***ADD THE FOLLOWING SECTION TO DIVISION II – CONSTRUCTION DETAILS***

### SECTION 214 – ENGINEERED SOIL

NOTE TO SPEC WRITER: FOR STREET PROJECTS. Foundations within ESM will need additional analysis.

**DESCRIPTION**

**214.01.01 GENERAL**

A. This work shall consist of installing, furnishing, preparing, and compacting Engineered Soil Mix (ESM) on a prepared subgrade for the purpose of compaction capacity of 95% and providing ample space in which tree roots will successfully grow. This work shall also consist of related items as indicated on construction documents or as specified here within.

**214.01.02 SUMMARY**

1. The section includes Engineered Soil Mix and related items required for a complete installation.

**214.01.03 RElated work**

1. Section 212 Landscaping
2. Section 213 Irrigation Systems

**214.01.03 REFERENCES**

1. The following references are used herein:

ASTM: American Society of Testing Materials

USDA: United States Department of Agriculture

AASHTO: American Association of State Highway and Transportation Officials

AOAC: Association of Official Agricultural Chemists

**214.01.04 QUALITY ASSURANCE**

1. Qualifications of the installing Contractor shall be submitted. The Contractor shall have a minimum of 5 years of experience installing engineered soil. Submit list of projects, including contract/project name and contact information.
2. Suppliers for the Engineered Soil Mix (ESM): All Engineered Soil mixing shall be performed by an agreed upon supplier using appropriate soil measuring, mixing and shredding equipment of sufficient capacity and capability to assure proper quality control and consistent mix ratios. Mixing of engineered soil mix at the project site shall not be permitted.
3. The Engineered Soil Mix supplier shall have available at the mixing site sufficient equipment, instrumentation including qualified technicians to determine the weights and water content of the mix components immediately prior to the mixing procedure. The Contractor shall monitor these critical elements throughout the mixing process to provide adequate quality control. The supplier shall maintain a quality control log of material weight, water content and mix proportions for every 15 tons of material mixed. Maintain adequate moisture content during the mixing process. Soil and mix components shall easily shred and break down without clumping. Soil clods shall easily break down into fine crumbly texture. Soil shall not be overly wet or dry. The supplier shall measure and monitor the amount of soil moisture at the mixing site periodically during the mixing process.

**214.01.05 SUBMITTALS**

1. The Contractor shall submit within ten (10) calendar days after receipt of Notice to Proceed, material and equipment submittals, including manufacturer’s name and address, supplier’s name and address, samples, certificates, manufacturer’s literature, test results for materials specified below. No materials shall be ordered until the required samples have been reviewed by the ENGINEER.
2. There will be no deviation from the approved submittals without the written authorization by the ENGINEER.
3. Submit ½ cubic foot representative sample of clay loam; one cubic foot representative sample of crushed stone, and one cubic foot representative sample of Engineered Soil Mix for approval.
4. Submit soil test and analysis reports for sample of clay loam from an independent soil-testing laboratory.
	* + 1. Submit a mechanical analysis of the clay loam sample and particle size analysis including the following gradient of mineral content:

* + - 1. Sieve analysis shall be performed and compared to USDA Soil Classification System. Sieve analysis shall be done by a combined hydrometer and wet sieving using sodium hexametaphosphate as a dispersant in compliance with ASTM D422 after destruction of organic matter by hydrogen peroxide.

* + - 1. Submit a chemical analysis, performed in accordance with current AOAC Standards, to include pH and soluble salts.

E. Submit sample of crushed stone to be used in the production of the Engineered Soil Mix.

F. The sample of Engineered Soil Mix may be tested of the following at the discretion of the ENGINEER:

* + - 1. Compaction in accordance with ASTM D698/AASHTO T99 without removing oversize aggregate.
			2. California Bearing Ration in accordance with ASTM D1883 – soaked CBR shall equal or exceed a value of 50.
			3. Measured dry-weight percentage of stone in mixture.

G. Any deviation from the specified crushed stone and clay loam specifications shall be approved by the ENGINEER.

**214.01.06 DELIVERY STORAGE AND HANDLING**

A. Packaged Materials: Deliver packaged materials in containers showing weight, analysis, and name of manufacturer. Protect materials from deterioration during delivery, and while stored at site. Do not store materials unprotected.

B. Engineered Soil Mix shall be delivered at or near optimum compaction moisture content as determined by AASHTO T99 (ASTM D 698) and shall not be placed in frozen, wet or muddy sites.

C. Protect Engineered Soil Mix from exposure from excess water and from erosion at all times. Do not allow excess water to enter the site prior to compaction. If water is introduced into soil after grading, allow water to drain to optimum compaction moisture content.

**MATERIALS**

**214.02.01 ENGINEERED SOIL MIX (ESM)**

1. The components for the ESM mix shall conform to the following specifications:
	* + 1. Crushed granite stone: ¾” to 1 ½” crushed granite quarry rock of angular, sharp texture. ASHTO #4.
				1. Stone shall be clean, sharp a free of other stone other than granite. Stone shall be angular in shape with a maximum average length, width and depth ration of 2:1:1. Stones with visible fracture lines will be rejected.
				2. Stones shall have a PH between 6.0 and 8.5.
				3. Soluble slat levels less than 300 ppm.
			2. Clay loam soil shall conform to the following requirements:
				1. Gradation Limits

Coarse sand: 10 to 15 percent

Medium sand: 15-20 percent

Fine sand: 0 to 5 percent

Silt: 25 to 35 percent

Clay 27 to 35 percent

USDA Designation Size in mm

Gravel +2 mm

Coarse Sand 0.50-2.0 mm

Medium Sand 0.25-0.50 mm

Fine Sand 0.05-0.25 mm

Silt 0.002-0.05 mm

Clay minus 0.002 mm

* + - * 1. Chemistry Limits

 pH between 5.5 and 8.5

 Soluble salt levels less than 300 ppm.

* + - 1. Hydrogel: coated potassium propenoate-propenamide copolymer, acceptable to Engineered Soil Mix manufacturer.
				1. Amereq, 800-832-8788
				2. Broadleaf P4, 949-631-8184
				3. Or approved equal.
1. Mix Proportions:
	* + 1. Approved proportion of materials in Engineered Soil shall be as follows:

|  |  |  |
| --- | --- | --- |
| *Component* | *By units of weight* | *By percentage* |
| Crushed Granite Stone | 100 dry weight | 70.97-74.97 |
| Clay Loam Soil | 18 – 21 dry weight | 25 – 29 |
| Hydrogel | 0.03 dry weight | 0.03 |
| Water | 10 ± (includes water in other ingredients) |  |
| Other amendments | As recommended by test analysis |

1. Filter fabric: Non-woven continuous filament polyester fabric.
	* + 1. Weight 4.0 oz per square yard minimum.
			2. Grab strength 100 lbs. water flow rate 105 gpm/sq ft.
			3. Delivered in 15- foot wide roles minimum.
2. Water: Clean, fresh and free of substances or matter which could inhibit vigorous growth of plants.

**CONSTRUCTION**

1. **PREPARATION**

A. Identify locations for Engineered Soil Mix in field and secure ENGINEER’s acceptance before start of work. Make minor adjustments as may be required.

1. **PROJECT AND UNDERGROUND CONDITIONS**
2. Utilities: The Contractor shall locate and confirm the location of all underground utilities and structures prior to the start of any excavation. Perform work in a manner which will avoid possible damage. Hand excavate, as required. Maintain grade stakes set by others until removal is mutually agreed upon by parties concerned.
3. All areas to receive ESM shall be inspected by the installing contractor prior to the start of work. All defects such as incorrect grading, compaction, and inadequate drainage shall be reported to the ENGINEER prior to beginning the work.
4. The Contractor shall repair any underground utilities or foundations damaged during the progress of this work.
5. **MIXING PROTOCOL**
6. Mixing of the Engineered Soil Mix (ESM) at the project site is not permitted.
7. Spread the crushed stone on a paved surface to maximum depth of six (6) inches. Mix the Hydrogel and sufficient water into slurry and spray over the crushed stone. After the stone is uniformly wetted by the slurry, spread the clay loam evenly over the crushed stone. Spray the remaining water over the soil and mix with a loader of other device until the mix obtains an even consistency. Do not over mix or over wet. If the mix begins to form balls or pellets of soil around the aggregate, discard the batch. Any palletized soil will be rejected.
8. ESM may alternatively be mixed in a commercial pug mill or other equipment approved by the Engineer.
9. Mixing should include any required soil amendments to alter soil fertility including, soil sulfur, iron sulfate, lime, fertilizers for pH adjustment, etc., as indicated to reduce deficiencies in soil analysis.
10. After completion of the mixing and prior to installation, protect the ESM stockpiles(s) from rain and mix separation through erosion and excessive vibration during handling and placement. Cover the stockpile at all times with plastic sheeting.
11. Contractor shall procure sufficient quantities of ESM in advance of the time needed at the job site to allow adequate time for final quality control testing as required by the progress of the work. ESM shall be stored in piles no larger than 400 cubic yards and each pile shall be numbered for identification and quality control purposes. Storage piles shall be protected from drying out, rain and erosion by covering with plastic sheeting.
12. **DELIVERY STORAGE AND HANDLING**
13. Prior to any delivery of ESM, Contractor shall hold a preconstruction meeting with the Engineer, mixers and operators and submit a logistics plan to discuss schedules, methods and techniques for mixing, delivery and installation of material.
14. Do not deliver or place soils in wet, muddy or frozen conditions.
15. Materials shall be delivered at or near optimum compaction moisture content as determined by ASTM D 698 (AASHTO T 99).
16. Do not delivery or place materials in an excessively moist condition (beyond 2% above optimum compaction moisture content as determined by ASTM D698 (AASHTO T 99). Protect ESM from drying out, absorbing excess water and from erosion at all times. Do not store materials unprotected from large rainfall events.
17. Do not allow excess water to enter site prior to compaction. If water is introduced into material after grading, allow material to drain or aerate to optimum compaction moisture content.
18. ESM stored longer than two (2) days shall be inspected for water content, rehydrated and remixed as required to meet optimum compaction moisture content.
19. **SITE PREPARATION**
20. Do not proceed with installation of ESM material until all subsurface drain lines, walls, curb footings, irrigation lines and/or utility work in the area have been installed. For site elements dependent on ESM for foundation support, postpone installation until immediately after the installation of ESM. All subsurface drainage systems shall be operational prior to the installation of ESM.
21. Excavate and compact the proposed sub-grades to depths, slopes and widths as shown on drawings. Maintain all required angles of repose of the adjacent materials as shown on the drawings. Do not over excavate compacted subgrades of adjacent pavement or structures. Confirm that the subgrade is at the proper elevation and compacted as required. Subgrade elevations shall slope parallel to the finish grade or toward subsurface drain lines.
22. Excavate existing native soil so that the finish grade of the bottom of the structural soil will be the same grade as the bottom of the planted tree or minimum depth as shown on drawings, whichever depth is deeper. Contractor to verify with tree nursery the depths of the proposed tree rootballs, submit average depths of rootballs to Engineer so that final depth of excavation can be determined.
23. Dispose of excess subsoil removed from excavations. Clear the site of all construction debris, trash, rubble and any foreign material. In the event that fuels, oils, concrete washouts silts or other material harmful to plants have been spilled into the subgrade material, excavate the soil sufficiently to remove the harmful material. Fill any over excavation with approved fill and compact to the required subgrade compaction.
24. Protect adjacent walls, walks and utilities from damage or staining by soil. Clean up all trash and any soil or dirt spilled on any paved surface at the end of each working day. Any damages to the paving or architectural work caused by the installation of ESM shall be repaired or replaced by the Contractor at no additional cost. Maintain silt and sediment control devices and provide adequate methods to assure that trucks and other equipment do not track soil from the site.
25. **INSTALLATION OF ENGINEERED SOIL MIX**
26. Install ESM in 6-inch lifts and compact every 12” to 18” as required. Compact all materials to 95% peak dry density as defined by ASTM D 698 (standard AASHTO compaction curve AASHTO T 99). Hand tamp as necessary to protect utilities, irrigation lines and other subsurface features. Compaction testing procedures and equipment shall be calibrated for non-cohesive soils. No compaction shall occur when moisture content exceeds maximum as listed therein. Delay compaction 24 hours if moisture content exceeds maximum allowable and protect ESM during delays in compaction with plastic or plywood.
27. The ESM shall be able to maintain drainage of water at 0.75 inches per hour after completion of compaction. Test the completed installation with a minimum of one random percolation test per 300 square feet of area as follows: Dig a hole in the compacted ESM 10 inches in diameter and 10 inches deep. Fill with water and let it drain completely. Immediately refill with water and time the rate of fall of the water in the hole. The water shall recede at a minimum rate of 0.75 inch per hour. All testing shall be done in the presence of the Engineer. In the event that the installation fails to percolate at the required rate, the soil in the area shall be re-tested to determine if it meets the particle size distribution specified. Material that does not meet the specifications shall be removed at no extra cost to the Owner.
28. Bring ESM to finished grades as shown on the drawings. Immediately protect the ESM material from contamination by toxic materials, trash, debris, water containing cement, clay, silt or material that will alter the particle size distribution of the mix. After the ESM is installed, do not significantly delay, schedule or phase the progress or installation of the next layer of paving and planting above/in the ESM.
29. The Engineer may periodically check the material being delivered and installed at the site for color and texture consistency with the approved sample provided by the Contractor as part of the submittal for ESM. In the event that the installed material varies significantly from the approved sample, the Engineer may request that the Contractor test the installed ESM. Any soil that varies significantly from the approved testing results, as determined by the Engineer, shall be removed and new ESM installed that meets these specifications.
30. **FINE GRADING**
	* 1. After the initial placement and rough grading of the ESM but prior to the start of fine grading, the Contractor shall request review of the rough grading by the Engineer. The Contractor shall set sufficient grade stakes for checking the finished grades. Adjust the finish grades to meet field conditions as directed. Provide smooth transitions between slopes of different gradients and direction. Fill all dips and remove any bumps in the overall plane of the slope. The tolerance for dips and bumps in the ESM areas shall be a 3-inch deviation from the plane in 10 feet. All fine grading shall be inspected and approved by the Engineer prior to the installation of other items to be placed on the ESM.
31. **INSTALLATION OF FILTER FABRIC**
32. After the installation is completed and reviewed by the Engineer, install Filter Fabric on top of ESM in all areas that will be located below paving. Cut off excess fabric at the edge of the Engineered Soil.
33. Upon completion of ESM installation, clean areas. Remove all excess fill soils, mix stockpiles and legally dispose of all waste materials trash and debris. Sweep do not wash, all paving and other exposed surfaces of dirt and mud until the final paving has been installed over the mix. Avoid washing the area until all paving has been completed.
34. **INSTALLATION OF STREET TREES IN ENGINEERED SOIL MIX**
35. After the installation of the ESM and Filter Fabric is completed and adjacent pavement has cured and been approved by the Engineer, the street trees can be installed.
	* + 1. Do not excavate planting holes until irrigation and drainage systems are tested and approved by Engineer.
			2. Locate planting holes in the center of tree well as shown on the plans or required by the Engineer. Notify any conflicts with underground utility lines to the attention of the Engineer.
			3. Excavate holes to diameter and depth shown on plans. Avoid over excavating or contaminating ESM with native soil.
			4. Stockpile excavated ESM to use as backfill. Cover with plastic sheeting to protect stockpile from contamination and drying out. ESM stockpiled longer than two (2) days shall be inspected for water content, rehydrated and remixed as required to meet optimum compaction moisture content.
36. Prior to planting, test drainage of plants pits by filling with water twice in succession. Conditions permitting the retention of water in tree pits for more than 12 hours shall be brought to the attention of the Engineer.
37. Handle the tree carefully. Set rootball on bottom of pit and center it in tree well opening in the sidewalk. Backfill with ESM and settle with watering. Raise rootballs that settle below accepted finish grade.
38. **CLEAN UP**
39. During soil work, keep pavements clean and work area in an orderly condition.
40. Upon completion of ESM and tree installation, clean all affected areas. Remove all excess fills, soils, and mix stockpiles and legally dispose of all waste materials, trash and debris. Removal l tools, and equipment and provide a clean and clear site. Sweep do not wash, all paving and other exposed surfaces of dirt and mud until the paving has been installed over the structural soil material. Do not wash hardscape until the structural soil has been covered by the finished surface(s) per plans.
41. **INSPECTION AND ACCEPTANCE**
42. When structural ESM work is completed, ENGINEER will, upon request, make an inspection to determine acceptability. Structural soil work may be inspected for acceptance in portions as agreeable to ENGINEER, provided each portion of work offered for inspection is complete.
43. When inspected work does not comply with requirements, replace rejected work and have re-inspected by ENGINEER until found to be acceptable.

**METHOD OF MEASUREMENT**

**214.04.01 MEASUREMENT**

1. The quantity of ENGINEERED SOIL MIX will be measured per cubic yard based upon the total number cubic yards installed and accepted by the Engineer.
2. The quantity of FILTER FABRIC will be measured per square feet based upon the total number square feet installed and accepted by the OWNER.

**BASIS OF PAYMENT**

**214.05.01 PAYMENT**

The accepted quantity of ENGINEERED SOIL MIX will be paid for at the contract unit price of cubic yards and shall include all materials, equipment, labor, water and disposal required to perform this work and all work as shown on the drawings, as specified herein and as directed by the Engineer. The above payment shall also include loading; trucking; placing; excavation; soil; soil amendment; crushed stone; Hydrogel; compaction; fees; costs and permits as may be required and all other items necessary to complete the work as shown on the Plans, as specified herein and as directed by the ENGINEER.

The accepted quantity of FILTER FABRIC will be paid for at the contract unit price of square feet and shall include all materials, equipment, labor, and disposal required to perform this work and all work as shown on the drawings, as specified herein and as directed by the Engineer. The above payment shall also include loading; trucking; placing; fees; costs and permits as may be required and all other items necessary to complete the work as shown on the Plans, as specified herein and as directed by the ENGINEER.

Payment will be made under:

|  |  |  |
| --- | --- | --- |
| **ITEM NO.** | **ITEM DESCRIPTION** | **UOM** |
| 214.0010 | ENGINEERED SOIL MIX  | CY |
| 214.0020 | FILTER FABRIC | SF |

**END OF SECTION 214**