SECTION 02200

EARTHWORK

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Preparation of subgrades for buildings, structures, walks and pavements.
2. Pavement base.
3. Excavation and backfill within building lines for pile caps and beams.
4. Excavation and backfill within building lines for under-slab mechanical and electrical work.
5. Placement and compaction of general site fill.

B. Related Sections:

1. Section 01450 - Testing Laboratory Services.
2. Section 02520 - Portland Cement Concrete Pavement: Compacted base material for concrete paving.
3. Section 02900 - Landscaping.
4. Divisions 15 and 16: Excavation and backfill associated with mechanical and electrical utilities and appurtenances.

1.2 DEFINITIONS

A. Excavation: Removal of material to subgrade elevations indicated and subsequent disposal of materials removed.

B. Unauthorized Excavation: Removal of materials beyond indicated dimensions and subgrade elevations without specific direction of Architect. Unauthorized excavation, as well as remedial work directed by Architect, shall be at Contractor's expense.

1. Under grade beams, footings, foundation bases, or retaining walls, fill unauthorized excavation by extending bottom of concrete to excavation bottom, without altering required top elevation. Lean concrete fill may be used to bring elevations to proper position, when acceptable to Architect.
2. In locations other than those above, backfill and compact unauthorized excavations as specified for authorized excavations of same classification, unless otherwise directed by Architect.

C. Subgrade: The undisturbed earth or the compacted soil layer immediately below subsequent construction.

D. Pavement Base: Select material especially placed and compacted on prepared subgrade to receive paving.

E. Structure: Buildings, foundations, slabs, pavements, walks, curbs, appurtenances for drainage, mechanical and electrical systems, and other stationary construction occurring at, above or below ground surface.

F. Borrow: Fill or backfill material obtained off-site.

1.3 QUALITY ASSURANCE

A. Codes and Standards: Perform earthwork in compliance with local codes, ordinances, and applicable requirements of authorities having jurisdiction.

B. Testing and Inspection Service: An independent testing and inspection laboratory will perform soil testing and inspection service during earthwork operations. Refer to Section 01450.

1.4 PROJECT CONDITIONS

A. Existing Utilities: Contact owners of known and suspected underground utilities to identify types and locations of existing underground utilities in areas of excavation work. If utilities are indicated to remain in place, provide adequate means of support and protection during earthwork operations.

1. If uncharted, or incorrectly charted, piping or other utilities are encountered during excavation, consult Architect immediately for directions. Cooperate with Owner and utility companies in keeping services and facilities in operation. Repair damaged utilities to satisfaction of utility owner.
2. Do not interrupt in-use utilities except when permitted in writing and then only after acceptable temporary utility services have been provided.
3. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies for shutoff of services if lines are active.

B. Use of Explosives: Use of explosives is not permitted.

C. Protection of Persons and Property: Barricade open excavations occurring as part of this work and post with warning lights.

1. 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. Provide erosion control to prevent displacement of soils and deposit of soil-bearing water runoff or airborne dust on adjacent properties and pavements.
4. Perform excavation by hand within drip line of large trees to remain. Protect root systems from damage or dry out to the greatest extent possible. Maintain moist condition for root system and cover exposed roots with moistened burlap.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. Backfill and Fill Materials: Sand free of wood roots, clay lumps and other deleterious materials. Sand fill should have no more than 10% material passing the No. 200 sieve; liquid limit less than 25; plasticity index less than 6.

B. Unacceptable Materials: Materials from on-site excavation shall not be used.

2.2 OTHER MATERIALS

A. Pavement Base Material: Naturally or artificially graded mixture of pumped riversand complying with ASTM D-2940, as indicated on the drawings. Mixture shall be free from sticks, mud, clay, vegetation and other deleterious materials, with 100% passing a 1-½ inch sieve and not over 5% passing a No. 200 sieve.

1. Graduation shall be as follows:

U.S. SIEVE	PERCENT PASSING
1-½"	100
1"	90 - 100
¾"	70 - 100
No. 4	35 - 65
No. 40	12 - 32
No. 200	5 - 12

2. Maximum Liquid Limit 25 and Maximum plastic Index 6, for material passing No. 40 sieve.

B. Geotextile Filter Fabric: Standard non-woven, continuous filaments of pervious polyester. Fabric shall be spun-bound, or needle-punched. It shall possess the following minimum average roll values (MARV):

Physical Properties	Test Methods	Requirements
Weight	ASTM D-5261	7.2 oz./s.y.
Thickness	ASTM D-5199	90 mils
Grab Tensile Strength (MD)	ASTM D-4632	200 lbs.
Grab Elongation (MD)	ASTM D-4632	60 %
Trapezoidal Tear Strength (MD)	ASTM D-4533	75 lbs.
Puncture Resistance	ASTM D-4833	90 lbs.
Mullen Burst Strength	ASTM D-3786	350 psi
Water Flow Rate	ASTM D-4491	100 gpm/s.f.
Permittivity	ASTM D-4491	1.40 sec-1
Permeability	ASTM D-4491	0.35 cm/sec
Apparent Opening Size	ASTM D-4751	#70 U.S. Std. Sieve 0.210 mm

Use Trevira 011/250, HBC–10NW, or approved equal. Polypropylene is not an acceptable substitute material. A typical 1-foot overlap in all directions is required for all installations.

C. Warning Tape: Acid- and alkali-resistant polyethylene film tape manufactured for marking and identifying underground utilities, 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility.

1. Detectable Tape: Provide tape with metallic core encased for corrosion protection, detectable by a metal detector when tape is buried up to 2'-6" deep.
2. Tape Colors: Identify utility types by permanently colored tapes as follows:
   a. Electric - Red.
   b. Gas, oil, steam, dangerous materials - Yellow.
   c. Telephone and other communications - Orange.
   d. Water - Blue.

e. Sewers - Green.

PART 3 - EXECUTION

3.1 PROTECTION

A. General: Perform the work and provide temporary facilities to protect structures, utilities, sidewalks, pavements and other existing facilities and new construction from damage due to earthwork operations.

B. Cold Weather Protection: Provide enclosures and insulating covers necessary to protect subgrades from damage due to freezing.

3.2 SITE FILLING

A. General: Fill site by placing and compacting specified fill material in layers to grade elevations required.

B. Preparation of Ground Surface: Remove debris, obstructions, and deleterious materials including wet and unsatisfactory soil. In addition, muck out and dispose of accumulations of organic materials in low areas. Thoroughly clean holes and depressions to undisturbed natural soil and fill with acceptable material to approximate uniform grade elevation before starting general fill. This operation shall not be done during or in anticipation of inclement weather.

C. Fill Placement and Compaction: Place satisfactory soil materials in layers of thickness indicated below and compact each layer by heavy compaction equipment. Where compaction using hand-operated tampers is necessary, place and compact soil in layers one-half the thickness specified below.

1. Under pavement areas and the building, place fill in layers of approximately 8 inches loose thickness and compact to at least the percentage density specified in paragraph COMPACTION.
2. Do not place fill material on surfaces that are muddy, frozen or contain frost or ice. Do not place fill material on unsound surface.
3. Place fill materials evenly adjacent to structures, to required elevations. Carry material uniformly around structures to approximately same elevation in each lift, to prevent wedging action against structure.

3.3 EXCAVATION

A. Description: Excavation is unclassified and includes excavation to subgrade elevations indicated, regardless of character of materials and obstructions encountered.

1. Include removal of pavements and other surface obstructions, underground structures, utilities, and other items which are encountered, unless such items are indicated to remain.

B. Unauthorized Excavation: Correct over-excavation as specified in PART 1.

C. Demolition and Re-compaction: Any existing pavements beneath the proposed new pavement areas

should be demolished and all material removed from the site. The exposed surface beneath the demolished pavement or stripped areas should be scarified to a depth of 8 inches and re-compacted. The natural subgrade should be proof-rolled prior to the placement of new base material.

3.4 DEWATERING

A. Water Control: Prevent surface water and subsurface or ground water from flowing into excavations, from ponding on prepared subgrades, and from flooding project site and surrounding area. Protect subgrades from softening and damage by water accumulation.

B. Water Removal: Provide and maintain pumps, well points, sumps, suction and discharge lines, and other dewatering system components necessary to convey water away from excavations and subgrades.

C. Temporary Earthwork: Establish and maintain temporary dikes, drainage ditches and other diversions to control water flow and to convey rain water and water removed from excavations to collecting or runoff areas. Do not use trench excavations as temporary drainage ditches.

3.5 STORAGE OF EXCAVATED MATERIALS

A. Stockpiling: Stockpile acceptable excavated materials and borrow materials for backfill and fill where directed. Place, grade, and shape stockpiles for proper drainage.

1. Locate and retain soil materials away from edge of excavations. Do not store within drip line of trees indicated to remain.

B. Disposal: Dispose of excess excavated soil material and materials not acceptable for use as backfill or fill.

3.6 EXCAVATION FOR STRUCTURES

A. Extent of Excavations: Conform to elevations and dimensions shown within a tolerance of plus or minus 0.10 foot, and extending a sufficient distance from footings and foundations to permit placing and removal of concrete formwork, installation of services, and other construction and for inspection. Do not disturb bottom of excavations intended for bearing.

B. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before concrete reinforcement is placed. Trim bottoms to required lines and grades to leave solid base to receive subsequent work.

3.7 EXCAVATION FOR PAVEMENTS AND WALKS

A. General: Cut surface under pavements and walks to comply with cross-sections, elevations and grades as indicated, allowing for required base thickness.

3.8 TRENCH EXCAVATION FOR PIPES AND CONDUIT

A. Trench Width: Excavate to uniform width, sufficient to provide working clearance on both sides of pipe or conduit.

B. Trench Depth: Excavate to depth indicated or required for indicated slope and invert elevations.

Support bottom of pipe or conduit on undisturbed soil, or on compacted bedding where required.

1. For pipes or conduit less than 6 inches 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.
2. For pipes and conduit 6 inches or larger in nominal size, shape bottom of trench to fit bottom of pipe for 90 degrees (bottom ¼ of the circumference).
3. At each pipe joint, dig bell holes to facilitate jointing and relieve pipe bell of loads. Ensure continuous bearing of pipe barrel on bearing surface.

3.9 BACKFILL

A. General: Place soil material in layers to required subgrade elevations, using materials specified in Part 2 of this Section. Compact each layer to required density. Where compaction using hand-operated tampers is necessary, place and compact soil in layers one-half the thickness specified below.

1. Under building slab, place backfill in maximum 6-inches loose thickness layers and compact to at least the density specified under heading COMPACTION.
2. Under pavements, place backfill in maximum 6-inches loose thickness layers and compact to at least the density specified under heading COMPACTION.

B. Related Work: Backfill excavations as promptly as work permits, but not until completion of the following:

1. Acceptance of construction below finish grade including, where applicable, dampproofing.
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 leave in place.
5. Removal of trash and debris from excavation.
6. Permanent or temporary horizontal bracing is in place on horizontally supported walls.

C. Conditions: Before compaction, moisten or aerate each layer as necessary to provide optimum moisture content. Do not place backfill on surfaces that are muddy, frozen, or contain frost or ice.

D. Placement: Place backfill evenly adjacent to structures, piping, or conduit to required elevations. Prevent wedging action of backfill against structures or displacement of piping or conduit by carrying material uniformly around structure, piping, or conduit to approximately same elevation in each lift.

3.10 COMPACTION

A. General: Control compaction, providing minimum percentage of density specified for each area classification indicated below. Correct improperly compacted areas or lifts if soil density tests indicate inadequate compaction.

B. Density Requirements: Compact each layer of fill and backfill to not less than the following percentages of maximum density, in accordance with ASTM Standards.

1. Under vehicle pavement, base course material shall be compacted to 95% maximum dry density per ASTM D-1557.

2. River sand backfill material, where required, shall be compacted to 95% maximum dry density

per ASTM D-1557.

3. Holes and depressions in natural ground (prior to general filling) - 90% maximum dry density per ASTM D-698.
4. Under structures, each layer of backfill and fill material at 95% maximum density per ASTM D-1557.
5. Under lawns and unpaved areas, each layer of fill and backfill material at 90% maximum density per ASTM D-698.
6. Under drainage structure slab, compact to 90% relative density per ASTM D-4254.

C. Moisture Control: Where subgrade or layer of soil material must be moisture conditioned before compaction, aerate soil to dry it, or uniformly apply water to surface of subgrade or layer of soil material. Apply water in minimum quantity as necessary to prevent free water from appearing on surface during or subsequent to compaction operations.

1. Remove and replace, or scarify and air dry, soil material that is too wet to permit compaction to specified density.
2. Stockpile or spread soil material that has been removed because it is too wet to permit compaction. Assist drying by discing, harrowing, or pulverizing until moisture content is reduced to a satisfactory value.

3.11 GRADING

A. General: After compacting properly, uniformly grade areas, including adjacent transition areas, to provide smooth finished surface within specified tolerances, with uniform levels or slopes between points where elevations are indicated or between such points and existing grades.

B. Outside Structures: Grade areas adjacent to structures to drain away from structures and to prevent ponding. Finish surfaces free from irregular surface changes and as follows:

1. Lawn or Unpaved Areas: Finish areas to receive topsoil to within not more than 0.10 foot above or below required subgrade elevations.
2. Pavements and Walks: Shape surface to line, grade, and cross-section, with finish surface not more than 0.10 foot above or below required subgrade elevation.

C. Under Structures: Grade surfaces smooth and even, free of voids, to required elevation. Provide final grades within a tolerance of ½ inch when tested with a 10-foot straightedge.

D. Compaction: After grading, compact surfaces to the indicated density.

3.12 PAVEMENT BASE

A. General: Place pavement base material, in layers of specified thickness, over subgrade surface to support paving.

1. Refer to other Division 2 sections for paving specifications.

B. Grade Control: During construction, maintain lines and grades including crown and cross-slope of pavement base.

C. Shoulders: Place shoulders along edges of pavement base to prevent lateral movement. Construct

shoulders of acceptable soil materials, placed in such quantity to compact to thickness of each pavement base layer. Compact and roll at least a 12-inch width of shoulder simultaneous with the compaction and rolling of each layer of pavement base.

D. Placing: Place pavement base material on prepared subgrade in layers of uniform thickness, conforming to indicated cross-section and thickness. Maintain optimum moisture content for compacting base material during placement operations.

1. When a compacted pavement base is indicated to be 6 inches thick or less, place material in a single layer. When indicated to be more than 6 inches thick, place material in equal layers, except no single layer more than 6 inches or less than 3 inches in thickness when compacted.

3.13 SUBSURFACE DRAINAGE BACKFILL

A. Subsurface Drain: Place a layer of filter fabric around perimeter of drainage trench as indicated, including surface of concrete foundation. Place a 6-inch compacted course of drainage fill material on filter fabric; avoid damaging and displacing fabric. After drainage pipe is installed and tested, encase pipe in a minimum 6-inch thickness of compacted drainage fill material overlaid with filter fabric.

1. Place filter fabric smoothly, without tears, wrinkles and folds.
2. Overlap filter fabric 6 inches at ends and edges.

B. Backfill: Place and compact specified backfill material over drainage fill as indicated; avoid damaging and displacing fabric.

3.14 FIELD QUALITY CONTROL

A. Quality Control Testing During Construction: Allow testing service to inspect and approve each subgrade, fill layer and pavement base before further backfill or construction work is performed.

B. Perform field density tests in accordance with ASTM D 1556 (sand cone method) or ASTM D 2167 (rubber balloon method), as applicable.

1. Field density tests may also be performed by the nuclear method in accordance with ASTM D 2922, providing that calibration curves are periodically checked and adjusted to correlate to tests performed using ASTM D 1556. In conjunction with each density calibration check, check the calibration curves furnished with the moisture gages in accordance with ASTM D 3017.
2. If field tests are performed using nuclear methods, make calibration checks of both density and moisture gages at beginning of work, on each different type of material encountered, and at intervals as directed by the Architect.

C. Pavement Areas: Perform at least one field density test for every 1,000 sq. ft. of paved area but in no case fewer than three tests. Perform tests on the following:

1. Each layer of fill/backfill and pavement base material.

D. Trench Backfill: In each compacted initial and final backfill layer, perform at least one field

density test for each 100 linear feet or less of trench, but not fewer than two tests.

E. Corrective Work: When testing agency reports that fills or backfills, and pavement base materials are below specified density, the Contractor shall perform additional compaction and testing, without additional cost to the Owner, until specified density is obtained.

3.15 MAINTENANCE

A. Protection of Graded Areas: Protect newly graded areas from traffic and erosion. Keep free of trash and debris.

B. Corrections: Reconstruct subgrades damaged by freezing, rain, accumulated water, and construction activities, before subsequent construction commences. Repair and reestablish grades in settled, eroded, and rutted areas to specified tolerances. Scarify or remove and replace material to depth necessary; reshape and recompact at optimum moisture content to the required density.

C. Settling: Where pavement subgrade settling is measurable or observable before pavement is placed, add fill material, compact, and re-grade. Restore appearance, quality, and condition of surface to match adjacent work.

3.16 DISPOSAL OF EXCESS AND WASTE MATERIALS

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

END OF SECTION