

SECTION 310000 - EARTHWORK

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide all materials, equipment and labor necessary to furnish and construct the roadway subgrade and all appurtenant work, complete in place, as shown on the Drawings and as specified herein.

B. **Work Covered in this Section:**

1. Site Clearing, Grubbing and Stripping.
2. Preparation for Fill Material.
3. Roadway Excavation.
4. Roadway Grading and Compaction.

1.2 RELATED WORK SPECIFIED ELSEWHERE

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| A. Section 024100 | Demolition. |
| B. Section 015700 | Site Preparation. |
| C. Section 312300 | Utility Earthwork. |
| D. Section 321000 | Asphalt Pavement, Base and Surface Treatments. |
| E. Division 1 | General Requirements. |

1.3 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. **State of California (Caltrans) Standards:**

1. Standard Specifications:

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|------------|------------------------|
| Section 16 | Clearing and Grubbing. |
| Section 19 | Earthwork. |
| Section 68 | Subsurface Drains. |
| Section 88 | Engineering Fabrics. |

B. **Uniform Building Code.**

C. **Commercial Standards:**

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|-------------|----------------------------------------------------------------------------------------------------|
| ASTM C 117 | Test Method for Materials Finer than 75- μ m (No. 200) Sieve in Mineral Aggregates by Washing. |
| ASTM C 136 | Method for Sieve Analysis of Fine and Course Aggregates. |
| ASTM D 1556 | Test Method for Density of Soil in Place by the Sand-Cone Method. |

ASTM D 1557	Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 10-lb (4.54-kg) Rammer and 18-in. (457-mm) Drop.
ASTM D 2844	Test Method for Resistance <i>R</i> -Value and Expansion Pressure of Compacted Soils.
ASTM D 2922	Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
ASTM D 3017	Test Method for Water Content of Soil and Rock in Place By Nuclear Methods (Shallow Depth).
ASTM D 4318	Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

1.4 CONTRACTOR SUBMITTALS

- A. **Certificates of Compliance:** Certificates of Compliance shall be provided for all products and materials proposed to be used under this Section.

1.5 QUALITY ASSURANCE

- A. All soils testing will be done by a testing laboratory of the CITY'S choice and at the CITY'S expense, except as otherwise specified in this Section.
- B. Where soil material is required to be compacted to a percentage of relative compaction, the maximum density at optimum moisture content will be determined in conformance with ASTM D 1557. Field density in-place and moisture content tests will be performed in conformance with ASTM D 2922 and ASTM D 3017, respectively, or by such other means acceptable to the ENGINEER.
- C. If the tested materials show non-compliance with the required relative compaction, the CONTRACTOR shall accomplish such remedy as may be required to insure compliance.
- D. The CITY will pay the cost of the first test and one re-test. Subsequent re-testing after the first re-test to show compliance shall be at the CONTRACTOR'S expense.
- E. The CONTRACTOR shall notify the ENGINEER at least 48 hours prior to performing any site clearing, grubbing, or stripping.
- F. Finish subgrade at any point shall not vary more than 0.1-foot above or below the subgrade shown on the Drawings.

1.6 PROJECT CONDITIONS

- A. Material for embankments, where required, shall consist of suitable excavated material if available, or such imported fill material as may be required conforming to the requirements of this Section and the appurtenant soils report.
- B. The CONTRACTOR shall be solely responsible for the maintenance of the graded surface at all times including implementing all erosion control measures as shown on the drawings during the winter months.
- C. The CONTRACTOR shall be solely responsible for provision of adequate site drainage at all times as shown on the grading and erosion control plans during the course of the WORK.

PART 2 -- PRODUCTS

2.1 SUITABLE FILL MATERIAL

- A. Import fill material shall consist of inert granular soil and rock fragments and shall conform to the requirements of the appurtenant soils report.
- B. All fill material, import or native, shall be free of organic materials, trash and debris, moderately to highly expansive clays, or any other deleterious materials, and shall be subject to the approval of the ENGINEER.
- C. In addition to the soils report requirements, the top 2 feet of import fill material below the subgrade for the roadway shall conform to the following requirements:
 - 1. Fill material shall conform to the following as determined by ASTM C 117 and ASTM C 136:

a. Maximum particle size	3 inches
b. Percent passing 1-inch sieve	90-100 percent
c. Percent passing No. 200 sieve	less than 20 percent
 - 2. Plasticity Index for acceptable import fill materials shall be a maximum of 15 when determined by the procedure set forth in ASTM D 4318.
 - 3. The liquid limit shall not exceed 40 percent as determined by the procedures set forth in ASTM D 4318.
 - 4. Import fill material shall have an R-value of 25 or greater as determined by ASTM D 2844.
- D. The CONTRACTOR shall submit to the ENGINEER at least 10 working days prior to use on the site its proposed source of import fill material along with a soils report and Certification from the designated source that the proposed source materials conform to this Section.
- E. All suitable native fill material containing clods or hard lumps of earth over 6 inches in the greatest dimension shall be broken up before compaction. All suitable native fill material consisting of large rocky material or hard lumps, such as hardpan or cemented gravel which cannot be broken readily, shall be well distributed in the lower portions throughout the earthwork.

PART 3 -- EXECUTION

3.1 SITE CLEARING, GRUBBING AND STRIPPING

- A. Clearing and grubbing shall conform to Section 16, "Clearing and Grubbing," of the Caltrans Standard Specifications and this Section.
- B. Unless otherwise shown on the Drawings, clearing and grubbing shall be performed within the entire street right-of-way area. No burning of material will be allowed.
- C. The site shall be stripped and cleared of all vegetation, debris and organic-laden top soil as required by the appurtenant soils report. The stripped material shall be removed from the site or stockpiled for landscaping purposes if allowed by the appurtenant soils report. This material shall not be used as import fill.
- D. No clearing or grubbing of the site can take place until any environmental review associated with the project, if any, has been completed and approved by the appropriate agencies.

3.2 PREPARATION FOR FILL MATERIAL

- A. Prior to placing import fill material, all areas to receive fill shall be scarified and compacted. Unless otherwise stated in the appurtenant soils report, the area shall be scarified to a minimum of 8 inches, material shall be moisture conditioned by wetting or drying to a range of 2 percent to 5 percent over optimum moisture content, and compacted to a density of not less than 90 percent relative compaction in conformance with ASTM D 1557.

3.3 ROADWAY GRADING AND COMPACTION

- A. Roadway grading shall consist of grading the site to the lines and grades called for on the Drawings. Roadway grading, placing and compacting shall conform to Section 19-5, "Compaction" and Section 19-6, "Embankment Construction," of the Caltrans Standard Specifications and as modified by this Section.
- B. Damage to underlying native soils caused by the CONTRACTOR'S operations shall be repaired and re-compacted under the supervision of and to the satisfaction of the ENGINEER at no additional cost to the CITY.
- C. Material for roadway fill shall be placed in lifts or horizontal layers not exceeding 8 inches in un-compacted thickness. Unless otherwise specified in the appurtenant soils report, material shall be moisture conditioned by wetting or drying as specified in Section 3.2 above, and compacted to a density of not less than 90 percent relative compaction in conformance with ASTM D 1557. In addition, in fill areas the upper 2 feet below street subgrade for the width of the traveled way shall be compacted to a density of not less than 95 percent relative compaction in conformance with ASTM D 1557.
- D. Final preparation of subgrade shall be in conformance with PART 3 - EXECUTION of Section 321000, "Asphalt Pavement, Base and Surface Treatments."

3.4 ROADWAY EXCAVATION

- A. Roadway excavation shall conform to Section 19-1, "General" and Section 19-2, "Roadway Excavation" of the Caltrans Standard Specifications, except the reference to Section 19-5, "Compaction," is deleted, and except that Section 19-2.02, "Unsuitable Material," is modified as follows:
 - 1. When directed by the ENGINEER, the CONTRACTOR shall excavate the unstable or unsuitable underlying material to the depth determined by the appurtenant soils report.
 - 2. Subgrade shall be prepared in conformance with PART 3 - EXECUTION, of Section 321000, "Asphalt Pavement, Base and Surface Treatments."

3.5 UNDERGROUND STRUCTURES

- A. Where abandoned underground structures and pipelines are encountered in the street areas, remove to sufficient depth to allow underground lines to cross, backfill and compact during rough grading. The ENGINEER may require further work to be done if visual inspection indicates during construction.

- END OF SECTION -

SECTION 311300

SELECTIVE TREE AND VEGETATION TRIMMING AND REMOVAL

PART 1 -- GENERAL

1.1 THE REQUIREMENT

- A. The CONTRACTOR shall provide all materials, equipment and labor necessary to perform the selective tree and vegetation trimming and all appurtenant work, complete in place, as shown on the Drawings and as specified herein.
- B. Work Specified in this Section:
 - 1. Verification of trees and vegetation to be trimmed with ENGINEER.
 - 2. Trimming of trees and other vegetation in the street right of way.
 - 3. Removal of trees and other vegetation as approved by the ENGINEER.
 - 4. Removal of cuttings and clean-up of the jobsite.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 321000 Asphalt Pavement, Base, and Surface Treatments.
- B. Section 321200 Flexible Pavement Coatings.
- C. Division 1 General Requirements.

1.3 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. State of California (Caltrans) Standards:

1. Standard Specifications:

Section 12 Construction Area Traffic Control Devices.

B. Commercial Standards:

- 1. CAL-OSHA Standards.
- 2. ANSI Regulations.

1.4 CONTRACTOR SUBMITTALS

- A. The CONTRACTOR shall submit copies of the supervising arborist's certification from the Western Chapter of the International Society of Arboriculture to the ENGINEER prior to performing the WORK.
- B. The CONTRACTOR shall submit copies of required resident notifications to the ENGINEER for review prior to distribution. The CONTRACTOR shall follow up each notification and parking restriction posting with submittal to the ENGINEER of a signed affidavit confirming time and date of each notification or posting.

1.5 QUALITY ASSURANCE

- A. All trimming work shall be performed under the direct supervision of and in conformance with the recommendations of an arborist certified by the Western Chapter of the International Society of Arboriculture and the City of Livermore Municipal Code Section 12.20.

1.6 QUALITY CONTROL

- A. The CONTRACTOR shall be held responsible for any damage to trees, vegetation, or private property caused by its construction operations or trees that die after improper pruning or trimming. At the CITY'S option, the CONTRACTOR shall be assessed for the value of the damage to the trees, vegetation or private property based upon the the International Society of Arboriculture's Standard method of valuation.
- B. The CONTRACTOR shall furnish all tools and equipment and employ trained tree trimmer personnel under the direction of the arborist to operate all equipment and perform all handwork efficiently and skillfully.
- C. The trimming work shall be performed in a safe and proper manner adhering to CAL-OSHA standards and ANSI regulations.

PART 2 -- PRODUCTS

2.1 TREE SEALER

- A. Tree sealer shall be as manufactured by **Ready to Use "Tre-hold,"** or equal, tree sealer conforming to the following specifications:
 - 1. A commercial grade, quick drying, tree sealer which shall have suitable qualities to coat and seal damaged bark and cuts, and inhibit secondary growth. Application shall be made in accordance with the manufacturer's printed recommendations.

PART 3 -- EXECUTION

3.1 ORDER OF WORK

- A. Trimming and/or removal shall be performed only on trees or vegetation requiring work in order to conform to the parameters set forth in this Section, unless otherwise directed by the ENGINEER.
- B. The CONTRACTOR shall identify all trees and vegetation determined to require trimming or removal with temporary chalk paint markings on the adjacent street travelway for review by the ENGINEER prior to beginning any cutting operations.
- C. A list verifying the address and/or location of all trees or vegetation to be trimmed or removed shall be prepared by the CONTRACTOR and submitted to the ENGINEER for review by the City's designated landscape specialist.
- D. The CONTRACTOR shall notify all property occupants when trees or vegetation is to be trimmed or removed in accordance with this Section. All written notifications to be distributed to affected property occupants shall be submitted to the ENGINEER for review prior to distribution. The CONTRACTOR shall distribute notifications and post temporary no parking restrictions per this Section a minimum of 72 hours in advance of any cutting operations.

3.2 PUBLIC NOTIFICATION

- A. All residents, businesses, and public facilities affected by the WORK shall be provided with prior notification in accordance with Division 1, General Requirements. All notifications shall be in a form of written posting, setting the time and date that the cutting operations will take place. The CONTRACTOR shall follow up each notification with submittal to the Engineer of a signed affidavit confirming time and date of each notification or posting.
- B. "No Parking" zones shall also be established where necessary to accomplish trimming operations in conformance with the Division 1, General Technical Requirements.

3.3 TREE AND VEGETATION TRIMMING

- A. Tree limbs or other vegetation obstructions shall be trimmed to a minimum height of 11 feet above the roadway, as measured from the lip of gutter, and to 8 feet-9 inches above the sidewalk, as measured from the back of sidewalk. The crown of the tree shall be balanced as necessary. Balancing of the crown of the tree shall be accomplished by thinning, reducing end weights, shortening long heavy limbs, removing deadwood, weak limbs, and sucker growth. Limbs shall be pruned back to an appropriate lateral branch.
- B. Tree limbs shall not be torn or ripped. All final pruning cuts shall be clean cuts.
- C. Trees and vegetation shall be trimmed in such a manner as not to injure adjacent trees, plants, and/or improvements which are to be preserved.
- D. Cuts or damage to areas of tree bark caused by the CONTRACTOR'S trimming operations shall be treated with a sealer such as "Tre-hold," or equivalent, as approved by the ENGINEER. Application of the tree sealer shall be made according to the manufacturer's printed recommendations.
- E. All trimmings and debris generated from these operations shall be removed completely from both the public right of way and adjacent private property and properly disposed of in a legal manner in conformance with the Division 1, General Requirements.

- END OF SECTION -

SECTION 311316

ROOT PRUNING

PART 1 -- GENERAL

1.1 THE REQUIREMENT

- A. The CONTRACTOR shall provide all materials, equipment, and labor necessary to perform all root pruning necessary to construct improvements, and all appurtenant work, complete in place, as shown on the Drawings and as specified herein.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 321000 Asphalt Pavement, Base and Surface Treatments.
- B. Section 321300 Concrete Surface Improvements.
- C. Division 1 General Requirements.

1.3 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. **State of California (Caltrans) Standards:**

1. Standard Specifications:

- Section 12 Construction Area Traffic Control Devices.

B. **Commercial Standards:**

- 1. CAL-OSHA Standards.
- 2. ANSI Regulations.

1.4 CONTRACTOR SUBMITTALS

- A. The CONTRACTOR shall submit copies of the supervising arborist's certification from the Western Chapter of the International Society of Arboriculture to the ENGINEER prior to performing the WORK.

1.5 QUALITY ASSURANCE

- A. All root pruning work shall be performed under the direct supervision of and in conformance with the recommendations of an arborist certified by the Western Chapter of the International Society of Arboriculture.

1.6 QUALITY CONTROL

- A. The CONTRACTOR shall be held responsible for any damage to trees, vegetation, or private property caused by its construction operations.
- B. The CONTRACTOR shall furnish all tools and equipment and employ sufficient trained personnel to operate all equipment and perform all handwork efficiently and skillfully.
- C. The root pruning work shall be performed in a safe and proper manner adhering to CAL-OSHA standards and ANSI regulations.

PART 2 -- PRODUCTS

2.1 ROOT SEALER

- A. Root sealer shall be manufactured by **Ready to Use "Tre-hold,"** or equal conforming to the following specifications:
 - 1. A commercial grade, quick drying, root sealer which shall have suitable qualities to coat and seal damaged bark and cuts, and inhibit secondary growth. Application shall be made in accordance with the manufacturer's printed recommendations.

PART 3 -- EXECUTION

3.1 TRAFFIC CONTROL

- A. The CONTRACTOR shall use suitable measures, including signs, portable barricades, tape and flaggers, as required in conformance with the Division 1, General Requirements.

3.2 ROOT PRUNING

- A. Where concrete repair work occurs adjacent to or over tree roots where damage has been caused by root intrusion, the roots shall be removed to a minimum depth of at least 8 inches below the bottom of the new concrete improvements. Roots shall be cut as far from the tree as possible alongside the edge of the new curb or sidewalk. Roots must be completely severed prior to their removal.
- B. If removal of a root is determined by the Arborist to potentially endanger the stability or health of the tree, the CONTRACTOR shall provide the ENGINEER with the findings and avoid cutting the roots until approval from the ENGINEER has been received.
- C. Root pruning shall not be performed until after removal of the existing concrete improvements but shall be completed prior to base and subgrade excavations. Root pruning shall be achieved by use of a **Vermeer** root cutter or equivalent method approved by the ENGINEER. Tree roots may occasionally be cut by sawing or chopping with a sharp saw or axe on an individual case basis, but only with the express approval of the Arborist and the ENGINEER.
- D. Tree roots shall not be torn or ripped. All final root pruning cuts shall be clean cuts.
- E. Cuts on tree roots 1-inch diameter or larger and areas of bark or skin damage caused by root pruning operations shall be treated with a root sealer and growth inhibitor.
- F. At sites where excavation has exposed living roots to the air the CONTRACTOR shall cover the exposed roots within 2 hours of exposure with base rock, soil, moist burlap or other means acceptable to the Arborist and the ENGINEER. Inspection by the ENGINEER is required prior to permanent backfill.
- G. Roots shall be pruned in such a manner as not to injure adjacent trees, plants and/or improvements which are to be preserved.
- H. In addition to root pruning, trimming of the tree crown may be required as determined by the Arborist. Trimming of the tree crown shall be in conformance with PART 3 - Execution of Section 311300 "Selective Tree and Vegetation Trimming and Removal."

- END OF SECTION -

SECTION 312300 - UTILITY EARTHWORK

PART 1 -- GENERAL

1.1 THE REQUIREMENT

- A. The CONTRACTOR shall provide all materials, equipment, and labor necessary to perform and complete all utility earthwork as shown on the Drawings and as specified herein.
- B. The work of this Section includes all earthwork required for construction of the project. Such earthwork shall include, but may not necessarily be limited to, the loosening, removing, loading, transporting, depositing, and compacting in its final location of all materials wet and dry, as required for the purposes of completing the work, which shall include, but not necessarily be limited to, the furnishing, placing, and removing of sheeting, shoring and bracing necessary to safely support the sides of all excavations; all pumping, ditching, draining and other required measures for the removal or exclusion of water from the excavation; the supporting of structures above and below the ground; all backfilling around structures and all backfilling of trenches and pits; the disposal of excess excavated materials; borrow of materials to make up deficiencies for fills; and all other incidental earthwork.
- C. Hazardous materials shall be handled in accordance with all regulatory agency requirements.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 024100 Demolition.
- B. Section 015700 Site Preparation.
- C. Section 310000 Earthwork.
- D. Section 312323 Controlled Low Strength Materials (CLSM).
- E. Division 2 and 5 Pipe Sections as applicable.
- F. Section 328000 Irrigation Systems.
- G. Section 329113 Landscape Soil Preparation.
- H. Section 329300 Landscape Planting.
- I. Section 331100 Piping, General.
- J. Division 1 General Requirements.

1.3 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. **State Codes:**

California Labor Code.

Construction Safety Orders of the State of California.

B. **State of California (Caltrans) Standards:**

1. Standard Specifications:

Section 25	Aggregate Subbases.
Section 26	Aggregate Bases.
Section 68	Subsurface Drains.
Section 88	Engineering Fabrics

C. **Commercial Standards:**

ASTM D 422	Test Method for Particle-Size Analysis of Soils.
ASTM D 1556	Test Method for Density of Soil in Place by the Sand-Cone Method.
ASTM D 1557	Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 10-lb (4.54-kg) Rammer and 18-in. (457-mm) Drop.
ASTM D 1633	Test Method for Compressive Strength of Molded Soil-Cement Cylinders.
ASTM D 2419	Method for Sand Equivalent Value of Soils and Fine Aggregate.
ASTM D 2487	Test Method for Classification of Soils for Engineering Purposes.
ASTM D 2922	Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
ASTM D 3017	Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).
ASTM D 3776	Test Methods for Mass Per Unit Area (Weight) of Woven Fabric.
ASTM D 3786	Method of Hydraulic Bursting Strength of Knitted Goods and Nonwoven Fabrics: Diaphragm Bursting Strength Tester Method.
ASTM D 4253	Test Methods for Maximum Index Density of Soils Using a Vibratory Table.
ASTM D 4254	Test Methods for Minimum Index Density of Soils and Calculation of Relative Density.
ASTM D 4318	Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
ASTM D 4491	Test Methods for Water Permeability of Geotextiles by Permittivity.

ASTM D 4632	Test Method for Grab Breaking Load and Elongation of Geotextiles.
ASTM D 4751	Test Method for Determining the Apparent Opening Size of a Geotextile.
OSHA	Occupational Safety and Health Administration.

1.4 CONTRACTOR SUBMITTALS

- A. The CONTRACTOR'S attention is directed to the provisions for "Shoring and Bracing Drawings" in Section 6705 of the California Labor Code. The CONTRACTOR, prior to beginning any trench or structure excavation 5 feet deep or over, shall submit to the ENGINEER for review for compliance with Section 6705 the CONTRACTOR'S detailed plan showing design of all shoring, bracing, sloping of the sides of excavation, or other provisions for worker protection against the hazard of caving ground during the excavation of such trenches or structure excavation. If such plan varies from the shoring system standards established in the Construction Safety Orders of the State of California, such alternative system plans shall be prepared, stamped and signed by a civil or structural engineer licensed in the State of California at the CONTRACTOR'S expense.
- B. **Certificates of Compliance:** Certificates of Compliance shall be provided for all products and materials proposed to be used under this Section.
- C. For all materials that are not pre-approved by the CITY the CONTRACTOR shall designate the source and/or submit samples of all materials in advance of their use for required testing and ENGINEER'S approval. All testing costs shall be at the CONTRACTOR'S expense.

1.5 QUALITY ASSURANCE

- A. **General:** All soils testing will be done by a testing laboratory of the CITY'S choice at the CITY'S expense except as otherwise specified in Paragraph 1.5 C. below.
- B. Where soil material is required to be compacted to a percentage of maximum density the maximum density at optimum moisture content will be determined in accordance with ASTM D 1557. Where cohesionless, free draining soil material is required to be densified to a percentage of relative density the calculation of relative density will be determined in accordance with ASTM D 4253 and D 4254. Field density in-place tests will be performed in accordance with ASTM D 2922, or by such other means acceptable to the ENGINEER.
- C. In case the first test and one re-test of the fill or backfill show non-compliance with the requirements the CONTRACTOR shall accomplish such remedy as may be required to insure compliance. Subsequent re-testing after the first re-test to show compliance shall be at the CONTRACTOR'S expense.
- D. The CONTRACTOR shall notify the ENGINEER at least 48 hours prior to performing any utility excavation.

PART 2 -- PRODUCTS

2.1 SUITABLE BACKFILL MATERIALS

- A. Suitable Backfill shall be a selected or processed clean, fine earth, rock, or sand, free from objectionable material, vegetation, or other deleterious substances.
- B. The following TYPES of backfill materials are designated and defined as follows:

- TYPE 1. **Sand** shall be material with 100 percent passing a 3/8-inch sieve, at least 90 percent passing a No. 4 sieve, and a sand equivalent value not less than 30.
- TYPE 2. **Class 2 Aggregate Base** shall be crushed rock aggregate base material meeting the requirements of Section 26, "Aggregate Bases," for 19 millimeter maximum grading, of the Caltrans Standard Specifications.
- TYPE 3. **Class 1, Type A or B, Permeable Material** shall be crushed stone, or gravel, durable and free from slaking or decomposition under action or alternate wetting or drying, uniformly graded, and shall meet the requirements of Section 68-1.025 for Class 1, "Permeable Material," of the Caltrans Standard Specifications.
- TYPE 4. **Class 2 Permeable Material** shall be crushed rock or gravel, durable and free from slaking or decomposition under the action of alternate wetting or drying, uniformly graded, and shall meet the requirements of Section 68-1.025 for Class 2 "Permeable Material," of the Caltrans Standard Specifications.
- TYPE 5. **Manufactured Backfill** shall be manufactured, angular, granular, crushed stone, rock, or slag with 100 percent passing a one-inch sieve and less than one percent passing a No. 4 sieve.
- TYPE 6. **Controlled Low Strength Materials (CLSM)** shall conform to the requirements of Section 02320 "Controlled Low Strength Materials (CLSM)."
- TYPE 7. **Native** material shall be material obtained from on-site excavations, provided the materials are not classified as unsuitable. Native material shall be free of stones, lumps, broken concrete or bituminous surfacing over 4 inches in diameter, objectionable material, vegetation, and deleterious substances.
- TYPE 8. **Topsoil** material may be material which has been obtained at the site or may be imported, and shall meet the requirements of Section 02911, "Landscape Soil Preparation." Removal of the topsoil shall be done after the area has been stripped of vegetation and debris as specified.
- TYPE 9. **Aggregate Subbase** shall conform to the grading and quality requirements of Section 25, "Class 2 Aggregate Subbase" of the Caltrans Standard Specifications.

2.2 UNSUITABLE BACKFILL MATERIAL

- A. Unsuitable soils for backfill material shall include soils which, when classified under ASTM D 2487, fall in the classifications of Pt, OH, or OL. Types CH and MH soils will be permitted in unimproved areas only where required compaction and stability can be demonstrated. In addition, any soil which cannot be compacted sufficiently to achieve the percentage of maximum density specified for the intended use, shall be classified as unsuitable material.
- B. Any material determined to be hazardous is defined as unsuitable material.
- C. Washed, smooth rock (pea gravel) is classified as unsuitable material.
- D. Where moisture content of the material is not in conformance with Section 310000, "Earthwork," the material will be classified as unsuitable material.

2.3 USE OF SUITABLE BACKFILL MATERIAL TYPES

- A. The CONTRACTOR shall use the types of materials as designated herein for all required backfill construction.

B. Backfill material types shall be used in conformance with the following provisions:

1. **Bedding** backfill, as defined under PART 3 - EXECUTION of this Section herein, shall be Sand; Class 2 Aggregate Base; Class 1, Type A Permeable Material; or Class 2 Permeable Material, meeting the requirements of Product Types 1, 2, 3A, or 4.
2. **Pipe Zone** backfill, exclusive of bedding, as defined under PART 3 - EXECUTION of this Section herein, shall be as follows:
 - a. Plastic pipe shall be backfilled with Sand meeting the requirements of Product Type 1.
 - b. Mortar coated pipe, concrete pipe, and ductile iron pipe shall be backfilled with Sand; Class 2 Aggregate Base backfill material; Crushed Rock or Gravel, meeting the requirements of Product Types 1, 2, 3A, or 4.
 - c. Coal tar enamel coated pipe, polyethylene encased pipe, tape wrapped pipe, and other non-mortar coated pipe shall be backfilled with Sand; or natural, rounded, non-crushed material, meeting the gradation requirements of Product Types 1, 3 A, or 4.
 - d. Vitrified clay pipe shall be backfilled with Sand, or Manufactured Backfill material, meeting the requirements of Product Type 1 or 5; or Class 2 Aggregate Base; Class 1, Type A Permeable Material; or Class 2 Permeable Material, meeting the requirements of Product Types 2, 3A, or 4, only if properly compacted with hand tampers or vibratory compactors as appropriate.
 - e. Backfill for sub-drainage systems shall be designed on a case-by-case basis.

The pipe zone backfill for all other pipelines excluding those listed above shall be Sand; Class 2 Aggregate Base; Class 1 Type A Permeable Material; Class 2 Permeable Material; Manufactured Backfill; meeting the requirements of Product Types 1, 2, 3A, 4, or 5. **Note:** Where pipelines are installed on grades exceeding 4 percent, and where backfill materials are graded such that there is less than 10 percent passing a No. 4 sieve, trench plugs of impermeable clay type material or concrete shall be provided at minimum intervals of 200 feet.

3. **Trench Zone** backfill as defined under PART 3 - EXECUTION of this Section herein, shall be Sand; Class 2 Aggregate Base; Class 1, Type A, Permeable Material; Class 2 Permeable Material; Manufactured Backfill; Native; or Aggregate Subbase meeting the requirements of Product Types 1, 2, 3A, 4, 5, 6, 7, or 9.
4. **Final Zone** backfill as defined under PART 3 - EXECUTION of this Section herein, shall consist of the following materials for each condition listed below.
 - a. Final Zone backfill under paved areas shall be Class 2 Aggregate Base, CLSM, or Class 2 Aggregate Subbase, meeting the requirements of Product Types 2, 6, or 9.
 - b. Final Zone Backfill in unimproved areas shall be Native or Class 2 Aggregate Subbase meeting the requirements of Product Types 7 or 9.
 - c. Final Zone backfill in landscape areas shall be Native meeting the requirements of Product Type 7. Topsoil and amendments shall be Product Type 8 as specified in Section 02911, "Landscape Soil Preparation," and as shown on the Drawings.
 - d. Final Zone backfill under graveled roads shall be Class 2 Aggregate Base, CLSM, Native, or Class 2 Aggregate Subbase meeting the requirements of Product Types 2, 6, 7, or 9.
5. **Minor structures.** Backfill materials around minor structures shall be any Trench Zone Product Type except Sand, Native, or Topsoil, Product Types 1, 7, or 8.

6. **Over-excavation** backfill shall be Class 1, Type B Permeable Material meeting the requirements of Product Type 3B. For wet trench conditions place a filter fabric on top and below of the permeable material to prevent migration of fines.

2.4 FILTER FABRIC

- A. Filter fabric shall be non-woven synthetic fabric meeting the requirements of Section 88-1.03, "Filter Fabric," of the Caltrans Standard Specifications. Filter fabric shall be non-woven synthetic fabric with a minimum Grab Strength of 90 pounds; a minimum Burst Strength of 180 pounds, a minimum Puncture Strength of 50 pounds, a Water Flow Rate of at least 40 gal/min/sf, and an Apparent Opening Size of between 60 and 110.

2.5 STEEL PLATE

- A. When steel plate bridging is provided in-lieu of backfill and temporary asphalt, it shall conform to Section 602.1 of the Caltrans Encroachment Permit Manual, with the following minimum thicknesses:

Trench Width	Minimum Plate Thickness
(10") 0.25 m	(1/2") 13 mm
(1' - 11") 0.58 m	(3/4") 19 mm
(2' - 7") 0.80 m	(7/8") 22 mm
(3' - 5") 1.04 m	(1") 25 mm
(5' - 3") 1.60 m	(1 1/4") 32 mm

For spans greater than 5 feet-3 inches, a structural design shall be prepared by a California registered civil engineer.

PART 3 -- EXECUTION

3.1 GENERAL

- A. Where abandoned underground structures are encountered in the street areas, remove to sufficient depth to allow underground lines to cross, backfill and compact during rough grading. The ENGINEER may require further work to be done if visual inspection indicates during construction.

3.2 MINOR STRUCTURE EXCAVATION

- A. **General:** Except when specifically provided to the contrary, excavation shall include the removal of all materials of whatever nature encountered, including all obstructions of any nature that would interfere with the proper execution and completion of the work. The removal of said materials shall conform to the lines and grades shown on the Drawings or ordered by the ENGINEER. Unless otherwise provided, the entire construction site shall be stripped of all vegetation and debris, and such material shall be removed from the site prior to performing any excavation or placing any fill. The CONTRACTOR shall furnish, place, and maintain all supports and shoring that may be required for the sides of the excavations, and all pumping, ditching, or other measures required for the removal or exclusion of water, including storm water, groundwater, and wastewater reaching the site of the work from any source so as to prevent damage to the work or adjoining property. Excavations shall be sloped or otherwise supported in a safe manner in accordance with applicable State safety requirements and the requirements of OSHA Safety and Health Standards for Construction (29CFR1926). The limits of structure excavation shall be a minimum of 12 inches beyond the outside edge of the structure, and at a minimum no larger than necessary to facilitate backfill, compaction and testing operations. For structures poured against undisturbed soil the width of the structure wall shall be no more than 2 inches greater than specified or shown on the Drawings.

- B. **Excavation Beneath Minor Structures:** Except where otherwise specified for a particular structure or as directed by the ENGINEER, excavation shall be carried to the grade of the bottom of the structure. When directed by the ENGINEER, areas beneath minor structures shall be over-excavated. When such over-excavation is directed, both over-excavation and subsequent backfill to the required grade shall be performed. After over-excavation is performed and before backfill is placed, the exposed surface shall be scarified to a depth of 6 inches, brought to optimum moisture content, and rolled with heavy compaction equipment to obtain 90 percent of maximum density.

3.3 PIPELINE AND UTILITY TRENCH EXCAVATION

- A. **Trench Width:** Unless otherwise shown or directed, excavation for pipelines and utilities shall be open-cut trenches. Trench widths shall be kept as narrow as is practical for the method of densification selected by the CONTRACTOR, but shall have a minimum width at the bottom of the trench equal to the outside diameter of the pipe plus 24 inches. The maximum width at the top of the pipe shall be equal to the outside diameter of the pipe plus 36 inches for pipe diameters 18 inches and larger, and to the outside diameter of the pipe plus 24 inches for pipe diameters less than 18 inches. For deep trenches, the maximum width requirement may be waived for constructability reasons with the written approval of the ENGINEER. For telecommunications conduits (electrical, telephone, cable TV/communication conduits), street light and traffic signal conduits, the width of the trench shall be as shown on the City standard details.
- B. **Subgrade:** The surface of the subgrade after compaction shall be hard, uniform, smooth, self draining, and true to grade and cross section.
- C. **Trench Bottom:** The pipe bedding shall be given a final trim establishing grade such that each pipe section when first laid will be continually in contact with the bedding along the extreme bottom of the pipe. Rounding out the trench bottom or bedding to form a cradle for the pipe will not be allowed. The CONTRACTOR shall excavate for bell holes and fittings.
- D. **Open Trench:** The maximum amount of open trench permitted in any one location shall be the length necessary to accommodate the amount of pipe installed and backfilled in a single day. All trenches shall be fully backfilled at the end of each day or, in lieu thereof, shall be covered by heavy steel plates adequately braced and capable of supporting vehicular traffic in those locations where it is impractical to backfill at the end of each day. The above requirements for backfilling or use of steel plate may be waived in cases where the trench is located further than 100 feet from any travelled roadway or occupied structure. In such cases, however, barricades and warning lights meeting safety requirements shall be provided and maintained.
- E. **Trench Over-Excavation:** Where indicated trenches shall be excavated to the depth shown, and then backfilled to the grade of the bottom of the Pipe Zone.
- F. **Over-Excavation:** When ordered by the ENGINEER, whether or not indicated on the Drawings, trenches shall be over-excavated beyond the depth shown. Such over-excavation shall be to the depth ordered. The trench shall then be backfilled to the grade of the bottom of the Pipe Zone.
- G. Where pipelines are to be installed in embankment or structure fills, the fill shall be constructed to a level a minimum of 2 feet above the top of the pipe, as directed by the ENGINEER, or as recommended by the pipe manufacturer, whichever is greater, before the trench is excavated.

3.4 OVER-EXCAVATION NOT ORDERED, SPECIFIED, OR SHOWN

- A. Any over-excavation carried below the grade ordered, specified, or shown, shall be backfilled to the required grade and densified with the specified material and compaction. Such work shall be performed by the CONTRACTOR at its own expense.

3.5 EXCAVATION IN LAWN AREAS

- A. Where excavation occurs in lawn areas, the sod shall be carefully removed, stockpiled, watered and preserved for replacement. Excavated material may be placed on the lawn provided that a tarp or other suitable method is employed to protect the lawn from damage. The lawn shall not remain stockpiled for more than 48 hours. Immediately after completion of backfilling and testing of the pipeline, the sod shall be replaced in a manner so as to restore the lawn as near as possible to its original condition. CONTRACTOR shall provide new sod, in kind, if removed sod has remained stockpiled for more than 48 hours.
- B. All other landscaping shall be replaced in kind in conformance with Section 329113, "Landscape Soil Preparation," and Section 329300, "Landscape Planting," as shown on the Drawings or as directed by the ENGINEER. All damaged irrigation systems, including piping and electrical wiring, shall be repaired and operating properly the same day they are damaged, in conformance with Section 328000, "Irrigation Systems."

3.6 EXCAVATION IN VICINITY OF TREES

- A. Except where trees are shown to be removed, trees shall be protected from injury during construction operations. No tree roots over 2 inches in diameter shall be cut without express permission of the ENGINEER. Trees shall be supported during excavation by any means previously reviewed by the ENGINEER.
- B. If existing roots over one inch in diameter are cut during the course of the work, the cut faces shall be thoroughly coated with emulsified asphalt made especially for use on cut or damaged plant tissues. Exposed roots shall be covered with wet burlap to prevent them from drying out.

3.7 ROCK EXCAVATION

- A. Rock excavation shall include removal and disposal of the following: (1) all boulders measuring 1/3 of a cubic yard or more in volume; (2) all rock material in ledges, bedding deposits, and unstratified masses; (3) concrete or masonry structures which have been abandoned; and (4) conglomerate deposits which are so firmly cemented that they possess the characteristics of solid rock.
- B. **Explosives and Blasting:** Use of Explosives and Blasting will not be permitted.

3.8 DISPOSAL OF EXCESS EXCAVATED MATERIAL

- A. The CONTRACTOR shall remove and dispose of all excess excavated material to a suitable site. The proper and legal disposal shall be the responsibility of the CONTRACTOR.

3.9 BACKFILL - GENERAL

- A. Backfill shall not be dropped directly upon any structure or pipe. Backfill shall not be placed around or upon any structure for a minimum of 72 hours or until the concrete has attained sufficient design strength to withstand the loads imposed, whichever is greater.
- B. Except for Product Type 3B material being placed in over-excavated areas or trenches and unless specifically excepted by the ENGINEER, backfill shall not be placed until after all water is removed from the excavation.

3.10 PIPE AND UTILITY TRENCH ZONES AND BACKFILL

A. **Pipe Zone and Backfill:**

1. The Pipe Zone is defined as that portion of the vertical trench cross-section lying between a plane 6 inches below the bottom surface of the pipe, i.e., the trench subgrade, and a plane at a point 12 inches above the top surface of the pipe.
2. The Pipe Zone shall be backfilled with the specified backfill material. The CONTRACTOR shall exercise care to prevent damage to the pipeline coating, cathodic bonds, or the pipe itself during the installation and backfill operations.

B. **Bedding:** The bedding is defined as that portion of the Pipe Zone lying between a plane 6 inches below the bottom surface of the pipe, the trench subgrade, and a level line from the bottom of the pipe.

1. Bedding shall be provided for all pipelines.
2. After compacting the bedding the CONTRACTOR shall perform a final trim for establishing grade, such that each pipe section when first laid will be continually in contact with the bedding along the extreme bottom of the pipe.

C. **Trench Zone and Backfill:** After the Pipe Zone backfill has been placed as specified above, and after all excess water has completely drained from the trench, backfilling of the Trench Zone may proceed.

The Trench Zone is defined as that portion of the vertical trench cross-section lying between a plane 12 inches above the top surface of the pipe and a plane at a point 24 inches below the roadway subgrade in paved areas, or 24 inches below the finished surface grade in landscaped or unimproved areas.

D. **Final Zone and Backfill:** The Final Zone is defined as the last 24 inches between the top of the Trench Zone and the roadway subgrade in paved areas, and the last 24 inches of the vertical trench cross-section lying between the top of the Trench Zone and the finish final grade in landscaped or unimproved areas.

E. **Utility Crossing:** For any new pipeline installation that crosses under an existing electric, gas, telephone, or cable tv utility pipe(s) or conduit(s) the CONTRACTOR shall replace the existing backfill material around the existing utility pipe(s) or conduit(s) with PG&E SAND. PG&E SAND shall be placed from a plane 6 inches below the bottom of the lowest utility pipe or conduit to a plane 12 inches above the top of the highest utility pipe or conduit, and for the full width of the new trench. PG&E SAND backfill shall be compacted to 95 percent maximum density in conformance with COMPACTION AND BACKFILL MATERIALS as specified below.

3.11 PLACING AND SPREADING OF BACKFILL MATERIALS

- A. Backfill materials shall be placed and spread evenly in horizontal layers. The backfill layers shall be evenly spread so that when compacted each layer shall not exceed 6 inches in thickness.
- B. During spreading each layer shall be thoroughly mixed as necessary to promote uniformity of material in each layer and uniformity of moisture throughout backfill materials. Pipe Zone backfill materials shall be manually spread around the pipe so that when compacted the Pipe Zone backfill will provide uniform bearing and side support.
- C. Where the backfill material moisture content is below the optimum moisture content water shall be added before or during spreading until the proper moisture content is achieved.

- D. Where the backfill material moisture content is too high to permit the specified degree of compaction, the material shall be dried or replaced until the moisture content is satisfactory.
- E. Backfill shall be mechanically compacted by means of tamping rollers, sheepsfoot rollers, pneumatic tire roller, vibrating rollers, or other mechanical tampers. All such equipment shall be of a size and type subject to review by the ENGINEER. Impact-type pavement breakers (stompers) will not be permitted. Permission to use specific compaction equipment shall not be construed as guaranteeing or implying that the use of such equipment will not result in damage to adjacent ground, existing improvements, or new improvements. The CONTRACTOR shall make its own determination in this regard.
- F. Material for mechanically compacted backfill may be placed in loose lifts which, prior to compaction, shall not exceed the thickness specified below for various types of equipment:
 - 1. Vibratory equipment, including vibratory plates, vibratory smooth-wheel rollers, and vibratory pneumatic-tired rollers - maximum lift thickness of 2 feet.
 - 2. Rolling equipment, including sheepsfoot (both vibratory and non-vibratory), grid, smooth-wheel (non-vibratory), pneumatic-tired (non-vibratory), and segmented wheels - maximum lift thickness of 1 foot.
 - 3. Hand-directed mechanical tampers-maximum lift thickness of 4 inches.
- G. Mechanically compacted landfill shall be placed in horizontal layers of thickness not exceeding those specified above, compatible to the material being placed and the type of equipment being used. Each layer shall be evenly spread, moistened or dried, if necessary, and then tamped or rolled until the specified relative compaction has been attained.

3.12 COMPACTION OF BACKFILL MATERIALS

- A. Each layer of backfill material as defined herein, shall be mechanically compacted to the specified percentage of maximum density. Equipment that is consistently capable of achieving the required degree of compaction shall be used and each layer shall be compacted over its entire area while the material is at the required moisture content range.
- B. Flooding, ponding, or jetting shall not be used.
- C. Equipment weighing more than 10,000 pounds shall not be used closer to structure walls than a horizontal distance equal to the depth of the fill against the structure wall at that time. Hand operated power compaction equipment shall be used where use of heavier equipment is impractical or restricted due to weight limitations.
- D. **Compaction Requirements:** The following compaction test requirements shall be in accordance with ASTM D 1557 for cohesive type materials and in accordance with ASTM D 4253 and D 4254 for “non-plastic” cohesionless free draining granular type materials. Where other agency or utility company requirements govern, the highest compaction standards shall apply.

<u>Location or Use of Fill</u>	<u>Percentage of Maximum Density</u>	<u>Percentage of Relative Density</u>
Pipe Zone backfill including bedding and overexcavated zone.	90	65
Final Zone backfill beneath paved areas or structures.	95	70

Final Zone backfill beneath unpaved access areas, landscape, or unimproved areas.	90	55
Trench Zone backfill.	90	65
Backfill beneath minor structures.	95	70
Backfill around minor structures.	90	65

Maximum Density refers to maximum dry density according to ASTM D 1557 laboratory test procedures. Percentage of Relative Density refers to ASTM D 4253 and ASTM D 4254 laboratory test procedures. Relative density should only be used for "non-plastic" cohesionless free draining, granular-type materials.

E. **Trench Backfill Requirements:** The pipe class has been structurally designed based upon the trench configuration previously specified herein.

1. The CONTRACTOR shall maintain the previously specified trench width up to a horizontal plane lying 12 inches above the top of the pipe.
2. If, at any location under said horizontal plane, the CONTRACTOR slopes the trench walls or exceeds the maximum trench widths indicated the Pipe Zone backfill shall be "improved" or the pipe class improved at no additional cost to the CITY. "Improved" backfill shall mean Control Low Strength Materials or other equivalent materials acceptable to the ENGINEER.
3. If the allowable deflection specified for the pipe is exceeded, the CONTRACTOR shall expose and reround or replace the pipe, repair all damaged lining and coating, and reinstall the Pipe Zone material and Trench Zone backfill as specified.
4. All trenches shall have a minimum of 2 inches of temporary asphalt placed daily and maintained unless final paving can be completed in the same day. Temporary asphalt shall be placed flush with adjacent pavement grade.

Steel plates may be used to cover open trenches in-lieu of backfill and temporary asphalt pavement.

3.13 STEEL PLATE

- A. **General:** When backfilling operations of an excavation in the traveled way, whether transverse or longitudinal, cannot be properly completed within a work day, steel plate bridging with a non-skid surface and shoring may be required to preserve unobstructed traffic flow.
- B. When steel plate bridging is required, the following conditions shall apply:
 1. Steel plates used for bridging must extend a minimum of 12 inches beyond the edges of the trench.
 2. Steel plate bridging shall be installed to operate with minimum noise.
 3. The trench shall be adequately shored to support the bridging and traffic loads.
 4. Temporary paving with cold asphalt concrete shall be used to feather the edges of the plates, if plate installation by Method (2) is used.

5. Bridging shall be secured against displacement by using adjustable cleats, shims or other devices.
- C. Steel plate bridging and shoring shall be installed using either Method (1) or (2):
1. Method 1 For speeds more than 45 mph:

The pavement shall be cold planed to a depth equal of the thickness of the plate and to a width and length equal to the dimensions of the plate.
 2. Method 2 For speeds 45 mph or less:

Approaching plate(s) and ending plate (if longitudinal placement) shall be attached to the roadway by a minimum of 2 dowels pre-drilled into the corners of the plate and drilled 2 inches into the pavement. Subsequent plates are butted to each other. Fine graded asphalt concrete shall be compacted to form ramps, maximum slope 8.5 percent with a minimum 12 inch taper to cover all edges of the steel plates. When steel plates are removed, the dowel holes in the pavement shall be backfilled with either graded fines of asphalt concrete mix, concrete slurry or an equivalent slurry.
- D. Steel plate bridging should not exceed 4 consecutive working days in any given week.

- END OF SECTION -

SECTION 312323 - CONTROLLED LOW STRENGTH MATERIALS (CLSM)

PART 1 -- GENERAL

1.1 REQUIREMENTS

- A. Controlled Low Strength Materials (CLSM) will be allowed only on a case-by-case basis with the written approval of the ENGINEER.
- b. The CONTRACTOR shall provide all materials, equipment, and labor necessary to furnish and place CLSM, complete in place, and shall mix, place, finish, and do all other work to produce a cementitious hand excavatable mixture of aggregate, cement, pozzolan, water, and admixtures to be used as backfill or pipe abandonment fill, as shown on the Drawings and as specified herein.
- C. The CONTRACTOR is hereby advised that flotation or displacement of the pipe may occur during installation of the CLSM. The CONTRACTOR shall make necessary provisions to ensure that the pipe is installed according to the alignment and grade specified on the Drawings. Any pipe that is floated shall be removed and replaced at the CONTRACTOR'S expense.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 312300 Utility Earthwork.
- B. Division 1 General Requirements.

1.3 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. **Commercial Standards:**

ACI 229	Controlled Low Strength Materials.
ACI 232	Fly Ash/Other Pozzolans in Concrete.
ASTM C 31	Practice for Making and Curing Concrete Test Specimens in the Field.
ASTM C 39	Test Method for Compressive Strength of Cylindrical Concrete Specimens.
ASTM C 42	Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
ASTM C 94	Specification for Ready-mixed Concrete.
ASTM C 150	Specification for Portland Cement.
ASTM C 260	Specification for Air-Entraining Admixtures for Concrete.
ASTM C 494	Specification for Chemical Admixtures for Concrete.
ASTM C 618	Specification for Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Additive in Portland Cement Concrete.
ASTM D 1586	Method for Penetration Test and Split Barrel Sampling of Soils.

ASTM D 1633	Test Method for Compressive Strength of Molded Soil-Cement Cylinders.
ASTM D 2922	Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow-Depth).
ASTM D 3017	Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow-Depth).

1.4 CONTRACTOR SUBMITTALS

- A. **Mix Design:** Prior to beginning any work the CONTRACTOR shall submit to the ENGINEER for review, the pre-approved CLSM mix designs which shall show the proportions and gradations of all materials proposed for each class and type of CLSM to be used.
- B. **Certificate of Compliance:** Certificates of Compliance shall be provided for all products and materials proposed to be used under this Section.

PART 2 -- PRODUCTS

2.1 CONTROLLED LOW STRENGTH MATERIALS (CLSM)

A. **General:**

1. CLSM shall be a flowable, hand-excavatable mixture of cement, pozzolan, coarse and fine aggregate and water which has been mixed in accordance with ASTM C 94.
2. **Composition:** The following parameters shall be within the indicated limits and as necessary to produce the indicated compressive strengths.
 - a. Mix proportions shall be as approved.
 - b. Entrained air content shall be between 8 percent minimum and 20 percent maximum.
 - c. Water reducing agent content shall be as approved.
3. **Properties:**
 - a. Density shall be between 120 PCF minimum and 135 PCF maximum.
 - b. Slump shall be as approved.
 - c. Compressive strength at 28 days for flowable CLSM shall be between 50 psi minimum and 150 psi maximum.

B. **Cement:** Cement shall be Type II in accordance with the requirements of ASTM C 150.

C. **Pozzolan:** Pozzolan shall be added to improve the flowability and shall be Type F in accordance with the requirements of ASTM C 618.

D. **Aggregate:** Coarse aggregate shall consist of a well graded mixture of crushed rock, soil, or sand with a maximum size aggregate of ½ inch. 100 percent shall pass the ¾ inch sieve. Not more than 30 percent shall be retained by the ⅜ inch sieve and not more than 12 percent shall pass the No. 200 sieve. All material shall be free from organic matter and not contain more alkali, sulfates, or salts than the native materials at the site of the WORK.

E. **Admixtures:**

1. Air entraining shall be added to improve the workability and shall be in accordance with the requirements of ASTM C 260.

F. **Water:** Water shall be clean and free from objectionable quantities of silty organic matter, alkali, salts, and other impurities.

G. **Controlled Low Strength Materials (CLSM):**

1. CLSM shall be a mixture of cement, pozzolan, coarse and fine aggregate, admixtures, and water batched by a ready mix concrete plant and delivered to the WORK by means of standard transit mixing trucks. The mixture shall produce a cementitious, flowable, hand excavatable material.
2. The actual mix proportion and slump shall be as determined by the approved mix design.
3. The entrained air content shall be a minimum of 8 percent and a maximum of 20 percent as required by the CONTRACTOR to meet the uses specified herein.

PART 3 -- EXECUTION

3.1 TESTING

- A. All testing during the work will be done by a testing laboratory of the CITY'S choice at the CITY'S expense except as otherwise noted.
- B. In case the tests of the CLSM show non-compliance with the specifications the CONTRACTOR shall accomplish such remedy as may be required to insure compliance. Subsequent testing to show compliance shall be by a testing laboratory selected by the CITY and shall be at the CONTRACTOR'S expense.
- C. **Density:** The installed density of the material will be determined in accordance with ASTM D 2922.
- D. **Compressive Strength:** The compressive strength will be determined in accordance with ASTM C 39.

3.2 PREPARING PLACEMENT FOR CLSM

- A. The trench subgrade or compacted fill to receive CLSM shall be complete and acceptable in accordance with Section 312300, "Utility Earthwork."

3.3 DELIVERING CLSM

- A. CLSM shall be delivered to the WORK in standard transit mix trucks.

3.4 PLACING CLSM

- A. CLSM shall be delivered in place by means of tailgate discharge, conveyor belts, pumped in place, or other means acceptable to the ENGINEER.
- B. CLSM shall be directed in place by means of a vibrator, shovel or rod to ensure that all voids, crevices, and pockets are filled with CLSM. Care shall be taken to avoid over-consolidation of the material separating the large and fine aggregate.

- C. CLSM shall be continuously placed against undisturbed in-situ earth material unless otherwise approved by the ENGINEER. Where new CLSM must be placed against existing CLSM, the placement shall be clean of all loose and foreign material. The surface of existing CLSM shall be soaked a minimum of one hour before placement of fresh CLSM. No standing water will be allowed before starting placement of fresh CLSM.
 - D. When placing CLSM for trench plugs (trench dams), the CONTRACTOR shall ensure that no voids exist around the pipe barrel and that the CLSM completely fills the trench width, including keyways, for the full depth required, as shown on the Drawings.
- 3.5 PROTECTING CLSM
- A. CLSM shall be protected from running water, rain, freezing or other conditions that could damage the material until the material has been accepted and final fill complete.
 - B. No equipment, traffic, or backfill shall be allowed on the CLSM until the surface of the CLSM is able to withstand a 20 psi load without displacement or damage. If necessary, the CONTRACTOR shall provide steel trench plates that span the trench, as specified in Section 312300, "Utility Earthwork," until the CLSM has reached the required strength.
- 3.6 CURING
- A. CLSM shall be kept damp for a minimum of 7 days or until final fill is completed.

- END OF SECTION -