If the indicated depth of footing excavation is reached without developing the required strata bearing capacity, the Owner's Geotechnical Technician on site will immediately advise the Contractor on the required bearing elevation for each individual footing or mat. Revisions will be paid for in accordance with the Contract condition relative to changes in the Work.
- D. Survey Work, Grades, and Elevations:
1. Grades and Elevations: Finished grades indicated by spot elevation and normal contour line elevations denote finished top surface elevations. Report conflicts, errors and inconsistencies in grades and elevations to Architect/Engineer for resolution. Do not proceed with the work in questionable areas until conflicts are resolved by the Architect/Engineer.
 2. Survey Work: Lay out work to the lines and levels required before excavation. Record actual measurements of each footing and mat plan centerline location, bottom elevation, deviation from specified tolerances, and all other pertinent data as required.

1.5 SUBMITTALS

- A. Laboratory Test Reports: Submit the following reports directly to the Architect/Engineer from the testing services, with copy to Contractor and Owner:

1. Test reports on borrow and fill material including optimum moisture-maximum density curve for each type of soil.
2. Verification reports of each footing subgrade.
3. Field density test reports.
4. Report of actual unconfined compressive strength and/or results of bearing tests of each strata tested.
5. All other test reports as required by "Testing Laboratory Services", and other specification sections.
6. Product Data.

1.6 JOB CONDITIONS

- A. Site Information: Data on indicated subsurface conditions are not intended as representations or warranties of accuracy or continuity between soil borings. It is expressly understood that Owner will not be responsible for interpretations or conclusions drawn there from by Contractor. Data are made available for convenience of Contractor. Additional test borings and other exploratory operations may be made by the Contractor at no cost to the Owner.
- B. Removal of Items Remaining from Demolition: Include as part of earthwork the breaking up and removal of all concrete slabs, pavements, footings, foundations, cisterns, septic tanks, abandoned underground utility lines and all other obstructions remaining from previous demolition operations that may have occurred.
- C. Existing Utilities:
 1. The drawings indicate the locations of known active and inactive above grade and below grade utilities. Locate all existing underground utilities in areas of work before proceeding. Provide adequate support and protection during earthwork operations of utilities that are to remain in place. Demolish and completely remove from the site existing utilities indicated to be removed. Coordinate through the SPM communication with Plant Operations Utility Services and if required the public utility companies for proper shut-off of services for active lines.
 2. If any active utility not indicated in drawings is encountered, notify Architect/Engineer, SPM, and FPI and protect from damage until instructions for proper disposition of the utility are given by the Architect/Engineer. Perform the requested work in compliance with rules and regulations of authority having jurisdiction.
 3. Repair active utilities scheduled to remain that are damaged by earthwork operations to the satisfaction of the utility owner.
 4. If any inactive utility not indicated on the drawings is encountered, remove, plug, or cap as directed by the Architect/Engineer. Abandoned in place utilities shall be surveyor located and identified in the As-Built record set of drawings. Obtain any necessary data relative to proposed abandonment of existing utility service from authority having jurisdiction.

5. Do not interrupt existing utilities serving facilities occupied and used by Owner or others, during occupied hours, except when permitted in writing by Architect/Engineer and then only after acceptable temporary utility services have been provided. Follow UH Service Interruption Procedure through the SPM.

Provide minimum of 48-hour notice to Architect/Engineer, and receive written notice to proceed before interrupting any utility. Refer to UH outage policy for additional requirements.

D. Use of Explosives:

1. The use of explosives is not permitted.

E. Protection of Persons and Property:

1. Barricade open excavations occurring as part of this work and post with warning lights. Operate warning lights as recommended by authorities having jurisdiction.
2. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout and other hazards created by earthwork operations.
3. Perform excavation within drip-line of large trees to remain by hand, and protect the root system from damage or dryout to the greatest extent possible. Maintain moist condition for root system and cover exposed roots with burlap. Paint root cuts of 1" diameter and larger with emulsified asphalt tree paint.
4. Accidental or Careless Damage to Work Intended to Remain in Place: Restore to a condition as good or better than existed before work was commenced as approved by the Architect/Engineer and at no additional cost to the Owner.

PART 2 - PRODUCTS

2.1 DEFINITION OF SOIL MATERIALS

- A. Satisfactory Soil Materials: Satisfactory soil materials are defined as those complying with ASTM D 2487 soil classification groups GW, GP, GM, SM, SW, and SP. Some CL materials subject to the requirements for "Select Fill" may be acceptable.
- B. Unsatisfactory Soil Materials: Unsatisfactory soil materials are defined as those complying with ASTM D 2487 soil classification groups GC, ML, MH, CH, OL, OH, and PT. Groups SC and CL are also unsatisfactory unless conforming to requirements specified below.
- C. Fill and Backfill:
 1. Definition: "Fill" is soil material that is used to raise existing grades such as under foundation slabs or above footings, or to replace unsuitable material. Backfill" is soil material that is used to fill an excavation, to fill against the structure, or to fill behind foundation walls.
 2. Select Fill: "Select fill" material shall be used as noted on the drawings as fill and/or backfill and shall conform to one of the following:

- a. Sandy clay or clayey sand having a plasticity index between 7 and 19 and a liquid limit not exceeding 35. Material shall be free of debris, roots, vegetation, organic matter and all other deleterious substances and free of rock or gravel greater than 2" in any dimension.
 - b. Satisfactory Soil Material as defined above free of clay, rock, or gravel larger than 2" in any dimension and free of debris, roots, vegetation, waste and all other deleterious materials.
3. Drainage Fill: "Drainage fill" shall be used as noted on the drawings as fill material that is used around a drainage pipe in a wall drainage system or under a foundation slab as part of an underfloor drainage system and shall conform to the following:
 - a. Uniformly graded mixture of natural or crushed gravel, crushed stone, and natural sand, conforming to the coarse aggregate requirements of ASTM C 33, size 67 with 100% passing a 1" sieve and 0% to 5% passing a No. 8 sieve.
 - b. Washed evenly graded mixture of crushed stone or crushed or uncrushed gravel, ASTM C33; coarse-aggregate grading Size 56; with 100% passing a 1 1/2" sieve and not more than 5% passing a No. 4 sieve.
4. Drainage Backfill: "Drainage backfill" shall be used as noted on the drawings as backfill material that is used behind a foundation wall as part of a wall drainage system. Drainage backfill must be compatible with any drainage fill material to which it comes in contact as part of the complete wall drainage system. Drainage backfill shall conform to the following:
 - a. A washed free draining river sand graded so that 100% will pass a 3/8" sieve and less than 3% shall pass a No. 200 sieve.
 - b. Washed evenly graded mixture of crushed stone or crushed or uncrushed gravel, ASTM D448; coarse-aggregate grading Size 57; with 100% passing a 1 1/2" sieve and not more than 5% passing a No. 8 sieve.
5. Impervious Fill: "Impervious Fill" shall be used as noted on the drawings as backfill material that is used as a cap to seal off surface water from penetrating into backfill below. The material shall be lean clay with a Liquid Limit of between 35 and 50, with a Plasticity Index of between 20 and 30, and capable of compacting to a dense composite.
6. Granular Base under slab-on-grade: "Granular Base" material shall be used as noted on the drawings as fill material between the moisture retarder and the slab and shall be a clean, well-graded, granular mixture of crushed stone, crushed, recycled concrete, or crushed or uncrushed gravel that is compactable and drains well.

Subject to compliance with requirements, the following materials are acceptable:

Crushed, recycled concrete with 100% passing the 1 1/2 inch sieve, 45% to 60% passing the 3/8" sieve, 25% to 40% passing the #4 sieve, 20% to 35% passing the #8 sieve, 10% to 30% passing the #100 sieve, and 0% to 5% passing the #200 sieve.

7. Leveling Sub-base under Moisture Retarder: "Leveling Sub-Base" shall be used as noted on the drawings as a thin smoothing layer over the sub-grade and directly below the moisture retarder. The material shall be a clean mixture of crushed stone, crushed gravel, and manufactured or natural sand; ASTM D448, size 10, with 100 percent passing a No. 4 sieve and 10 to 30 percent passing a No. 100 sieve; meeting deleterious substance limits of ASTM C33 for fine aggregates.
8. Cement Stabilized Sand Backfill: "Cement Stabilized Sand" shall be used as noted on the drawings and in these specifications as backfill material and shall be a well mixed composite of the following materials:
 - a. Granular soil material conforming to one of the following:
 - (1) Uniformly graded mixture of natural or crushed gravel, crushed stone, and natural sand, conforming to the fine aggregate (concrete sand) requirements of ASTM C 33, with 100% passing a 3/8" sieve and 2% to 10% passing a No. 100 sieve.
 - (2) Concrete sand, 3/8" to No. 100, conforming to ASTM C 33.
 - (3) A washed free draining river sand graded so that 100% will pass a 3/8" sieve and less than 3% shall pass a No. 200 sieve.
 - b. Potable Water added in such proportion to make the mixture workable and fully hydrate the cement.
 - c. Cement, Type I, ASTM C 150 added in such proportion that the cement to dry sand ratio by weight shall be a minimum of 7%.

The cement stabilized sand shall produce a minimum unconfined compressive strength of 100 PSI in 48 hours and 400 PSI in 7 days where compacted to 95% density according to ASTM D 698 without additional moisture control, cured in accordance with ASTM C 31 Item 9, and tested in accordance with ASTM C 31.

Perform and complete compaction of cement stabilized materials within four (4) hours of the time when water was added at the mixing plant. Cement stabilized materials older than four (4) hours shall not be used shall be removed from the site.

9. Use of On-site Materials: On-site materials (i) may be used for fill and backfill only when approved by the Owner's Testing Laboratory. (ii) are not satisfactory for use on this project and shall be hauled off and disposed of in a safe manner.
- D. Approval: All soil materials used for the project shall be approved by the Owner's Testing Laboratory prior to hauling or placement. Soil materials used for fill and backfill shall be retested and reapproved each time the source or character of the material changes.
- E. Filter Fabric: Nonwoven geotextile, specifically manufactured as a drainage geotextile: made from polyolefins, polyesters, or polyamides: and with the following minimum properties determined according to ASTM D4759 and referenced standard test methods:

Grab Tensile Strength: 100 lbf: ASTM D4632
Tear Strength: 40 lbf: ASTM D4533
Puncture Resistance: 50 lbf; ASTM D4833
Water Flow Rate; 90 gpm per sq. ft.; ASTM D4491
Apparent Opening Size; No. 50; ASTM D4751

- F. Separation Fabric: Woven geotextile, specifically manufactured for use as a separation geotextile; made from polyolefins, polyesters, or polyamides; and with the following

minimum properties determined according to ASTM D 4759 and referenced standard test methods:

Grab Tensile Strength: 200 lbf; ASTM D4632
Tear Strength: 75 lbf; ASTM D4533
Puncture Resistance: 90 lbf; ASTM D4833
Water Flow Rate; 4 gpm per sq. ft.; ASTM D4491
Apparent Opening Size; No. 30; ASTM D4751

- G. Geocomposite Drainage System: A manufactured system consisting of a geotextile filter fabric specified above that is fusion bonded to a high-impact plastic cusped core and with the following minimum properties.

Flow rate, @3600 psf and hydraulic gradient = 1.0, ASTM D4716: 5 gpm/ft. width
Compressive Strength, ASTM D1621: 15,000 psf

Subject to compliance with requirements, provide one of the following:

"MiraDRAIN MD-2000", TC MiraDRI, Inc., Norcross, GA
"Sheet Drain HS", Greenstreak, St. Louis, MO
"J-DRain 300", JDR Enterprises, Inc., Alpharetta, GA
"Hydraway 100", Solutia, Inc., St. Louis, MO
"Enkadrain 9010", Akzo Nobel Geosynthetics Company, Enka, NC

Flow rate, @3600 psf and hydraulic gradient = 1.0, ASTM D4716: 15 gpm/ft. width
Compressive Strength, ASTM D1621: 18,000 psf

Subject to compliance with requirements, provide one of the following:

"MiraDRAIN MD-6000", TC MiraDRI, Inc., Norcross, GA
"Sheet Drain", Greenstreak, St. Louis, MO
"J-DRain 400", JDR Enterprises, Inc., Alpharetta, GA
"Hydraway 300", Solutia, Inc., St. Louis, MO
"Enkadrain 9120", Akzo Nobel Geosynthetics Company, Enka, NC

- H. Slotted Collector Pipe: Provide Schedule 80 PVC pipe with 0.10 inch slots comprising a minimum of 8% of the total surface area of the pipe but no more than 10%.

PART 3 - EXECUTION

3.1 CLEARING AND GRUBBING

- A. Remove all existing slabs, pavements, trash, rubbish, debris, trees, roots, stumps, underbrush, grass, shrubs, plants and other vegetation from within the mass excavation limits.

3.2 PREPARATION

- A. Survey Work:

1. Set required lines and levels as required to accurately perform the excavation work.

2. Maintain all bench marks and other reference points.

B. Protection of Existing Work:

1. Protect bench marks and existing structures, utilities, roads, sidewalks, paving, curbs and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations. In areas where excavations must be carried to such depths that surcharge from streets, sidewalks, or earth pressure create hazardous conditions, provide sheet piling, shoring and bracing, or combinations thereof, as required to protect excavations. Remove shoring and bracing before backfilling is completed, but not before permanent supporting structure is in place.
2. Protect excavations by laying back sides on a maximum 1:1 slope or by other methods as required to prevent cave-ins and loose dirt from falling into excavations.
3. Provide erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.
4. Notify Architect/Engineer of any unexpected subsurface conditions. Discontinue work in area until Architect/Engineer provides notification to resume work.

3.3 EXCAVATION

- A. Unclassified Excavation: The excavation for this project is unclassified. The Contractor is required to excavate to subgrade elevations specified, regardless of the character of materials or obstructions encountered. No additional costs will be paid by the Owner for any underground obstructions encountered.

B. Unauthorized Excavation:

1. Unauthorized excavation consists of removal of materials beyond indicated subgrade elevations or dimensions without specific direction of Architect/Engineer. Unauthorized excavation, as well as remedial work directed by Architect/Engineer, shall be at Contractor's expense.
2. Under footings, foundation bases, or foundation walls, fill unauthorized excavation by extending indicated bottom elevation of footing or base to excavation bottom, without altering required top elevation. Lean concrete fill or cement stabilized sand may be used to bring elevation to proper position, when acceptable to Architect/Engineer and approved by the Geotechnical Engineer.
3. Elsewhere, backfill and compact unauthorized excavations as specified for authorized excavations of same classification, unless otherwise directed by Architect/Engineer.

C. Approval of Subgrade:

1. When excavation has reached required subgrade elevations, notify Owner's Geotechnical Engineer who will make an inspection of conditions.

2. Proofroll exposed subgrade below building with appropriate compaction equipment. Conduct proofrolling operations only in the presence of the Owner's Geotechnical Engineer. Undercut areas which "pump" or "rut" during operations to firm natural soil, and backfill and compact as specified.
3. If unsuitable bearing materials are encountered at required subgrade elevations, carry excavations deeper and replace excavated material with cement stabilized sand, lean concrete, or select fill as directed by Owner's Geotechnical Engineer.
4. Removal of unsuitable material and its replacement as directed will be paid on basis of contract conditions relative to changes in the work.
5. Reconstruct subgrades damaged by freezing temperature, frost, rain, accumulated water, or construction activities as directed by the Owner's Geotechnical Engineer.

D. Stability of Excavations:

1. Slope sides of excavations to comply with local codes and ordinances having jurisdiction and in accordance with the requirements noted in the Geotechnical Report. Shore and brace where sloping is not possible because of space restrictions or stability of material excavated.
2. Maintain sides and slopes of excavations in safe condition until completion of backfilling. Protect slopes from erosion by covering the slope with material such as polyethylene sheet.

E. Shoring and Bracing:

1. Provide materials for shoring and bracing, such as sheet piling, uprights, stringers and cross-braces, in good serviceable condition.
2. Establish requirements for trench shoring and bracing to comply with local codes and authorities having jurisdiction.
3. Maintain shoring and bracing in excavations regardless of time period excavations will be open. Carry down shoring and bracing as excavation progresses.
4. Provide permanent steel sheet piling or pressure creosoted timber sheet piling wherever subsequent removal of sheet piling might permit lateral movement of soil under adjacent structures. Cut off tops as required and leave permanently in place.

F. Dewatering:

1. Prevent surface water and subsurface or ground water from flowing into excavations and from flooding project site and surrounding area.
2. Do not allow water to accumulate in excavations. Remove water to prevent softening of foundation bottoms, undercutting footings, and soil changes detrimental to stability of subgrades and foundations. Provide and maintain pumps, well points, sumps, suction and discharge lines, and other dewatering system components necessary to convey water away from excavations.

3. Establish and maintain temporary drainage ditches and other diversions outside excavation limits to convey rain water and water removed from excavations to collecting or run-off areas. Do not use trench excavations as temporary drainage ditches. Do not discharge drainage water lines into municipal sewers without municipal approval. Prevent water running onto adjacent properties and public thoroughfares. Direct surface drainage away from excavated areas.

G. Material Storage:

1. Where required by schedule or site limitations, stockpile satisfactory soil materials and/or select fill where directed, until required for backfill or fill. Place, grade and shape stockpiles for proper drainage.
2. Locate and retain soil materials away from edge of excavations. Do not store within drip-line of trees indicated to remain.
3. Dispose of excess soil material and waste materials as herein specified.

H. Excavation for Structures:

1. Conform to elevations and dimensions shown within a tolerance of plus or minus 0.10'. Excavations for footings and mats may be neat excavated where possible with sides and top edges free of loose or wet materials. Where neat excavation is not possible, excavate by open cut and allow sufficient distance from the edge of footings and foundations to permit placing and removing concrete formwork, installing services, other construction, and for inspection.
2. In excavating for footings and foundation, take care not to disturb bottom of excavation. Excavate by hand to final grade just before concrete reinforcement is placed. Where unsatisfactory bearing surfaces are encountered, the area shall be undercut as required and backfilled with cement stabilized sand or lean concrete as directed by the Geotechnical Engineer. Trim bottoms to required lines and grades to leave solid, clean, level and flat base to receive other work.
3. Protect soils exposed at the base of completed foundation excavations against disturbance from construction activities and changes in moisture content. Excavations shall not be left overnight unless it is protected with a minimum 2" thick seal slab of lean concrete. Where the bottom of the excavation will be exposed to movement of crawler type heavy equipment, the contractor may leave about one foot of undisturbed soil above indicated bottom of footing elevations until just prior to final excavation.
4. Mat Excavation: The final one foot of mat excavation shall be performed over small areas and shall produce minimal disturbance to the bearing surface. As soon as the excavated area is cleaned, all loose material removed, and soft spots filled, the bearing area shall be immediately covered with a 3" unreinforced seal slab of lean concrete before proceeding to the next area of excavation.
5. For pile foundations, stop excavations from 6" to 12" above bottom of pile cap before piles are placed. After piles have been driven, remove loose and displaced material, and excavate to final grade, leaving solid base to receive concrete pile caps.

I. Excavation and Backfilling for Trenches:

1. Dig trenches to the uniform width required for particular item to be installed, sufficiently wide to provide ample working room. Provide 6" to 9" clearance on both sides of pipe or conduit.
 2. Excavate trenches to depth indicated or required. Carry depth of trenches for piping to establish indicated flow lines and invert elevations. Beyond building perimeter, keep bottoms of trenches sufficiently below finish grade to keep the top of pipe or conduit below the frost line.
 3. Where rock is encountered, carry excavation 6" below required elevation and backfill with a 6" layer of crushed stone or gravel prior to installation of pipe.
 4. For pipes or conduit 5" or less in nominal size and for flat-bottomed multiple-duct conduit units, do not excavate beyond indicated depths. Hand excavate bottom cut to accurate elevations and support pipe or conduit on undisturbed soil.
 5. For pipes or conduit 6" or larger in nominal size, tanks and other mechanical/electrical work indicated to receive subbase, excavate to subbase depth indicated, or, if not otherwise indicated, to 6" below bottom of work to be supported.
 6. Except as otherwise indicated, excavate for exterior waterbearing piping (water, steam, condensate, drainage) so top of piping is not less than 3'-6" below finished grade.
 7. Grade bottoms of trenches as indicated, notching under pipe bells to provide solid bearing for entire body of pipe.
 8. Backfill trenches with concrete where trench excavations are close to column or wall footings such that the bottom of the excavation is below the zone of influence of such footings, or which pass under wall footings. The zone of influence of a footing is defined by 45 degree planes extending downward from the bottom edges of the footing. Place concrete to level of bottom of adjacent footing. In other locations, backfill trenches with select fill.
 9. Do not backfill trenches until tests and inspections have been made and backfilling authorized by Geotechnical Engineer or other authorized Owner's representative. Use care in backfilling to avoid damage or displacement of pipe systems.
 10. For piping or conduit less than 2'-6" below surface of roadways, provide 4" thick concrete base slab support. After installation and testing of piping or conduit, provide minimum 4" thick encasement (sides and top) of concrete prior to backfilling or placement of roadway subbase.
- J. Cold Weather Protection: Protect excavation bottoms against freezing when atmospheric temperature is less than 35°F.

3.4 PLACING FILL AND BACKFILL

- A. Location: Place satisfactory and approved soil material in layers to required subgrade elevations for each area classification listed below:

1. Excavations: In excavations use select fill or approved excavated material. Place in layers to required subgrade elevations.
 2. Building Slabs: Under building slabs use select fill as shown on the drawings. Place fill between the top of footings and mats and the building slab or the bottom of the drainage course.
 3. Around Footings and Mats: Backfill around the formed edges of footings and mats with lean concrete or cement-stabilized sand.
 4. Behind Foundation Walls: Behind foundation walls, use drainage fill around the wall drain and drainage backfill over the drainage fill and wall drain up to within two feet of grade. Use impervious fill material at the top 24" of the wall backfill.
 5. Under Walks: Use minimum 6" deep course of base or subbase material, or approved excavated material.
 6. Backfill Adjacent to Structures: Backfill against the structure with select fill up to within two feet of grade. Use impervious fill material at the top 24" of backfill adjacent to structures.
 7. Under Steps: Use minimum 6" course of subbase or base material.
 8. Under Piping and Conduit: Under piping and conduit use subbase or base material, shaped to fit bottom of trench.
- B. Prior to Backfill Placement: Backfill excavations as promptly as work permits but not until completion of each of the following:
1. Acceptance of construction below finish grade including, where applicable, dampproofing, waterproofing, and perimeter insulation.
 2. Inspection, testing, approval, and recording locations of underground utilities.
 3. Removal of concrete formwork.
 4. Removal of shoring and bracing, and backfilling of voids with satisfactory materials. Cut off temporary sheet piling driven below bottom of structures and remove in manner to prevent settlement of the structure or utilities, or leave in place if required.
 5. For basement walls, until floor construction at top of wall is complete.
 6. Removal of trash and debris.
 7. Permanent or temporary horizontal bracing is in place on horizontally supported walls.
- C. Ground Surface Preparation:
1. Remove vegetation, debris, unsatisfactory soil materials, obstructions, and deleterious materials from ground surface prior to placement of fills. Plow, strip, or break-up sloped surfaces steeper than 1 vertical to 4 horizontal so that fill material will bond with existing surface.

2. When existing ground surface has a density less than that specified under "Compaction" for particular area classification, break up ground surface, pulverize, moisture-condition to optimum moisture content, and compact to required depth and percentage of maximum density.

D. Grading:

1. General: Uniformly grade areas within limits of grading under this section, including adjacent transition areas. Smooth finished surface within specified tolerances, compact with uniform levels or slopes between points where elevations are indicated, or between such points and existing grades.
2. Grading Outside Building Lines: Grade areas adjacent to building lines to drain away from structures and to prevent ponding. Finish surfaces free from irregular surface changes to the following tolerances:
 - a. Lawn or Unpaved Areas: Plus or minus 1 inch.
 - b. Walks: Plus or minus 1 inch.
3. Grading Surface of Fill Under Building Slabs: Provide final grades within a tolerance of 1/2" when tested with a 10' straightedge.
4. Compaction: After grading, compact subgrade surfaces to the depth and indicated percentage of maximum or relative density for each area classification.
5. Allowance for Compaction and Settlement: Allow for natural compaction and settlement during grading operations. Where excessive settlement occurs, scarify settled areas, fill and compact to required subgrade levels.

3.5 COMPACTION

- A. General: Control all soil compaction during construction, providing minimum percentage of density specified for each area classification indicated below. Place backfill and fill materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.
- B. Percentage of Maximum Density Requirements: Compact soil to not less than the following percentages of maximum density for soils which exhibit a well-defined moisture density relationship (cohesive soils) determined in accordance with ASTM D 698 ASTM D 1557; and not less than the following percentages of relative density, determined in accordance with ASTM D 4253 and 4254, for soils which will not exhibit a well-defined moisture-density relationship (cohesionless soils). Cohesive soils are defined as those that have more than 50% of the soil material by weight passing the #200 sieve.
 1. Structures, Building Slabs and Steps, and Pavements: Scarify the top 6" of subgrade. Re-compact the top six inches and compact each lift of fill material at the optimum moisture content ($\pm 2\%$) to 95% maximum density for cohesive material or 85% relative density for cohesionless material. Place and compact the 1/2" layer of the leveling sub-base at the optimum moisture content ($\pm 2\%$) to 85% relative density before placing the moisture retarder. After installing the moisture retarder, place and compact the granular base material at the optimum moisture content ($\pm 2\%$) to 85% relative density.

2. Building Slabs and Steps: Remove a minimum of * feet of existing subgrade material and replace with fill material up to the planned subgrade level. Compact each lift at the optimum moisture content ($\pm 2\%$) to 95% maximum density or 85% relative density. Place and compact the $\frac{1}{2}$ " layer of the leveling sub-base at the optimum moisture content ($\pm 2\%$) to 85% relative density before placing the moisture retarder. After installing the moisture retarder, place and compact the granular base material at the optimum moisture content ($\pm 2\%$) to 85% relative density.
3. Behind Foundation Walls: Compaction requirements within five feet of the wall shall be 75% relative density. Compaction requirements outside the five-foot band shall be 85% of relative density. The moisture content shall be at optimum moisture ($\pm 2\%$). The top two feet of impervious fill shall be compacted at optimum moisture content to 90% or 95% of maximum density depending on the proximity to the wall.
4. Behind Foundation Wall: Compaction requirements within five feet of the wall shall be 75% relative density for cohesionless soils and 90% maximum density for cohesive soils. Compaction requirements outside the five-foot band shall be 85% of relative density or 95% maximum density. The moisture content shall be at optimum moisture ($\pm 2\%$). The top two feet of impervious fill shall be compacted at optimum moisture content to 90% or 95% of maximum density depending on the proximity to the wall.
5. Lawn or Unpaved Areas: Scarify and re-compact top 6" of subgrade and each layer of backfill or fill material at the optimum moisture content ($\pm 2\%$) to 90% maximum density for cohesive soils and 85% relative density for cohesionless soils.
6. Walkways: Scarify and re-compact top 6" of subgrade and each layer of backfill or fill material at the optimum moisture content ($\pm 2\%$) to 90% maximum density for cohesive material and 85% relative density for cohesionless material.

C. Moisture Control:

1. Where subgrade or layer of soil material must be moisture conditioned before compaction, uniformly apply water to surface of subgrade, or layer of soil material, to prevent free water appearing on surface during or subsequent to compaction operations.
2. Remove and replace, or scarify and air dry, soil material that is too wet to permit compaction to specified density.
3. Soil material that has been removed because it is too wet to permit compaction may be stockpiled or spread and allowed to dry. Assist drying by discing, harrowing or pulverizing until moisture content is reduced to a satisfactory value.

3.6 BUILDING SLAB DRAINAGE COURSE

- A. General: Drainage course consists of placement of drainage fill material, in layers of indicated thickness, over subgrade surface to support concrete building slabs.
- B. Placing:

1. Place drainage fill material on prepared subgrade in layers of uniform thickness, conforming to indicated cross-section and thickness. Compact drainage course to not less than 95 percent of relative density as determined by ASTM D4254. Maintain optimum moisture content ($\pm 2\%$) for compacting material during placement operations.
2. When a compacted drainage course is shown to be 6" thick or less, place material in a single layer. When shown to be more than 6" thick, place material in equal layers, except no single layer more than 6" or less than 3" in thickness when compacted.

3.7 FIELD QUALITY CONTROL

- A. Refer to Section entitled "Testing Laboratory Services" for required quality control testing during construction.

3.8 MAINTENANCE

- A. Protection of Graded Areas:
 1. Protect newly graded areas from traffic and erosion. Keep free of trash and debris.
 2. Repair and re-establish grades in settled, eroded, and rutted areas to specified tolerances.
- B. Reconditioning Compacted Areas: Where completed compacted areas are disturbed by subsequent construction operations or adverse weather, scarify surface, re-shape, and compact to required density prior to further construction.
- C. Settling: Where settling is measurable or observable at excavated areas during general project warranty period, remove surface (pavement, lawn or other finish), add backfill material, compact, and replace surface treatment. Restore appearance, quality, and condition of surface or finish to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.9 DISPOSAL OF EXCESS WASTE MATERIALS

- A. Removal from Owner's Property: Remove waste materials, including unacceptable excavated material, trash and debris, and dispose of it off Owner's property.

3.10 UNIT PRICES

- A. Basis of Bids: Include excavation work and other earthwork necessary to produce the work required.
- B. Changes in the Work: Payment for changes in earthwork will be made on the actual net volume change of foundation in place and accepted based on design dimensions shown. No additional compensation will be made for excavation, concrete fill, reinforcing, or other costs due to unauthorized over-excavating in any dimension.
- C. Unit Prices: Quote Unit Prices which include full compensation for labor, materials, tools, equipment, and incidentals required for excavation, trimming, shoring, casing as required, dewatering, and other necessary items for complete installation. Provide Unit Prices for

the following items, as set forth in the Contract conditions, which will apply in the event additions to or deductions from the Work are required and authorized by a written order from the Architect and approved by the Owner to the Contractor. Refer to Section 03 30 00 for concrete, reinforcing steel, and dowel Unit Price requirements.

1. Soil excavation, per cu. yd.
2. Rock excavation, per cu. yd.
3. Select fill material, placement, and compaction, per cu. yd.
4. Cement stabilized sand and/lean concrete material and placement, per cu. yd.

END OF SECTION 31 23 00