ITEM 754.1 SAND BASED STRUCTURAL SOIL CUBIC YARD

GENERAL

Work under this item shall conform to the relevant provisions of Section 751 of the MassDOT Standard Specifications, Division II, and the following:

The work consists of the furnishing and installing of sand based structural soil to the dimensions and details as shown on the Plans.

SCOPE OF WORK

This section specifies administrative and procedural requirements for manufactured sand-based structural soils including, but not limited, to the following:

1. Evaluation of rough subgrade water infiltration;
2. Planting soil material acquisition;
3. Testing and analysis for specification conformance;
4. Inspection and testing of subgrade for preparation of subgrade;
5. Preparation of mixes and testing for conformance;
6. Installation and placement of soils;
7. Decompaction of soils;
8. Final in-place testing of soils; and
9. Clean-up.

QUALITY ASSURANCE/DEFINITIONS

Definitions:

ASA: American Society of Agronomy

Candidate Contractor shall submit written documentation of at least five years of contracting and landscape construction experience completing project of similar scope, complexity, and value.

Candidate Contractor shall submit at least three project references including project address, dollar value, owner's name, owner's email and phone number.

Certificates: Provide certificates required by authorizes having jurisdiction, especially for any composted materials. Contractor shall submit certification that all soil blend components and all soil blends meet all environmental standards of the State of Massachusetts.

Testing for Sand Based Structural Soil: Testing is required at the following intervals:

Testing of individual components for all soil and subsoil mixes. After test results for components have been accepted, create sample mixes of each planting soils and subsoil mixes and perform tests. After the test results for planting soil and subsoil sample mixes have been accepted, produce, sample and submit test results for 200 cubic yard

stockpiles prior to delivery to the job site. Approval of 200 cubic yard stockpiles shall be at the soil supplier's facility before shipment to the site. Testing applies to all soil blends of the planting profile. In-place tests: Compaction tests of planting soil and subsoil layers.

Test Reports: Submit certified reports for tests as described in this Section.

Mechanical gradation (sieve analysis) shall be performed and compared to USDA Soil Classification System. Percent clay (0.002 mm) shall be reported separately in addition to silt (ASTM D-422-63, hydrometer method).

The silt and clay content shall be determined by a Hydrometer Test of soil passing the #270 sieve.

Chemical analysis shall be undertaken for Nitrate Nitrogen, Ammonium Nitrogen, Phosphorus, Potassium, Calcium Magnesium, Aluminum, Iron, Manganese, Lead, Cation Exchange Capacity, Soluble Salts, acidity (pH) and buffer pH.

Tests shall be conducted in accordance with Recommended Soil Testing Procedures for the Northeastern United States, 3rd Edition, Northeastern Regional Publication No. 493; Agricultural Experiment Stations of Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont and West Virginia; Revised – December 15, 1995. Referenced Document may be obtained on the web at http://ag.udel.edu/EXTENSION/agnr/soiltesting.htm.

Test include for the following:

1. Test for soil Organic Matter by loss of weight on ignition, as described in Northeastern Regional Publication No. 493, 3rd edition.
2. Test for soil CEC by exchangeable acidity method as described in Northeaster Regional Publication No. 493, 3rd edition.
3. Test for soil Soluble Salts shall be by the 1:2 (v:v) soil:water Extract method as described in Northeaster Regional Publication No. 493, 3rd edition.
4. Test for Buffer pH by the SMP method as described in Northeastern Regional Publication No. 493, 3rd edition.

Certified reports on analyses from producers of composted organic materials are required, particularly when sources are changed. Analyses will include all tests for criteria specified herein.

Density Tests: ASTM D1556 Density of Soil and Rock In Place Using Sane cone Method. ASTM D698 Test Method for Laboratory Compaction Characteristics of Soil using Standard Effort.

In-place density test shall be carried out at a rate of one test per 550 square feet for each type of material placed.

Saturated hydraulic conductivity: Test procedure ASTM D5856-95 (2000).

In-place Infiltration: ASTM D3385 – 09 Standard Test Method for Infiltration Rate of Soils

in Field Using Double-Ring Infiltrometer.

In-place Infiltration tests shall be conducted on the subgrade after all construction activities are completed in those areas.

Frequency of Infiltration testing shall be every thirty-five feet along the streetscape plantings or at location designated by the Engineer.

Testing Agencies: The following firms are acceptable testing agencies for various components:

Leaf Yard Water Compost Stability Test and Pathogens/ Metals/ Vector Attraction: Woods End Research Laboratory, P.O. Box 297, Mt. Vernon, ME 04352, tel: 201.293.2457, fax: 201.293.2488.

Leaf Yard Waste Compost/ All other tests except those listed above: University of Massachusetts, West Experiment Station, Amherst, MA 01003, tel: 413.545.2311, fax: 413.545.1931.

Mechanical Gradation and Chemical Analysis, All Components and Soil Mixes: University of Massachusetts, West Experiment Station, Amherst, MA 01003, tel: 413.545.2311, fax: 413.545.1931.

Samples: Prior to ordering the below listed materials, submit representative samples to the Engineer for review and approval. Do not order materials until the Engineer’s approval has been obtained. Delivered materials shall closely match the approved samples.

Organic Amendment: duplicate samples of 1 gallon. Base Loam: duplicate samples of 1 gallon.

Coarse Sand: duplicate samples of 1 gallon.

Sand-Based Structural Soil, after approval of individual components: duplicate samples of 1 gallon.

Sources for Soil Components and Soil Mixers: Submit information identifying sources for all soil components and the firm responsible for mixing of soil mixes.

The Engineer shall have the right to reject any soil supplier.

Soil mix supplier shall have a minimum of five years of experience at supplying custom planting soil mixes.

Submit supplier name, address, telephone and fax numbers and contact name, email and website address are also acceptable.

Submit certification that accepted supplier is able to provide sufficient quantities of materials and mixes for the entire project.

Inspections

The Contractor shall not place Sand-Based Structural Soil or Sand Drainage Layer prior to inspection and approval of the Engineer for compliance with depth, grading, and compaction specifications. Infiltration Testing of subgrade results shall be available before inspection. The Contractor shall request inspection before proceeding.

DELIVERY, STORAGE AND HANDLING

In addition, the following provision is established: Material shall not be banded or hauled, placed or compacted when it is wet as after a heavy rainfall or is frozen. Soil shall be handled only when the moisture content is less than at field capacity. The Engineer shall be consulted to determine if the soil is too wet to handle.

Store and handle packaged material in strict compliance with manufacturer's instructions and recommendations. Protect all materials from weather, damage, injury, and theft.

Sequence deliveries to avoid delay. On-site storage space is permissible only with written approval from the City of Boston. Deliver materials only after preparations for placement of sand based structural soil has been completed.

Prohibit vehicular and pedestrian traffic on or around stockpiled soil.

MATERIALS

General

Samples of individual components of soil mixes in addition to blended soil mixes shall be submitted by the Contractor for testing and analysis to the approved testing laboratory. Comply with specific materials requirements specified.

No base component material or soil components for soil mixes shall be used until certified test reports by an approved agriculture chemist have been received and approved by the Engineer.

As necessary, make all soil mix amendments and resubmit test reports indicating amendments until approved.

The Engineer may request additional testing by Contractor for confirmation of mix quality and/or soil mix amendments at any time until completion.

Base Loam for mixing

Base Loam as required for blending with other components shall be a naturally occurring soil formed from geologic soil forming processes without admixtures of sand or organic matter sources (composts). Base Loam as required for the work shall be free of subsoil, large stones, earth clods, sticks, clay lumps, roots or other objectionable, extraneous matter or debris. Base Loam shall also be free of quack-grass rhizomes, Agropyron Repens, and the nut-like tubers of nutgrass, Cyperus Esculentus, and all other primary

noxious weeds. Base Loam shall not be delivered or used for planting while in a frozen or muddy condition. Base Loam for mixing shall conform to the following grain size distribution for material passing the #10 sieve.

U.S. Sieve No.	% Passing by Weight	
	Min.	Max.
10	---	100
18	85	100
35	70	95
60	50	85
140	36	53
270	32	42
0.002 mm	3	6

The ratio of the particular size for 80% passing (D80) to the particle size for 30% passing (D30) shall be 8 or less (D80/D30 < 8). Maximum size shall be one-inch largest dimension. The maximum retained on the #10 sieve shall be 20% by weight of the total sample. Tests shall be by combined hydrometer and wet sieving in compliance with ASTM D422 after destruction of organic matter by ignition. The organic content shall be between 4.0 and 8.0 percent by weight.

Chemical analysis shall be undertaken for Nitrate Nitrogen, Ammonium Nitrogen, Phosphorus, Potassium, Calcium Magnesium, Aluminum, Iron, Manganese, Lead, Cation Exchange Capacity, Soluble Salts, acidity (pH) and buffer pH.

Uniformly Graded Coarse Sand

Sand for Sand-Based Structural Soil shall be uniformly graded medium to coarse sand consisting of clean, inert, rounded to sub-angular grains of quartz or other durable rock free from loam or clay, mica, surface coatings and deleterious materials with the following gradation:

U.S. Sieve No.	% Passing by Weight	
	Min.	Max.
10	100	---
18	60	80
35	25	45
60	8	20
140	0	8
270	0	3
0.002 mm	0	0.5

Maximum size shall be one-inch largest dimension. The maximum retained on the #10 sieve shall be 20% by weight of the total sample. The ratio of the particle size for 70% passing (D70) to the particle size for 20% passing (D20) shall be 3.5 or less. (D70/D20 <3.5) Tests shall be by combined hydrometer and wet sieving in compliance with ASTM D422 after destruction of organic matter by ignition. pH shall be less than 7.2.

Organic Amendment

Organic Matter for amending planting soils shall be a stable, humus-like material produced from the aerobic decomposition and curing of Leaf yard Waste Compost, composted for a minimum of one year (12 months). The leaf yard waste compost shall be free of debris such as plastics, metal, concrete or other debris. The leaf yard waste compost shall be free of stones larger than ½", larger branches and roots. Wood chips over 1" in length or diameter shall be removed by screening. The compost shall be a dark brown to black color and be capable of supporting plant growth with appropriate management practices in conjunction with addition of fertilizer and other amendments as applicable, with no visible free water or dust, with no unpleasant odor, and meeting the following criteria as reported by laboratory tests.

The ratio of carbon to nitrogen shall be in the range of 12:1 to 25:1.

Stability shall be assessed by the Solvita procedure. Protocols are specified by the Solvita manual (version 4.0). The compost must achieve a maturity index of 6 or more as measured by the Solvita scale. Stability tests shall be conducted by Woods End Research Laboratory, Mt. Vernon, Maine.

Pathogens/Metals/Vector Attraction reduction shall meet 40 CFR Part 503 rule, Table 3, page 9392, Vol. 58 No. 32, and Commonwealth of Massachusetts 310 CMR 32.00 (for applications to soils with human activity).

Organic content shall be at least 20 percent (dry weight). One hundred percent of the material shall pass a 3/8" (or smaller) screen. Debris such as metal, glass, plastic, wood (other than residual chips), asphalt or masonry shall not be visible and shall not exceed one percent dry weight. Organic content shall be determined by weight loss on ignition for particles passing a number 10 sieve according to procedures performed by the West Experiment Station at the University of Massachusetts, Amherst or equal as follows. A 50-cc sub-sample of the screened and mixed compost is ground to pass the number 60 sieve. Two to three grams (+ 0.001g) of ground sample, dried to a constant weight at 105 degrees C is placed into a muffle furnace. The temperature is slowly raised (5 degrees C / minute) to 450 degrees C and maintained for three hours. The sample is removed to an oven to equilibrate at 105 degrees C and the weight is taken. Organic matter is calculated as loss on ignition.

pH: The pH shall be between 6.5 to 7.2 as determined from a 1:1 soil-distilled water suspension using a glass electrode pH meter American Society of Agronomy Methods of Soil Analysis, Part 2, 1986.

Salinity: Electrical conductivity of a one to five soil to water ratio extract shall not exceed 2.0 mmhos/cm (dS/m).

The compost shall be screened to 3/8" maximum particle size and shall contain no more than 3 percent material finer than 0.002mm as determined by hydrometer test on ashed material.

Nutrient content shall be determined by the University of Massachusetts Soil Testing Laboratory or equivalent laboratory and utilized to evaluate soil required amendments for

the mixed soils. Chemical analysis shall be undertaken for Nitrate nitrogen, Ammonium Nitrogen, Phosphorus, Potassium, calcium, Aluminum, Magnesium, Iron, Manganese, Lead, Soluble Salts, Cation Exchange Capacity, soil reaction (pH) and buffer pH.

Sand Based Structural Soil Planting Medium

The Sand-Based Structural Soil Planting Medium shall consist of a blend of approximately four parts of by volume of Coarse Sand, one part by volume of Base Loam, and one- and one-half parts by volume or Organic Amendment. Blending of the components shall be carried out with earth moving equipment prior to delivery and placement. The components shall be blended to create a uniform mixture.

The final blended Sand-Based Structural Soil Planting Medium shall conform to the following grain size distribution for material passing the #10 sieve:

U.S. Sieve No.	% Passing by Weight	
	Min.	Max.
10	100	---
18	68	90
35	38	63
60	18	39
140	10	18
270	6	9
0.002 mm	1	2

Maximum size shall be one-inch largest dimension. The maximum retained on the #10 sieve shall be 15% by weight of the total sample.

The ratio of the particle size for 70% passing (D70) to the particle size for 20% passing (D20) shall be 3.5 or less (D70/D20 < 3.5). Tests shall be by combined hydrometer and wet sieving in compliance with ASTM D422 after destruction of organic matter by ignition. Organic content shall be between 2.0 and 3.0 percent. pH shall be 6.0 to 7.0.

PRE-INSTALLATION EXAMINATION AND PREPARATION

Coordinate activities with other project contractors so that there is no soil disturbance from traffic or other construction activities subsequent to placement.

Pre-Installation Examination Required: The Contractor shall examine previous work, related work, and conditions under which this work is to be performed and shall notify the Engineer in writing of all deficiencies and conditions detrimental to the proper completion of this work. Beginning work means Contractor accepts substrates, previous work, and conditions. The Contractor shall not place any planting soil until all work in adjacent areas is complete and approved by the Engineer.

Placement of Sand-Based Structural Soil

After subgrade levels have been reached, and immediately prior to placing Sand-Based Structural Soil, the entire subgrade area shall be thoroughly compacted. Sand-Based

Structural Soil shall be spread in lifts not greater than eight inches and compacted with a minimum of two passes of vibratory compaction equipment to a density between 94 and 96 percent Standard Proctor. Sand-Based Structural Soil shall be placed within the areas shown on the Plans.

PROTECTION

Protect newly graded areas from traffic, freezing and erosion. Keep free of trash, debris or construction materials from other work.

Repair and re-establish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or compacted due to subsequent construction operations or weather conditions. Scarify or remove and replace material to a depth as directed by the Engineer; reshape and re-compact at optimum moisture content to the required density.

Where settling occurs, before final acceptance or during the warranty period, remove finish surfacing, backfill with additional approved material, compact to specified rates, and restore any disturbed areas to a condition acceptable to the Engineer.

COORDINATION AND EXCESS MATERIALS

Coordinate activities with other project contractors so that there is no soil disturbance from traffic or other construction activities subsequent to placement.

POST-INSTALLATION TESTING

In-place density test shall be carried out at a rate of one test per 550 square feet for each type of material placed. The standard test for surface and subsurface density shall be ASTM D-698. Final test results shall be submitted to the Engineer.

METHOD OF MEASUREMENT

Sand Based Structural Soil will be measured for payment by the cubic yard, complete in place, after compaction to the depth specified on the Plans or as directed. No additional compensation will be made to account for settlement, shrinkage, and penetration into the underlying material.

BASIS OF PAYMENT

Sand Based Structural Soil will be paid for at the Contract unit price per cubic yard, which price shall include all labor, materials, equipment, and incidental costs required to complete the work. No separate payment will be made for testing, analysis, and grading, but all costs in connection therewith shall be included in the Contract unit price bid.

Excavation will be paid for separately under Item 120.1, Unclassified Excavation.

Sand Drainage Layer will be paid for separately under Item 154.02, Sand.

Washed No. 3 Stone aggregate layer will be paid for separately under Item 156.03, Washed No. 3 Stone.

Non-Woven Geotextile Fabric will be paid for separately under Item 698.3, Non-Woven Geotextile Fabric.

Impermeable Liner (if required) will be paid for separately under Item 698.6, Impermeable Liner.