SECTION 311013

SITE PREPARATION

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes stripping of existing weeds and grasses.

1.2 PROJECT CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-preparation operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
2. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

1.3 QUALITY ASSURANCE

A. Qualifications: Work shall be performed by personnel trained and experienced in the work and shall be done under the direct supervision of a superintendent on Contractor's staff.

B. Workmanship: Perform work in conformance with recognized acceptable practices. Where job requirements require deviation from those practices, obtain approval from Landscape Architect before processing.

1.4 EXISTING CONDITIONS

A. Protection of Existing Utilities:

1. Existence and location of underground items are not guaranteed. Investigate and field verify before starting work. Excavation and backfill in the vicinity of existing items of work shall be carried out with extreme caution.
2. Contractor shall be held responsible for any damage and for maintenance and protection of existing utilities.
3. Indicate on record drawings where there is conflict between field conditions and drawings.

PART 2 - PRODUCTS

2.1 EQUIPMENT

A. Machinery: Machinery shall be approved by Owner. Contractor shall provide equipment and machinery sufficient for proper execution of Work.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect and maintain benchmarks and survey control points from disturbance during construction.

B. Protect existing site improvements to remain from damage during construction.

1. Restore damaged improvements to their original condition, as acceptable to Owner.

3.2 TREE PROTECTION

A. Erect and maintain temporary fencing around Tree Protection Zones (TPZ) before starting site clearing. TPZ is 1.50 feet away in radial distance from the trunk for every inch in stem diameter. Remove fence when construction is complete.

B. Do not excavate within Tree Protection Zones, unless otherwise indicated.

C. Repair or replace trees and vegetation indicated to remain that are damaged by construction operations, in a manner approved by Architect.

3.3 UTILITIES

A. Locate, identify, disconnect, and seal or cap off utilities indicated to be removed.

1. Arrange with utility companies to shut off indicated utilities.

B. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Owner's Representative not less than two weeks in advance of proposed utility interruptions to allow conformance with Utility Department Outage Notification protocols.
2. Do not proceed with utility interruptions without Owner's Representative written permission.

3.4 EXISTING WEED AND GRASS STRIPPING

A. Strip area with work limits shown on Drawings of lawns and vegetation under the direction of the Landscape Architect.

B. Method of removal shall remove a minimum amount of topsoil and shall be even so that there is not a general change to overall grading.

3.5 DISPOSAL

A. Disposal: Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.

1. Separate recyclable materials produced during site clearing from other nonrecyclable materials. Store or stockpile without intermixing with other materials and transport them to recycling facilities.

END OF SECTION 311013

SECTION 31 11 00 - CLEARING AND GRUBBING

PART 1 - GENERAL

A. Subsurface data is available from the Owner. Contractor is urged to carefully analyze the site conditions.

1.1 SCOPE

A. This section pertains to the specifications for clearing and grubbing, topsoil removal and stockpiling, disconnecting, capping or sealing, and abandoning site utilities in place, and disposal of all vegetation, rubbish and excess material, as required for site grading and related staging areas as noted on the drawings and in accordance with these specifications. Protecting any existing trees, shrubs, groundcovers, plants and grass to remain shall be dictated by Section 02 41 13 Selective Site Demolition. Soil preparations for final landscaping media shall be dictated by Section 32 91 13 Soil Preparation.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Drawings and general provisions of the Contract, including A-procurement and Contracting Requirements, Division 00 and Division 01 apply to this section.

B. Section 02 41 13 Selective Site Demolition
C. Division 02 Section “Existing Conditions” for demolition of buildings, structures, and site improvements.

D. Section 31 22 13 Site Grading

E. Section 31 25 13 Erosion and Sedimentation Control

F. Section 31 23 33 Trenching Backfill and Compaction

G. Section 32 91 13 Soil Preparation

1.3 DEFINITIONS

A. Topsoil: See Section 32 91 13 Soil Preparation under article 1.2.D Topsoil

B. Tree Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction, and defined by the drip line of individual trees or the perimeter drip line of groups of trees, unless otherwise indicated.

C. Subgrade: The uppermost surface of an excavation, including excavation for trenches, or the top surface of a fill or backfill immediately below base course, pavement, or topsoil materials.

D. Unauthorized excavation consists of removing materials beyond indicated subgrade elevations or dimensions without direction by the Owner’s representative. Unauthorized excavation, as well as remedial work directed by the Owner’s Rep shall be at the Contractor's expense.

1.4 MATERIAL OWNERSHIP

A. Except for stripped topsoil or other materials indicated to remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

1.5 SUBMITTALS

A. Photographic and/or digitally recorded documentation, sufficiently detailed, of existing conditions of trees and plantings, adjoining construction, and site improvements must be prepared. Unless otherwise documented, any damage discovered to trees, plantings, and site features denoted to remain, will be considered the responsibility of the contractor to correct. The owner may at his/her discretion request such photographs and/or video tapes be submitted at any time.

B. Record drawings, according to Division 01, identifying and accurately locating capped utilities and other subsurface structural, electrical, and mechanical conditions.

1.6 PROJECT CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.

2. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

B. Salvable Improvements: Carefully remove items indicated on drawings to be salvaged and store on Owner's premises where indicated. Contractor to contact Owner’s representative for coordination.

C. Do not commence site clearing operations until temporary erosion and sedimentation control measures are in place

D. Utility Locator Service: Notify Lonestar Notification Center at 713-732-0365 for area where Project is located before site clearing.

E. General site narrative - [DESCRIBE THE SITE IN ITS VIRGIN STATE i.e. VACANT, PREVIOUSLY IMPROVED, ETC AND THEN DESCRIBE THE INTENT OF THIS PORTION OF THE PROJECT]

F. Staging Areas - Approval must be obtained from the Owner to use any area for staging that is not specifically identified as such on the plans. The Contractor shall restore all areas used for staging, the extent of said restoration to be defined by the Owner upon granting approval for the use of said area for staging.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. Satisfactory Soil Materials: Requirements for satisfactory soil materials are specified in Division 31 Section 31 22 13 "Site Grading"

1. Obtain approved borrow soil materials off-site when satisfactory soil materials are not available on-site.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect and maintain benchmarks and survey control points from disturbance during construction.

B. Protect existing site improvements to remain from damage during construction.

1. Restore damaged improvements to their original condition, as acceptable to Owner.

C. Locate and clearly flag trees and vegetation to remain or to be relocated

D. Control dust and noise, perform work in accordance with requirement of authorities having jurisdiction. No explosives are permitted. No on-site burning is permitted. [COORD LAST TWO SENTENCES WITH THE PROJECT PARAMETERS]

3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

A. Provide temporary erosion and sedimentation control measures per Section 31 25 13 ”Erosion and Sedimentation Controls”.

B. Provide measures according to a sediment and erosion control plan, specific to the site, which complies with EPA 832/R-92-005 or requirements of authorities having jurisdiction, whichever is more stringent.

C. Inspect, repair, and maintain erosion and sedimentation control measures during construction until permanent vegetation has been established.

D. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal

3.3 TREE PROTECTION (NOT USED)

3.4 UTILITIES

A. Locate, identify, disconnect, and seal or cap off utilities indicated to be removed

1. Arrange with utility companies to shut off indicated utilities. Contractor is responsible for any service charge required for shut-off action. If other outstanding fees or billings are encountered, the Contractor shall notify the Owner’s representative for direction.

B. Known utilities are shown on drawings. If utility discovered that is not shown contact Owner’s representative for direction. Do not interrupt unknown utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Owner’s representative not less than two weeks in advance of proposed utility interruptions.

2. Do not proceed with utility interruptions without Owner’s written permission.

3.5 CLEARING

A. Construction - That portion of the site required for constructing the work under these specifications shall be cleared of all vegetation, such as trees, brush, grass and weeds and all other objectionable matter to the limits as depicted in the plans. Stumps and roots shall be completely removed.

B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.

1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches and compact each layer to a density equal to adjacent original ground.

3.6 STRIPPING

A. Topsoil stripping:

1. Remove sod and grass before stripping topsoil.

2. Strip topsoil to whatever depths are encountered in a manner to prevent intermingling with underlying subsoil or other waste materials. A minimum of six (6) inches of soil shall be stripped. This must be verified with the geotechnical report provided by the owner for this project. If discrepancy, review with Owner prior to start of work.

a. Remove subsoil and nonsoil materials from topsoil, including trash, debris, weeds, roots, and other waste materials.

3. Stockpile topsoil materials away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust.

a. Limit height of topsoil stockpiles to 72 inches. [COORD THIS WITH THE OWNER, CONTRACTOR, AND PROJECT CONDITIONS TO ENSURE THAT THIS HEIGHT IS APPROPRIATE]

b. Do not stockpile topsoil within tree protection zones.

c. Stockpile surplus topsoil to allow for re-spreading deeper topsoil.

4. Strip man-made fills under structures and pavements to minimum 12” below the ground surface and dispose of all waste materials.

B. At all times during clearing and stripping operations the area shall be kept in a manner to prevent ponding. Refer to Section 31 25 13 "Erosion and Sedimentation Control."

3.7 SITE IMPROVEMENTS

A. Remove existing above- and below-grade improvements as indicated and as necessary to facilitate new construction.

B. Remove slabs, paving, curbs, gutters, and aggregate base as indicated.

1. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut length of existing pavement to remain before removing existing pavement. Saw-cut faces vertically.

2. Paint cut ends of steel reinforcement in concrete to remain to prevent corrosion.

3.8 DISPOSAL

A. Disposal of cleared materials - Subject to approval of the Owner, material from clearing operations shall be disposed of by removal from the worksite.

1. Disposal of Material by Removal

a. Material disposed of by removal from the construction area shall be removed from the areas prior to the completion of the work under these specifications. All materials removed shall become the property of the Contractor.

b. Materials to be disposed of by dumping shall be hauled to an approved dump. It shall be the responsibility of the Contractor to make any necessary arrangements with private parties and with local officials pertinent to locations and regulations of such dumping. Any fees or charges required to be paid for dumping of materials shall be paid by the Contractor.

c. In hauling any material from the site, it shall be the responsibility of the Contractor to prevent debris from dropping from vehicles and littering the site or area streets and roads. The Contractor shall promptly remove any debris which falls from vehicles.

d. Separate recyclable materials produced during site clearing from other nonrecyclable materials. Store or stockpile without intermixing with other materials and transport them to recycling facilities

3.9 STOCKPILING

A. All topsoil from the stripping operations shall be stockpiled in the areas so designated on the drawings. Materials shall be deposited and spread in such a manner to ensure proper drainage and prevent severe erosion of the stockpile.

B. Stockpile borrow materials and satisfactory excavated soil materials. Stockpile soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.

1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

END OF SECTION

SECTION 31 22 13 - SITE GRADING

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. This Section pertains to the earthwork generally consisting of excavation, filling, backfilling and subgrade preparation as required for construction of site retaining walls/structures, slab on grade walks, pavement surfaces, landscaped areas and the general shaping of the site as shown, described or reasonably inferred on the drawings.

B. Subsurface data is available from the *Owner. Contractor is urged to carefully analyze the site conditions.

C. This section excludes work necessary for building pad preparations. Work within the building footprint and surrounding 5 feet shall be accomplished under technical specification 31 23 00 Excavation and Fill prepared by *STRUCTURAL ENGINEER].

D. Construction Means, Methods, Techniques, Sequences and Procedures:

1. The Contractor is solely responsible for, and has sole control over, construction means, methods, techniques, sequences and procedures, and for coordinating all portions of the Work.

2. Shoring that is required to complete the Work, is considered a method or technique and is the sole responsibility of the Contractor. If a regulatory agency requires a licensed engineer to design, approve or provide drawings for shoring, then it is the sole responsibility of the Contractor to engage the services of a qualified Engineer for shoring design services.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Drawings and general provisions of the Contract, including A-procurement and Contracting Requirements, Division 00 and Division 01 apply to this section.

B. Section 31 11 00 Clearing and Grubbing

C. Section 31 23 33 Trenching, Backfilling and Compaction

D. Section 31 25 13 Erosion and Sedimentation Control

E. Section 32 12 16 Asphalt Concrete Paving

F. Section 32 13 13 Concrete Paving

G. Section 31 23 00 Excavation and Fill

H. Contractor shall comply with all current, applicable codes and regulations, including the Uniform Building Code.

I. Contractor shall comply as applicable with Standard Specifications for Public Works Construction, Current Edition, including all City and County Amendments (herein after referred to as "Standard Specifications"). *[REVISE TO STATE SPECIFIC CITY AND COUNTY REGULATIONS]

J. Geotechnical Data: Subsurface data is available from the *Owner. Contractor is urged to carefully analyze the site conditions.

1.3 PERMITS

A. Prior to commencement of work, the Contractor shall be responsible for obtaining, at the contractors own expense unless otherwise specified in the Contract, Supplementary or General Conditions, all construction permits necessary to complete the site grading according to the plans and specifications.

1.4 APPLICABLE PUBLICATIONS

A. The following specifications of the latest issue listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent required by the references thereto.

1. Texas Department of Transportation 2004 Standard Specifications for Construction of Highways, Streets and Bridges (TxDOT).

*2. American Society for Testing and Materials (ASTM).

[THESE MAY CHANGE. REVIEW THE GEOTECH REPORT TO GET THE PROPER STANDARDS AND TESTING METHODS.]

a. D 698 Laboratory Compaction Characteristics of Soil Using Standard Effort.

b. D 1556 Density & Unit Weight of Soil in Place by the Sand-Cone Method.

c. D 1557 Laboratory Compaction Characteristics of Soil Using Modified Effort.
**[TO BE USED IF MODIFIED PROCTOR DENSITIES REQUIRED.]

d. D 4253 Maximum Index Density & Unit Weight of Soils using a Vibratory Table.

e. D 4254 Minimum Index Density & Unit Weight of Soils in Calculation of Relative Density.

f. D 2922 Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depths)

3. *[REFERNECE ANY LOCAL CODES OR REGULATIONS THAT PERTAIN TO THE PROJECT INTENT THAT THE CONTRACTOR NEEDS TO BE AWARE OF]

1.5 PROTECTION OF EXISTING UTILITIES AND ADJACENT WORK

A. Prior to earthwork operations, existing utilities, facilities and permanent objects to remain shall be located and adequately protected. Contractor shall contact the local utility

coordinating committee or the utility company involved to locate all public and private utility company lines.

B. If unknown and uncharted utilities are encountered during excavation, promptly notify Owner and the governing utility company when determinable and wait for instructions. Also refer to the University of Houston's Plant Operations Planned and Emergency Utility Outage Policy.

C. For private property utilities found, if it is ascertained by Owner that such utility line has been abandoned, properly cap line at a depth approved by Owner or remove line as directed. All work to cap and remove abandoned public utilities found, must be coordinated through the governing utility company.

D. If such unknown utilities are encountered and work is continued without contacting the Owner for instructions, and damage is caused to said utilities, Contractor shall repair, at his own expense, such damage to the satisfaction of the Owner and the Utility Company.

E. Refer to Specification section 31 11 00 for other site related items requiring protection.

1.6 DEFINITIONS

*[REVISE DEFINITIONS BELOW TO MEET PROJECT INTENT AND SCOPE]

A. Excavation consists of the removal of material encountered to subgrade elevations and the reuse or disposal of materials removed.

B. Subgrade: The uppermost surface of an excavation, including excavation for trenches, or the top surface of a fill or backfill immediately below base course, pavement, or topsoil materials.

C. Borrow: Soil material obtained off-site when sufficient approved soil material is not available from excavations.

D. Base Course: The layer placed between the subgrade and surface pavement in a paving system.

E. Unauthorized excavation consists of removing materials beyond indicated subgrade elevations or dimensions without direction by the *Owner's rep. Unauthorized excavation, as well as remedial work directed by the Owner's Rep shall be at the Contractor's expense.

G. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below ground surface.

H. Unforeseen Excavation: Excavation of material, regardless of its character or nature, below the subgrade elevation required to construct the work as indicated on the drawings or specified herein.

I. Geotechnical Engineer: Person or company contracted by the owner and/or through the architect to provide testing and onsite Geotechnical services during the construction schedule.

1.7 QUALITY ASSURANCE

A. Pre-Excavation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Meetings."

B. Codes and Standards: Perform earthwork complying with requirements of authorities having jurisdiction.

C. Testing and Inspection Service: Owner will employ a qualified independent geotechnical engineering testing agency to classify proposed on-site and borrow soil materials to verify that soils comply with specified requirements and to perform required field and laboratory testing. Contractor responsible to coordinate with the testing agency prior to start of work requiring testing so as to minimize unnecessary cost or delays to the project.

D. Testing:

1. Owner will retain and pay a qualified Geotechnical engineer to take all field samples and do all laboratory testing necessary to verify compliance of the work to these Specifications or as required by City or other regulatory agencies. The Geotechnical Engineer shall submit results of all testing done during the course of the work to the Owner, Architect, and Contractor.

2. Notify testing lab a minimum of 48 hours in advance of the time testing is required to satisfy requirements of this section.

3. Should testing specified above show work which does not satisfy these Specifications, the Contractor shall pay, through the Owner, for all additional tests required to determine the extent of work that is not satisfactory and for all additional tests necessary to demonstrate compliance with these specifications.

4. All tests shall be performed by the Soil Engineer in accordance with ASTM D 1557, D1556, D2922, D3017, or other test method selected by Geotechnical Engineer.

E. Certification: *[NOTE HERE ANY ITEMS THAT ARE NEEDED UPON COMPLETION OF WORK, IF NEEDED]

1.8 PROJECT/SITE CONDITIONS

A. *[USE THIS PARAGRAPH TO DESCRIBE THE PROJECT. VIRGIN SITE, PREVIOUSLY USED FOR BUILDINGS, ROADWAYS, UTILITIES, ETC. PROVIDE THE BIDDER/CONTRACTOR WITH AN EXPLANATION OF WHAT WE KNOW OF THE SITE AND WHAT WE EXPECT HE MAY ENCOUNTER. ALSO INCLUDE ANY PARTICULAR WORK CONDITIONS THAT THE OWNER OR THE AREA MIGHT IMPOSE (DIFFERENT THAN ANOTHER PROJECT).]

1.9 SUBMITTALS

A. Samples: Submit samples of all materials used for Architect's approval wherever specified or as directed by the Architect.

B. Shoring and Slope Protection Design:

1. Prior to beginning any excavation, submit certification to the Architect that the proposed shoring and slope protection system has been accepted and approved by all

governing jurisdictions. Certification shall be signed and sealed by the engineer of record for the shoring design.

2. Provide signed letter from the Geotechnical Engineer stating that the proposed design complies with the recommendations of geotechnical reports.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. Fill materials and sources must be approved by the Owner. The Contractor is responsible for providing adequate samples and testing results to the Owner for testing and approval.

B. Select fill per 2.2 shall be used beneath all site retaining walls and site structures where fill material is required to achieve the grades and elevations on the plans.

C. General fill per 2.3 material shall be used for fill in landscaping areas not supporting structures. Topsoil per 2.4 shall be spread over landscape areas as needed.

D. Fill material beneath paving can be per 2.2 and 2.3. Regardless of the fill material used, subgrade treatment shall be chemically stabilized for the thickness specified and detailed in the drawings.

E. Material excavated onsite may be used as fills, with prior Geotechnical Engineer approval.

1. Site Materials:
*[REVISE THIS SECTION AS NEEDED TO MEET PROJECT SPECIFICS IN GEOTECHNICAL REPORT]
a. Onsite fill materials shall be free of organic or deleterious products.

b. *[USE THIS PART TO DESCRIBE HOW EXISTING MATERIALS ON SITE CAN BE USED PER GEOTECHNICAL REPORT. THE FOLLOWING IS AN EXAMPLE FROM A SPECIFIC PROJECT] (*Soils derived from the existing fills, and the Lindavista formational soils, are generally suitable for use in engineered fills. However, materials containing significant quantities of cobbles and boulders may require mixing with finer-grained on-site material to obtain gradations for fill soils that meet project specifications for use as engineered structural fill. Discontinuous residual clay soils may be encountered beneath the fill. These soils are considered potentially expansive and/or compressible and therefore are unsuitable for the direct support of structures. Selective grading of these soils is recommended, if encountered, and these materials shall be removed from the site or well mixed into nonstructural fills.)*

c. Moisture content of existing soils may require adjustment for compaction approval.

2.2 SELECT FILL

A. The select fill shall consist of sandy clay, lime stabilized clays or clean sand, uniformly graded and free of objectionable material. ***[COORD WITH GEOTECHNICAL REPORT AND REVISE PREVIOUS SENTENCE AS NEEDED. THEN DELETE 1, 2, AND/OR 3 AS NEEDED TO MEET

PROJECT INTENT. WE TYPICALLY DO NOT WANT SAND BENEATH PAVEMENT AT ANY TIME BUT THERE COULD BE REASONS THAT IT IS NEEDED ON THE PROJECT]

1. Sandy Clay Fill: Sandy clay fill shall have a plasticity index between 10 and 20. The fill materials shall be placed in loose lifts not exceeding eight (8) inches in height and compacted to 95 percent of Standard Maximum Density at the proper moisture content for that soil type as defined by ASTM D 698.

2. Lime Stabilized Clay Fill: [CHEMICALLY STABILIZED SOILS ARE TYPICALLY USED WHEN SANDY CLAY FILL IS AVAILABLE ON SITE OR NOT COST EFFECTIVE TO USE OR BRING TO THE SITE] Lime clays may be stabilized in place or mixed with lime at another location on the site and placed and compacted. Lime stabilization shall be performed in accordance with Section 31 32 13.29 "Lime Stabilization" or 31 32 13.26 Lime-Fly Ash or Fly Ash Stabilization. The percent of lime to be used shall be determined by the testing laboratory at the source prior to acceptance of the material for fill. The material shall be placed in loose lifts not exceeding eight (8) inches in thickness and compacted to 95 percent of Standard Maximum Density at the proper moisture content for that soil type as determined by ASTM D 698.

3. Clean Sand Fill: Clean sand fill is defined as having less than 12 percent passing the No. 200 sieve and less than 12 percent retained on the No. 10 sieve and having a plasticity index below 10. Clean sand fill should be placed in loose lifts 12 inches thick and compacted using vibratory equipment to at least 80 percent relative density as determined by ASTM D 4253 and ASTM D 4254 or other equivalent test method. Where determined necessary by the Owner's testing laboratory or Geotechnical engineer, cement stabilization will be required. [DO NOT USE DIRECTLY BENEATH PAVEMENT AT ANY TIME. CLEAN SAND IS TYPICALLY NOT DESIRED IN AREAS WHERE THE UNDERLYING SOILS ARE EXPANSIVE CLAYS OR OTHER MATERIALS THAT MOISTURE WOULD CAUSE TO MOVE OR LOOSE SRTENGTH. DO NOT INCLUDE UNLESS COORDINATED WITH THE GEOTECH AND SRTUCTURAL ENGINEER. DO NOT USE DIRECTLY BENEATH PAVEMENT AT ANY TIME.]

2.3 GENERAL FILL

A. General fill material shall be used for fill in landscaping areas not supporting structures, but may be used beneath pavement where approved by the Engineer. General fill material may be any native soil free of debris, trash, rocks over 2 inches in diameter and other objectionable material. General fill shall be placed and compacted in lifts not exceeding 12" in thickness to 95 percent standard density as defined by ASTM D 698. Where called for by the plans or by the landscape specifications, the fill shall be kept sufficiently low to accommodate the proper depth of topsoil and related sod or other vegetation.

2.4 TOPSOIL

A. Topsoil material shall be native earthen material suitable for growth of vegetation such as silty and sandy loams. The site stripings may be used as topsoil unless otherwise dictated by the Owner. Topsoil shall be spread over landscape areas to a depth of 4 to 6 inches and compacted to 85 percent of standard density ASTM D 698. Stockpiling of Topsoil may not exceed 6 feet in height.

2.5 SPECIAL DRAINAGE MEDIA

A. All Retaining Wall backfill material shall be clean open-graded crushed rock or gravel, maximum 3/4" particle size in accordance with the Standard Specifications and detail in the geotechnical report.*[STATE HERE IN THIS PREVIOUS STATEMENT WHERE THE DETAILS CAN BE FOUND ie IN THE PLANS, IN THE GEOTECH REPORT, ETC]

B. Drainage 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 D 4759 and referenced standard test methods:

1. Grab Tensile Strength: 110 lbf; ASTM D 4632.

2. Tear Strength: 40 lbf; ASTM D 4533.

3. Puncture Resistance: 50 lbf; ASTM D 4833.

4. Water Flow Rate: 150 gpm per sq. ft.; ASTM D 4491.

5. Apparent Opening Size: No. 50; ASTM D 4751.

C. Approved Materials

1. Mirafi 140 filter fabric

2. or acceptable substitution.

PART 3 - EXECUTION

3.1 PREPARATION

A. Inspection:

1. Prior to performing the work of this Section, carefully inspect the installed work of all other trades and verify that all such work is complete to the point where work may properly commence.

2. Verify that work may proceed in complete accordance with the design.

B. Discrepancies:

1. In the event of discrepancy, immediately notify the *[Architect, Engineer].

C. General

1. Use all means necessary to control dust on or near the site resulting from the performance of the Work. Thoroughly moisten all surfaces to prevent dust being a nuisance to the public, adjacent uses, and concurrent work on site. Moisture level

during compaction operations shall not exceed that amount as specified by Geotechnical Engineer.

2. Verify existing grades and dimensions before starting any grading operations. If any discrepancy exists, notify Architect immediately.

3. Use all means necessary to protect all existing features, products, or items designated to remain, as well as all work of this Section. In the event of damage, repair or replace immediately to the approval of and at no additional cost to the Owner.

4. Protect and maintain existing benchmarks throughout the course of the work. Reestablish monuments or stakes disturbed or destroyed during the course of the Work at no additional expense to the Owner.

5. Conduct work so as to avoid injury to persons and damage to adjacent property. Provide appropriate shoring, bracing and barriers, including light when necessary.

6. Coordinate operations with, and provide access to, the Geotechnical Engineer or designated representative during demolition and construction for purposes of testing, investigation and inspection.

D. Preparation

1. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.
2. 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.

3. Protect subgrade from excessive drying or excessive moisture.

3.2 EXCAVATION

A. General - Contractor shall complete all excavation required regardless of the variations in hardness, type, or density of materials encountered, to the dimensions and elevations shown on the drawings. When unsatisfactory material is uncovered, that material shall be removed and replaced with select fill, the extent of such excavation to be directed by the Owner. Unsatisfactory material shall be removed to the stockpile area or from the site as directed by the Owner. Payment for over excavation directed by Owner shall be paid as directed in Division 01 Specifications

1. Unclassified Excavation: Excavation is unclassified and includes excavation to subgrade elevations regardless of the character of surface and subsurface conditions encountered, including rock, soil materials, and obstructions.

a. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.

b. Remedial work due to over-excavation including provision of suitable and stable backfill meeting the degree of compaction required shall be at the Contractor’s expense.

2. Borrow Material: If excavated materials of a suitable nature are not of sufficient quantity to complete the work, contractor may provide borrow material in sufficient quantity to complete the work at Owner's approval at no additional cost to the Owner.

3. Disposing of Excavated Material: Dispose of excess satisfactory soil material and all unsatisfactory soil material and rock obtained from excavations in accordance with the provisions of this Section. [IF KNOWN AT TIME OF EDITING SPECS, EXPAND THIS SECTION TO INCLUDE ANY PROJECT SPECIFIC DIRECTION TO CONTRACTOR REGARDING STOCKPILING, DISPOSAL, ETC]

B. Excavation for Pavement

1. The material exposed after excavation shall be scarified to a depth of six (6) inches and compacted to at least 95 percent of Standard (ASTM D 698) Maximum Density within **minus 3 to plus 5 ** percent of

[**COORDINATE WITH THE GEOTECH REPORT. IF COHESIONLESS SOIL IS USED FOR SUBGRADE SUCH AS SAND, USE ASTM D 4253 AND ASTM D 4254 INSTEAD OF ASTAM D698 AND REDUCE DENSITY REQUIREMENTS TO 80 PERCENT RELATIVE DENSITY.]

optimum moisture content of the soil. ***Where necessary to achieve the required compaction, stabilization methods as outlined in paragraph 3.2.B.4 of this specification shall be used.

[***IF STABILIZATION IS ALWAYS TO BE REQUIRED, OMIT "WHERE NECESSARY"]

2. Excavation required beneath pavement sections shall comply with elevations and dimensions shown on the plans and detailed sections within a tolerance of plus or minus 0.10 foot. Contractor shall take care not to disturb areas that are designated to be protected or are outside the construction limits. Excavated areas shall be kept free of ground and surface water.

C. Cut Slopes and Ditches

1. Slopes and grades of ditches shall conform to the plans within a tolerance of plus or minus 0.10 foot. No exposed slopes shall be steeper than three feet horizontal to one foot vertical. Where slope protection is specified or called out on the plans, said protection shall be placed as soon as practical, after exposing the slope. Erosion and sedimentation controls shall be implemented in all cut areas as specified in Section 31 25 13 Erosion and Sedimentation Control.

3.3 FILL AND BACKFILL

A. Placement

1. Fill material shall be placed in loose lifts not exceeding eight (8) inches for areas beneath site structures and pavement, and twelve (12) inches for landscape areas not supporting structures. Fill areas shall be compacted to 95 percent of Standard Maximum Density at the proper moisture of that soil as defined by ASTM D 698.

2. Each lift shall be thoroughly compacted and shall have obtained satisfactory density prior to proceeding with the next lift.

3. The top six (6) inches of material beneath vehicular pavement shall be * stabilized after placement as shown in the details. . *[THERE ARE TIME, PLACES AND SITUATIONS WHERE STABILIZATION OF THE TOP 6 INCHES MAY NOT BE REQUIRED. COORD WITH THE PROJECT INTENT AND GEOTECH REPORT AND REVISE 3.2.A.3 AS NEEDED]

4. Material shall be free of trash and rocks over three (3) inches in diameter.

5. Fill shall be brought up to the proper elevations as determined from the lines, grades, sections and elevations shown on the plans.

B. Site Retaining Wall/Structure Backfill:

1. Place granular material as engineered backfill at all building and site retaining walls.

2. For precast site retaining walls, install specified gravel and filter fabric prior to backfill installation. Position according to manufacturers recommendations

3. Place in accordance with applicable portions of the Standard Specifications.

4. Compact per approved methods, using hand operated compaction equipment. Compact to at least 90% per ASTM D1557.*[REVISE AS NEEDED TO FIT PROJECT AND CONFORM TO GEOTECHNICAL REPORT]

C. Compaction and Finishing

1. Suitable compaction equipment commonly used to meet the requirements for this type of compaction work should be used.

2. The finished surface shall be reasonably smooth, compacted, and free from irregular surface changes. The surface grade shall be consistent with the drainage intent shown on the plans such that no unwanted ponding shall occur.

3. Surface shall not be more than 0.10 feet above or below the established grade, and all ground surfaces shall vary uniformly between indicated grades.

4. Cut material from the site may be used for fill material if approved by Owner. Where cut material is used as fill, each lift of such material shall be properly mixed to obtain a uniform material, with clay being the predominant material when mixed with silt, maintaining a plasticity index less than 20.

[*COORDINATE THIS WORK THE PROJECT INTENT AND GEOTECH REPORT.]

a. Lime stabilization shall be used for clay material and shall conform to Section 31 32 13.19 - Lime Stabilization or 31 32 13.26 Lime-Fly Ash or Fly Ash Stabilization.

b. Cement stabilization shall be used for sandy or silty materials and shall conform to Section 31 32 13.16 - Cement Stabilization.

3.4 EROSION & PROTECTION

A. There shall be at all times adequate protection to newly graded areas to prevent soil erosion as provided in Section 31 25 13, Erosion and Sedimentation Control.

B. Soil erosion that occurs prior to acceptance of the work shall be repaired at no expense to the Owner.

C. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

D. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.

1. Scarify or remove and replace soil material to depth as directed by Owner's Testing and Inspection Service; reshape and re-compact.

E. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.

1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to the greatest extent possible.

3.5 GRADING

A. Rough Grading

1. Cut and fill shall be left sufficiently high to require cutting by fine grading.

2. Grade to subgrade depths required for construction of finished surface materials and for controlled internal drainage of site.

B. Fine Grading

1. Fine grading shall conform to elevations required to insure finished elevations as indicated on the drawings.

2. Provide a smooth transition between adjacent existing grades and new grades

C. Slope grades to direct water away from buildings and to prevent ponding at a minimum of 5% grade for the initial 20 feet, as shown on the drawings or as directed by architect. Maximum cross slope for all walkways shall be 2% for disabled access. Finish subgrades to required elevations within the following tolerances:

1. Lawn or Unpaved Areas: Plus or minus 0.1 foot (1.2 inches)

2. Walks: Plus or minus ½ inch

3. Pavements: Plus or minus ½ inch

3.6 TESTING AND INSPECTION

A. Testing of Materials and Installed Work

1. Materials and installed work require testing to show that the specifications for the materials and work have been met. The Owner may, at the Owner's expense, take random tests on materials and installed work. The Contractor shall allow free access to material stockpiles and facilities at all times. In fill areas each lift must be tested and approved before proceeding on the next lift. Tests, not specifically indicated to be done at Owner's expense including the retesting of rejected materials and installed work, shall be done at the Contractor's expense.

a. Testing to be provided by Owner

i. All tests

b. Testing to be provided by Contractor

i. All retesting for areas failing the first test.

B. Contractor shall notify Owner's testing laboratory 24 hours in advance of beginning any earth work operations and coordinate testing schedules to meet these specifications.

C. Maximum density tests per ASTM D 698 shall be taken on all fill materials at a rate of one test for each type of soil to be used and at least one test for every 1000 cubic yards of fill.

D. Field density tests per ASTM D 1556 or ASTM D 2922 shall be taken on all fill material at a rate of one test for every 10,000 square feet and at least one test per lift.

E. All imported fill material shall be approved prior to importing.

3.7 DUST ABATEMENT

A. The Contractor shall comply with applicable Federal, State, and local laws and regulations concerning the prevention and control of dust pollution.

B. During the performance of the work required by these specifications or any operations appurtenant thereto, whether on right-of-way provided by the Owner or elsewhere, the Contractor shall furnish all the labor, equipment, materials, and means required, and shall carry out proper and efficient measures wherever and as often as necessary to reduce the dust nuisance, and to prevent dust which has originated from the contractor's operations from damaging crops, orchards, cultivated fields, and dwellings, or causing a nuisance to persons. The Contractor will be held liable for any damage resulting from dust originating from the contractor's operations under these specifications.

*C. Dust Control shall be accomplished by one of the following methods:
[*THIS MAY BE DELETED OR MODIFIED BASED UPON PROJECT NEEDS.]

1. Whenever ordered by the Owner, the Contractor shall furnish and distribute over the traveled road surfaces, which have not yet been fully restored, an application of

Calcium Chloride. The material used shall be Regular Flake Calcium Chloride having a minimum chemical content of Calcium Chloride of 77%. Unless otherwise specified or ordered by the Owner, rate of application shall be three (3) pounds per square yard of surface covered.

2. Whenever ordered by the Owner, the Contractor shall apply on traveled road surfaces "Bituminous Surface Treatment" in accordance with the current Texas Standard Specifications for Construction of Highways, Streets and Bridges.

D. The cost of sprinkling or of other methods of reducing formation of dust shall be included in the prices bid in the schedule for other items of work.

3.8 STORAGE OF SOIL MATERIALS

A. Stockpile borrow materials and satisfactory excavated soil materials. Stockpile soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.

1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

2. Stockpile Topsoil may not exceed 6 feet in height.

3.9 FIELD QUALITY CONTROL

A. General: Testing shall be the responsibility of the Owner and costs of initial testing shall be paid by Owner. Cost of all subsequent testing necessary due to non-compliance with specifications shall be paid by Contractor.

B. Density Test:

1. Density tests shall be performed by an approved commercial testing laboratory approved per ASTM D 1557.

2. Tests shall be performed in accordance with the referenced Standards.

3. Field and laboratory tests for moisture-density relations shall be determined in accordance with ASTM D 1557. The frequency and location of field density tests will be determined by the Geotechnical Engineer.

4. Trenches improperly compacted shall be reopened to the depth directed, then refilled and compacted to the density specified at no additional cost to the Owner.

3.10 DRAINAGE CONTROLS

A. Provide all necessary temporary apparatus, pumps, curbs or ditches as required to divert or convey water from any source away from the Work. Do not allow water from any source to accumulate within or damage earthwork.

END OF SECTION

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/ft3 (2,700 kN-m/m3))
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 Servicesand 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 uitilities 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 Prcedure 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 polylolefins, 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 cuspated 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, seam, 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 (± 2%) to 95% maximum density for cohesive material or 85% relative density for cohesionless material. Place and compact the ½" layer of the leveling sub-base at the optimum moisture content (± 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 (± 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 (± 2%) to 95% maximum density or 85% relative density. Place and compact the ½" layer of the leveling sub-base at the optimum moisture content (± 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 (± 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 (± 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 (± 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 (± 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 (± 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 (± 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

SECTION 31 23 33 - TRENCHING, BACKFILLING AND COMPACTION

PART 1 - GENERAL

1.1 SCOPE

A. This Section specifies the requirements for excavating and backfilling for storm sewer, sanitary sewer, water distribution lines, and all related appurtenances. Excavation and backfill shall be in conformance with the locations, lines, elevations and grades shown on the plans. This section also specifies the requirements for clay plugs that must be installed near building face on all utility trenches including water, storm sewer, sanitary sewer, mechanical, electrical, telecom, data, plumbing and other utility trenches for slab on grade and structural first floor building projects.

B. Subsurface data is available from the Owner. Contractor is urged to carefully analyze the site conditions.

1.2 APPLICABLE PUBLICATIONS

A. The following specifications and standards of the latest issue listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent required by the reference thereto.

1. American Society for Testing and Materials (ASTM).

   a. D 698 – Laboratory Compaction Characteristics of Soil Using Standard Effort.

   b. D 1556 Density and Unit Weight of Soil in Place by the Sand-Cone Method.

   c. D 4253 - Maximum Index Density and Unit Weight of Soils using a Vibratory Table.

   d. D 4254 - Minimum Index Density and Unit Weight of Soils in Calculation of Relative Density.

   e. D2321-89 Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications

2. Texas Department of Transportation (TxDOT) Test Procedures

   a. Tex-110-E Particle Size Analysis of Soils

   b. Tex-120-E Soil Cement Testing

1.3 RELATED WORK SPECIFIED ELSEWHERE

A. Drawings and general provisions of the Contract, including A-Procurement and Contracting Requirements, Division 00 and Division 01 apply to this section.

B. Section 31 23 33 – Site Grading

C. Section 31 41 33 - Trench Safety

D. Section 33 10 00 – Water Distribution System

E. Section 33 30 00 – Sanitary Sewer

F. Section 33 34 00 – Sanitary Force Main

G. Section 33 40 00 - Drainage

1.4 SUBMITTALS

A. Material Test Reports: From a qualified testing agency indicating and interpreting test results for compliance of the following with requirements indicated:

1. Classification according to ASTM D 2487 of each [on-site] [and] [or] [borrow] soil material proposed for backfill

B. Pre-excavation Photographs or other digitally recorded media: Show existing conditions of adjoining construction and site improvements, including finish surfaces that might be misconstrued as damage caused by earthwork operations. Submit before excavation begins.

1.5 PROJECT CONDITIONS

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by Owner and then only after arranging to provide temporary utility services according to requirements indicated

1. Follow the University of Houston's Plant Operations Planned and Emergency Utility Outage Policy.

2. Utility Locator Service: Notify Lonestar Notification Center at 713-732-0365 for area where Project is located before excavating.

B. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies to shut off services if lines are active.

C. Utilities have been located from surveys and available existing records. Not all utilities may be shown on the Drawings. Locate all utilities prior to beginning any construction activities.

D. Where utilities require adjustment or relocation to construct the Work, and those utilities are shown on the Drawings, relocation or adjustment is a part of the Work and shall be completed at no additional expense to the Owner.

E. Where utilities require adjustment or relocation to construct the Work, and those utilities are not shown on the Drawings, notify Architect before proceeding. Relocate or adjust utility as directed. Utility relocation and/or adjustment will be paid for according to the Contract provisions for changes in Work.

F. If utility is damaged by Contractor, notify utility owner and Architect immediately. Repair or replacement of utilities damaged by Contractor, whether utilities are shown on the drawings or not shown on the drawings, shall be Contractor's expense.

1.6 PERMITS

A. Prior to commencement of work, the Contractor shall be responsible for obtaining, at the contractors own expense, all construction permits necessary to complete the project according to the plans and specifications.

1.7 DEFINITIONS

A. Excavation consists of the removal of material encountered to subgrade elevations and the reuse or disposal of materials removed.

B. Subgrade: The uppermost surface of an excavation, including excavation for trenches, or the top surface of a fill or backfill immediately below base course, pavement, or topsoil materials.

C. Borrow: Soil material obtained off-site when sufficient approved soil material is not available from excavations.

D. Base Course: The layer placed between the subgrade and surface pavement in a paving system.

E. Unauthorized excavation consists of removing materials beyond indicated subgrade elevations or dimensions without direction by the Owner's rep. Unauthorized excavation, as well as remedial work directed by the Owner's Rep shall be at the Contractor's expense.

F. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below ground surface.

G. Utilities include underground pipes, conduits, ducts, and cables, as well as underground services within building lines.

H. Unforeseen Excavation: Excavation of material, regardless of its character or nature, below the subgrade elevation required to construct the work as indicated on the drawings or specified herein.

I. Bedding Material: Granular material utilized to bed piped utilities placed in trench excavations.

1.8 QUALITY ASSURANCE

A. Pre-Excavation Conference: Conduct conference at Project site to comply with requirements in Division 01.

B. Codes and Standards: Perform earthwork complying with requirements of authorities having jurisdiction.

C. Testing and Inspection Service: Owner will employ a qualified independent geotechnical engineering testing agency to classify proposed on-site and borrow soil materials to verify that soils comply with specified requirements and to perform required field and laboratory testing.

PART 2 - PRODUCTS

2.1 EARTH BACKFILL

A. Earth backfill shall be native soils free of debris, trash, rocks over 2 inches in diameter and other objectionable material.

2.2 CEMENT STABILIZED SAND BACKFILL

A. Cement stabilized sand material shall contain clean bank sand meeting TxDOT Test Method TEX-110-E, water and a minimum of 7% hydraulic cement based on the dry weight of the aggregate meeting TxDOT Test Method Tex-120-E.

2.3 SAND BACKFILL

A. Clean bank sand meeting TxDOT Test Method TEX-110-E.

2.4 WATER

A. Water used for mixing or curing shall be reasonably clean and free of oil, salt, acid, alkali, sugar, vegetable matter or other substances injurious to the finished product.

B. Water sources other than the local municipal domestic water supply must be approved by the Owner.

C. If onsite reclaimed water sources are used, tanks and apprentices must be clearly marked with the words “non-potable” water.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.

B. 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.

3.2 EXCAVATION

A. General:

1. All utility trenches shall be constructed in conformance with OSHA trench safety standards.

2. Sheeting and shoring shall be accomplished to the extent necessary to maintain the sides of the trench in a vertical position throughout the construction period for trenches five (5) feet in depth or deeper. Where approved, trench sides may be laid back in lieu of shoring to meet OSHA safety standards.

3. Utilities shall not be constructed or laid in a trench in the presence of water. All water shall be removed from the trench sufficiently prior to the line placing operation to insure a dry, firm bed on which to place the utility line.

4. Unclassified Excavation: Excavation is unclassified and includes excavation to subgrade elevations regardless of the character of surface and subsurface conditions encountered, including rock, soil materials, and obstructions.

    a. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.

    b. Remedial work due to over-excavation including provision of suitable and stable backfill meeting the degree of compaction required shall be at the Contractor's expense.

5. Borrow Material: If excavated materials of a suitable nature are not of sufficient quantity to complete the work, provide borrow material in sufficient quantity to complete the work at no additional cost to the Owner.

6. Disposing of Excavated Material: Dispose of excess satisfactory soil material and all unsatisfactory soil material and rock obtained from excavations in accordance with the provisions of this Section.

7. Where utilities are in fill, compact fill material to 95% standard proctor maximum dry density at least 12" above the top of the proposed utility prior to excavation of trench.

8. Where indicated widths of utility trenches are exceeded, provide stronger pipe, or special installation procedures, as required by Owner's Rep. Unauthorized excavation, as well as remedial work directed by the Owner's Rep, shall be at the Contractor's expense.

B. Sewer Trenches:

1. For pipe sizes less than 42" in diameter, the minimum trench width shall be outside diameter of pipe plus 18 inches.

2. For pipe sizes 42" in diameter and larger the minimum trench width shall be outside diameter of pipe plus 24 inches.

3. Trenches shall be excavated to a depth at least 6" below the barrel of pipe, and then the pipe bedding shall be placed as shown on the appropriate details contained with the plans and as described in paragraph 3.3 A. of this section.

C. Appurtenances

1. Excavation for manholes, tie-in to existing facilities and similar structures shall be sufficient to leave at least 12" clear between the outer surfaces and the embankment or sheeting that may be used to hold and protect the banks. Any over depth excavation below such appurtenances shall be refilled with cement stabilized sand, as directed, at no additional cost to Owner.

D. Water line Trenches:

1. Water lines must be a minimum of four feet in depth from the top of proposed grade to the top of pipe, unless otherwise shown on the plans.

2. Trench width for water lines shall be a minimum of the outside pipe diameter plus 18 inches.

3. Trenches shall be excavated to a depth of at least 6 inches below the barrel of pipe, and then the pipe bedding shall be placed as shown on the details within the plans and as described in paragraph 3.3 B. of this section.

3.3 PIPE BEDDING AND BACKFILL

A. Storm and sanitary sewer trenches:

1. Pipe shall be bedded in trench in accordance with the details shown on the plans. When pipe has greater than twelve (12) feet of cover, use Class A bedding and backfill.

2. Cement stabilized sand shall be per Part 2.2.A of this specification, mixed in a mill type mixer. When the details call for cement stabilized sand bedding, the material shall extend from a point 6" below the bottom of the pipe to the level of the spring line. This material cannot be used after is loses its moisture content.

3. The cement stabilized sand shall be thoroughly rodded after being placed in trench.

4. Bedding, sewer pipe and initial backfill over the top of pipe must be placed in a single day's operation for any given portion of pipe. Initial backfill shall be placed to one foot above the top of pipe for earth backfill and 6 inches over the top of pipe for cement stabilized sand backfill.

5. Remainder of trench backfill shall be placed the next day or later in 8" lifts, after pipe is laid in conformance with these specifications and the details on the plans.

6. Backfill shall be placed in uniform layers not to exceed 8" loose depth, and compacted to a minimum of 95 percent of Standard Maximum Density (ASTM D 698) at the proper moisture content specified in the Geotechnical report for this project.

7. Backfill, under pavement and to one foot from outer edge, shall be cement stabilized sand of the type and method described under paragraph 3.3 A.1 through 5, above, up to one foot below subgrade elevation. Remainder of backfill to subgrade to be as specified in paragraph 3.3 A.5. above and stabilized where required.

B. Water line Trenches

1. Pipe bedding shall consist of 6 inches of clean sand placed before the pipe is laid.

2. After laying pipe and insuring that the pipe is properly placed and supported by the sand bedding, clean sand backfill shall be placed to 6 inches above the top of pipe. The sand backfill shall be thoroughly rodded and tamped for compaction.

3. For water lines beneath pavement and to one foot horizontally from the outer edge of pavement, the remainder of the trench backfill shall be clean sand placed up to the top of subgrade, thoroughly rodded and tamped.

4. For water lines not beneath pavement or within one foot horizontally from the outer edge of pavement, the remainder of the trench backfill shall be earth fill paced in uniform layers not to exceed 8" loose depth, each lift to be compacted to a minimum

of 95 percent of Standard Density (ASTM D698) at the proper moisture content specified in the Geotechnical report for this project. All earth backfill to be placed the next day or later after the pipe is laid.

C. Bentonite Clay Plug for All Utility Trenches (water, storm, sanitary, mechanical, electrical, telecom, plumping, etc.)

1. All trenches must have a bentonite granular clay plug installed to reduce the transmission of ground water under slab on grade buildings and structural first floor buildings.

a. The plug must be installed at a distance of one foot beyond the face of the building foundation and be a minimum of one-foot wide.

b. The plug must extend 6” beneath utility trench into undisturbed soil. This portion of the clay plug must be installed prior to the installation of the utility pipe.

c. The plug must extend across the entire trench width and extend 6” into undisturbed soil beyond the trench width. Install bentonite clay plug and the utility pipe at the same time.

d. The plug must extend to within 12” of finished grade. A clay plug cap consisting of material with a plasticity index greater than 15 and a liquid limit in excess of 30 shall be placed on top of the bentonite granular clay plug. This clay plug cap shall fill the remaining 12” up to finished grade and be placed up to the edge of the building.

3.4 STORAGE OF SOIL MATERIALS

A. Stockpile borrow materials and satisfactory excavated soil materials. Stockpile soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.

1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.5 FIELD QUALITY CONTROL

A. General: Testing shall be the responsibility of Owner and costs of initial testing will be paid by Owner. Cost of subsequent testing necessary due to non-compliance with Specifications shall be paid by Contractor.

B. Density Test:

1. Density tests shall be performed by representatives of Owner’s Testing Agency.

2. Frequency and scope of testing shall be established by Geotechnical Engineer, and as required by local jurisdictional authority.

If Geotechnical Engineer has not established a frequency of testing in the Geotechnical Report, testing shall be at every 100 linear foot of trench at a minimum of one per lift and a minimum of one per day.

3. Tests shall be performed in accordance with the referenced Standards.

4. Laboratory tests for moisture-density relations shall be determined in accordance with ASTM D 1557. A minimum of one test shall be performed for each major soils type. In addition, sufficient number of retests or check points shall be performed to evaluate accuracy of maximum density values being used.

5. Field in-place density shall be determined in accordance with ASTM Test Methods D 1556 or D 2922, and the moisture-density relations shall be determined in accordance with ASTM Test Method D 1557.

6. Reopen improperly compacted trenches to depth directed, then refill and compact to the specified density at no additional cost to Owner

END OF SECTION

SECTION 31 25 13 - EROSION AND SEDIMENTATION CONTROL

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. This Section pertains to the provisions for the control of erosion in the construction area and in stockpile areas including seeding, the construction of temporary swales and sedimentation basins as required and shown on the drawings. All areas where existing vegetation and grass cover have been bared by construction activities shall be protected from erosion.

B. Contractor is responsible for meeting all local, state and federal regulations regarding erosion control including the applicable provisions of the National Pollution Discharge Elimination System, Phase II, regulations from the Clean Water Act.

C. This project shall be designed to meet LEED Silver design criteria. Construction activity pollution prevention is a mandatory requirement.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Drawings and general provisions of the Contract, including A-Procurement and Contracting Requirements, Division 00 and Division 01 apply to this section.

B. Section 31 11 00 Clearing and Grubbing

C. Section 31 22 13 Site Grading

D. Section 31 23 33 Trenching, Backfilling and Compaction

E. Section 33 40 00 Drainage

F. Texas Department of Transportation’s Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges (2004)

G. Harris County Public Infrastructure Department Engineering Division Specifications for the Construction of Roads and Bridges within Harris County, TX – latest printing October 2003.

1.3 PERMITS (NOT USED)

1.4 APPLICABLE PUBLICATIONS (NOT USED)

1.5 PROTECTION OF ADJACENT WORK (NOT USED)

1.6 DEFINITIONS

A. Best Management Practices (BMP's) means physical facilities schedules of activities, prohibition of practices, maintenance procedures, and other management practices , when properly designed, installed, and maintained, will be effective to prevent or reduce the discharge of pollution associated with construction activities. BMP's also include treatment requirements, operating procedures, and practices to control site runoff, spillage or leaks, sludge or waste disposal, or drainage from raw material storage.

B. Block Sodding: Sodding for erosion control and for final stabilization shall consist of providing and planting Bermuda grass, San Augustine grass, or other acceptable sod along or across such areas as are designated on the drawings and in accordance with the specification requirements herein outlined.

C. Hydromulch Seeding: Seeding, followed by the application of a mulch erosion control blanket shall consist of preparing the ground, sowing of seeds, application of a fertilizer, and stabilization with mulch consisting of a biodegradable fiber along and across such areas as are designated on the plans and in accordance with these specifications

D. Silt Fence: The reinforced filter fabric barrier consists of geotextile fabric supported by a net reinforced fence stretched across and attached to supporting posts or frame and entrenched. Work shall be performed during construction operations and prior to final stabilization to control erosion and sedimentation as designated on the plans and in accordance with these specifications.

E. Inlet Protection Barriers: The inlet protection barrier consists of a geotextile fabric (filter fabric) supported by a net reinforced fence structure and constructed around a storm drain inlet, catch basin, or culvert. An alternative design of the inlet protection barrier, as approved by the Engineer, consists of fiber rolls placed around a frame, staked in place (or weighted down with clean gravel bags), and constructed around a storm drain inlet, catch basin or culvert. This work shall be performed during construction operations and prior to final stabilization to control erosion and sedimentation. As designated on the plans and in accordance with these specifications.

F. Sediment Basins: A sediment basin is a temporary basin or dam constructed across a waterway or excavated location to intercept sediment-laden runoff and to trap and retain the sediment. A sediment basin is usually installed at points of discharge from drainage areas greater than 5 acres. Work shall be performed during construction operations and prior to final stabilization to control erosion and sedimentation as designated on the plans and in accordance with these specifications.

G. Stabilized Construction Access: This work shall consist of the installation of temporary erosion protection and sediment control stabilized construction access - type I, rock, utilized during construction operations and prior to final stabilization, in accordance with these specifications and construction drawings

H. Rock Filter Dams: Rock filter dams are temporary berms constructed of stone to intercept and slow storm water runoff to retain sediment on the construction site.

1. Depending upon the type of rock filter dam specified in the construction plans as Type 1, 2, 3, or 4, the aggregate fill may be unwrapped, wrapped in twisted hexagonal wire mesh, or confined in a gabion wire basket. Applications of RockFilter Dams are as follows:

    a. Type 1 dams may be used at toe of slopes, around inlets, in small ditches, and at dike or swale outlets. Type 1 dams are recommended for erosion and sediment control from a drainage area of 5 acres or less.

    b. Type 2 dams may be used in ditches and at dike or swale outlets.

    c. Type 3 dams may be used in stream flow.

d. Type 4 sack gabions may be used in ditches and smaller channels to form an erosion and sediment control dam

1.7 QUALITY ASSURANCE

A. Codes and Standards: Install and maintain erosion control systems in compliance with all authorities having jurisdiction.

1.8 PROJECT/SITE CONDITIONS (NOT USED)

1.9 SUBMITTALS (NOT USED)

PART 2 - PRODUCTS

2.1 SUSTAINABLE MATERIALS

A. Contractor shall strive to utilize sustainable materials, which include rapidly renewable materials, regional materials, regionally manufactured materials, regionally extracted materials, recycled contents.

B. This project is intended to meet LEED silver criteria.

2.2 GRASS

A. Materials for erosion control seeding shall conform to TxDOT Item 164.

B. Materials for erosion control sodding shall conform to TxDOT Item 162.

2.3 FERTILIZER

A. Materials for fertilizing erosion control seeding and/or sodding shall conform to TxDOT Item 166.2

2.4 WATER

A. Use clean potable water for maintaining the grass developed after erosion control seeding and/or sodding. *[REVIEWER CAN ENTERTAIN GREEN OPTIONS OF USING OTHER WATER SOURCES BESIDES POTABLE WATER. EXPAND DESCRIPTIONS HERE] Water shall be reasonably clean and free of oil, salt, acid, alkali, sugar, vegetable matter or other substances injurious to the finished product.

B. Water sources other than the local municipal domestic water supply must be approved by the Owner.

C. If onsite reclaimed water sources are used, tanks and apprentices must be clearly marked with the words “non-potable” water.

2.5 SILT FENCE

A. Geotextile fabric for Silt Fences must meet the TxDOT Departmental Material Specifications DMS 6230 Temporary Sediment Control Fence Fabric.

2.6 STRAW BALES

A. Standard rectangular hay bales bound by baling wire, clean and dry

2.7 INLET PROTECTION BARRIERS

A. Geotextile per 2.5 Silt Fence above.

B. Hardwood Posts shall be 2x2 minimum length 4 feet.

C. Net reinforced fence shall be 2 inch by 4 inch welded wire fabric mesh. The mesh support height shall be the equivalent height, or greater, of the geotextile fabric to be attached.

2.8 STABILIZED CONSTRUCTION ACCESS

A. Materials to be per TxDOT spec section 506.2.E.1 for Type 1

2.9 ROCK FILTER DAM

A. Materials. Geotextile fabric shall consist of a woven monofilament or spunbond nonwoven fibers consisting of long-chain synthetic polymers composed of at least 95 percent by weight of polyolefins. Geotextile fabric shall equal or exceed the following average roll values or as directed by the Engineer:

1. Minimum average roll value.

a. Elongation ³ 50 percent.

b. Grab Strength – 200 pounds.

c. Puncture Strength – 75 pounds.

d. UV Stability (retained strength) – 50 percent after 500 hours of exposure.

2. Maximum average roll value.

a. Apparent Opening Size (AOS) – 0.6 mm/#30 US sieve.

B. Geotextile fabric shall be resistant to commonly encountered soil chemicals, mildew, rot, insects, and deterioration resulting from exposure to sunlight or heat. Geotextile fabric shall provide an expected useable life comparable to the anticipated construction period.

C. Aggregate for the rock filter dams shall consist of crushed stone. Aggregate particles shall be composed of clean, hard, durable materials free from adherent coatings, salt, alkali, dirt, clay, loam, shale, soft or flaky materials or organic and injurious matter. Aggregate shall be cubic or rounded form, not elongated, flat, shapes. Spalls, fragments, and chips shall not exceed 5 percent by weight. Crushed concrete shall not be substituted for the crushed stone unless as approved by the Engineer. *[NOTE THAT CRUSHED CONCRETE IS TYPICALLY A PREFERED OPTION FOR PROJECTS WANTING LEED ACCREDITATION. MODIFY THIS PREVIOUS SENTENCE ACCORDINGLY FOR LEED PROJECTS] Aggregate size shall depend upon the type of

rock filter dam specified in the construction plans. Aggregate size based on type of rock filter dam is as follows:

1. Type 1: 3 inches to 5 inches, open-graded.

2. Type 2: 3 inches to 5 inches, open-graded.

3. Type 3: 4 inches to 8 inches, open-graded.

4. Type 4: 3 inches to 5 inches, open-graded.

D. Mesh is required for reinforced type rock filter dams. Mesh shall be 20 gauge galvanized double twisted hexagonal wire mesh with 1-inch diameter hexagonal openings. Mesh wire shall be zinc coated prior to being double twisted. Reinforcing spiral binders, lacing wire, and stiffeners shall be made of wire having the same coating material and same wire size as the wire mesh. Gabion wire baskets shall equal or exceed the requirements of the wire mesh.

PART 3 - EXECUTION

3.1 GENERAL

A. Protection

1. Protect benchmarks, monuments, existing structures, existing fences, existing roads, existing sidewalks, existing paving, existing curbs, and other features indicated on Drawings to remain, or not indicated to be removed, from damage and displacement. If damaged or displaced, notify Engineer and correct defects as directed.

2. Protect above and below grade utilities which are to remain.

B. Preparation:

1. Use all means necessary to control dust on and near the work, and on and near off-site storage, and spoil areas, if such dust is caused by performance of the work of this Section, or if resulting from the condition in which Project Site is left by Contractor.

2. Moisten surfaces, as required, to prevent dust from being a nuisance to the public, neighbors, and concurrent performance of other work on Project Site.

C. Install erosion control systems at the site's boundary at locations where stormwater runoff will leave the site prior to starting any clearing, stripping, or earthwork operations

D. Minimize the time areas are to be exposed without vegetative cover.

E. Properly dispose of solid waste, paints, solvents, cleaning compounds, etc.

F. Store construction materials in designated areas away from drainageways and low areas.

G. Provide portable toilets and properly dispose of sanitary sewage.

H. Construct containment berms and utilize drip pans at fuel and liquid storage tanks and containers.

3.2 INSTALLATION OF EROSION CONTROL DEVICES

A. Install erosion control devices to protect adjacent and downstream properties from damage and pollution resulting from erosion caused by the work of this Contract.

1. Implement erosion control measures indicated on drawings and additional erosion control measures necessary to prevent damage to adjacent and downstream properties.

B. Install silt fence located along perimeter of site or grading limits immediately following site clearing operations specified under Division 31 Section 31 11 00 Clearing and Grubbing.

1. Install silt fence fabric from a continuous roll for the length of the silt fence whenever possible to minimize the number of joints.

a. Create joints in fabric by securely fastening fabric at the support post with overlap extending to the next post.

2. Drive support post into ground not less than 18 inches.

3. Excavate a 4 inch wide by 4 inch deep trench on up-slope side of silt fence.

a. Line trench with silt fence fabric material.

b. Backfill trench with soil or gravel.

C. Install straw bale fence at completion of grading operations in affected area as indicated on drawings.

1. Install erosion control devices at storm sewer inlets immediately after completion of the storm sewer.

2. Place straw bales in a single row, lengthwise on the contour, and embedded 4 inches into soil.

3. Secure each individual bale in place by stakes or reinforcement bars driven through bales into the ground to a depth of not less than 18 inches.

D. Install inlet protection barriers at curb inlets and at area inlets.

E. Install straw bale fences as ditch checks in drainage ditches.

F. Install Stabilized Construction Access per TxDOT specification 506.4.C.5.

G. Rock filter dams shall be installed so as to prevent downstream deposition of sediment and debris from the construction site. Rock filter dams shall be constructed to meet the following criteria:

1. Type 1:

a. Non-reinforced.

b. Height: 18-24 inches

c. Top width: 2 feet minimum.

d. Upstream and downstream side slope of dam: 2:1 maximum.

e. Open graded aggregate 3-5 inches.

2. Type 2:

a. Reinforced with wire mesh.

b. Height: 18-36 inches.\

c. Top width: 2 feet minimum.

d. Upstream and downstream side slope of dam: 2:1 maximum.

e. Open graded aggregate 3-5 inches.

3. Type 3:

a. Reinforced with wire mesh.

b. Height: 36-48 inches.

c. Top width: 2 feet minimum.

d. Upstream and downstream side slope of dam: 3:1 maximum.

e. Open graded aggregate 4-8 inches.

4. Type 4:

a. Reinforced in a gabion wire basket.

b. Height: 30 inches minimum.

c. Top width: 2 feet minimum.

d. Upstream and downstream side slopes of dam: none specified.

e. Open graded aggregate 3-5 inches.

5. The separation geotextile fabric and wire mesh shall be sized and placed in accordance with the rock filter dam detail and as specified by the type of rock filter dam shown in the construction plans. The separation geotextile fabric may be omitted only as approved by the Engineer. The separation geotextile fabric and wire mesh shall be securely staked with wooden or metal stakes to the bottom and side slopes of the ditch or channel prior to aggregate placement. Sack gabions for Type 4 rock filter dams

shall be securely staked with wooden or metal stakes to the bottom and side slopes of the ditch or channel, as well.

6. Aggregate fill shall be placed to the width, length, height and slopes in accordance with this specification and the rock filter dam detail and as specified by the type of rock filter dam shown in the construction plans. The height of the dam shall be measured vertically from the existing ground to the top of the filter dam. The length of the dam shall be measured across the top centerline of the dam from embankment to embankment and includes the additional length embedded into the embankment. Width of the dam shall be measured along the top face of the dam.

7. Wire mesh shall be folded upstream side over the aggregate fill and tightly secured to itself on the downstream side using wire tires. Hog rings may be substituted for wire ties.

8. Additional aggregate fill or gravel bags shall be placed and secured at the embedded section to prevent low flows from short circuiting the dam at the adjacent dirt embankment area.

9. The Contractor shall be responsible for periodic reshaping, repairing, and maintaining of rock filter dams as directed by the Engineer.

10. The Contractor is responsible for removal and proper disposal of sediment and debris from the rock filter dam. Removed sediment and debris shall not be allowed to flush into the storm sewer system, waterways, jurisdictional wetlands, or onto adjacent properties. Sediment deposits shall be removed before they reach one-third of the height of the dam. Uncontaminated sediment can be placed at the project spoil site or, if properly handled, spread out to supplement fill requirements. If sediment has been contaminated, then it shall be disposed of in accordance with the applicable federal, state, and local regulations. Offsite disposal shall be the responsibility of the Contractor. Contractor is encouraged to reuse aggregate and wire mesh if remaining materials meet original spec requirements.

3.3 EROSION CONTROL SEEDING

A. Exposed fill and stockpile areas shall be protected from windborne erosion if the phasing of the construction operations is anticipated to leave the exposed fill and stockpile areas unattended for 6 weeks or more. At completion of stockpiling operations, stockpiles shall be shaped and graded to drain. Provide a layer of mulch to all sides of the stockpile to protect the stockpile from windborne erosion.

B. Areas designated on the drawings to be seeded shall be seeded in accordance to the Texas Department of Transportation Standard Specifications, Item 164, titled "Seeding for Erosion Control". Broadcast seeding method shall be used as described in TxDOT, Item 164.4 unless otherwise instructed.

C. Areas to be seeded with slopes steeper than 10H:1V shall also utilize a soil retention blanket as specified in TxDOT Item 169 Soil Retention Blanket.

3.4 TEMPORARY SWALES

A. Temporary drainage swales shall be provided as required to carry drainage away from the work area to an approved outfall point.

B. Unless otherwise shown on the drawings, swales shall be earthen "V" shaped channels graded to a sufficient depth and slope to carry the anticipated runoff, but at least two (2) feet deep with a slope of 0.1%.

C. Swales not designated to remain in place at the completion of the contract shall be cleaned of any muck, debris and other unsuitable material and filled with approved fill before final grading operations begin.

D. Swales shall have erosion control barriers as required in these specifications.

3.5 FILL AND CUT SLOPES

A. Fill slopes in all cases shall be no steeper than 3:1 unless specifically stated on the plans or approved by the Owner's Geotechnical engineer.

B. When cut slopes exceed 2:1 for depths over three (3) feet, proper bracing and shoring per OSHA requirements shall be used and maintained.

C. For permanent slopes, cut or fill, between 2:1 and 10:1, erosion protection shall be provided with hydromulching seeding, sodding, or other method as approved.

D. Where cut slopes of more than 5 feet deep, extend more than 100 feet in length, contractor shall provide a backfill drain at the top of the slope to ease in drainage and erosion control.

3.6 SEDIMENTATION BASINS

A. Sedimentation ponds shall be provided when designated on the plans.

B. All drainage from cleared areas shall be routed through the sedimentation basin.

C. Contractor will be responsible for the operation and maintenance of the pond during construction.

3.7 MAINTENANCE

A. Check all erosion control measures after each rainfall event to ensure that they are in proper working order.

1. Immediately restore all measures to installed condition.

2. During the course of construction all temporary swales constructed for this contract shall be maintained so as to allow proper drainage from the construction area. Before Contractor leaves the site at the end of construction, all temporary swales must be reworked to meet final conditions as set forth in the drawings and specifications.

3. The Contractor shall assure that all subwork with other contractors at the site understand the importance of the erosion control features. The Contractor shall require all subcontractors to respect the function of the erosion control features and enlist their coordination in maintaining existing swales and ditches.

B. Inspect silt and straw bale fences at least once a week.

1. Immediately replace damaged portions of the silt fences, including portions which have collapsed, contain tears, have decomposed, or have become ineffective.

2. Remove sediment deposits, as necessary, to provide adequate sediment storage and to maintain the integrity of fences. Dispose of accumulated sediment by spreading over upland areas of the site.

C. Maintain erosion control devices in place, as specified, until completion of the work of this Contract.

1. At completion of work, inspect all systems, make necessary repairs, remove and dispose of all accumulated sediment, and turn completely operable systems over to Owner for continued maintenance.

D. Where necessary for equipment and vehicular access to the work areas, adequately sized culverts shall be installed and maintained to provide the access without disturbing the site drainage.

E. Sedimentation Basins.

1. Contractor shall be responsible for maintaining the pond and the outfall and sediment retarding structure in good working condition throughout the time the pond is to be in operation.

2. When sediment and debris fill the pond to over one third (1/3) its designed capacity, the pond shall be cleaned out.

3. The sediment from the clearing operation shall be stockpiled with like materials per Specification 31 11 00 Clearing and Grubbing. If the material is found to not meet the stockpiling requirements listed in 31 11 00, they must be removed from the site as described in 31 11 00.

3.8 INSPECTIONS

A. Inspect all erosion control systems and devices at least once every seven calendar days.

B. Inspect all erosion control systems and devices within 24 hours of the end of any storm which results in precipitation of 1/2 inch or more.

C. During inspections, locations where stormwater leaves the site shall be inspected for evidence of erosion or sediment deposition.

D. Correct deficiencies within three calendar days.

E. Complete a report of each inspection. Report shall contain the following minimum information:

1. Inspector's name

2. Inspection date

3. Observations of the effectiveness of erosion control systems

4. Actions taken if necessary to correct deficiencies

5. Listing of areas where construction operations have permanently or temporarily stopped

6. Authorized signature

END OF SECTION

SECTION 31 31 16 - TERMITE CONTROL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

Retain or delete this article in all Sections of Project Manual.

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. The Contractor's attention is specifically directed, but not limited, to the following documents for additional requirements:
   1. *Uniform General Conditions for Construction Contracts*, State of Texas, 2010 (UGC).
   2. The University of Houston's *Supplemental General Conditions and Special Conditions for Construction.*

1.2 SUMMARY

A. Section Includes:

Adjust list below to suit Project.

1. **Soil** treatment with termiticide.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of termite control product.

1. Include the EPA-Registered Label for termiticide products.

1.4 INFORMATIONAL SUBMITTALS

Coordinate first paragraph below with qualification requirements in Section 014000 "Quality Requirements" and as supplemented in "Quality Assurance" Article.

A. Qualification Data: For qualified Installer.

Retain first paragraph below for product certificates from manufacturers.

B. Product Certificates: For termite control products, from manufacturer.

Retain first five paragraphs below if applicable and coordinate with Section 017700 "Closeout Procedures."

C. Soil Treatment Application Report: After application of termiticide is completed, submit report for Owner's records and include the following:

1. Date and time of application.
2. Moisture content of soil before application.
3. Termiticide brand name and manufacturer.
4. Quantity of undiluted termiticide used.
5. Dilutions, methods, volumes used, and rates of application.
6. Areas of application.
7. Water source for application.

D. Wood Treatment Application Report: After application of termiticide is completed, submit report for Owner's records and include the following:

1. Date and time of application.
2. Termiticide brand name and manufacturer.
3. Quantity of undiluted termiticide used.
4. Dilutions, methods, volumes used, and rates of application.
5. Areas of application.

E. Warranties: Sample of special warranties.

1.5 QUALITY ASSURANCE

Retain first option in first paragraph below for bait-station system and polymer barriers with termiticide. Retain second option for metal mesh barrier system.

A. Installer Qualifications: A specialist who is licensed according to regulations of authorities having jurisdiction to apply termite control treatment and products in jurisdiction where Project is located [**, and who employs workers trained and approved by manufacturer to install manufacturer's products**].

B. Regulatory Requirements: Formulate and apply termiticides and termiticide devices according to the EPA-Registered Label.

C. Source Limitations: Obtain termite control products **from single manufacturer**:
1. Dominion 2L Termiticide/Insecticide

Retain paragraph below if Work of this Section is extensive or complex enough to justify a preinstallation conference.

D. Preinstallation Conference: Conduct conference at [**Project site**] <**Insert location**>.

1.6 PROJECT CONDITIONS

Retain first two paragraphs below if soil treatment is required.

A. Environmental Limitations: To ensure penetration, do not treat soil that is water saturated or frozen. Do not treat soil while precipitation is occurring. Comply with requirements of the EPA-Registered Label and requirements of authorities having jurisdiction.

B. Coordinate soil treatment application with excavating, filling, grading, and concreting operations. Treat soil under footings, grade beams, and ground-supported slabs before construction.

Retain first paragraph below if wood treatment is required.

C. Apply wood treatment after framing, sheathing, and exterior weather protection is completed but before electrical and mechanical systems are installed.

1.7 WARRANTY

When warranties are required, verify with Owner's counsel that special warranties stated in this article are not less than remedies available to Owner under prevailing local laws.

Warranty in first paragraph below is for protection of construction from infestation and not specifically for methods used. Insert bait-station system and warranty terms if applicable. If required, contact HUD for its current "Subterranean Termite Soil Treatment Builder's Guarantee."

A. Soil Treatment Special Warranty: Manufacturer's standard form, signed by Applicator and Contractor, certifying that termite control work, consisting of applied soil termiticide treatment, will prevent infestation of subterranean termites. If subterranean termite activity or damage is discovered during warranty period, re-treat soil and repair or replace damage caused by termite infestation.

Verify available warranties and warranty periods with manufacturers listed in Part 2 articles.

1. Warranty Period: [**Three**] [**Five**] <**Insert number**> years from date of Substantial Completion.

1.8 MAINTENANCE SERVICE

Retain or delete this article to suit products and the needs of Owner. Coordinate with warranty requirements if any. Example below is for soil treatment.

A. Continuing Service: Beginning at Substantial Completion, provide [**12 months'**] <**Insert number**> continuing service including monitoring, inspection, and re-treatment for occurrences of termite activity. Provide a standard continuing service agreement. State services, obligations, conditions, terms for agreement period, and terms for future renewal options.

PART 2 - PRODUCTS

2.1 SOIL TREATMENT

Retain this article unless another method of preconstruction treatment is permitted by authorities having jurisdiction.

A. Termiticide: Provide an EPA-Registered termiticide, complying with requirements of authorities having jurisdiction, in an aqueous solution formulated to prevent termite infestation. Provide quantity required for application at the label volume and rate for the maximum termiticide concentration allowed for each specific use, according to product's EPA-Registered Label.
   1. Products: Subject to compliance with requirements, provide Dominion 2L Termiticide/Insecticide or approved equal.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Applicator present, for compliance with requirements for[**moisture content of soil per termiticide label requirements,**] interfaces with earthwork, slab and foundation work, landscaping, utility installation, and other conditions affecting performance of termite control.

B. Proceed with application only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. General: Comply with the most stringent requirements of authorities having jurisdiction and with manufacturer's written instructions for preparation before beginning application of termite control treatment. Remove all extraneous sources of wood cellulose and other edible materials such as wood debris, tree stumps and roots, stakes, formwork, and construction waste wood from soil within and around foundations.

B. Soil Treatment Preparation: Remove foreign matter and impermeable soil materials that could decrease treatment effectiveness on areas to be treated. Loosen, rake, and level soil to be treated except previously compacted areas under slabs and footings. Termiticides may be applied before placing compacted fill under slabs if recommended in writing by termiticide manufacturer.

   1. Fit filling hose connected to water source at the site with a backflow preventer, complying with requirements of authorities having jurisdiction.

3.3 APPLICATION, GENERAL

A. General: Comply with the most stringent requirements of authorities having jurisdiction and with manufacturer's EPA-Registered Label for products.

3.4 APPLYING SOIL TREATMENT

Retain this article for soil treatment and revise to suit Project; delete if not applicable. Products must be applied according to manufacturer's EPA-Registered Label for maximum performance.

A. Application: Mix soil treatment termiticide solution to a uniform consistency. Provide quantity required for application at the label volume and rate for the maximum specified concentration of termiticide, according to manufacturer's EPA-Registered Label, to the following so that a continuous horizontal and vertical termiticidal barrier or treated zone is established around and under building construction. Distribute treatment evenly.

Revise five subparagraphs below to suit Project.

1. Slabs-on-Grade and Basement Slabs: Under ground-supported slab construction, including footings, building slabs, and attached slabs as an overall treatment. Treat soil materials before concrete footings and slabs are placed.
2. Foundations: Adjacent soil, including soil along the entire inside perimeter of foundation walls; along both sides of interior partition walls; around plumbing pipes and electric conduit penetrating the slab; around interior column footers, piers, and chimney bases; and along the entire outside perimeter, from grade to bottom of footing. Avoid soil washout around footings.
3. Crawlspaces: Soil under and adjacent to foundations as previously indicated. Treat adjacent areas including around entrance platform, porches, and equipment bases. Apply overall treatment only where attached concrete platform and porches are on fill or ground.

Examples of masonry voids are the insides of hollow masonry units and behind masonry veneer.

4. Masonry: Treat voids.
5. Penetrations: At expansion joints, control joints, and areas where slabs will be penetrated.

Insert requirements here for crawlspaces used as plenum spaces only after seeing Evaluations for cautionary information.

B. Avoid disturbance of treated soil after application. Keep off treated areas until completely dry.

C. Protect termiticide solution, dispersed in treated soils and fills, from being diluted until ground-supported slabs are installed. Use waterproof barrier according to EPA-Registered Label instructions.

D. Post warning signs in areas of application.

E. Reapply soil treatment solution to areas disturbed by subsequent excavation, grading, landscaping, or other construction activities following application.

END OF SECTION 31 31 16

SECTION 31 32 13.16 - CEMENT STABILIZATION

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. This Section pertains to the specifications for cement stabilization of sandy or silty soil and consists of pulverizing, addition of Portland cement, mixing, wetting and compacting the mixed material to the required density. This Section applies to natural ground, embankment, or pavement subgrade and shall be constructed as specified herein and in conformity with the typical sections, details, lines and grades as shown on the plans.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Drawings and general provisions of the Contract, including Procurement and Contracting Requirements, Division 00 and Division 01 apply to this section.

B. Section 31 11 00 – Clearing and Grubbing

C. Section 31 22 13 - Site Grading

D. Section 32 01 16.72 – Asphalt Pavement Recycling

E. Section 32 12 16 – Asphalt Concrete Paving

F. Section 32 13 13 – Concrete Paving

1.3 PERMITS (NOT USED)

1.4 APPLICABLE PUBLICATIONS

The following publications of the latest issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent indicated by references thereto:

A. Texas Department Transportation 2004 Standard Specifications for Construction of Highways, Streets and Bridges (TxDOT):

1. Item 520-Weighing and Measuring Equipment

B. American Society for Testing and Materials Standards (ASTM):

1. C 150-07 Standard Specification for Portland Cement

2. D 698-07e1 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3)

3. D 1557-07 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3)

C. Texas Department of Transportation (TxDOT) Test Procedures:

1. Test Method Tex-114-E - Laboratory Compaction Characteristics and Moisture-Density Relationship of Subgrade, Embankment Soils, and Backfill Material

1.5 DEFINITIONS

A. Subgrade: The uppermost surface of an excavation, including excavation for trenches, or the top surface of a fill or backfill immediately below base course, pavement, or topsoil materials.

B. Backfill: Soil material or controlled low-strength material used to fill an excavation.

C. Base Course: The layer placed between the subgrade and surface pavement in a paving system.

D. Geotechnical Engineer: Person or company contracted by the owner and/or through the architect to provide testing and onsite Geotechnical services during the construction schedule.

1.6 QUALITY ASSURANCE

A. Codes and Standards: Perform earthwork complying with requirements of authorities having jurisdiction.

B. Testing and Inspection Service: Owner will employ a qualified independent geotechnical engineering testing agency to classify proposed on-site and borrow soil materials to verify that soils comply with specified requirements and to perform required field and laboratory testing. Contractor responsible to coordinate with the testing agency prior to start of work requiring testing so as to minimize unnecessary cost or delays to the project.

C. Testing:

1. Owner will retain and pay a qualified Geotechnical engineer to take all field samples and do all laboratory testing necessary to verify compliance of the work to these Specifications or as required by City or other regulatory agencies. The Geotechnical Engineer shall submit results of all testing done during the course of the work to the Owner, Architect, and Contractor.

2. Notify testing lab a minimum of 48 hours in advance of the time testing is required to satisfy requirements of this section.

3. Should testing specified above show work which does not satisfy these Specifications, the Contractor shall pay, through the Owner, for all additional tests required to determine the extent of work that is not satisfactory and for all additional tests necessary to demonstrate compliance with these specifications.

4. All tests shall be performed by the Soil Engineer in accordance with ASTM C150, D 698, D1557, Tex-114-E or other test method selected by Geotechnical Engineer.

D. Certification: *[NOTE HERE ANY ITEMS THAT ARE NEEDED UPON COMPLETION OF WORK, IF NEEDED]

1.7 PROJECT/SITE CONDITIONS

A. Cement treatment shall not be mixed or placed when the air temperature is below 40 degrees F and is falling, but may be mixed or placed when the air temperature is above 35 degrees F and is rising, the temperature being taken in the shade and away from artificial heat and with the further provision that cement treatment shall be mixed or placed only when weather conditions are suitable.

B. Completed sections of cement treated material in place may be opened immediately to local traffic and to construction equipment and to all traffic after the curing period, provided the cement treated course has hardened sufficiently to prevent marring or distorting the surface by equipment or traffic.

C. The Contractor shall be required, within the limits of his contract, to maintain the cement treated course in good condition until all work has been completed and accepted. Maintenance shall include immediate repairs of any defects that may occur. This work shall be done by the Contractor at his own expense and repeated as often as may be necessary to keep the area continuously intact. Faulty work shall be replaced for the full depth of treatment. It is the intent of this specification that the Contractor constructs the plan depth of cement treatment in one homogeneous mass. The addition of thin stabilized layers will not be permitted in order to provide the minimum specified depth.

D. Design Strength

Cement mixture shall produce at least 750 psi unconfined compressive strength at 7 days. Percent of cement to be used shall be coordinated with Geotechnical Report but in no way shall the percent of cement added be less than 5%

1.8 SUBMITTALS

A. None required for this section. *[REVISE AS NEEDED]

PART 2 - PRODUCTS

2.1 SOIL

A. Soil shall consist of approved sand or silt material free from vegetation or other objectionable matter encountered in the existing subgrade and other acceptable material used in preparation of the subgrade in accordance with this specification.

2.2 PORTLAND CEMENT

A. Cement shall be Type 1 of a standard brand of Portland cement and shall conform to the requirements of ASTM Designation: C 150-07.

B. One sack, containing 1 cubic foot of cement, shall be considered as weighing 94 pounds net. One barrel of cement shall be considered as weighing 376 pounds net and containing 4 cubic feet.

C. It is the Contractors option to use bulk cement, provided the apparatus for handling, weighing and spreading the cement is approved in writing. Cement weighing equipment shall be as specified below in 3.1.A.

2.3 WATER

A. Water used for mixing or curing shall be reasonably clean and free of oil, salt, acid, alkali, sugar, vegetable matter or other substances injurious to the finished product.

B. Water sources other than the local municipal domestic water supply must be approved by the Owner.

C. If onsite reclaimed water sources are used, tanks and apprentices must be clearly marked with the words “non-potable” water.

PART 3 - EXECUTION

3.1 EQUIPMENT

A. Equipment utilized where materials are specified to be measured or proportioned by weight shall conform to the requirements of the TxDOT specifications, Item 520, "Weighing and Measuring Equipment.” Equipment necessary for the proper construction of the work shall be on the project, in first-class working condition, both as to type and condition, prior to the start of construction operations. The Contractor shall at all times provide sufficient equipment to enable continuous prosecution of the work and completion in the required number of working days.

B. Portland cement treatment for materials in place may be constructed with any machine or combination of machines and auxiliary equipment that will produce results as outlined in this specification.

C. Mixing may be accomplished by a multiple-pass traveling mixing plant or a single-pass traveling mixing plant.

D. The equipment provided by the Contractor shall be operated by experienced and capable employees and shall be that equipment necessary to provide a cement treatment meeting the requirements herein specified.

3.2 CONSTRUCTION METHOD

A. It is the primary requirement of this specification to secure a completed course of treatment containing a uniform Portland cement mixture free from loose or segregated areas, of uniform density and moisture content, well bound for its full depth and with a smooth surface suitable for placing subsequent courses. It shall be the responsibility of the Contractor to regulate the sequence of work, to process a sufficient quantity of material to provide full depth as shown on plans, to use the proper amount of Portland Cement to maintain the work and rework the courses as necessary to meet the above requirements.

3.3 PREPARATION OF SUBGRADE

A. Before other construction operations are begun, the subgrade shall be graded and shaped as required to construct the Portland cement treatment for material in place in conformance with the lines, grades, thickness and typical cross section shown on the plans. Unsuitable soil or material shall be removed and replaced with acceptable soil.

B. The subgrade shall be firm and able to support without displacement the construction equipment and the compaction hereinafter specified. Soft or yielding subgrade shall be corrected and made stable before construction proceeds.

3.4 PULVERIZATION

A. The soil shall be pulverized such that at the completion of moist-mixing, 100 percent by dry weight passes a 1-inch sieve, and a minimum of 80 percent passes a No. 4 sieve, exclusive of gravel or stone retained on these sieves.

3.5 APPLICATION OF CEMENT

A. Portland cement shall be spread uniformly on the soil in such quantity that all soil to be treated receives the minimum percentage of cement. If a bulk cement spreader is used, it shall be positioned by string lines or other approved method during spreading to insure a uniform distribution of cement.

B. Cement shall be applied to an area such that the operation can be continuous and completed in daylight within 6 hours of such application.

C. The percentage of moisture in the soil, at the time of cement application, shall not exceed the quantity that will permit uniform and intimate mixture of soil and cement during dry mixing operations. It shall not exceed the specified optimum moisture content for the soil cement mixture.

D. No equipment, except that used in spreading the mixture, will be allowed to pass over the freshly spread cement until it is mixed with the soil.

3.6 MIXING AND PROCESSING

A. Unless otherwise shown on the plans, either method (A) or (B) below may be used at the option of the Contractor.

1. Multiple-Pass Traveling Mixing Plant

a. After the cement has been applied it shall be dry-mixed with the soil. Mixing shall continue until the cement has been sufficiently blended with the soil to prevent the formation of cement balls when water is applied. Any mixture of soil and cement that has not been compacted and finished shall not remain undisturbed for more than 30 minutes.

b. Immediately after the dry mixing of soil and cement is complete, water as necessary shall be uniformly applied and incorporated into the mixture. Pressurized equipment and supply provided shall be adequate to insure continuous application of the required amount of water to sections being processed within 3 hours of application of the cement. Proper care shall be exercised to insure proper moisture distribution at all times. After the last increment of water has been added, mixing shall continue until a thorough and uniform mix has been obtained.

2. Single-Pass Traveling Mixing Plant

a. After the cement has been applied it shall be sufficiently dry-mixed with the soil to prevent the formation of cement balls when water is applied. Un-pulverized soil lumps in the soil cement mixture immediately behind the mixer that are dry will not be allowed. Should this condition prevail, the Contractor shall "pre-wet" the raw soil as necessary to correct this condition.

b. This mixer shall be provided with means for visibly and accurately gauging the water application. The water shall be applied uniformly through a pressure spray bar.

c. After cement is spread, mixing operations shall proceed as follows:

i. The mixer shall in one continuous operation thoroughly moist-mix the soil, cement and water, spread the completed soil cement mixture evenly over the machine processed width of the subgrade and leave it in a loose condition ready for immediate compaction.

ii. The soil and cement mixture shall not remain undisturbed, after mixing and before compacting, for more than 30 minutes.

3.7 COMPACTION AND FINISHING

A. The material shall be compacted to not less than 95 percent of the Standard Maximum Density (ASTM D698-07e1) and as shown on the plans. At the start of compaction, the percentage of moisture in the mixture and in un-pulverized soil lumps, based on oven-dry weights, shall not be below or more than two percentage points above the specified optimum moisture content and shall be less than that quantity which will cause the soil cement mixture to become unstable during compaction and finishing. When the uncompacted soil cement mixture is wetted by rain so that the average moisture content exceeds the tolerance given at the time of final compaction, the entire section shall be reconstructed in accordance with this specification at the sole expense of the Contractor.

B. The specified optimum moisture content and density shall be determined in the field by Test Method Tex-114-E or other approved methods, on representative samples of soil cement mixture obtained from the area being processed.

C. Prior to the beginning of compaction, the mixture shall be in a loose condition for its full depth. The loose mixture then shall be uniformly compacted to the specified density within 2 hours after the application of cement.

D. After the soil and cement mixture, is compacted, water shall be uniformly applied as needed and thoroughly mixed in with a spiketooth harrow or equal. The surface shall then be reshaped to the required lines, grades and cross section and then lightly scarified to loosen any imprint left by the compacting or shaping equipment.

E. The resulting surface shall be thoroughly rolled with a pneumatic tire roller and "clipped", "skinned", or "tight bladed" by a power grader to a depth of approximately 1/4 inch, removing all loosened soil and cement from the section. The surface shall then be thoroughly compacted with the pneumatic roller, adding small increments of moisture as needed during rolling. If plus No. 4 aggregate is present in the mixture, one complete coverage of the section with the flat wheel roller shall be made immediately after the "clipping" operation. When directed by the Owner, surface finishing methods may be varied

from this procedure provided a dense, uniform surface, free of surface compaction planes, is produced. The moisture content of the surface material must be maintained within two (2) percent of its specified optimum during all finishing operations. Surface compaction and finishing shall proceed in such a manner as to produce, a smooth, closely knit surface, free of cracks, ridges or loose material conforming to the crown, grade and line shown on the plans in a timeframe no longer than 2 hours from the initial application of cement.

F. Finished Surface should not vary more than 3/8 inch when tested with a straight edge 10-16 feet long.

G. Thickness of finished subgrade shall be at least the thickness shown on the plans within ¼ inch tolerance and can exceed the thickness shown on the plans as needed to meet the needs of the project

3.8 CURING

A. Protection and Cover

After the cement treated course has been finished as specified herein, the surface shall be protected against rapid drying by any of the following curing methods for a period no less than 3 days or until the surface or subsequent courses are placed:

1. Maintain in a thorough and continuously moist condition by sprinkling, or

2. Apply a 2-inch layer of earth on the completed course and maintain in a moist condition, or

3. Apply an asphalt membrane to the treated course, immediately after same is completed. The quantity and type of asphalt shall be sufficient to completely cover and seal the total surface of the base and fill all voids. If the Contractor elects to use this method, it shall be the Contractor's responsibility to protect the asphalt membrane from being picked up by traffic by either sanding or dusting the surface of same. The asphalt membrane may remain in place when the proposed surface or other base courses are placed.

B. Surface

1. The surface or other base courses may be applied on the finished base as soon after completion as operations will permit.

3.9 CONSTRUCTION JOINTS

A. At the end of each day's construction a straight transverse construction joint shall be formed by cutting back into the total width of completed work to form a true vertical face free of loose and shattered material.

B. Cement treatment for large, wide areas shall be built in a series of parallel lanes of convenient length and width as approved.

END OF SECTION

SECTION 31 32 13.19 - LIME STABILIZATION

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. This Section specifies the requirements for treating and stabilizing existing subgrade material or select fill material under pavements or site structures as shown on the drawings, by pulverizing, adding lime, and finishing to the lines and grades shown on the drawings and constructed as specified herein.

B. This section excludes work necessary for building pad preparations. Work within the building footprint and surrounding 5 feet shall be accomplished under technical specification 31 23 00 Excavation and Fill prepared by *STRUCTURAL ENGINEER].

1.2 APPLICABLE PUBLICATION

The following publications of the latest issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent indicated by references thereto:

A. Texas Department of Transportation 2004 Standard Specifications for Construction of Highways, Streets and Bridges (TxDOT):

1. Item 260 - Lime Treatment (Road Mixed).

2. Item 263 – Lime Treatment (Plant Mixes)

B. Texas Department of Transportation Departmental Material Specifications (DMS) latest edition.

1. DMS 6350 – Lime and Lime Slurry

C. American Society for Testing and Materials Standards (ASTM):

1. D 698-07e1 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Efforts (12,400 ft-lbf/ft3 (600 kN-m/m3))

2. D 1556-07 Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.

1.3 RELATED WORK SPECIFIED ELSEWHERE

A. Drawings and general provisions of the Contract, including A-procurement and Contracting Requirements, Division 00 and Division 01 apply to this section.

B. Section 31 11 00 – Clearing and Grubbing

C. Section 31 22 13 – Site Grading

D. Section 32 12 16 – Asphalt Concrete Pavement

E. Section 32 13 13 – Concrete Pavement

1.4 DEFINITIONS

A. Subgrade: The uppermost surface of an excavation, including excavation for trenches, or the top surface of a fill or backfill immediately below base course, pavement, or topsoil materials.

B. Backfill: Soil material or controlled low-strength material used to fill an excavation.

C. Base Course: The layer placed between the subgrade and surface pavement in a paving system.

D. Geotechnical Engineer: Person or company contracted by the owner and/or through the architect to provide testing and onsite Geotechnical services during the construction schedule.

1.5 SUBMITTALS

A. None required for this section.

1.6 PROJECT CONDITIONS

*[PROVIDE A NARRATIVE IN THIS SECTION IF THE PROJECT SCOPE REQUIRES SUCH. IF NOT, NOTE (NOT USED) NEXT TO 1.6 PROJECT CONDITIONS]

1.7 QUALITY ASSURANCE

A. Codes and Standards: Perform earthwork complying with requirements of authorities having jurisdiction.

B. Testing and Inspection Service: Owner will employ a qualified independent geotechnical engineering testing agency to classify proposed on-site and borrow soil materials to verify that soils comply with specified requirements and to perform required field and laboratory testing. Contractor responsible to coordinate with the testing agency prior to start of work requiring testing so as to minimize unnecessary cost or delays to the project.

C. Testing:

1. Owner will retain and pay a qualified Geotechnical engineer to take all field samples and do all laboratory testing necessary to verify compliance of the work to these Specifications or as required by City or other regulatory agencies. The Geotechnical Engineer shall submit results of all testing done during the course of the work to the Owner, Architect, and Contractor.

2. Notify testing lab a minimum of 48 hours in advance of the time testing is required to satisfy requirements of this section.

3. Should testing specified above show work which does not satisfy these Specifications, the Contractor shall pay, through the Owner, for all additional tests required to determine the extent of work that is not satisfactory and for all additional tests necessary to demonstrate compliance with these specifications.

4. All tests shall be performed by the Geotechnical Engineer in accordance with ASTM D 698, D1556, or other test method selected by Geotechnical Engineer.

PART 2 - PRODUCTS

2.1 LIME SLURRY

A. Lime slurry for use in treating the subgrade shall conform to the chemical and physical requirements listed in Tables 1 and 2 of TxDOT Departmental Material Specification (DMS) 6350 for Commercial Lime Slurry. Lime Slurry may be prepared at the job site or other Owner approved location by using Hydrated Lime or Quicklime as specified by chemical and physical requirements in Tables 1 and 2 of TxDOT Departmental Material Specifications (DMS) 6350.

2.2 WATER

A. Water used for mixing or curing shall be reasonably clean and free of oil, salt, acid, alkali, sugar, vegetable matter or other substances injurious to the finished product.

B. Water sources other than the local municipal domestic water supply must be approved by the Owner.

C. If onsite reclaimed water sources are used, tanks and apprentices must be clearly marked with the words “non-potable” water.

2.3 SOIL

A. Soil should be a clayey type soil, free of organic material, large rocks and other unsuitable materials with a plasticity index greater than 15 and a liquid limit in excess of 30. The soil should not contain more than twenty percent sands or silts.

PART 3 - EXECUTION

3.1 GENERAL

A. Construction methods shall conform to the applicable specifications of the TxDOT specifications, Item 260, Lime Treatment.

B. Lime shall be spread only on that area where the first mixing operations can be completed during the same working day.

3.2 APPLICATION

A. The percent of lime to the dry weight of the soil shall be a minimum of five (5) percent. Refer to the Project Geotechnical Report.

[*CHECK WITH GEOTECHNICAL REPORT FOR EXCEPTIONS.]

B. The lime shall be mixed with water in trucks with approved distributors and applied as a thin water suspension or slurry.

C. The distribution of lime shall be uniformly placed in such quantity that all soil to be treated receives the minimum percentage of lime and successive passes made until the proper moisture and lime content is obtained.

D. The distributor truck shall be equipped with an agitator which will keep the lime and water in uniform mixture unless the prescribed consistency can be otherwise maintained. If an agitator is not used, a standby pump shall be available at the site for agitating the lime and water in case of delays in dispersing the slurry.

3.3 MIXING

A. The material and lime shall be thoroughly mixed by approved road mixers until a homogeneous, friable mixture of material and lime is obtained, free from all clods or lumps.

B. Immediately after the "first mixing" operation, the mixture shall be brought to the proper moisture content and sealed with a light pneumatic rubber tire roller and left to cure for 1 to 4 days, as directed by the Owner. If rework is required to obtain compaction after 72 hours of the last mixing, add 25% of the specified rate of lime.

C. After curing time the material shall be uniformly mixed. All clods shall be reduced in size by raking, blading, discing, harrowing, scarifying or other approved method.

3.4 COMPACTION

A. Compaction of the mixture shall begin immediately after final mixing and in no case later than 3 calendar days after final mixing.

B. The moisture content at time of compaction shall be at optimum to 4 percent above optimum.

*[CHECK GEOTECHNICAL REPORT AND REVISE IF NEEDED]

C. The mixture when used as pavement subgrade shall be compacted by sheepsfoot rollers or 25 ton pneumatic self-propelled rollers until a minimum density of 95 percent of Standard Maximum Density (ASTM D-698-07e1) is obtained.

D. The mixture when used for support of a building slab or foundation shall be compacted by the same method above until a minimum density of 90 percent of Standard Maximum Density (ASTM D-1557-07) is obtained.

3.5 FINISHED SUBGRADE GRADING

A. Surface of the subgrade shall not show any deviation in excess of 1/4 inch above or one inch below established subgrade elevation. Thickness of the finished subgrade shall be at least the thickness shown on the plans within ¼ inch tolerance and can exceed the thickness shown on the plans as needed to meet the needs of the project.

B. The surface shall be uniform and smooth without large clumps or voids.

END OF SECTION

SECTION 31 32 13.26 - LIME-FLY ASH OR FLY ASH STABILIZATION

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. This Section specifies the requirements for treating and stabilizing existing subgrade material or select fill material under pavements or site structures as shown on the drawings, by pulverizing, adding lime and or fly ash, and finishing to the lines and grades shown on the drawings and constructed as specified herein.

B. This section excludes work necessary for building pad preparations. Work within the building footprint and surrounding 5 feet shall be accomplished under technical specification 31 23 00 Excavation and Fill prepared by *STRUCTURAL ENGINEER].

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Drawings and general provisions of the Contract, including A-procurement and Contracting Requirements, Division 00 and Division 01 apply to this section.

B. Clearing and Grubbing: Section 31 11 00

C. Site Grading: Section 31 22 13

D. Asphalt Concrete Paving: Section 32 12 16

E. Concrete Pavement: Section 32 13 13

1.3 PROJECT/SITE CONDITIONS

A. It is the primary requirement of this specification to secure a completed course of treated material containing a uniform lime fly ash or fly ash mixture free from loose or segregated areas, or uniform density and moisture content, well bound for its full depth and with a smooth surface suitable for placing subsequent courses. It is to be the responsibility of the Contractor to regulate the sequence of his work, to process a sufficient quantity of material to provide full depth as shown on PLANS, to use the proper amounts of lime and fly ash, maintain the work, and rework the courses as necessary to meet the above requirements.

B. [LIST ANY SPECIAL CONDITIONS UNIQUE TO THIS PROJECT THAT DEAL WITH LIME-FLY ASH OR FLYASH STABILIZATION]

1.4 SUBMITTALS (Not Used)

1.5 APPLICABLE PUBLICATIONS

A. American Society for Testing and Materials (ASTM) C977-03 Standard Specification for Quicklime and Hydrated Lime for Soil Stabilization.

B. ASTM Specification C618-08 Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.

C. Texas Department of Transportation Test Method Tex-114-E, Laboratory Compaction Characteristics and Moisture-Density Relationship of Subgrade, Embankment Soils, and Backfill Material

D. Texas Department of Transportation 2004 Standard Specifications for Construction of Highways, Streets and Bridges (TxDOT) Item 420 Weighing and Measuring Equipment.

1.6 DEFINITIONS

A. Subgrade: The uppermost surface of an excavation, including excavation for trenches, or the top surface of a fill or backfill immediately below the base course, pavement, granular leveling fill, or topsoil materials.

B. Geotechnical Engineer: The Geotechnical Engineer responsible for geotechnical design and materials testing.

C. Base Course: The granular material forming the pavement base supported by the subgrade in asphalt pavement or unit paver pavement sections.

D. Embankment: soil material used to fill an excavation

1.7 QUALITY ASSURANCE

A. Codes and Standards: Perform earthwork complying with requirements of authorities having jurisdiction.

B. Testing and Inspection Service: Owner will employ a qualified independent geotechnical engineering testing agency to classify proposed on-site and borrow soil materials to verify that soils comply with specified requirements and to perform required field and laboratory testing. Contractor responsible to coordinate with the testing agency prior to start of work requiring testing so as to minimize unnecessary cost or delays to the project.

C. Testing:

1. Owner will retain and pay a qualified Geotechnical engineer to take all field samples and do all laboratory testing necessary to verify compliance of the work to these Specifications or as required by City or other regulatory agencies. The Geotechnical Engineer shall submit results of all testing done during the course of the work to the Owner, Architect, and Contractor.

2. Notify testing lab a minimum of 48 hours in advance of the time testing is required to satisfy requirements of this section.

3. Should testing specified above show work which does not satisfy these Specifications, the Contractor shall pay, through the Owner, for all additional tests required to determine the extent of work that is not satisfactory and for all additional tests necessary to demonstrate compliance with these specifications.

4. All tests shall be performed by the Geotechnical Engineer in accordance with Test Method Tex-114-E or other approved methods selected by Geotechnical Engineer.

D. Certification: (none needed)

PART 2 - PRODUCTS

2.1 LIME

A. Lime to meet the requirements of ASTM C977-03 for hydrated lime or quicklime. When Quicklime is specified, the Contractor is to select, prior to construction, the grade to be used and notify the Engineer in writing before changing from one grade to another.

2.2 FLY ASH

A. Fly ash to meet ASTM Specification C618-05, Class C. Fly ash to also have a minimum CaO content of 20 percent.

2.3 WATER

A. Water used for mixing or curing shall be reasonably clean and free of oil, salt, acid, alkali, sugar, vegetable matter or other substances injurious to the finished product.

B. Water sources other than the local municipal domestic water supply must be approved by the Owner.

1. If onsite reclaimed water sources are used, tanks and apprentices must be clearly marked with the words “non-potable” water.

2.4 SOIL

A. Soil should be a clayey type soil, free of organic material, large rocks and other unsuitable materials with a plasticity index greater than 10 and a liquid limit in excess of 30. The soil should not contain more than twenty percent sands or silts.

PART 3 - EXECUTION

3.1 EQUIPMENT

A. All machinery, tools, and equipment used are to be maintained in a satisfactory and workmanlike manner.

B. Lime and fly ash is to be stored and handled in closed weather-proof containers until immediately before distribution on the road. If storage bins are used, they are to be completely enclosed. Material in bags to be stored in weatherproof buildings with adequate protection from ground dampness.

C. If lime and/or fly ash is furnished in trucks, each truck is to have the weight of lime and fly ash verified on public scales. Scales are to conform to the requirements of the TxDOT Item 420 "Weighing and Measuring Equipment."

D. If lime and/or fly ash is furnished in bags, each bag is to bear the manufacturer's certified weight. Bags varying more than 5 percent from that weight may be rejected. The average weight of bags in any shipment, as shown by weighing 50 bags taken at random, is to be not less than the manufacturer's certified weight.

3.2 CONSTRUCTION

A. Preparation of Roadbed: Before other operations are begun, the roadbed is to be graded and shaped as required to construct in conformance with the lines, grades, thickness, and typical cross-section on the PLANS. Unsuitable soil or material to be removed and replaced with acceptable material. The subgrade to be firm and able to support, without displacement, the construction equipment and the compaction hereinafter made stable by scarifying, and aeration or adding lime and/or fly ash, and compacting until it is of uniform stability. If the Contractor elects to use a cutting and pulverizing machine to remove the subgrade material accurately to the secondary grade and pulverizing the material at the same time, there is no requirement to neither expose the secondary grade nor windrow the material. However, the Contractor will be required to roll the subgrade, as directed by the geotechnical engineer, before using the pulverizing machine and correct any soft areas that this riling may reveal. This method to be permitted only where a machine is provided, which ensures that the material is cut uniformly to the proper depth and which has cutters to plane the secondary grade to a smooth surface over the entire width of the cut. The machine to be of such design that a visible indication is given at all times that the machine is cutting to the proper depth.

B. Application: Lime to be spread only on that area where the first mixing operation can be completed during the same working day. The sequence for application of lime and fly ash to be as specified below. The application and mixing of lime or fly ash with the material to be accomplished by the methods hereinafter described as "Slurry Placing."

1. Slurry Placing: The lime or fly ash to be mixed with water in vehicles with approved distributors and applied as a thin water suspension or slurry. Quicklime to be applied with a lime percentage not less than that applicable for the grade used. The distribution of lime or fly ash as directed by the Owner to be attained by successive passes over a measured section of roadway until the proper moisture and lime or fly ash content has been secured. The distributor vehicle to be equipped with an agitator to keep the lime or fly ash and water in a uniform mixture.

C. Mixing

1. Mixing: The materials to be uniformly mixed by approved methods.

a. If the soil binder lime mixture contains clods, they are to be reduced in size by raking, blading, sinking, barrowing, scarifying, or the use of other approved pulverization methods. This shall be done in a way such that when all nonslaking aggregates retained on the No. 4 sieve are removed, the remainder of the material is to meet the following requirements when tested at the field moisture condition or dry by laboratory sieves.

1) Minimum Passing 1-3/4-inch Sieve: 100 percent.

2) Minimum Passing No 4 Sieve: 60 percent.

b. It is the intent of this specification that lime and fly ash may be spread sequentially prior to commencement of mixing operations.

c. During the interval of time between application and mixing, hydrated lime or fly ash that has been exposed to excessive loss due to washing or blowing not to be accepted for payment. Spreading, mixing, compaction, and finishing for lime-fly ash stabilized subgrade to be completed during daylight hours of the same day.

2. Mixing Procedures for Fly Ash Only: If fly ash only is to be used without lime, the following mixing procedures to apply.

   a. The raw material to be thoroughly mixed by approved road mixers or other approved equipment, and the mixing continued until a homogeneous, friable mixture is obtained, free from all clods or lumps.

   b. The fly ash to be distributed at a uniform rate and in such manner as to reduce the scattering of fly ash by wind. Fly ash not to be applied when wind conditions are such that blowing fly ash becomes objectionable to traffic or adjacent property owners. A motor grade shall not be used to spread fly ash.

   c. The material and fly ash to be thoroughly mixed by approved road mixers or other approved equipment, and the mixing continued until a homogeneous, friable mixture of material is obtained, free from all clods or lumps. If the soil bind-fly ash mixture contained clods, they are to be reduced in size by raking, blading, discing, hallowing scarifying, or the use of other approved pulverization methods. This shall be done in a way such that when all nonslaking aggregates retained on the No. 4 sieve are removed, the remainder of the material meets the following requirements when tested at the field moisture condition or dry by laboratory sieves:

      1) Minimum Passing 1-3/4-inch Sieve: 100 percent.

      2) Minimum Passing No. 4 Sieve: 60 percent.

   d. Fly ash to be applied only to such an area that all the operations can be continuous and completed in daylight.

   e. During the interval of time between application and mixing, fly ash that has been exposed to the open air for a period of 6 hours or more or to excessive loss due to washing or blowing not to be accepted for payment. It is recommended that mixing and compaction of fly ash stabilized subgrade be completed within 2 hours in order to take advantage of rapid initial set characteristics.

   f. Mixing after the addition of fly ash to be accomplished dry or with a minimum amount of water to prevent fly ash balls.

D. Compaction: Compaction of the mixture to begin immediately after adding and mixing of the last stabilizing agent and be completed within 6 hours. The material to be aerated or sprinkled as necessary to provide the optimum moisture. Compaction to begin at the bottom and continue until the entire depth of mixture is uniformly compacted by the "Density Control" method.

Description	Density
For Lime-Fly Ash or Fly Ash Treated Subgrade	Not less than 95 percent

The testing to be as outlined in Test Method Tex-114-E or other approved methods. In addition to the requirements specified for density, the full depth of the material shown on the PLANS to be compacted to the extent necessary to remain firm and stable under

construction equipment. Throughout this entire operation, the shape of the base course to be maintained by blading, and the surface upon completion to be smooth and in conformity with the typical section shown on the PLANS and to the established lines and grades.

E. Finishing, Curing, and Preparation for Surfacing: After the final layer or course of the lime-fly ash or fly ash treated subgrade, subbase, or base has been compacted, it is to be brought to the required lines and grades in accordance with the typical sections.

1. The resulting base surface to be thoroughly rolled with a pneumatic tire roller and "clipped," "skinned," or "tight bladed" by a power grader to a depth of approximately 1/4-inch, removing all loosened stabilized material from the section. The surface then to be thoroughly compacted with the pneumatic roller, adding small increments of moisture as needed during rolling. If plus No. 4 aggregate is present in the mixture, one complete coverage of the section with the flat wheel roller to be made immediately after the "clipping" operation. Surface finishing methods to be varied from this procedure provided a dense, uniform surface free of surface compaction planes is produced. The moisture content of the surface material must be maintained at optimum during all finishing operations. Surface compaction and finishing to proceed in such a manner as to produce, in not more than 2 hours, a smooth, closely knit surface, free of cracks, ridges, or loose material conforming to the crown, grade, and line shown on the plans.

2. After the lime-fly ash or fly ash treated course has been finished as specified herein, the surface is to be protected against rapid drying by either of the following curing methods for a period of not less than 3 days or until the surface or subsequent courses are placed.

    a. Maintain a thorough and continuously moist condition by sprinkling.

    b. Apply a 2-inch layer of earth on the completed course and maintain in a moist condition.

3. Completed sections of lime-fly ash or fly ash treated material in place may be opened immediately to local traffic and to construction equipment and to all traffic after the curing period, provided the lime-fly ash or fly ash treated course has hardened sufficiently to prevent marring or distorting the surface by equipment or traffic.

3.3 MEASUREMENT

A. Lime-fly ash or fly ash treatment of the subgrade, existing subbase, and existing base to be measured by the square yard to neat lines as shown on the typical sections. When dry lime or quick lime is used, the quantity of lime to be measured by the ton of 2,000 pounds dry weight. When Quicklime is used, the quantity of lime to be calculated from the required minimum percent solids based upon the use of Grade 1, Grade 2, or Grade 3 as follows.

1. Grade 1: The "Dry Solids Content" to be at least 31 percent by weight of the slurry and the quantity of lime to be calculated by the ton of 2,000 pounds based on the 31 percent, as delivered on the road.

2. Grade 2: The "Dry Solids Content" to be at least 35 percent by weight of the slurry and the quantity of lime to be calculated by the ton of 2,000 pounds based on the 35 percent, as delivered on the road.

3. Grade 3: The "Dry Solids Content" to be at least 46 percent by weight of the slurry and the quantity of lime to be calculated by the ton of 2,000 pounds based on the 46 percent, as delivered on the road.

B. Fly ash to be measured by the ton of 2,000 pounds dry weight. Fly ash may be applied in dry or in Slurry form. Moisture content in the final mix not to exceed moisture by more than 2 percent.

3.4 PAYMENT

Work performed and materials furnished as prescribed by this Item and measured as provided under paragraph 3.3A are to be paid at the lump sum price bid in the proposal.

A. Fly ash to be paid for at the unit bid per ton of 2,000 pounds for "Fly Ash," which price to be full compensation for furnishing all fly ash.

B. "Lime-Fly Ash Treated Subgrade (Density Control)" and "Fly Ash Treated Subgrade (Density Control)" to be paid for at the unit price bid per square yard of compacted subgrade.

1. Manipulation of "Lime-Fly Ash Treated Subgrade" and "Fly Ash Treated Subgrade" to be paid for at the unit price bid per square yard per Item "Manipulation of Lime, Fly Ash, and or Cement for Stabilization of Compacted Subgrade."

2. "Density Control" is required on this project. Sprinkling and rolling not to be paid for directly, but the cost of all sprinkling and rolling to be subsidiary to other bid items.

3. The unit price bid to be full compensation for all correction of secondary subgrade; for loosening, mixing, pulverizing, spreading, drying, application of lime and/or application of fly ash, water content of the slurry, shaping, and maintaining; for all manipulations required; for all hauling and freight involved; for all tools equipment, labor, and for all incidentals necessary to complete the work.

END OF SECTION

SECTION 31 41 33 - TRENCH SAFETY

PART 1 - GENERAL

A. This Section is intended to provide specifications for the minimum requirements for trench safety. The Contractor shall endeavor to insure the safety of their employees working in and around trenches and other excavations in accordance with current Occupation and Safety Health Administration (OSHA) standards and in particular, Excavations, Trenching and Shoring, Federal OSHA Standards, 29 C.F.R. part 1926, Subpart P, as amended including Final Rule, published in Federal Register Vol. 54, No. 209 Tuesday October 31, 1989 and latest amendment thereto. These specifications outline minimum standards of construction safety to be followed, but should not be construed as the means, methods and operations of construction. Where the Contractor deviates from these outlined minimum standards, the Contractor is required to submit for approval by the Owner sealed engineering plans designed by a Registered Professional Engineer in the State of Texas showing the proposed method of trench protection. A copy of the approved design shall be kept at the site.

1.1 SCOPE OF WORK

A. For all trenches in excess of five (5) feet of depth or for all trenches less than five (5) feet of depth in soils which will not stand up in vertical excavations, the Contractor shall either lay back the sides of the excavation, provide sheeting and shoring to hold the walls of the excavation in place, or use a trenching box meeting or exceeding the protection provided by the sheeting and shoring system. Trenches are defined by a horizontal width less than 15 feet. In all cases the method of trench wall protection shall be in conformance with the plans, details, and specifications. Alternate methods suggested by the Contractor for trench wall protection must be designed and sealed by a Registered Professional Engineer. Owner's approval to use an alternate Engineer’s design shall be permission to deviate from the specifications only and shall not be construed in any way to mean approval of the specific design, means or method of construction. The Contractor shall assume full responsibility for the system design the contractor uses, including those options presented in the contract documents and in these specifications.

B. If an Owner’s representative determines trench safety methods are unsafe, they can stop construction until conditions are corrected.

C. Any construction not in accordance with OSHA regulations may not be eligible for payment, and any delays in construction to bring the project within OSHA regulations will not be the responsibility of the Owner or the Engineer.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Section 31 22 13 Site Grading

B. Section 31 23 33 Trenching, Backfilling and Compaction

C. Section 33 10 00 Water Distribution System

D. Section 33 30 00 Sanitary Sewer

E. Section 33 34 00 Sanitary Force Main

F. Section 33 40 00 Drainage

PART 2 - PRODUCTS

A. Materials used for sheeting, sheet piling, cribbing, bracing, shoring, underpinning, and other structural retaining systems shall be in good serviceable condition, of good quality, of a suitable condition and grade to perform the intended use. Wood shall be sound, free from large or loose knots, and of the proper dimensions. The Contractor shall be responsible for maintaining the systems in a manner consistent with the intended design and in a manner that will prevent exposure of workers to hazards.

PART 3 - EXECUTION

3.1 GENERAL SAFETY REQUIREMENTS

A. The work area shall be kept free of hazards to the employees. All surface encumbrances which may create a hazard shall be removed, supported or otherwise isolated as necessary to safeguard employees.

B. The Contractor shall take special precautions to locate existing utilities and to protect those systems as required. The Contractor shall call the Utility Coordinating Committee as required 24 hours prior to excavating around existing utilities.

C. The Contractor shall provide safe access and egress to excavations. Ramps or stairways shall be structurally sound and capable of providing a safe means of escape from the excavation. Trenches in excess of four (4) feet in depth shall have a safe means of egress from the trench spaced such that no more than 25 feet of lateral travel would be required to reach the egress system.

D. The employees shall be protected from work place hazards such as vehicular traffic, falling loads, and hazardous atmosphere. Excavations shall be marked so that employees and equipment are clearly warned of the location of the excavations. Trenches shall be kept free of water accumulations that would present a hazard to employees. Adjacent structures shall be stabilized as necessary so as not to present a possible hazard to the employees. Equipment shall be kept sufficiently clear of excavations so as not to create a potential overburden stress to trench walls causing cave-ins. Safe access shall be provided with handrails where access over trenches is required.

E. Emergency rescue equipment as required by OSHA shall be readily available at the site and shall be maintained to good working condition.

F. Daily inspections of excavations, the adjacent areas, and the protective systems shall be made by a person or persons competent to make such inspections to keep the Contractor notified of unsafe conditions so that necessary precautionary actions can be taken.

3.2 TRENCH WALL LAYBACK

A. General

In areas where no pavement or other structural elements are to be constructed, the sides of the trenches over five (5) feet deep may be sloped to provide protection from cave ins. If written approval is given by the Owner, trenches beneath pavement or other structures may

also be laid back. Backfill for laid back trenches shall be as provided for a vertical wall trench for the full width of the excavation.

B. Layback Slope Requirements

1. The Contractor shall be responsible for providing the proper lay back slopes for all soil conditions encountered. Where soils data is provided for the Contractor's use, that information is intended as a sampling of the types of soils materials that may be encountered; however, the Contractor shall be diligent in observing the actual soil conditions as the work proceeds and shall be responsible for providing a safety system adequate to meet the minimum standards for the actual types of soils encountered. Special precautions shall be taken to monitor conditions when working in fill areas, areas subject to surcharge and areas exposed to vibrations from nearby equipment and machinery.

2. At the Contractor's option where a layback trench system is approved for use, the Contractor may layback the sides of the trench at a slope of one and one-half (1-1/2) feet horizontal to one (1) foot vertical without testing for the soil's stability. When this method is used, it does not preclude the removal of unsuitable materials encountered and replacement with suitable materials. This method shall not be used in unsuitable soils such as wet sands, silts, peat or in other areas which require special procedures, equipment and materials.

3. The Contractor may engage a competent person in the means of soil classification to determine the soil classification as a means of reducing the trench wall slopes. Layback slopes may be sloped up to the maximum allowable slopes as follows for the given types of soil.

MAXIMUM ALLOWABLE SLOPES

Soil Materials	For Excavations Less than 20 Feet Deep [c] Slope H:V	
Stable Rock	Vertical	(90°)
Type A-[b]	3/4:1	(53°)
Type B	1:1	(45°)
Type C	1 1/2:1	(34°)

Notes:

a) Numbers shown in parentheses next to maximum allowable slopes are angles expressed in degrees from the horizontal. Angles have been rounded off.

b) A short-term maximum allowable slope of 1/2H:1V (63°) is allowed in excavations in Type A soil that are 12 feet (3.67 m) or less in depth. Short-term maximum allowable slopes for excavations greater than 12 feet (3.67 m) in depth shall be 3/4H:1V (53°).

c) Sloping or benching for excavations greater than 20 feet deep shall be designed by a registered professional engineer.

4. The types of soil given in paragraph 3.2.B are defined as follows:

a) Stable Rock - Natural solid mineral matter that can be excavated with vertical sides and remain in tract while exposed.

b) Type A - Cohesive soils with an unconfined compressive strength of 1.5 tons per square foot or greater. Examples of cohesive soils are: clay, silty clay, sandy clay, clay loam and in some cases, silty clay loam and sandy clay loam cemented soils such as caliche and hard pan are also considered Type A. However, no soil is Type A if:

i. The soil is fissured.

ii. The soil is subject to vibration from heavy traffic, piling driving, or similar effects.

iii. The soil has been previously disturbed.

iv. The soil is part of a sloped, layered system where the layers dip into the excavation on a slope of four horizontal to one vertical or greater.

v. The soil is subject to other factors that would require it to be classified as a less stable material.

c) Type B - Soil that meets one of the following:

i. Cohesive soil with an unconfined compressive strength greater than 0.5 tons per square foot, but less than 1.5 tons per square foot.

ii. Granular cohesionless soils including: angular gravel, silt, silt loam, sandy loam and in some cases, silty clay loam and sandy clay loam.

iii. Previously disturbed soils except those which would otherwise be classified as Type C soil.

iv. Soil that meets the unconfined compressive strength or cementation requirements for Type A, but is fissured or subject to vibration.

v. Dry rock that is not stable.

vi. Material that is part of a sloped, layered system where the layers dip into the excavation on a slope less steep than four horizontal to one vertical, but only if the soil would otherwise be classified as Type B.

d) Type C - Soil that meets one of the following:

i. Cohesive soil with an unconfined compressive strength of 0.5 tons per square foot or less.

ii. Granular soils including: gravel, sand and loamy sand.

iii. Saturated or submerged soil.

iv. Submerged rock that is not stable.

v. Soil in a sloped, layered system where the layers dip into the excavation on a slope of four horizontal to one vertical or greater.

5. Unconfined compressible strength shall mean the load per unit area at which a soil will fail in compression. It can be determined by laboratory testing, estimated in the field using a pocket penetrometer, or other previously approved methods.

6. Wet soil shall mean soil that contains significantly more moisture than moist soil, but in such a range of values that cohesive material will slump or begin to flow when vibrated. Granular material that would exhibit cohesive properties when moist will lose those cohesive properties when wet.

7. Layered systems shall be classified in accordance with its weakest layer; however, each layer may be classified individually where a more stable layer lies under a less stable layer.

8. Previously classified material whose properties, factors, or conditions affecting its classification change in any way shall be reclassified as necessary and changes to the trench safety plan shall be accomplished before continuing any work in or near the trench where there may be potential danger to workers due to trench failure.

9. The slope of a laid back trench wall shall be less steep than the maximum allowable slope when there are signs of distress. The maximum allowable slope for a material in distress shall be 1/2 horizontal to one vertical or less steep than the maximum allowable slope for the material in a non-distressed condition. Distress shall mean a condition in which a cave-in is imminent or likely to occur.

10. When surcharge loads from adjacent structures, stored material or equipment, operating equipment, or traffic are present, a competent person shall determine the degree to which the actual slope must be reduced below the maximum allowable slope, and shall assure that such a reduction is achieved.

11. An adequate means of exit such as a ladder or steps shall be provided and located so as to require no more than 25 feet of lateral travel to exit the trench.

3.3 TIMBER SHORING

A. General

Timber shoring may be used as a means of trench protection from cave-ins in trenches that do not exceed 20 feet in depth. The timber shoring system may be used in lieu of sloping and benching systems, or in conjunction with those systems. Good judgment shall be used by the Contractor in selecting the proper system when alternative designs are given.

B. Soil Classification

The timber shoring system designs are subject to soil classifications outlined in 3.2.B.4 of this section. Classification shall be conducted by a competent person using the proper means and methods of classification as described in this section.

C. Basis and Limitations

1. Dimension of Timber Members

    a) The sizes of the timber members shown in the details are taken from the National Bureau of Standards (NBS) report, "Recommended Technical Provisions for Construction Practice in Shoring and Sloping of Trenches and Excavations." In addition where NBS did not recommend specific sizes for members, member sizes are based upon an analysis of the sizes required for use by existing codes and an empirical practice.

    b) The required dimensions of the members listed in the tables refer to actual dimensions and not nominal dimensions of the timber.

2. Limitation of Application

    a) It is not intended that the timber shoring specification apply to every situation that may be experienced in the field. This data was developed to apply to situations that are anticipated to be present at the site. Where the system provided does not meet the requirement of the actual conditions in the field, the Contractor shall either notify the Owner of the situation and present an engineered solution designed and sealed by the Registered Professional Engineer, or shall notify the Owner of the unanticipated conditions and await instructions.

    b) When any of the following conditions are present, the members specified and shown in the details are not considered adequate.

        i. When loads imposed by structures or by stored material adjacent to the trench weigh in excess of the load imposed by a two foot soil surcharge. Adjacent shall mean the area within a horizontal distance from the edge of the trench equal to the depth of the trench.

        ii. When vertical loads imposed on crossbraces exceed a 240 pound gravity load distributed on a one foot section of the center of the crossbrace.

        iii. When surcharge loads are present from equipment weighing in excess of 20,000 pounds.

        iv. When only the lower portion of a trench is shored and the remaining portion of the trench is sloped or benched unless:

            (1) The sloped portion is sloped at an angle less steep than 3H:1V;

            (2) The members are selected from the tables based upon the total trench depth from the top of the overall trench and not the toe of the slope.

3. Cross braces or trench jacks shall be placed in true horizontal position, be spaced vertically, and be secured to prevent sliding, falling or kickouts.

4. Backfilling and removal of trench supports shall progress together from the bottom of the trench. Jacks or braces shall be released slowly and, in unstable soil, ropes shall be

used to pull out the jacks or braces from above after employees have cleared the trench.

5. An adequate means of exit shall be provided such as a ladder or steps and shall be located so as to require no more than 25 feet of lateral travel to exit the trench.

6. Where necessary due to wet soils or other similar conditions, the shoring system shall use tight sheeting such that material is contained behind the sheeting.

3.4 ALTERNATIVE SHORING SYSTEMS

A. General

Alternative shoring systems may be used when approved by the Owner. Steel, aluminum or other approved materials may be used in lieu of wood for shoring where the system is designed, constructed and maintained in a manner that will give equal to or greater protection than the wood system.

B. Sheet Piling

Sheet piling may be used when approved by the Owner to shore the sides of the trench. Sheet piles shall be removed at the completion of the work unless otherwise directed by the Owner. When piling is to remain, the piling shall be cut off at least three feet from the top of the excavation or at least three feet from the top of the proposed finished grades, whichever is lower. The sheet piling system shall be designed by a Registered Professional Engineer and shall provide equal or greater protection than the specified wood shoring system. Materials for the piling shall be approved by the Owner.

C. Trench Boxes

Trench boxes that provide equal or greater protection as the specified wood shoring system may be used. The Contractor shall be responsible for insuring the adequacy, maintenance, and design of the trench box used. The Contractor shall also be responsible for the proper use and operation of the trench box.

D. Shield Systems

1. General

a) Shield systems shall not be subjected to loads exceeding those which the system was designed to withstand.

b) Shields shall be installed in a manner to restrict lateral or other hazardous movement of the shield in the event of the application of sudden lateral loads.

c) Workers shall be protected from the hazard of cave-ins when entering or exiting the areas protected by shields.

d) Workers shall not be allowed in trenches or shields when shields are being installed, removed, or relocated.

2. Excavations of earth material to a level not greater than two feet below the bottom of a shield shall be permitted, but only if the shield is designed to resist the forces

calculated for the full depth of the trench and there are no indications while the trench is open of a possible cave-in below the bottom of the shield.

3. Use of shields shall be subject to approval by the Owner.

END OF SECTION

SECTION 31 63 16 – AUGER CAST GROUT PILES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division- 01 Specification sections, apply to work of this section.

B. Information concerning a sub-surface soil investigation by an independent testing laboratory is available and will be furnished by the owner upon request. The data included therein may be used by the Contractor for his general information only. The Architect/Engineer will not be responsible for the accuracy or applicability of the data therein.

1.2 SCOPE OF WORK

A. The Pile Contractor shall furnish all materials, labor, services, equipment and shall install and cut off all piles at the locations and depths shown on the drawings or as otherwise directed by the Owner's Geotechnical Engineer. The piles shall be installed to have minimum working capacity as indicated in the General Notes on the drawings. The piles shall be free of defects, mud inclusions, voids, or other anomalies which can adversely influence pile performance.

B. The Pile Contractor shall furnish and place all reinforcing steel, dowels, and anchor bolts as shown on the drawings.

C. The Pile Contractor shall furnish all materials and labor as required to perform the load tests as specified herein and on the drawings.

D. The General Contractor shall provide all necessary excavation, sheeting and bracing or other adequate maintenance of excavation banks, suitable runways and ramps as necessary for pile driving, control of ground and surface water as necessary to keep the work area sufficiently dry, suitable access roads for movement of equipment and materials to and from pile locations, field layout required for pile work including setting and maintaining a location stake for each pile and giving cut-off grades on all piles, and removal of all overhead and underground obstructions as required.

1.3 INSTALLATION

A. Auger cast piles shall be placed by rotating a continuous flight hollow shaft auger into the ground to a predetermined pile depth or as otherwise directed by the Owner's Geotechnical Engineer. High-strength cement-base non-shrink grout shall be pumped with sufficient pressure through the auger shaft as the auger is withdrawn to fill the augered hole preventing hole collapse and any infiltration of soil into the hole and to cause the lateral penetration of the grout into soft or porous zones of the adjacent soil. A head of grout at least five feet above the

point of injection shall be maintained at all times during the pumping process so that the grout has a displacing action removing any loose material and maintaining the shape of the hole. This method of displacement shall be used at all times and shall not be dependent on whether the hole is sufficiently stable to retain its shape without support from the earth filled auger. Where reinforcement is shown on the drawings to be placed in the pile, it shall be placed while the grout is in a fluid state.

1.4 QUALIFICATIONS

A. Piles shall be installed only by a specialty Pile Contractor with suitable equipment, competent personnel, and a reputation of satisfactorily performing the work. He shall have a minimum of five years auger cast pile experience and a minimum of five successful pile installations on projects comparable in scope to this project. Evidence of compliance with this section shall be submitted to the Architect/Engineer prior to entering into a contract for the work.

1.5 QUALITY ASSURANCE

A. The Contractor is responsible for quality control, including workmanship and materials furnished by his subcontractors and suppliers.

B. The Pile Contractor shall comply with all provisions of the local building code and all other codes and standards specified on the drawings.

1.6 JOB CONDITIONS

A. Site Information:

1. Data on indicated subsurface conditions are not intended as representations or warranties of continuity of such conditions. It is expressly understood that Owner will not be responsible for interpretations or conclusions drawn from there by the Contractor. The data are made available for convenience of the Contractor.

2. Additional test borings and other exploratory operations may be made by the Contractor at no additional cost to the Owner. Notify and obtain approval from Owner prior to drilling borings.

B. Protection of Existing Structures: Protect structures, underground utilities and other construction from damage caused by pile augering operations.

C. Survey of Existing Structures: When structures are adjacent to pile augering operations record and report to Architect/Engineer surveyed elevation bench marks on structures where directed by Architect/Engineer before commencing work. Record and report elevation of each bench mark at least twice a day while pile augering is in progress. Should bench mark readings indicate displacement, halt drilling operations until corrective action has been provided and is acceptable to Architect/Engineer and Owner.

1.7 SUBMITTALS:

A. Drilling Records: The Pile Contractor and the Owner's Geotechnical Engineer shall each submit copies of the drilling record of each pile to the Architect/Engineer not later than 48 hours after drilling. The reports shall indicate the name of job, name of pile contractor, and drilling superintendent. For each pile installed, the report shall include the following information: pile location, pile number, pile diameter, actual tip elevation; actual surface elevation (top of grout), pile length, theoretical volume of grout, actual volume of grout placed, reinforcing steel size and depth actually placed, drilling start and finish time, grouting start and finish time, amount of drop in grout level in 24 hours, and a report of any unusual occurrences affecting pile performance. Notify the Architect/Engineer immediately by telephone when the grout level for any pile drops within 24 hours after installation. Reports prepared by the Owner's Geotechnical Engineer shall be compiled and signed by a registered professional engineer in the state of Texas. Reports prepared by the Pile Contractor shall be compiled and signed by the drilling superintendent.

B. Load Test Reports: The Owner's Geotechnical Engineer shall submit copies of test reports for each load test within 48 hours after completion of tests. The report shall include pile load test capacity, compressive test reports of the pile grout, tabular and graphical presentation of gross and net settlement of the pile top, pile data as prescribed in the previous section, and recommendations for production pile installation.

C. Alternates: The Pile Contractor shall submit his bid based on the specifications as written without exceptions. He may submit bids for alternates to the specifications or modifications to the design, load test program, or installation specifications for consideration by the Architect/Engineer and the Owner.

D. Shop Drawings: Submit shop drawings for review prior to construction. Shop drawings shall include, for each pile, grout design strength, sizes and lengths of piles, type and arrangement of reinforcing steel, dowels, and anchor bolts and total number and location of piles.

E. Calculations: Calculations sealed by a registered professional engineer in the state of Texas shall be submitted to verify any pile design and reinforcing steel different from that shown on the drawings. Installation shall not commence until such calculations have been reviewed and approved.

F. Load Test Frame: Submit shop drawings of the load test frame sealed by a registered professional engineer in the state of Texas.

G. Post Construction Survey: After completion of pile driving, the Contractor shall provide the Architect/Engineer with an as-built survey showing the actual locations of the piles at cut-off elevations. This survey shall show the plumbness of vertical piles, the slope of batter piles, and all abandoned piles and their replacements. No construction of superstructures shall commence until this survey has been reviewed and accepted by the Architect/Engineer. In order to facilitate the progress of the Work, the Contractor shall submit partial pile surveys for approval as the Work proceeds.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Grout: The cement-base non-shrink grout used to fill the augered hole shall consist of a mixture of Portland Cement, fine aggregate (sand), mineral filler (where used), fluidifier, and water. The grout shall be proportioned and mixed so as to be capable of maintaining solids in suspension without appreciable water gain and will penetrate and fill any voids in the foundation soils. The twenty-eight day compressive strength, as determined by grout cube tests, shall be 5000 psi minimum unless shown otherwise on the drawings. The grout mix design shall be prepared by the Pile Contractor and shall be reviewed and approved by the Owner's Testing Laboratory at least 15 days prior to use on the job.

B. Portland Cement: Portland cement shall conform to ASTM C150.

C. Fine Aggregate: Fine aggregate (sand) shall consist of hard, dense, durable, uncoated rock particles free from injurious amounts of silt, loam, lumps, soft or flaky particles, shale, alkali, organic matter, mica, and other deleterious substances and shall meet the requirements of ASTM C33. The sand shall be well graded from fine to coarse, with a fineness modulus between 1.4 and 3.4.

D. Mineral Filler: Mineral filler, when used, shall conform to ASTM C618 and shall be finely powdered silicous material which possesses the property of combining with the lime liberated during the process of hydration of Portland cement.

E. Fluidifier: Fluidifier shall be a compound possessing characteristics which will increase the fluidity of the grout, reduce bleeding, assist in the dispersal of cement grains, and neutralize the setting shrinkage of the grout. Acceptable products include "Interaid" as manufactured by the Grout Supply Company in Brecksville, Ohio, or other products approved by the Owner's Testing Laboratory.

F. Water: Clean, fresh, and potable.

G. Reinforcing Steel: ASTM A615, Grade 60.

2.2 AUGERING EQUIPMENT

A. The injection port through which the grout is discharged during the pile pumping procedures shall be located at the bottom of the auger below the cutting steel.

B. The auger flighting shall be continuous from the auger head to the top of the auger with no gaps or other breaks. The pitch of the auger flighting shall not exceed 9 inches.

C. Rotation of the piling leads shall be prevented by the use of a stabilizing arm.

D. A middle guide shall be used when the auger length exceeds 40 feet.

2.3 GROUT MIXING AND PUMPING EQUIPMENT

A. Only approved mixing and pumping equipment, free of oil or rust inhibitors, shall be used in the preparation and handling of the grout. All materials shall be such as to produce a homogeneous grout of the desired consistency.

B. Only ready-mix grout shall be used with an agitator of sufficient size between the ready-mix truck and the grout pump to insure a homogeneous mix and continuity in the pumping operations.

C. The grout pump shall be a positive displacement piston type pump with the capability of developing displacing pressures up to 400 psi at the pump. The pump shall have a pressure gauge in good working condition which indicates grout pumping pressure. The pump shall be equipped with a device to determine the volume of grout pumped into each pile. The minimum volume of grout placed in the pile hole shall at least equal the volume of the augered hole.

D. Additional standby grout equipment shall be maintained at the job site to prevent abandonment of piles if breakdowns occur.

PART 3 - EXECUTION

3.1 INSPECTION

A. The Pile Contractor shall examine the conditions under which piles are to be installed and shall notify the General Contractor in writing of conditions detrimental to proper and timely completion of the work. The Pile Contractor shall not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to him.

3.2 PRE-AUGERING WORK:

A. Site Conditions: Do not auger piles until earthwork in area which piles are to occupy has been completed, as follows:

1. Excavations: Earth excavation will be stopped at an elevation of 6" to 12" above bottom of footing before piles are drilled. Final excavation of required elevation of footing bottoms will be done as part of earthwork for buildings, after piles have been augered and tested.

2. Fills: Fills will be constructed and compacted to elevation of grade indicated on the drawings.

B. Pile Length Markings: Mark each auger length with a horizontal line at 1'-0" intervals, and the number of feet from tip at 5'-0" intervals.

3.3 AUGER CAST PILE EXCAVATION

A. Requirements:

1. Excavate holes for auger cast piles to required bearing strata or elevation as shown on the drawings, unless directed otherwise by the Owner's Geotechnical Engineer. Final auger cast pile elevations different from those shown on the drawings will be paid for in accordance with contract conditions relative to changes in the work.

2. Adjacent auger cast piles shall not be installed until the grout in any existing piles has attained its initial set to insure that there will be no interconnection between piles.

3. Maintain top of auger cast pile at the proper elevation shown on the drawings and do not allow grout overflow beyond pile configuration without cleaning pile top of excess grout. Top of pile shall be square and shall not be contaminated with soil.

4. Metal sleeves of the proper diameter and at least 18 inches in length shall be placed around the pile top to prevent contamination by foreign material.

5. The minimum volume of grout pumped into each pile shall at least equal the theoretical volume of the augered hole.

B. Drilling Tolerances:

1. Location: Locate center of gravity of each single pile or pile groups within 3" from specified location. Locate piles under walls within 1" from specified locations.

2. Plumbness: Piles shall not be out of plumb by more than 1.5% of length.

3. Grout Cut-Off Elevation: Plus 0" to minus 3".

4. Batter Angle: Maintain 1" in 10'-0" from required angle.

C. Piles with Drop in Grout Level: Piles that show a drop in grout level more than 1" in 24 hours shall be abandoned unless tested and approved otherwise by the Owner's Geotechnical Engineer. Pile capacity may be downgraded as determined by the Owner's Geotechnical Engineer.

D. Damaged or Misplaced Piles: Damaged piles, piles with a drop in grout level, or piles placed outside specified tolerances will not be accepted. Such piles shall be reported to the Architect/Engineer by the Contractor and the Owner's Testing Laboratory prior to augering new piles so that they may be evaluated and a possible redesign implemented. Cost of re-engineering shall be borne by the Pile Contractor.

1. Abandon piles rejected after drilling and backfill hole if required with approved cohesionless soil, placed and compacted throughout the length. Replace with new piles as directed by the Architect/Engineer and the Owner's Geotechnical Engineer.

2. Drill additional pile or piles where centerline tolerance is exceeded and redesign indicates the load on any pile exceeds 110% of design load, unless directed otherwise by the Architect/Engineer.

E. Obstructions: If rocks, boulders, timbers, bricks, or other unforeseen obstructions are encountered during the drilling operation that causes auger refusal (penetration rate of the earth augering equipment less than one foot per minute), then such piles shall be completed to the refusal depth and paid for on the unit basis specified in the contract. Additional piles, if required, as determined by the Owner's Geotechnical Engineer, shall be added and paid for in accordance with the contract basis for changes in the work.

F. Overexcavation: No payment will be made for extra length of auger cast piles when they are installed to a greater depth than required or as authorized by the Owner's Geotechnical Engineer. Overexcavated piles will be measured and paid for in accordance with the original design or authorized depth.

G. Excavated Material:

1. Remove excavated material and dispose of it off site.

3.4 GROUT PLACEMENT

A. All grout shall be ready-mix grout from a batch plant in accordance with the requirements of ASTM C94.

B. Stop grout placement at cut-off elevation shown, screed level, and apply a scoured, rough finish. Where cut-off elevation is above ground level, form top section above grade and extend pile, with proper reinforcing steel splices, as specified.

C. The operation of augering and grouting shall be uninterrupted. If interruptions occur and continuity of pile in its full cross-section cannot be assured then the pile shall be abandoned at the discretion of the Owner's Geotechnical Engineer.

D. Hot Weather Placement: Grout shall not exceed a temperature of 90°F during mixing or pumping. The mixing water shall be cooled as required to maintain this temperature limit.

E. Cold Weather Placement: Outside air temperature shall be 40°F and rising for the grouting operation unless special precautions, as approved by the Owner's Testing Laboratory, are maintained to keep the grout at 55°F or higher.

3.5 REINFORCING STEEL PLACEMENT

A. Before placing, clean reinforcing steel and dowels of loose rust, scale, dirt, grease, and other material which could reduce or destroy bond.

B. For piles with a single reinforcing bar specified, place bar during grouting operation. Maintain bar at center of pile for specified depth.

C. For piles with reinforcing cages specified, fabricate and erect cages as one continuous unit. Securely tie cage together with adequate ties (above that shown on the drawings if required) and with interior cross ties as required to maintain proper shape. Provide cage with guiding devices between cage and pile circumference along the pile length to insure minimum 3" cover to cage. Detail such devices on the shop drawings. Work cages into final position without bar misplacement after grout is placed and still in a fluid state.

D. Use templates to set anchor bolts and dowels. Protect exposed ends of dowels and anchor bolts from mechanical injury and exposure to weather.

3.6 PILE LOAD TEST

A. Perform load tests to verify design pile lengths and loads. Provide complete testing materials and equipment as required. Notify the Architect/Engineer in ample time before performing tests and perform tests only in the presence of the Owner's Geotechnical Engineer.

B. Test piles, furnished and installed by the Pile Contractor to determine pile criteria, may be located, cut off, and become part of foundation system provided they conform to contract requirements and are approved by the Owner's Geotechnical Engineer.

C. Test Piles Required:

Provide one single test pile as directed by the Owner's Geotechnical Engineer.

D. Drilling Test Piles:

1. Use test piles of same size and design as required for the project, and install with the same equipment as will be used in drilling permanent piles.

2. Install test piles at locations and to the depths as specified by the Owner's Geotechnical Engineer.

E. Pile Design Load: Design load per pile is shown on drawings.

F. Test Loads:

1. Load single test piles to twice required design load for each type pile.

2. Load groups of 3 test piles to 1-1/2 times load capacity of pile group.

G. Pile Load Testing: Pile test shall be at a location as determined by the Geotechnical Engineer and approved by the Architect/Engineer. Test shall be performed under the supervision of the Owner's Geotechnical Engineer. Costs of load tests shall be borne by the Pile Contractor. Design of the load test frame shall be the responsibility of the Drilling Contractor. Shop drawings of the load test frame shall be submitted for Architect/Engineer review and shall be prepared under the supervision of and sealed by a registered professional engineer in the state of Texas. Load and test piles which have been in place sufficient time to

allow concrete to attain its 28 day design compressive strength. Determine the load-settlement relationship of test piles under a vertical axial load, complying with ASTM D 1143.

1. Apply loads in increments not exceeding 25% of allowable pile load.

2. Apply test loads either by use of hydraulic jacks or by static loading. Use certified, calibrated jacks to develop the required test loads, maintain them, and release them in continuous operations. Drive anchor piles not closer than 5 ft. from any test pile or as directed by the Owner's Geotechnical Engineer.

3. Apply test loads so that allowable design load is reached in not less than 8 hours from start of load application. Maintain this load until no measurable settlement is observed in a period of 16 hours or longer, as may be required by local codes having jurisdiction. Do not apply subsequent loads until pile settlement becomes negligible.

4. After satisfactory allowable design load testing, apply additional loads so that total test load is reached in not less than 8 hours. Maintain total load until no measurable settlement is observed in a period of 16 hours, or longer as may be required by local codes having jurisdiction.

5. Measure and record settlement immediately before and after each increment of test load is applied, and immediately before and 24 hours after total load is removed.

6. The test pile will be considered as acceptable for stipulated bearing capacity if total net settlement, after deducting rebound, does not exceed 0.01" per ton of test load.

H. Test Reports:

1. Prepare reports for each test pile and include: Date of installation, test pile location, size and length of pile, grout compressive strength, tip elevation, surface elevation, theoretical and actual volume of grout, reinforcing steel size and depth placed, drilling start and finish time, grouting start and finish time, amount of drop in grout level in 24 hours, and any unusual circumstances affecting pile performance.

2. Include with the report a record of drilling equipment used.

3. Also include tabular and graphical representation of gross and net settlement of the pile top, relationship of actual load capacity to that predicted, and any recommendations for production pile installation.

3.7 APPROVAL BY GEOTECHNICAL ENGINEER

A. Approval by the Owner's Geotechnical Engineer is required on all pile installation criteria and his decision and judgment on pile length, rejection of piles, additional piles required, and all other pile installation and capacity questions shall be final.

3.8 CONTRACT BASIS

A. Basis for Bids: Bids will be based on the number, size, and length of piles shown on the drawings from tip to top of grout.

B. Basis for Payment:

1. The Contractor and the Owner's Geotechnical Engineer shall calculate the actual total length of piles installed on the job. The contract price per lineal foot shall include all labor, materials, tools, equipment, and incidentals, and for performing work for furnishing, drilling, cutting off, and capping all piles.

2. Measurements of pile lengths shall be based on effective length of acceptable piles in place with fractional lengths measured to the nearest foot. Payment for lineal footage in excess of that indicated in the bid and credit for lineal footage less than that indicated in the bid, shall be made at unit prices stated in the contract. Note that payment will be based on lengths of all the piles on the job added together for application of the unit prices and not lengths on a per pile basis.

3. Test piles that become part of completed foundation work will be considered as an integral part of the work.

4. No payment will be made for piles rejected for any reason including but not limited to piles placed out of specified tolerances, imperfect piles, piles that had a drop in grout level, piles with grout strength less than specified, misplaced or omitted reinforcing steel, and insufficient drilled length from that specified.

END OF SECTION 31 63 16

SECTION 31 63 24 – DRILLED AND UNDERREAMED FOOTINGS

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.

B. Information concerning a sub-surface soil investigation by the Owner's Geotechnical Engineer is available and will be furnished by the Owner upon request. The contractor may use the data included therein for his general information only. The Architect/Engineer is not responsible for the accuracy or applicability of the data therein.

1.2 DEFINITIONS

A. Casing: Steel cylinder used to resist earth and water pressures, to serve as concrete form, and to protect personnel.

B. Dry Method: A method of pier installation in which concrete is placed in the dry. Casing may or may not be used to maintain sidewall stability.

C. Owner's Representative: The Architect, Structural Engineer, or Geotechnical Engineer authorized to act on behalf of the Owner.

D. Owner's Representative- Geotechnical Engineer: The Geotechnical Engineer specifically authorized to carry out the responsibilities defined in this specification.

E. Probe hole: A 1.6 to 2.5 inch diameter hole usually drilled by air percussion methods to a required depth below the pier bottom. The Geotechnical Engineer feels the probe hole by lowering and raising a hooked rod. The size and amount of seams found enables the determination of the soundness of the subsurface formation.

F. Tremie method: Procedure for placing concrete under water or slurry using a watertight steel pipe or tube to place concrete without washing out cement fines.

1.3 STANDARDS

A. The following Standards are listed in this specification:

ASTM A36	Standard Specification for Carbon Structural Steel
ASTM A283	Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates
ASTM A929	Standard Specification for Steel Sheet, Metallic-Coated by the Hot-Dip Process for Corrugated Steel Pipe
ASTM C33	Standard Specification for Concrete Aggregates
ASTM C94	Specification for Ready Mixed Concrete
ASTM C150	Specification for Portland Cement
ASTM D1143	Standard Test Method for Piles Under Static Axial Compressive Load

1.4 SCOPE OF WORK

A. The Drilling Contractor shall furnish all labor, materials, services, equipment (including temporary casings where required), and shall install all piers at the locations and depths shown on the drawings or as otherwise directed by the Owner's Geotechnical Engineer. Installation methods compatible with the design may be used if acceptable to the Owner's Geotechnical Engineer. Methods that are not compatible with the design shall be excluded from consideration.

B. The Drilling Contractor shall furnish and place all reinforcing steel, dowels, and anchor bolts that are shown on the drawings to be embedded in the pier.

C. The Drilling Contractor shall furnish all materials and labor as required to perform the load tests as specified herein and on the drawings.

D. The General Contractor shall provide all necessary excavation, sheeting and bracing or other adequate maintenance of excavation banks, suitable runways and ramps as necessary for access of pier drilling, control of ground and surface water as necessary to keep the work area sufficiently dry, suitable access roads for movement of equipment and materials to and from pier locations, field layout required for pier work including setting and maintaining a location stake for each pier and giving cut-off grades on all piers, removal and replacement of all overhead and underground obstructions as required, and coordination of all concrete ordering and delivery.

1.5 QUALIFICATIONS

A. Drilled piers shall be installed by a specialty Drilling Contractor with suitable equipment, competent personnel, and a reputation of satisfactorily performing the work. The Contractor shall have a minimum of 5 years successful experience and a minimum of 5 successful installations on projects of a similar size and scope to this project and of using similar installation methods as may be anticipated for this project. Evidence of compliance with this section shall be submitted to the Architect/Engineer prior to entering into a contract for the work.

1.6 QUALITY ASSURANCE

A. The Contractor is responsible for quality control, including workmanship and materials furnished by his subcontractors and suppliers.

B. The Contractor shall comply with all local, state, and federal statutes, including OHSHA, for drilling and excavating.

C. Codes and Standards: The Drilling Contractor shall comply with the provisions of the following codes, specifications, and standards, except where more stringent requirements are shown or specified:

1. ACI 301 - "Specifications for Structural Concrete for Buildings".

2. ACI 117 - “Specifications for Tolerances for Concrete Construction and Materials."

3. ACI 318 - "Building Code Requirements for Reinforced Concrete".

4. Concrete Reinforcing Steel Institute (CRSI), "Manual of Standard Practice".

5. ANSI/AWS D1.1 "Structural Welding Code - Steel".

6. ANSI/AWS D1.4 "Structural Welding Code – Reinforcing Steel".

In addition, all applicable building code and local regulations shall be followed. In case of conflict, the strictest interpretation shall govern.

D. Survey Work:

1. The General Contractor shall employ a qualified and licensed professional engineer/land surveyor to perform all surveys, layouts and measurements for drilled pier work including the layout of anchor rods and/or reinforcing steel dowels embedded in drilled piers. The surveyor shall conduct the layout work for each drilled pier to the lines and levels required prior to beginning excavation and shall make actual in-place measurements of each drilled pier plan location, shaft diameter, bottom and top elevations and deviations from specified tolerances.

2. The surveyor shall record and submit all information pertinent to each drilled pier and cooperate with other testing and inspection personnel to provide data for all required reports.

E. Testing Laboratory Requirements: The Drilling Contractor shall cooperate with all testing and inspection personnel employed to perform field quality control tests and inspections. See Testing Laboratory section of the specifications for required tests and inspections to be performed by the Testing Laboratory and Geotechnical Engineer.

Inspection or testing by the Owner does not relieve the Contractor of his responsibility to perform the Work in accordance with the Contract Documents.

1.7 JOB CONDITIONS

A. Site Information:

1. Data on indicated subsurface conditions are not intended as representations or warranties of continuity of such conditions. It is expressly understood that Owner will not be responsible for interpretations or conclusions drawn therefrom by the Contractor. The data are made available for convenience of the Contractor.

2. The Contractor may make additional test borings and other exploratory operations at no additional cost to the Owner.

3. The Contractor shall inspect the site prior to drilling operations and shall determine any constraints to the work presented by the existing surface conditions and report them to the Owner’s Representative.

B. Protection of Existing Structures: Locate all existing underground structures and utilities that are to remain in service during construction. Protect above-ground structures, underground utilities and other construction from damage caused by drilling operations. Report any conflicts between drilling work and underground utilities and structures to the Owner’s Representative and do not proceed with the work until the conflict is resolved.

C. Survey of Existing Structures: Record and report to Architect/Engineer surveyed elevation benchmarks on structures where directed by the Owner’s Representative before commencing work, when structures are adjacent to drilling operations. Record

and report elevation of each benchmark at least twice a day while drilling is in progress. Should benchmark readings indicate displacement, halt drilling operations until corrective action has been provided and is acceptable to the Owner's Representative and the Owner.

1.8 PREINSTALLATION CONFERENCE

A. At least 7 days prior to beginning pier installation, the Contractor shall conduct a meeting to review the proposed excavation, inspection, and concrete and reinforcement placement methods and procedures to produce pier construction of the required quality. Also review requirements for submittals, status of coordinating work and availability of materials. Establish work progress schedule and procedures for bearing surface inspection, materials testing, and certifications. The Contractor shall send a pre-installation conference agenda to all attendees 7 days prior to the scheduled date of the conference.

B. The Contractor shall require responsible representatives of every party who is concerned with the concrete work to attend the conference, including but not limited to the following:

Contractor's Superintendent
Laboratory responsible for field material testing
Drilling Subcontractor
Ready-Mix Concrete Producer
Geotechnical Engineer
Owner's and Architect's/Engineer's Representative

C. Minutes of the meeting shall be recorded, typed and printed by the Contractor and distributed by him to all parties concerned within 5 days of the meeting. One copy of the minutes shall be transmitted to the following for information purposes:

Owner's Representative
Architect
Engineer-of-Record

D. The Engineer shall be present at the conference. The Contractor shall notify the Engineer at least 7 days prior to the scheduled date of the conference.

1.9 SUBMITTALS

A. Concrete Mix Design: Submit concrete mix designs suitable for method of concrete placement for Engineer and Owner's Testing Laboratory approval prior to pier installation.

B. Drilling Records: The Drilling Contractor and the Owner's Geotechnical Engineer or other authorized inspector shall each submit copies of the drilling record for each pier to the Architect/Engineer immediately after drilling. The reports shall indicate the name of the job, name of Drilling Contractor, and name of drilling superintendent. For each pier installed, the report shall indicate the following information:

1. Pier number and location

2. Pier shaft diameter

3. Pier underream diameter

4. Bottom elevation

5. Top elevation

6. Pier length

7. Theoretical volume of concrete in pier

8. Actual volume of concrete placed

9. Reinforcing steel size and depth actually placed

10. Drilling start and finish time

11. Concreting start and finish time

12. Variation from specified tolerances including surveyed location and plumbness

13. Construction method (dry method, or casing method)

14. Groundwater conditions (rate of water infiltration and depth of water in hole prior to concreting for dry piers; water elevation in hole for wet piers)

15. Elevation of top and bottom of any casing left in place

16. Description of temporary or permanent casing (including purpose, diameter, wall thickness and length)

17. Description and elevation of any obstructions encountered and whether removal was obtained

18. Description of pier bottom including amount and extent of loose material

19. Method of concrete placement

20. Any difficulties encountered in drilling or concreting operations

21. Any deviations from specifications.

Reports prepared by the Owner's Geotechnical Engineer or authorized inspector shall be compiled and signed by a licensed professional engineer in the state where the project is located. Reports prepared by the Drilling Contractor shall be compiled and signed by the drilling superintendent.

C. Shop Drawings:

1. Reinforcing Steel: Submit shop drawings for all drilled pier and pier cap reinforcing steel.

2. Installation Method: Submit detailed procedures of the installation method, including (where applicable) type and number of drilling rigs and equipment, casing size and length, casing removal method, drilling fluid type, dewatering method, concrete placement, and reinforcing steel securing and placement.

3. Steel Casings: Submit shop drawings for size, wall thickness, length, and grade of permanent steel casings required. Show all splices and methods of splicing.

4. Load Test Frame: Submit shop drawings of the load test frame sealed by a registered professional engineer in the state where the project is located.

D. Product Data: Submit manufacturer's product data with application and installation instructions for proprietary materials and items.

E. Load Test Reports: The Owner's Geotechnical Engineer shall submit copies of test reports for each load test immediately after completion of tests. The report shall include pier load test capacity, compressive test reports of the pier concrete, tabular and graphical presentation of gross and net settlement of the pier top, pier data as prescribed in the previous section, and specific recommendations for production pier installation.

F. Qualification Data:

1. Submit qualification data for firms and persons specified in the article entitled “Qualifications” to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

2. Submit Welding Procedure Specifications (WPS) in accordance with ANSI/AWS D1.1 for all welded joints in steel casing. Submit test reports showing successful passage of qualification tests for all non-prequalified WPSs.

3. Provide certification that welders to be employed in work have satisfactorily passed AWS qualification tests as specified. If recertification of welders is required, retesting will be at Contractor's responsibility.

G. Alternates: The Drilling Contractor shall submit his bid based on the specifications as written without exceptions. He may submit bids for alternates to the specifications or modifications to the design, load test program, or installation specifications for consideration by the Owner’s Representative and the Owner.

H. Post Construction Survey: After completion of pier placement, the Contractor shall provide the Owner’s Representative with an as-built survey showing the actual locations of the piers at the top elevations. This survey shall show the plumbness of vertical piers, and all abandoned piers and their replacements. No construction of superstructures shall commence until this survey has been reviewed and accepted by the Owner’s Representative. In order to facilitate the progress of the Work, the Contractor shall submit partial pier surveys for approval as the Work proceeds.

PART 2 - PRODUCTS

2.1 CONCRETE

Concrete shall be as specified in the "Cast-in-Place Concrete" section of the specifications, in the general notes, and on the drawings, with the additional requirements specified below:

A. Maximum Aggregate Size: Provide maximum aggregate size of three quarters of minimum clear spacing between individual reinforcing bars or bundles of bars, with 1 1/2" maximum.

B. Water Reducing Admixtures: Where required by mix design, use water-reducing admixtures in strict compliance with manufacturers' directions. Admixtures to increase cement dispersion, or provide increased workability for low-slump concrete may be used at contractor's option. Use admixtures in the amounts as recommended by manufacturer for climatic conditions prevailing at time of placing concrete. Adjust quantities of admixtures as required to maintain quality control.

C. Slump Limits: Proportion concrete to have a slump that is suitable for the placement process used. The mix must maintain flowability throughout the concrete placement time and during extraction of any temporary casing. Provide a minimum 6" slump concrete with retarder for temporarily cased piers at time of pulling casing.

2.2 REINFORCING STEEL

A. See "Concrete Reinforcing Steel" section of the specifications.

B. Reinforcing Support and Positioning Devices: Devices made of non-corrosive material that support and align reinforcing steel within the shaft and that provide the appropriate side and bottom cover to the reinforcing steel. Acceptable manufacturers include:

"Pieresearch"
"Aztec, a Dayton-Superior Company"
"Foundation Technologies, Inc."

2.3 STEEL CASING

A. Steel casing shall conform to ASTM A 283, Grade C or ASTM A 36.

B. Corrugated steel casing shall conform to ASTM A 929.

2.4 GROUT

A. Grout used for filling annular void outside permanent casings shall be sand cement grout consisting of Portland cement (ASTM C 150 Type I or III), sand (ASTM C 33), and water. Proportions by weight shall be one part cement, 2 1/4 to 2 1/2 parts sand, and the minimum amount of water required to obtain a workable mix but not exceeding a water-cement ratio of 1.0. The grout mix shall be suitable for the method of installation, whether by gravity feed or by pumping under pressure.

2.5 CONCRETE MIXING

A. Ready Mix Concrete: Comply with the requirements of ASTM C94.

B. Hot Weather Concreting: The maximum acceptable concrete temperature at the truck discharge point shall be 95°F. Refer to Hot Weather Concreting Practices specified in "Cast-in-Place Concrete" section of the specifications for required hot weather concreting practices.

C. Cold Weather Concreting Practices: Refer to the "Cast-in-Place Concrete" section of the specifications for cold weather concreting practices and the conditions under which they are to be followed.

PART 3 - EXECUTION

3.1 EXCAVATION

A. Requirements:

1. Excavate holes for drilled piers to dimensions and required bearing strata or elevations as shown on the drawings unless directed otherwise in the field by the Owner's Geotechnical Engineer.

2. Maintain sidewall stability during drilling. If sidewall instability is encountered that the Owner's Representative considers excessive, the Contractor shall use alternate drilling methods such as temporary casing.

3. Excavate holes for closely spaced piers and those occurring in fragile or sand stratas only after adjacent holes are filled with concrete and allowed to set a minimum of 6 hours or longer as required for concrete to harden unless temporary casing to maintain sidewall stability is used.

4. Drilled pier design dimensions and depths shown on the drawings shall be considered minimums and are based on bearing and/or friction in assumed strata. If bearing stratum is not capable of maintaining the assumed capacity, the foundation system shall be revised as directed by the Owner's Geotechnical Engineer and Owner's Representative. Revisions will be paid for in accordance with contract conditions relative to changes in the work. Refer to drawings for design bearing pressures, skin friction values, or pier load capacity.

5. Remove loose material and excess free water from the bottom of the shaft. Refer to the "Dewatering" section of the specifications. The bearing surface should be essentially flat within a tolerance of 1 vertical to 12 horizontal or with one step having a vertical height less than one-quarter of the diameter of the bearing area.

6. Where directed by the Geotechnical Engineer, provide a 1.6 inch to 2.5 inch diameter probe hole to a minimum depth below the bottom of the pier equal to the diameter of the bearing area.

B. Equipment:

1. Provide adequate equipment so work is expedited to the fullest extent possible. Use equipment fully capable of excavating shafts to depths, diameters, and sizes indicated, and within the specified tolerances. Maintain equipment in satisfactory operating condition and provide sufficient quantity of equipment to maintain the projected schedule of the Work.

2. Using bits or augers with a power-driven rotary-type rig, a shaft of a diameter specified on the drawings shall be excavated from the ground surface to a depth as specified on the drawings or as ordered by the Owner's Geotechnical Engineer.

C. Obstructions:

1. If rocks, boulders, or other unforeseen obstructions are encountered which cannot be removed by standard drilled pier excavation methods, and if such

obstructions are not indicated by available sub-surface data, removal of such obstructions will be paid for in accordance with the terms of the Contract relative to changes in the Work.

2. Remove such obstructions by hand labor using air-powered tools or by other safe methods recognized in the construction industry. Standard drilled pier excavation methods include the use of core barrels with pier drilling equipment.

3. The work of this Section includes demolition and removal of rock, boulders, concrete, masonry, and other subsurface obstructions that are indicated by the Contract Documents, or by the available subsurface exploration data, and such work will not be considered a change in the Work.

D. Overexcavation: No payment will be made for extra length or greater diameter of drilled piers when they are installed to a greater depth or are larger than required unless authorized by the Owner's Geotechnical Engineer. Overexcavated drilled piers will be measured and paid for in accordance with the original or authorized design depth and diameter.

E. Excavated Material:

1. Deposit and spread excavated material on site observing proper placement and compaction requirements.

2. Remove excavated material and dispose of it off site.

3.2 REQUIREMENTS FOR UNDERREAMS

A. Bell Configuration: The sides of the underream shall slope not less than

(i) 45° (60° bell may be used at contractor’s option.)
(ii) 60°

with the horizontal. The bell roof slope shall be a straight line or curve upward. The thickness of the bottom edge shall be at least (i) six inches (ii) three inches.

B. Underream to Shaft Diameter: The diameter of the underream shall not exceed three times the diameter of the shaft.

C. Test Underream: The Drilling Contractor shall install a test underream to demonstrate that the bells can be properly formed. The Geotechnical Engineer shall determine the size and location of the underream. The underream shall be formed by the same operator with the same equipment under the same conditions as will be used in the production of the piers. If approved by the Geotechnical Engineer, the underream may be used as a production pier.

Should the underream not be able to be properly installed, the foundation design will be altered and final installation approved by the Architect/Engineer.

D. Shoring of Bells: Where soil conditions are encountered which make it impractical to undercut bells to required dimensions, arch roof of bells or support with wood or steel shoring. Provide sufficient shores, resting on bearing stratum, to support earth against caving or collapse. If there is a tendency for roof to cave, leave shoring in place during concreting. Otherwise, remove shores and braces before placing concrete. When

shoring is to remain, use only vertical steel shores. Shoring shall be designed by a qualified engineer licensed in the state where the project is located.

3.3 DEWATERING

A. Provide and maintain pumping equipment to keep excavations free of water before placing concrete. An excavation is considered dry if the water rises at a rate of less than 1/4 inch per minute and the height of water at the bottom of the pier does not exceed two inches at the time of concrete placement.

B. Dewater in a manner that will not create subsidence or ground loss that might adversely affect the Work or existing adjacent structures. Should the dewatering system employed involve pumping inside the pier, extreme caution shall be used to prevent an unbalanced water head from causing a "blowout", bottom heave, or "quick" condition that could disturb the proposed bearing stratum or surrounding soil strata.

C. The dewatering method shall be submitted for review and approval of the Owner's Geotechnical Engineer.

D. Conduct water to general site run-off ditches and disposal areas with discharge lines. Provide ditching as required to conduct water to site drainage facilities.

E. If excessive water and/or sidewall instability is encountered and drilling operations must be halted, consult with Geotechnical Engineer and Owner’s Representative before using alternate methods of construction.

3.4 TEMPORARY STEEL CASINGS

A. Requirements:

1. Provide temporary casing at locations where the soil will not stand without support or where sloughing of the sides of shafts may seriously delay or endanger the satisfactory completion of excavation and placement of concrete. Also provide temporary casing at locations as directed by the Geotechnical Engineer to seal off the inflow of water into the excavation. Refer to the geotechnical report for conditions where casing may be required.

2. The Contractor shall have immediately available for use on the job an ample supply of casing for each size that will be required for use in the shafts and shall provide additional amounts, as required, to ensure the orderly progress of the job.

3. Such casing may be in short pieces but with jointing devices of sufficient strength that assembled sections of casing may be pulled complete as concrete is placed, or immediately thereafter. Provide casing of sufficient strength to withstand handling stresses, concrete pressure, and surrounding earth and/or fluid pressures. Make diameter of excavation in relation to diameter of casing such as to create a minimum of void space outside of casing. Provide casing with a minimum outside diameter equal to normal outside diameter of drilled foundations.

B. Delivery, Handling, and Storage of Casing

1. Deliver casing to site in undamaged condition.

2. Handle and protect casing to maintain diameter within plus or minus two percent.

C. Casing Withdrawal: Unless otherwise approved by the Owner's Representative, all temporary casing shall be removed from shafts as concrete is placed or immediately thereafter, and in such a manner as to prevent sloughing material from dropping to the bottoms of shafts or falling on top of freshly placed concrete. Casings shall be pulled in a single continuous smooth operation without sudden jerks or impact. Maintain head of concrete above the bottom of the casing that exceeds the soil and water pressure at all times during casing withdrawal. Do not vibrate concrete internally before the casing is withdrawn. A vibratory casing extractor may be used. Do not withdraw casing after the concrete has attained initial set. The casing withdrawal and concreting operations shall be observed by the Geotechnical Engineer.

3.5 REINFORCING STEEL PLACEMENT

A. Before placing, clean reinforcing steel and dowels of loose rust, scale, dirt, grease and other material that could reduce or destroy bond.

B. Fabricate and erect reinforcing cages in shafts as one continuous unit using inner ring reinforcing guide. Place reinforcement accurately and symmetrically about axis of hole and hold securely in position during concrete placement. The Contractor shall verify depths of drilled piers prior to cutting and tying reinforcing steel cages. Reinforcing steel shall be delivered to the site in standard 60-foot lengths and cut as required. Splice no more than 33% of the bars at any one location, alternating spliced and unspliced bars in a symmetrical pattern. Splices shall be 30 bar diameter compression splices for bars #11 and smaller and mechanical end bearing compression splices for #14 and #18 bars unless noted otherwise on the drawings. See drawings for additional splice information. The Contractor shall be responsible for adding additional reinforcing steel ties or spirals as required to ensure stability of cage and maintenance of shape and configuration as required for proper lifting, handling, and placement.

C. Provide cover to reinforcing steel of not less than 3 inches where exposed to soil and not less than 4 inches in temporarily cased piers. Provide spacer devices to maintain side and bottom cover. Devices shall be installed in accordance with manufacturer's instructions.

D. Permissible reinforcing steel upward vertical movement during casing withdrawal shall be no greater than 6 inches. Downward movement should not exceed 6 inches for every 20 feet of shaft length.

E. Use templates to set anchor bolts, leveling plates and other accessories furnished under work of other sections. A qualified and licensed Engineer/Land Surveyor shall determine the plan location and elevation of such devices. Provide spacers (capable of sliding on any temporary casings required), blocking and holding devices to maintain required position during concrete placement.

F. The General Contractor shall protect exposed ends of dowels and anchor bolts from mechanical damage and exposure to weather by wrapping and taping with polyethylene or other suitable material.

3.6 CONCRETE PLACEMENT

A. General:

1. Fill drilled piers with concrete immediately after inspection and approval by the Geotechnical Engineer or other authorized inspector. Use protection sheets (cut out to receive concrete) over excavation openings, extending at least 12" beyond edge. Complete the excavation and concrete placement in uncased excavations before the end of the workday unless the Architect/Engineer and Geotechnical Engineer grants permission to do otherwise in writing.

2. Place concrete continuously and in a smooth flow without segregating the mixed materials.

3. Place concrete by means of bottom discharge bucket, flexible drop chute, elephant trunk hopper, concrete pump, or tremie. Free fall of concrete may be used if provided for in concrete mix design and provided it is directed through a hopper or chute such that fall is down center of shaft without hitting sides or reinforcing steel. Free fall of concrete is not permitted for depths greater than the smaller of 20 times the shaft diameter or 60 feet.

4. Place concrete in-the-dry if at all possible. If water occurs, and it is impracticable to dewater drilled pier excavation, and reasonable attempts to seal off water flow have failed, allow water level to attain its normal level and place concrete by tremie method or by concrete pumping. Other methods of depositing concrete underwater may only be used if approved by Architect/Engineer.

5. Stop concrete placement at cut-off elevation shown, screed level, and apply a scoured, rough finish. Where cut-off elevation is above ground elevation, form top section above grade and extend shaft to required elevation.

6. Provide mechanical vibration for consolidation of at least top 5' of each shaft but only after any temporary casing is pulled or when casing is permanent.

7. Interrupted placing operations of over one hour duration will require a cold joint installation as follows. Leave resulting shaft surface approximately level. At resumption of concrete placing, clean off surface laitance, roughen as required, and slush with a 1-to-1 cement grout or commercial bonding agent before remainder of concrete is placed. Intentional cold joints will not be permitted.

8. Concrete shall not be placed in adjacent drilled piers located within three center-to-center shaft diameters of each other until concrete has cured a minimum of 6 hours.

9. Aluminum pipe or equipment shall not be used for placing concrete.

B. Tremie Method:

1. The drilled shafts shall be filled with concrete by the use of a tremie or concrete pump, sealed at the bottom, extending from above the ground surface to the bottom of the drilled shaft. Inspection of the empty tremie on the bottom may be requested of the Contractor by the Owner's authorized inspector. With the sealed tremie on the bottom of the shaft, the tube shall be filled to the top extending above the ground. The filled tremie shall be picked up approximately one (1) foot off the bottom of the shaft to allow the weight of the concrete to displace the seal at the bottom of the tremie. At no time is the tremie to be pulled to such a height as to clear the surface of the concrete already placed in the shaft. All concrete shall be poured through the now open tremie with care taken

to maintain a sufficient head of concrete to completely displace all water and suspended cuttings of material and to provide sufficient pressure so as to prevent reduction in pile diameter by earth pressure on the fresh concrete. The concrete in each pile shall be carried above cut-off elevation and then dipped out while fresh to cut-off elevation.

2. All concrete shall be deposited through the tremie or pump line so as to provide a continuous flow, without aggregate segregation, from bottom to top of pile. The production and delivery of the ready-mixed concrete shall be such that not more than 45 minutes shall elapse between the depositing of successive batches of concrete to ensure a monolithic unit of concrete. No deviation from this method will be acceptable.

3. Should the surface of the concrete in the shaft be breached by the tremie or pump line, the tube shall immediately be withdrawn from the hole, re-sealed and re-lowered below the surface of the concrete, and pouring operations re-started. Should the Owner's authorized inspector deem it necessary, the Contractor shall instead retrieve the reinforcing steel cage, redrill the shaft to reopen the hole, and begin the concreting operations from the bottom of the pier shaft.

4. If the Owner's authorized inspector has reason to suspect that the concrete was breached by the tremie or pump line or that the pier, for any other reason, may contain extraneous material or otherwise fail the specifications, he may order the pier cored for inspection and/or testing. If the core recovery and/or test results indicate non-compliance with the specifications, the Contractor shall bear the expense of the investigation and/or testing and shall also, at no cost to the Owner, install proper additional construction as required by the Architect/Engineer. Should the investigation and/or testing indicate compliance with the specifications the Owner shall bear the cost of such investigation and/or testing.

C. Hot and Cold Weather Placement: Refer to Part II.

3.7 CONSTRUCTION TOLERANCES

A. Plan Location: The tolerance on plan location for the top of the drilled pier shall not be more than 1/24 of the pier diameter or 3" in any direction, whichever is less. If the as-installed shaft is larger than required, the center of the shaft may be taken as the center of a shaft having the required area that lies wholly within the as-installed shaft.

B. Plumbness: Permissible tolerance for plumbness shall be 1.5% of the length. The centers of the top and bottom may be taken as the center of the required area that lies wholly within the as-installed area.

C. Bottom Area: The bottom of the pier shall be essentially horizontal within a tolerance of 1 vertical to 12 horizontal with the area of the bottom bearing not less than 98% of that specified on the drawings.

D. Top Area: The Contractor shall remove excess concrete at the top of the pier beyond the limits of the pier diameter. The pier top diameter shall be the same diameter as the shaft below. Piers extending above the ground surface shall be formed.

E. Concrete Cut-Off Elevation: Concrete cut-off elevation at the pier top shall be plus one inch to minus three inches.

F. Battered Piers: Battered piers shall be installed within 5% of the length from the specified inclination.

G. Anchorage Embedment Tolerance: Vertical and horizontal deviation from design location for individual anchorage components embedded in the pier shall not exceed ± 0.5 inches.

H. If any of the above tolerances are exceeded, the Architect/Engineer shall immediately be notified to evaluate the eccentricity in the pier and recommend corrective measures. The cost of re-engineering and corrective construction shall be borne by the Contractor.

3.8 PERMANENT STEEL CASINGS

A. Requirement: Provide permanent steel casings where shown on the drawings of sufficient strength to withstand handling stresses, concrete pressure, and surrounding earth and/or fluid pressures. Provide casings with minimum outside diameter equal to nominal outside diameter of shaft. Wall thickness shown on the drawings is a minimum required for design purposes. The Contractor is responsible for increasing thickness as required for the installation process.

B. Steel Pipe Casings: Provide steel pipe casings as shown on the drawings delivered in sections of any convenient length. Connect sections by continuous complete penetration welds performed according to AWS standards by certified welders during placement into drilled pier shaft excavation. Splice location and details shall be submitted for approval on steel pipe casing shop drawings.

C. Corrugated Steel Casings: Provide corrugated steel casings formed of galvanized or bituminous-coated steel sheets. Corrugated steel casings may be delivered in any convenient section of panel, with sections or panels field connected in accordance with manufacturers instructions.

D. Installation: Install permanent steel casing as excavation work progresses to ensure stability of drilled pier shaft walls. Remove and replace or repair casings which are damaged during installation and which could impair strength or efficiency of completed drilled pier.

E. Fill the void space between permanent casing and shaft excavation or between permanent liner and temporary casing with fluid grout by means of grout pipe and pump pressure as required to achieve uniform void filling.

3.9 INSPECTIONS AND TESTS FOR DRILLED PIER EXCAVATIONS

A. Verification of Design: Bottom elevations, bearing and/or skin friction capacities and lengths of drilled piers as shown on the drawings are estimated from available subsurface data. Actual elevations, pier lengths, and bearing and/or skin friction capacities will be determined by the Geotechnical Engineer from conditions found in the excavations.

B. Notification of Architect/Engineer: If field conditions differ from the data and design recommendations outlined in the Geotechnical Report, the Geotechnical Engineer shall notify the Architect/Engineer immediately.

C. Additional Tests: Additional tests may be required by the Geotechnical Engineer to determine new design criteria. Such tests shall be made as quickly as possible so as not to delay the concreting operations any longer than absolutely required.

D. Inspection Requirements: Each drilled pier shall be inspected by the authorized inspector and approved prior to placement of concrete.

E. Cooperation with Testing and Inspection Personnel: The Contractor shall provide facilities as required to assist in the inspection and testing of the excavations, and cooperate with the inspecting and testing personnel to expedite the work.

F. Notification of Inspector: The Contractor shall notify the authorized inspector at least six hours prior to the time the excavation will be ready for inspection.

G. Personnel Safety: The Contractor shall provide gas testing equipment, protective cage, or temporary casing of proper diameter, length, and thickness, and all other safety equipment required by law for inspection and testing of drilled piers and to protect workmen and inspectors during hand belling or other operations necessitating entry into shaft.

3.10 PIER LOAD TEST

A. Perform load tests to verify design pier lengths and loads. Provide complete testing materials and equipment as required. Notify the Architect/Engineer in ample time before performing tests and perform tests only in the presence of the Owner's Geotechnical Engineer.

B. Test piers, furnished and installed by the Pile Contractor to determine pier criteria, may be located, cut off, and become part of foundation system provided they conform to contract requirements and are approved by the Owner's Geotechnical Engineer.

C. Test Pier Required:

Provide one single test pier as directed by the Owner's Geotechnical Engineer.

D. Drilling Test Piers:

1. Use test piers of same size and design as required for the project, and install with the same equipment as will be used in drilling permanent piers.

2. Install test piers at locations and to the depths as specified by the Owner's Geotechnical Engineer.

E. Pier Design Load: Design load for test pier is shown on drawings.

F. Test Loads:

1. Load single test piers to twice required design load for each type pier.

2. Load groups of 3 test piers to 1-1/2 times load capacity of pier group.

G. Pier Load Testing: Pier test shall be at a location as determined by the Geotechnical Engineer and approved by the Architect/Engineer. Test shall be performed under the supervision of the Owner's Geotechnical Engineer. Design of the load test frame shall be the responsibility of the Drilling Contractor. Shop drawings of the load test frame shall be submitted for Architect/Engineer review and shall be prepared under the supervision of and sealed by a registered professional engineer in the state where the project is located. Costs of load tests shall be borne by the Drilling Contractor. Load and test piers which

have been in place sufficient time to allow concrete to attain its 28 day design compressive strength. Determine the load-settlement relationship of test piers under a vertical axial load, complying with ASTM D 1143.

1. Apply loads in increments not exceeding 25% of allowable pier load.

2. Apply test loads either by use of hydraulic jacks or by static loading. Use certified, calibrated jacks to develop the required test loads, maintain them, and release them in continuous operations. Drive anchor piers not closer than 5 ft. from any test pier or as directed by the Owner's Geotechnical Engineer.

3. Apply test loads so that allowable design load is reached in not less than 8 hours from start of load application. Maintain this load until no measurable settlement is observed in a period of 16 hours or longer, as may be required by local codes having jurisdiction. Do not apply subsequent loads until pier settlement becomes negligible.

4. After satisfactory allowable design load testing, apply additional loads so that total test load is reached in not less than 8 hours. Maintain total load until no measurable settlement is observed in a period of 16 hours, or longer as may be required by local codes having jurisdiction.

5. Measure and record settlement immediately before and after each increment of test load is applied, and immediately before and 24 hours after total load is removed.

6. The test pier will be considered as acceptable for stipulated bearing and/or skin friction capacity if total net settlement, after deducting rebound, does not exceed 0.01" per ton of test load but not greater than 3/4".

H. Test Reports:

1. The Owner's Geotechnical Engineer shall submit copies of the Pier Load Test Report as specified in Submittals section of this specification.

2. Include with the report a record of drilling equipment used.

3. Also include tabular and graphical representation of gross and net settlement of the pier top, relationship of actual load capacity to that predicted, and any recommendations for production pier installation.

3.11 APPROVAL BY THE GEOTECHNICAL ENGINEER

A. Approval by the Owner's Geotechnical Engineer is required on all pier installation criteria and his decision and judgment on pier length, rejection of piers, additional piers required, and all other pier installation and capacity questions shall be final.

3.12 CONTRACT BASIS

A. Basis of Bids: Bids shall be based on number of drilled piers, design length from top elevation to bottom of shaft (extended through the bell, if applicable), and diameter of shaft and bell, as shown on drawings. The bid price shall include cost for temporary casing of excavation that may be required.

B. Basis for Payment: Payment for drilled piers will be made on actual net volume of drilled piers in place and accepted. The actual length and shaft diameter, and bell diameter (if applicable) may vary to coincide with elevation where satisfactory bearing stratum is encountered, and with actual bearing value of bearing strata determined by testing services, and with stability and characteristics of soil strata. Adjustments will be made on net variation of total quantities, based on design dimensions for shafts and bells.

1. There will be no additional compensation for excavation, concrete fill, reinforcing, casings, or other costs due to unauthorized overexcavating shafts. Overexcavated piers will be measured and paid for in accordance with required design or authorized depth. No payment will be made for rejected drilled piers.

2. Prices quoted shall include full compensation for labor, temporary casing, materials, tools, equipment, and incidentals required for excavation, trimming, shoring, casings, dewatering, reinforcement, concrete, and other items for complete installation.

C. Unit Prices: Unit prices for the following items, as set forth in contract conditions, will apply in event additions to or deductions from work are required and authorized by written order from Architect/Engineer to Contractor.

Soil excavation (including temporary casing if required)	per cu. yd.
Rock excavation	per cu. yd.
Permanent steel casings, installed	per lin. ft.
Reinforcing steel and dowels, installed	per lb.
Concrete	per cu. yd.

END OF SECTION 31 63 24

SECTION 31 63 29 – DRILLED CONCRETE PIERS (CAISSONS)

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.

B. Information concerning a sub-surface soil investigation by the Owner's Geotechnical Engineer is available and will be furnished by the Owner upon request. The contractor may use the data included therein for his general information only. The Architect/Engineer is not responsible for the accuracy or applicability of the data therein.

1.2 DEFINITIONS

A. Casing: Steel cylinder used to resist earth and water pressures, to serve as concrete form, and to protect personnel.

B. Dry Method: A method of pier installation in which concrete is placed in the dry. Casing may or may not be used to maintain sidewall stability.

C. Owner's Representative: The Architect, Structural Engineer, or Geotechnical Engineer authorized to act on behalf of the Owner.

D. Owner's Representative - Geotechnical Engineer: The Geotechnical Engineer specifically authorized to carry out the responsibilities defined in this specification.

E. Probe hole: A 1.6 to 2.5 inch diameter hole usually drilled by air percussion methods to a required depth below the pier bottom. The Geotechnical Engineer feels the probe hole by lowering and raising a hooked rod. The size and amount of seams found enables the determination of the soundness of the subsurface formation.

F. Slurry Displacement Method: Method of drilling and concreting in which controlled slurry consisting of water, with or without additives such as bentonite, attapulgite, or polymer, is used to stabilize the hole. The slurry may be used either to maintain the stability of the uncased drilled pier hole or to allow concrete placement when water seepage into a drilled pier hole is too severe to permit concreting in the dry or both.

G. Tremie method: Procedure for placing concrete under water or slurry using a watertight steel pipe or tube to place concrete without washing out cement fines.

1.3 STANDARDS

A. The following Standards are listed in this specification:

ASTM A36	Standard Specification for Carbon Structural Steel
ASTM A283	Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates
ASTM A929	Standard Specification for Steel Sheet, Metallic-Coated by the Hot-Dip Process for Corrugated Steel Pipe
ASTM C33	Standard Specification for Concrete Aggregates
ASTM C94	Specification for Ready Mixed Concrete
ASTM C150	Specification for Portland Cement

ASTM D1143	Standard Test Method for Piles Under Static Axial Compressive Load
ASTM D4380	Standard Test Method for Density of Bentonitic Slurries
ASTM D4381	Standard Test Method for Sand Content by Volume of Bentonitic Slurries
ASTM D4972	Standard Test Method for pH of Soils

1.4 SCOPE OF WORK

A. The Drilling Contractor shall furnish all labor, materials, services, equipment (including temporary casings and/or dewatering where required), and shall install all piers at the locations and depths shown on the drawings or as otherwise directed by the Owner's Geotechnical Engineer. Installation methods compatible with the design may be used if acceptable to the Owner's Geotechnical Engineer. Methods that are not compatible with the design shall be excluded from consideration.

B. The Drilling Contractor shall furnish and place all reinforcing steel, dowels, and anchor bolts that are shown on the drawings to be embedded in the pier.

C. The Drilling Contractor shall furnish all materials and labor as required to perform the load tests as specified herein and on the drawings.

D. The General Contractor shall provide all necessary excavation, sheeting and bracing or other adequate maintenance of excavation banks, suitable runways and ramps as necessary for access of pier drilling, control of ground and surface water as necessary to keep the work area sufficiently dry, suitable access roads for movement of equipment and materials to and from pier locations, field layout required for pier work including setting and maintaining a location stake for each pier and giving cut-off grades on all piers, removal and replacement of all overhead and underground obstructions as required, and coordination of all concrete ordering and delivery.

1.5 QUALIFICATIONS

A. Drilled piers shall be installed by a specialty Drilling Contractor with suitable equipment, competent personnel, and a reputation of satisfactorily performing the work. The Contractor shall have a minimum of 5 years successful experience and a minimum of 5 successful installations on projects of a similar size and scope to this project and of using similar installation methods as may be anticipated for this project. Evidence of compliance with this section shall be submitted to the Architect/Engineer prior to entering into a contract for the work.

1.6 QUALITY ASSURANCE

The Contractor is responsible for quality control, including workmanship and materials furnished by his subcontractors and suppliers.

A. Codes and Standards: The Drilling Contractor shall comply with the provisions of the following codes, specifications, and standards, except where more stringent requirements are shown or specified:

1. ACI 301 - "Specifications for Structural Concrete for Buildings".

2. ACI 117 - “Specifications for Tolerances for Concrete Construction and Materials."

3. ACI 318 - "Building Code Requirements for Reinforced Concrete".

4. Concrete Reinforcing Steel Institute (CRSI), "Manual of Standard Practice".

5. ANSI/AWS D1.1 "Structural Welding Code - Steel".

6. ANSI/AWS D1.4 "Structural Welding Code – Reinforcing Steel".

In addition, all applicable building code and local regulations shall be followed. In case of conflict, the strictest interpretation shall govern.

B. Survey Work:

1. The General Contractor shall employ a qualified and licensed professional engineer/land surveyor to perform all surveys, layouts and measurements for drilled pier work including the layout of anchor rods and/or reinforcing steel dowels embedded in drilled piers. The surveyor shall conduct the layout work for each drilled pier to the lines and levels required prior to beginning excavation and shall make actual in-place measurements of each drilled pier plan location, shaft diameter, bottom and top elevations and deviations from specified tolerances.

2. The surveyor shall record and submit all information pertinent to each drilled pier and cooperate with other testing and inspection personnel to provide data for all required reports.

C. Testing Laboratory Requirements: The Drilling Contractor shall cooperate with all testing and inspection personnel employed to perform field quality control tests and inspections. See Testing Laboratory section of the specifications for required tests and inspections to be performed by the Testing Laboratory and Geotechnical Engineer.

Inspection or testing by the Owner does not relieve the Contractor of his responsibility to perform the Work in accordance with the Contract Documents.

1.7 JOB CONDITIONS

A. Site Information:

1. Data on indicated subsurface conditions are not intended as representations or warranties of continuity of such conditions. It is expressly understood that Owner will not be responsible for interpretations or conclusions drawn therefrom by the Contractor. The data are made available for convenience of the Contractor.

2. The Contractor may make additional test borings and other exploratory operations at no additional cost to the Owner.

3. The Contractor shall inspect the site prior to drilling operations and shall determine any constraints to the work presented by the existing surface conditions and report them to the Owner’s Representative.

B. Protection of Existing Structures: Locate all existing underground structures and utilities that are to remain in service during construction. Protect above-ground structures, underground utilities and other construction from damage caused by drilling operations. Report any conflicts between drilling work and underground utilities and structures to the Owner’s Representative and do not proceed with the work until the conflict is resolved.

C. Survey of Existing Structures: Record and report to Architect/Engineer surveyed elevation benchmarks on structures where directed by the Owner's Representative before commencing work, when structures are adjacent to drilling operations. Record and report elevation of each benchmark at least twice a day while drilling is in progress. Should benchmark readings indicate displacement, halt drilling operations until corrective action has been provided and is acceptable to the Owner's Representative and the Owner.

1.8 PREINSTALLATION CONFERENCE

A. At least 7 days prior to beginning pier installation, the Contractor shall conduct a meeting to review the proposed excavation, inspection, and concrete and reinforcement placement methods and procedures to produce pier construction of the required quality. Also review requirements for submittals, status of coordinating work and availability of materials. Establish work progress schedule and procedures for bearing surface inspection, materials testing, and certifications. The Contractor shall send a pre-installation conference agenda to all attendees 7 days prior to the scheduled date of the conference.

B. The Contractor shall require responsible representatives of every party who is concerned with the concrete work to attend the conference, including but not limited to the following:

Contractor's Superintendent
Laboratory responsible for field material testing
Drilling Subcontractor
Ready-Mix Concrete Producer
Geotechnical Engineer
Owner's and Architect's/Engineer's Representative

C. Minutes of the meeting shall be recorded, typed and printed by the Contractor and distributed by him to all parties concerned within 5 days of the meeting. One copy of the minutes shall be transmitted to the following for information purposes:

Owner's Representative
Architect
Engineer-of-Record

D. The Engineer shall be present at the conference. The Contractor shall notify the Engineer at least 7 days prior to the scheduled date of the conference.

1.9 SUBMITTALS

A. Concrete Mix Design: Submit concrete mix designs suitable for method of concrete placement for Engineer and Owner's Testing Laboratory approval prior to pier installation.

B. Drilling Records: The Contractor and the Owner's Geotechnical Engineer or other authorized inspector shall each submit copies of the drilling record for each pier to the Architect/Engineer immediately after drilling. The reports shall indicate the name of the job, name of Contractor, and name of drilling superintendent. For each pier installed, the report shall indicate the following information:

1. Pier number and location

2. Pier shaft diameter

3. Bottom elevation

4. Top elevation

5. Pier length

6. Theoretical volume of concrete in pier

7. Actual volume of concrete placed

8. Reinforcing steel size and depth actually placed

9. Drilling start and finish time

10. Concreting start and finish time

11. Variation from specified tolerances including surveyed location and plumbness

12. Construction method (dry method, casing method, or slurry displacement method)

13. Groundwater conditions (rate of water infiltration and depth of water in hole prior to concreting for dry piers; water elevation in hole for wet piers)

14. Elevation of top and bottom of any casing left in place

15. Description of temporary or permanent casing (including purpose, diameter, wall thickness and length)

16. Description and elevation of any obstructions encountered and whether removal was obtained

17. Description of pier bottom including amount and extent of loose material

18. Method of concrete placement

19. Any difficulties encountered in drilling or concreting operations

20. Any deviations from specifications.

Reports prepared by the Owner's Geotechnical Engineer or authorized inspector shall be compiled and signed by a licensed professional engineer in the state where the project is located. Reports prepared by the Contractor shall be compiled and signed by the drilling superintendent.

C. Shop Drawings:

1. Reinforcing Steel: Submit shop drawings for all drilled pier and pier cap reinforcing steel.

2. Installation Method: Submit detailed procedures of the installation method, including (where applicable) type and number of drilling rigs and equipment, casing size and length, casing removal method, drilling fluid type, dewatering method, concrete placement, and reinforcing steel securing and placement.

3. Steel Casings: Submit shop drawings for size, wall thickness, length, and grade of permanent steel casings required. Show all splices and methods of splicing.

4. Load Test Frame: Submit shop drawings of the load test frame sealed by a registered professional engineer in the state where the project is located.

D. Product Data: Submit manufacturer's product data with application and installation instructions for proprietary materials and items.

E. Load Test Reports: The Owner's Geotechnical Engineer shall submit copies of test reports for each load test immediately after completion of tests. The report shall include pier load test capacity, compressive test reports of the pier concrete, tabular and graphical presentation of gross and net settlement of the pier top, pier data as prescribed in the previous section, and specific recommendations for production pier installation.

F. Qualification Data:

1. Submit qualification data for firms and persons specified in the article entitled “Qualifications” to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

2. Submit Welding Procedure Specifications (WPS) in accordance with ANSI/AWS D1.1 for all welded joints in steel casing. Submit test reports showing successful passage of qualification tests for all non-prequalified WPSs.

3. Provide certification that welders to be employed in work have satisfactorily passed AWS qualification tests as specified in section 1.05-B. If recertification of welders is required, retesting will be at Contractor's responsibility.

G. Alternates: The Drilling Contractor shall submit his bid based on the specifications as written without exceptions. He may submit bids for alternates to the specifications or modifications to the design, load test program, or installation specifications for consideration by the Owner’s Representative and the Owner.

H. Post Construction Survey: After completion of pier placement, the Contractor shall provide the Owner’s Representative with an as-built survey showing the actual locations of the piers at the top elevations. This survey shall show the plumbness of vertical piers, and all abandoned piers and their replacements. No construction of superstructures shall commence until this survey has been reviewed and accepted by the Owner’s Representative. In order to facilitate the progress of the Work, the Contractor shall submit partial pier surveys for approval as the Work proceeds.

PART 2 - PRODUCTS

2.1 CONCRETE

Concrete shall be as specified in the "Cast-in-Place Concrete" section of the specifications, in the general notes, and on the drawings, with the additional requirements specified below:

A. Maximum Aggregate Size: Provide maximum aggregate size of three quarters of minimum clear spacing between individual reinforcing bars or bundles of bars, with 1 1/2" maximum.

B. Water Reducing Admixtures: Where required by mix design, use water-reducing admixtures in strict compliance with manufacturers directions. Admixtures to increase cement dispersion, or provide increased workability for low-slump concrete may be used at contractor's option. Use admixtures in the amounts as recommended by manufacturer for climatic conditions prevailing at time of placing concrete. Adjust quantities of admixtures as required to maintain quality control.

C. Slump Limits: Proportion concrete to have a slump that is suitable for the placement process used. The mix must remain fluid throughout the concrete placement time and during extraction of any temporary casing. Provide a minimum 6" slump concrete with retarder for temporarily cased piers at time of pulling casing.

2.2 REINFORCING STEEL

A. See "Concrete Reinforcing Steel" section of the specifications.

B. Reinforcing Support and Positioning Devices: Devices made of non-corrosive material that support and align reinforcing steel within the shaft and that provide the appropriate side and bottom cover to the reinforcing steel. Acceptable manufacturers include:

"Pieresearch"
"Aztec, a Dayton-Superior Company"
"Foundation Technologies, Inc."

2.3 STEEL CASING

A. Steel casing shall conform to ASTM A 283, Grade C or ASTM A 36.

B. Corrugated steel casing shall conform to ASTM A 929.

2.4 GROUT

A. Grout used for filling annular void outside permanent casings shall be sand cement grout consisting of Portland cement (ASTM C 150 Type I or III), sand (ASTM C 33), and water. Proportions by weight shall be one part cement, 2 1/4 to 2 1/2 parts sand, and the minimum amount of water required to obtain a workable mix but not exceeding a water-cement ratio of 1.0. The grout mix shall be suitable for the method of installation, whether by gravity feed of by pumping under pressure.

2.5 CONCRETE MIXING

A. Ready Mix Concrete: Comply with the requirements of ASTM C94.

B. Hot Weather Concreting: The maximum acceptable concrete temperature at the truck discharge point shall be 95°F. Refer to Hot Weather Concreting Practices specified in "Cast-in-Place Concrete" section of the specifications for required hot weather concreting practices.

C. Cold Weather Concreting Practices: Refer to the "Cast-in-Place Concrete" section of the specifications for cold weather concreting practices and the conditions under which they are to be followed.

PART 3 - EXECUTION

3.1 EXCAVATION

A. Requirements:

1. Excavate holes for drilled piers to dimensions and required bearing strata or elevations as shown on the drawings unless directed otherwise in the field by the Owner's Geotechnical Engineer.

2. Maintain sidewall stability during drilling. If sidewall instability is encountered that the Owner's Representative considers excessive, the Contractor shall use alternate drilling methods such as temporary casing or slurry displacement method.

3. Excavate holes for closely spaced piers and those occurring in fragile or sand stratas only after adjacent holes are filled with concrete and allowed to set a minimum of 6 hours or longer as required for concrete to harden unless temporary casing to maintain sidewall stability is used.

4. Drilled pier design dimensions and depths shown on the drawings shall be considered minimums and are based on bearing and/or friction in assumed strata. If bearing stratum is not capable of maintaining the assumed capacity, the foundation system shall be revised as directed by the Owner's Geotechnical Engineer and Owner's Representative. Revisions will be paid for in accordance with contract conditions relative to changes in the work. Refer to drawings for design bearing pressures, skin friction values, or pier load capacity.

5. Remove loose material and free water from the bottom of the shaft. The bearing surface should be essentially flat within a tolerance of 1 vertical to 12 horizontal or with one step that is less than one-quarter of the diameter of the bearing area.

6. Explore the bearing stratum of each pier with a probe hole to a minimum depth equal to the diameter of the bearing area below the bottom of the pier, unless waived by the Geotechnical Engineer.

B. Equipment:

1. Provide adequate equipment so work is expedited to the fullest extent possible. Use equipment fully capable of excavating shafts to depths, diameters, and sizes indicated, and within the specified tolerances. Maintain equipment in satisfactory operating condition and provide sufficient quantity of equipment to maintain the projected schedule of the Work.

2. Using bits or augers with a power-driven rotary-type rig, a shaft of a diameter specified on the drawings shall be excavated from the ground surface to a depth as specified on the drawings or as ordered by the Owner's Geotechnical Engineer.

C. Obstructions:

1. If rocks, boulders, or other unforeseen obstructions are encountered which cannot be removed by standard drilled pier excavation methods, and if such obstructions are not indicated by available sub-surface data, removal of such

obstructions will be paid for in accordance with the terms of the Contract relative to changes in the Work.

2. Remove such obstructions by hand labor using air-powered tools or by other safe methods recognized in the construction industry. Standard drilled pier excavation methods include the use of core barrels with pier drilling equipment.

3. The work of this Section includes demolition and removal of rock, boulders, concrete, masonry, and other subsurface obstructions that are indicated by the Contract Documents, or by the available subsurface exploration data, and such work will not be considered a change in the Work.

D. Overexcavation: No payment will be made for extra length or greater diameter of drilled piers when they are installed to a greater depth or are larger than required unless authorized by the Owner's Geotechnical Engineer. Overexcavated drilled piers will be measured and paid for in accordance with the original design or authorized design depth and diameter.

E. Excavated Material:

1. Deposit and spread excavated material on site observing proper placement and compaction requirements.

2. Remove excavated material and dispose of it off site.

3.2 DEWATERING

A. Provide and maintain pumping equipment to keep excavations free of water before placing concrete. An excavation is considered dry if the water rises at a rate of less than 1/4 inch per minute and the height of water at the bottom of the pier does not exceed two inches at the time of concrete placement.

B. Dewater in a manner that will not create subsidence or ground loss that might adversely affect the Work or existing adjacent structures. Should the dewatering system employed involve pumping inside the pier, extreme caution shall be used to prevent an unbalanced water head from causing a "blowout", bottom heave, or "quick" condition that could disturb the proposed bearing stratum or surrounding soil strata.

C. The dewatering method shall be submitted for review and approval of the Owner's Geotechnical Engineer.

D. Conduct water to general site run-off ditches and disposal areas with discharge lines. Provide ditching as required to conduct water to site drainage facilities.

E. If excessive water and/or sidewall instability is encountered and drilling operations must be halted, consult with Geotechnical Engineer and Owner’s Representative before using alternate methods of construction.

3.3 TEMPORARY STEEL CASINGS

A. Requirements:

1. Provide temporary casing at locations as directed by the Geotechnical Engineer where the soil will not stand without support or where sloughing of the sides of shafts may seriously delay or endanger the satisfactory completion of excavation

and placement of concrete. Also provide temporary casing at locations as directed by the Geotechnical Engineer to seal off the inflow of water into the excavation.

2. The Contractor shall have immediately available for use on the job an ample supply of casing for each size that will be required for use in the shafts and shall provide additional amounts, as required, to ensure the orderly progress of the job.

3. Such casing may be in short pieces but with jointing devices of sufficient strength that assembled sections of casing may be pulled complete as concrete is placed, or immediately thereafter. Provide casing of sufficient strength to withstand handling stresses, concrete pressure, and surrounding earth and/or fluid pressures. Make diameter of excavation in relation to diameter of casing such as to create a minimum of void space outside of casing. Provide casing with a minimum outside diameter equal to normal outside diameter of drilled foundations.

B. Delivery, Handling, and Storage of Casing

1. Deliver casing to site in undamaged condition.

2. Handle and protect casing to maintain diameter within plus or minus two percent.

C. Casing Withdrawal: Unless otherwise approved by the Owner's Representative, all temporary casing shall be removed from shafts as concrete is placed or immediately thereafter, and in such a manner as to prevent sloughing material from dropping to the bottoms of shafts or falling on top of freshly placed concrete. Casings shall be pulled in a single continuous smooth operation without sudden jerks or impact. Maintain head of concrete above the bottom of the casing that exceeds the soil and water pressure at all times during casing withdrawal. Do not vibrate concrete internally before the casing is withdrawn. A vibratory casing extractor may be used. Do not withdraw casing after the concrete has attained initial set. The casing withdrawal and concreting operations shall be observed by the Geotechnical Engineer.

3.4 REINFORCING STEEL PLACEMENT

A. Before placing, clean reinforcing steel and dowels of loose rust, scale, dirt, grease and other material that could reduce or destroy bond.

B. Fabricate and erect reinforcing cages in shafts as one continuous unit using inner ring reinforcing guide. Place reinforcement accurately and symmetrically about axis of hole and hold securely in position during concrete placement. The Contractor shall verify depths of drilled piers prior to cutting and tying reinforcing steel cages. Reinforcing steel shall be delivered to the site in standard 60-foot lengths and cut as required. Splice no more than 33% of the bars at any one location, alternating spliced and unspliced bars in a symmetrical pattern. Splices shall be 30 bar diameter compression splices for bars #11 and smaller and mechanical end bearing compression splices for #14 and #18 bars unless noted otherwise on the drawings. See drawings for additional splice information. The Contractor shall be responsible for adding additional reinforcing steel ties or spirals as required to ensure stability of cage and maintenance of shape and configuration as required for proper lifting, handling, and placement.

C. Provide cover to reinforcing steel of not less than 3 inches where exposed to soil and not less than 4 inches in temporarily cased piers. Provide spacer devices to maintain side

and bottom cover. Devices shall be installed in accordance with manufacturer's instructions.

D. Permissible reinforcing steel upward vertical movement during casing withdrawal shall be no greater than 6 inches. Downward movement should not exceed 6 inches for every 20 feet of shaft length.

E. Use templates to set anchor bolts, leveling plates and other accessories furnished under work of other sections. A qualified and licensed Engineer/Land Surveyor shall determine the plan location and elevation of such devices. Provide spacers (capable of sliding on any temporary casings required), blocking and holding devices to maintain required position during concrete placement.

F. The General Contractor shall protect exposed ends of dowels and anchor bolts from mechanical damage and exposure to weather by wrapping and taping with polyethylene or other suitable material.

3.5 CONCRETE PLACEMENT

A. General:

1. Fill drilled piers with concrete immediately after inspection and approval by the Geotechnical Engineer or other authorized inspector. Use protection sheets (cut out to receive concrete) over excavation openings, extending at least 12" beyond edge. Complete the excavation and concrete placement in uncased excavations before the end of the workday unless the Architect/Engineer and Geotechnical Engineer grants permission to do otherwise in writing.

2. Place concrete continuously and in a smooth flow without segregating the mixed materials.

3. Place concrete by means of bottom discharge bucket, flexible drop chute, elephant trunk hopper, concrete pump, or tremie. Free fall of concrete may be used if provided for in concrete mix design and provided it is directed through a hopper or chute such that fall is down center of shaft without hitting sides or reinforcing steel. Free fall of concrete is not permitted for depths greater than the smaller of 20 times the shaft diameter or 60 feet.

4. Place concrete in-the-dry if at all possible. If water occurs, and it is impracticable to dewater drilled pier excavation, and reasonable attempts to seal off water flow have failed, allow water level to attain its normal level and place concrete by tremie method or by concrete pumping. Other methods of depositing concrete underwater may only be used if approved by Architect/Engineer.

5. Stop concrete placement at cut-off elevation shown, screed level, and apply a scoured, rough finish. Where cut-off elevation is above ground elevation, form top section above grade and extend shaft to required elevation.

6. Provide mechanical vibration for consolidation of at least top 5' of each shaft but only after any temporary casing is pulled or when casing is permanent.

7. Interrupted placing operations of over one hour duration will require a cold joint installation as follows. Leave resulting shaft surface approximately level. At resumption of concrete placing, clean off surface laitance, roughen as required,

and slush with a 1-to-1 cement grout or commercial bonding agent before remainder of concrete is placed. Intentional cold joints will not be permitted.

8. Concrete shall not be placed in adjacent drilled piers located within three center-to-center shaft diameters of each other until concrete has cured a minimum of 6 hours.

9. Aluminum pipe or equipment shall not be used for placing concrete.

B. Tremie Method:

1. The drilled shafts shall be filled with concrete by the use of a tremie or concrete pump, sealed at the bottom, extending from above the ground surface to the bottom of the drilled shaft. Inspection of the empty tremie on the bottom may be requested of the Contractor by the Owner's authorized inspector. With the sealed tremie on the bottom of the shaft, the tube shall be filled to the top extending above the ground. The filled tremie shall be picked up approximately one (1) foot off the bottom of the shaft to allow the weight of the concrete to displace the seal at the bottom of the tremie. At no time is the tremie to be pulled to such a height as to clear the surface of the concrete already placed in the shaft. All concrete shall be poured through the now open tremie with care taken to maintain a sufficient head of concrete to completely displace all water and suspended cuttings of material and to provide sufficient pressure so as to prevent reduction in pile diameter by earth pressure on the fresh concrete. The concrete in each pile shall be carried above cut-off elevation and then dipped out while fresh to cut-off elevation.

2. All concrete shall be deposited through the tremie or pumpline so as to provide a continuous flow, without aggregate segregation, from bottom to top of pile. The production and delivery of the ready-mixed concrete shall be such that not more than 45 minutes shall elapse between the depositing of successive batches of concrete to ensure a monolithic unit of concrete. No deviation from this method will be acceptable.

3. Should the surface of the concrete in the shaft be breached by the tremie or pumpline, the tube shall immediately be withdrawn from the hole, re-sealed and re-lowered below the surface of the concrete, and pouring operations re-started. Should the Owner's authorized inspector deem it necessary, the Contractor shall instead retrieve the reinforcing steel cage, redrill the shaft to reopen the hole, and begin the concreting operations from the bottom of the pier shaft.

4. If the Owner's authorized inspector has reason to suspect that the concrete was breached by the tremie or pumpline or that the pier, for any other reason, may contain extraneous material or otherwise fail the specifications, he may order the pier cored for inspection and/or testing. If the core recovery and/or test results indicate non-compliance with the specifications, the Contractor shall bear the expense of the investigation and/or testing and shall also, at no cost to the Owner, install proper additional construction as required by the Architect/Engineer. Should the investigation and/or testing indicate compliance with the specifications the Owner shall bear the cost of such investigation and/or testing.

C. Hot and Cold Weather Placement: Refer to Part II.

3.6 SLURRY DISPLACEMENT METHOD

A. General:

1. The slurry displacement method of construction may be employed only if approved by the Geotechnical Engineer. The excavation shall be carried to final depth with the hole stabilized using drilling fluid of a minimum density acceptable to the Geotechnical Engineer. The drilling fluid may be reused, but it shall be treated, if necessary, to remove the granular material that is in suspension. Care shall be taken in the drilling to avoid caving or sloughing. The bottom of the hole shall be cleaned with a clean-out bucket or other appropriate tool. Type and proposed density of drilling fluid shall be submitted for approval by the Owner's Geotechnical Engineer.

2. Each finished shaft shall consist of a continuous column of concrete extending from the required top elevation to the required bearing surface, having firm contact against the vertical and horizontal surface of the earth surrounding it.

3. Shaft drilling and concrete placement shall be sequenced to prevent damage to adjacent shaft or shaft excavations.

B. Definitions

1. Slurry displacement method (SDM): Drilling, concreting, or drilling and concreting where slurry is used to stabilize the hole. The slurry may be used (a) for the maintenance of the stability of the unlined drilled shaft element; (b) to assist the drilling or insertion of casing as part of the shaft construction; or (c) to allow acceptable concrete placement when water seepage into a drilled shaft is too severe to permit concreting in the "dry."

2. Slurry or drilling fluid - water or prepared drilling mud properly mixed with water. The drilling fluid shall be treated as necessary to conform to the requirements given in Table 1.

3. Mud - pulverized solids used as the basic ingredient for making a water-based slurry.

C. Excavation

1. Shaft excavation shall be to the elevations and to the diameters shown on the Engineer's drawings. Bottom elevations are minimum depths. Shafts may be extended only at the approval of the Geotechnical Engineer.

2. Use methods and equipment for shaft excavation that leave the side of the hole and bottom free of loose material that would prevent intimate contact of the concrete with firm, undisturbed soil or rock. If loose or unacceptable material is present, reclean the hole to the satisfaction of the Geotechnical Engineer.

3. Use drilling tools and excavation procedures that minimize excessive negative pressure and avoid disturbance of the surrounding material in the excavations. Raise and lower the drilling tool in the hole at a rate that does not swirl the slurry and affect the stability of the hole.

4. At the completion of excavation and again before the start of concrete placement, clean the drilled-shaft bottom with an air-lift or recirculation system or a cleanout

bucket equipped with a one-way flap gate that prevents spoils in the bucket from reentering the shaft.

5. For piers designed without end bearing, the accumulated sediment at the bottom of the pier, measured by sounding with a weighted tape just prior to concreting, shall be less than 6 inches. If greater, reclean the hole to the satisfaction of the Geotechnical Engineer.

6. All spoil and excavated materials shall be kept away from each open shaft excavation to avoid contamination of the excavation after final cleanout.

7. Excavated materials shall be stockpiled or disposed of in areas designated by the Owner's representative.

8. Excavated materials temporarily placed at other locations for the convenience of the Contractor will be allowed only with written approval of the Owner's representative and shall finally be removed and placed within designated disposal areas.

D. PROVISIONS FOR OBSERVATION

1. The Contractor shall cooperate with the Owner and design team to ensure the expeditious and safe observation of the shaft excavations.

2. If the Geotechnical Engineer determines that the material at the bottom of any excavation is unsatisfactory, additional excavation or other corrective action shall be made as directed by the Geotechnical Engineer.

3. If additional excavation is required, the shaft bottom shall be drilled again and observed as described above. This procedure shall be repeated until a bearing material is reached that is approved by the Geotechnical Engineer.

E. SLURRY REQUIREMENTS

1. The mud slurry shall consist of a stable colloidal suspension of pulverized solids thoroughly mixed with water so that the properties specified in Table 1 are maintained. Attapulgite and bentonite shall meet API Specification 13A, Section 3, "Oil-Well Drilling-Fluid Material" dated March 1981. The type of mud used will depend on the subsurface conditions and mixing water character. The water used to mix the slurry shall be clean, drinkable, fresh water, obtained from sources approved by the Owner's Representative. Any physical or chemical treatment to the water or slurry that is considered necessary to have the slurry meet the specifications is the responsibility of the drilled shaft contractor. A written certificate shall be supplied to the Architect/Engineer by the mud supplier specifying the quality and yield for each shipment of mud received. A test report from the supplier giving the physical and chemical properties of the mud shall be supplied to the Architect/Engineer at the start of the work.

2. Water may be used in place of mixed mud slurry, subject to the approval of the Geotechnical Engineer on a pier-by-pier basis except for end bearing piers.

3. For shafts with endbearing greater than or equal to 25% of the total allowable capacity as shown on the structural drawings, the mud slurry sand content shall be limited to 4%.

4. The mud slurry shall be mixed in mud tanks on-site or arrive at the site premixed. The mud slurry shall be mixed, stored, and transported using equipment made for these purposes. Combining or mixing slurry in the shaft shall be not permitted.

5. The in-hole slurry shall meet the specifications prior to concreting. Replace or clean, recirculate, and remove sand from, the slurry to maintain the required slurry properties. Recycling of slurry is permitted provided that the recycled slurry satisfies the specified requirements. Submit to the Owner's Representative a written record of test results for each drilled pier.

6. The Contractor shall perform testing of the slurry according to the test methods prescribed in Table 1 and shall record the results for quality control purposes. Provide all field test equipment as required. The drilled-pier contractor shall have available at the site a slurry sampler capable of obtaining slurry samples at any depth within the drilled pier excavation. Slurry shall be sampled and tested in the mud tank and from samples recovered within 1 ft. from the bottom of each drilled shaft.

TABLE 1

SLURRY SPECIFICATIONS

Item to be Measured	Range of Results at 20°C	Test Method
Density, (pcf)** For slurry 1 ft from pier bottom		ASTM D 4380 (Mud Balance)
Mineral Slurries		
a. No end bearing	85 Max.	
b. With end bearing	70 Max.	
Polymer Slurry	64 Max.	
Marsh Funnel Viscosity, (sec./qt)		API-RP13B-1* Section 2
a. Mineral Slurry	25 to 60	(Marsh funnel & CUP)
b. Polymer Slurry	40 to 90	
Sand Content by Volume (%), before concreting, for slurry 1 ft from pier bottom		ASTM D 4381 (Sand screen set)
Mineral Slurries		
a. No end bearing	20 Max.	
b. With end bearing	4 Max.	
Polymer Slurry	1 Max.	
pH, during excavation	7 to 12	ASTM D 4972

* Reference Test Method is American Petroleum Institute (API), Spec. 13B, Eighth Edition, April 1980, issued by American Petroleum Institute - Production Department - 211 N. Ervay, Suite 1700, Dallas, Texas 75201.

** The density of the mud slurry shall not be less than what is needed to drill the shaft.

F. Installation Method

1. Where pre-drilled piers are to be installed below the groundwater level or in caving and sloughing soils, and the procedure is approved by the Geotechnical Engineer and the Owner's Representative, use a premixed mud slurry to stabilize the excavation. Maintain the slurry level in the excavation above any unstable zones a sufficient distance to prevent caving or sloughing of those zones but no less than 5 feet above the groundwater level.

2. Set temporary surface casing to contain the slurry, unless waived by the Owner's Representative.

G. Concreting Method

1. Concreting of the drilled pier shall be completed the same day that the excavation is complete. If this is not possible, the excavation will be required to be redrilled, cleaned, and slurry tested before concreting.

2. Place concrete by tremie method or by pumping. Use tremie or pump pipes made of steel and with watertight joints. Use tremie pipe with a minimum diameter of 8 inches or pump pipe with a minimum diameter of 4 inches.

3. Use a capped or pig-plugged tremie or pump pipe inserted and seated in the excavation at the bottom of the pier prior to commencement of the concrete placement.

4. If a capped pipe is used, use tremie or pump pipe with a seal consisting of a bottom plate, or a device acceptable to the Geotechnical Engineer, that seals the bottom of the pipe until the pipe reaches the hole bottom. Place enough concrete in the pipe to prevent the flow of slurry into the tremie pipe when it is lifted off the bottom.

5. If a pig is used, set the open tremie pipe loosely on the bottom. Insert the pig at the top and then place concrete pushing the pig ahead, separating the concrete from the slurry. Take care to ensure that the pig is properly sized to fit in the pipe, and keep the concrete separate from the slurry so that all slurry is expelled from the pipe during the initial charging process. When the pipe is fully filled with concrete, lift the pipe off the bottom the minimum amount needed to start the concrete flowing. Once concrete flow has started, place concrete into tremie at a fast enough rate to maintain a positive head of concrete inside pipe relative to slurry level outside pipe.

6. Embed tremie of pump pipe sufficiently in concrete to maintain seal throughout concrete placement to prevent re-entry of slurry suspension into the pipe. Provide minimum embedment of 5 feet. If the seal is lost, withdraw pipe, replace the seal, and re-start tremie using a capped tremie or capped pump pipe.

7. Displace out of the pier or remove from the pier the first portion of concrete that comes to the top of the pier that contains concrete contaminated with slurry until acceptable concrete is visible. Add or remove concrete to specified cutoff level.

8. Raise or lower the tremie pipe in an acceptable manner that does not break the seal and does not cause channelization or segregation.

9. Pump the displaced slurry to holding tanks. Do not allow slurry to spill onto or contaminate the site. Do not use excavated slurry pits, unless accepted by the Owner's Representative.

10. Do not use aluminum pipe or equivalent for placing concrete.

11. Measure and report actual volume of concrete placed and theoretical volume versus depth at depth intervals not exceeding the shaft diameter.

3.7 CONSTRUCTION TOLERANCES

A. Plan Location: The tolerance on plan location for the top of the drilled pier shall not be more than 1/24 of the pier diameter or 3" in any direction, whichever is less. If the as-installed shaft is larger than required, the center of the shaft may be taken as the center of a shaft having the required area that lies wholly within the as-installed shaft.

B. Plumbness: Permissible tolerance for plumbness shall be 1.5% of the length. The centers of the top and bottom may be taken as the center of the required area that lies wholly within the as-installed area.

C. Bottom Area: The bottom of the pier shall be essentially horizontal within a tolerance of 1 vertical to 12 horizontal with the area of the bottom bearing not less than 98% of that specified on the drawings.

D. Top Area: The Contractor shall remove excess concrete at the top of the pier beyond the limits of the pier diameter. The pier top diameter shall be the same diameter as the shaft below. Piers extending above the ground surface shall be formed.

E. Concrete Cut-Off Elevation: Concrete cut-off elevation at the pier top shall be plus one inch to minus three inches.

F. Battered Piers: Battered piers shall be installed within 5% of the length from the specified inclination.

G. Anchorage Embedment Tolerance: Vertical and horizontal deviation from design location for individual anchorage components embedded in the pier shall not exceed ± 0.5 inches.

H. If any of the above tolerances are exceeded, the Architect/Engineer shall immediately be notified to evaluate the eccentricity in the pier and recommend corrective measures. The cost of re-engineering and corrective construction shall be borne by the Contractor.

3.8 PERMANENT STEEL CASINGS

A. Requirement: Provide permanent steel casings where shown on the drawings of sufficient strength to withstand handling stresses, concrete pressure, and surrounding earth and/or fluid pressures. Provide casings with minimum outside diameter equal to nominal outside diameter of shaft. Wall thickness shown on the drawings is a minimum required for design purposes. The Contractor is responsible for increasing thickness as required for the installation process.

B. Steel Pipe Casings: Provide steel pipe casings as shown on the drawings delivered in sections of any convenient length. Connect sections by continuous complete penetration welds performed according to AWS standards by certified welders during placement into drilled pier shaft excavation. Splice location and details shall be submitted for approval on steel pipe casing shop drawings.

Design bottom edge of lowest casing section to provide cutting shoe for penetrating into rock strata and affecting water seal.

C. Corrugated Steel Casings: Provide corrugated steel casings formed of galvanized or bituminous-coated steel sheets. Corrugated steel casings may be delivered in any convenient section of panel, with sections or panels field connected in accordance with manufacturer's instructions.

D. Installation: Install permanent steel casing as excavation work progresses to ensure stability of drilled pier shaft walls. Remove and replace or repair casings which are damaged during installation and which could impair strength or efficiency of completed drilled pier.

E. Fill the void space between permanent casing and shaft excavation or between permanent liner and temporary casing with fluid grout by means of grout pipe and pump pressure as required to achieve uniform void filling.

3.9 INSPECTIONS AND TESTS FOR DRILLED PIER EXCAVATIONS

A. Verification of Design: Bottom elevations, bearing and/or skin friction capacities and lengths of drilled piers as shown on the drawings are estimated from available subsurface data. Actual elevations, pier lengths, and bearing and/or skin friction capacities will be determined by the Geotechnical Engineer from conditions found in the excavations.

For piers bearing on rock, a rock core shall be taken for a depth equal to one pier diameter below the bottom of the pier for observation and possible testing by the Geotechnical Engineer to confirm rock quality below the bearing elevation.

B. Notification of Architect/Engineer: If field conditions differ from the data and design recommendations outlined in the Geotechnical Report, the Geotechnical Engineer shall notify the Architect/Engineer immediately.

C. Additional Tests: Additional tests may be required by the Geotechnical Engineer to determine new design criteria. Such tests shall be made as quickly as possible so as not to delay the concreting operations any longer than absolutely required.

D. Observation Requirements: Each drilled pier shall be inspected by the authorized inspector and approved prior to placement of concrete.

E. Cooperation with Testing and Inspection Personnel: The Contractor shall provide facilities as required to assist in the inspection and testing of the excavations, and cooperate with the inspecting and testing personnel to expedite the work.

F. Notification of Observer: The Contractor shall notify the authorized observer at least twelve hours prior to the time the excavation will be ready for inspection. Drilled shaft installation shall not proceed without the authorized observer on site.

G. Personnel Safety: The Contractor shall provide gas testing equipment, protective cage, or temporary casing or shoring of proper diameter, length, and thickness, and all other safety equipment required by law for inspection and testing of drilled piers and to protect workmen and inspectors during hand belling or other operations necessitating entry into shaft.

3.10 PIER LOAD TEST

A. Perform load tests to verify design pier lengths and loads. Provide complete testing materials and equipment as required. Notify the Architect/Engineer in ample time before performing tests and perform tests only in the presence of the Owner's Geotechnical Engineer.

B. Test piers, furnished and installed by the Contractor to determine pier criteria, may be located, finished, and become part of foundation system provided they conform to contract requirements and are approved by the Owner's Geotechnical Engineer.

C. Test Piers Required:

Provide one single test pier as directed by the Owner's Geotechnical Engineer.

D. Drilling Test Piers:

1. Use test piers of same size and design as required for the project, and install by the same methods with the same equipment and personnel as will be used in drilling permanent piers.

2. Install test piers at locations and to the depths as specified by the Owner's Geotechnical Engineer.

E. Pier Design Load: Design load for test pier is shown on drawings.

F. Test Loads:

1. Load single test piers to twice required design load for each type pier.

2. Load groups of 3 test piers to 1-1/2 times load capacity of pier group.

G. Pier Load Testing: Pier test shall be at a location as determined by the Geotechnical Engineer and approved by the Architect/Engineer. Test shall be performed under the supervision of the Owner's Geotechnical Engineer. Costs of load tests shall be borne by the Contractor. Design of the load test frame shall be the responsibility of the Contractor. Shop drawings of the load test frame shall be submitted for Architect/Engineer review and shall be prepared under the supervision of and sealed by a registered professional engineer in the state where the project is located. Load and test piers which have been in place sufficient time to allow concrete to attain its 28 day design compressive strength. Determine the load-settlement relationship of test piers under a vertical axial load, complying with ASTM D 1143.

1. Apply loads in increments not exceeding 25% of allowable pier load.

2. Apply test loads either by use of hydraulic jacks or by static loading. Use certified, calibrated jacks to develop the required test loads, maintain them, and release them in continuous operations. Install anchor piers no closer than three pier diameters of larger pier from any test pier or as directed by the Owner's Geotechnical Engineer.

3. Apply test loads so that allowable design load is reached in not less than 8 hours from start of load application. Maintain this load until no measurable settlement is observed in a period of 16 hours or longer, as may be required by local codes

having jurisdiction. Do not apply subsequent loads until pier settlement becomes negligible.

4. After satisfactory allowable design load testing, apply additional loads so that total test load is reached in not less than 8 hours. Maintain total load until no measurable settlement is observed in a period of 16 hours, or longer as may be required by local codes having jurisdiction.

5. Measure and record settlement immediately before and after each increment of test load is applied, and immediately before and 24 hours after total load is removed.

6. The test pier will be considered as acceptable for stipulated bearing and/or skin friction capacity if total net settlement, after deducting rebound, does not exceed 0.01" per ton of test load but not greater than 3/4".

H. Test Reports:

1. The Owner's Geotechnical Engineer shall submit copies of the Pier Load Test Report as specified in Submittals section of this specification.

2. Include with the report a record of drilling equipment used.

3. Also include tabular and graphical representation of gross and net settlement of the pier top, relationship of actual load capacity to that predicted, and any recommendations for production pier installation.

3.11 APPROVAL BY THE GEOTECHNICAL ENGINEER

A. Approval by the Owner's Geotechnical Engineer is required on all pier installation criteria and his decision and judgment on pier length, rejection of piers, additional piers required, and all other pier installation and capacity questions shall be final.

3.12 CONTRACT BASIS

A. Basis of Bids: Bids shall be based on number of drilled piers, design length from top elevation to bottom of shaft and diameter of shaft, as shown on drawings. The bid price shall include cost for temporary casing of excavation that may be required.

B. Basis for Payment: Payment for drilled piers will be made on actual net volume of drilled piers in place and accepted. The actual length and shaft diameter may vary to coincide with elevation where satisfactory bearing or friction strata is encountered, and with actual bearing value of bearing strata determined by testing services, and with stability and characteristics of soil strata. Adjustments will be made on net variation of total quantities, based on design dimensions for shafts.

1. There will be no additional compensation for excavation, concrete fill, reinforcing, casings, or other costs due to unauthorized overexcavating shafts. Overexcavated piers will be measured and paid for in accordance with required design or authorized depth. No payment will be made for rejected drilled piers.

2. Prices quoted shall include full compensation for labor, temporary casing, materials, tools, equipment, and incidentals required for excavation, trimming, shoring, casings, dewatering, reinforcement, concrete, and other items for complete installation.

C. Unit Prices: Unit prices for the following items, as set forth in contract conditions, will apply in event additions to or deductions from work are required and authorized by written order from Architect/Engineer to Contractor.

Soil excavation (including temporary casing if required)	per cu. yd.
Soil excavation by slurry method	per cu. yd.
Rock excavation	per cu. yd.
Permanent steel casings, installed	per lin. ft.
Reinforcing steel and dowels, installed	per lb.
Concrete	per cu. yd.

END OF SECTION 31 63 29