Designation: ~~D8297/D8297M – 20~~ D8297/D8297M – 22

Standard Test Method for Determination of Erosion Control Products (ECP) Performance in Protecting Slopes from Sequential Rainfall-Induced Erosion Using a Tilted Bed Slope[1]

This standard is issued under the fixed designation D8297/D8297M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. ~~Scope~~ Scope*

1.1 This test method is used to evaluate the ability of erosion control products (ECP) to protect slopes from rainfall-induced erosion using an adjustable tilting bed slope. The standard slopes range from 2:1 to 4:1 (H:V) having a target rainfall intensity of 3.5 in./h [90 mm/h].

1.2 There are three main elements the ECPs must have the ability to perform: 1. Absorb the impact force of raindrops, thereby reducing soil particle loosening and detachment through "splash" mechanisms; 2. Slow runoff and encourage infiltration, thereby reducing soil particle displacement and transport through "overland flow" mechanisms; and 3. Trap soil particles beneath the ECP. When comparing data from different ECPs under consideration, it is important to keep the test conditions the same for the ECPs being evaluated, for example, the rainfall intensity rate and the slope.

1.3 The results of this test method can be used to evaluate performance and acceptability, and can be used to compare the effectiveness of different ECPs. This method provides a comparative evaluation of an ECP to baseline bare soil conditions under controlled and documented conditions. This test method can provide information about a product that is under consideration for a specific application where no performance information currently exists.

1.4 This test method covers the use of three different soil types, ECP installation: sprayed, rolled, or dry applied, and a runoff collection procedure. This test is typically performed indoors, but may be performed outside as long as certain requirements are met. Partially enclosed facilities are acceptable providing the environmental conditions are met.

1.5 *Units*—The values stated in either inch-pound units or SI units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in nonconformance with the standard. Reporting of test results in units other than inch-pound shall not be regarded as nonconformance with this standard.

1.5.1 The gravitational system of inch-pound units is used when dealing with inch-pound units. In the system, the pound (lbf) represents a unit of force (weight), while the units for mass is slugs. The slug unit is not given, unless dynamic (F = ma) calculations are involved.

1.5.2 It is common practice in the engineering/construction profession to concurrently use pounds to represent both a unit of mass

[1] This test method is under the jurisdiction of ASTM Committee D18 on Soil and Rock and is the direct responsibility of Subcommittee D18.25 on Erosion and Sediment Control Technology.

Current edition approved ~~May 15, 2020~~June 1, 2022. Published ~~June 2020~~June 2022. Originally approved in 2020. Last previous edition approved in 2020 as D8297/D8297M – 20. DOI: ~~10.1520/D8297_D8297M-20.~~10.1520/D8297_D8297M-22.

***A Summary of Changes section appears at the end of this standard**

(lbm) and of force (lbf). This practice implicitly combines two separate systems of units; the absolute and the gravitational systems. It is scientifically undesirable to combine the use of two separate sets of inch-pound units within a single standard. As stated, this standard includes the gravitational system of inch-pound units and does not use/present the slug unit of mass. However, the use of balances and scales recording pounds of mass (lbm) or recording density in lbm/ft^3 shall not be regarded as nonconformance with this standard.

1.5.3 Calculations are done using only one set of units; either gravitational inch-pound or SI. Other units are permissible provided appropriate conversion factors are used to maintain consistency of units throughout the calculations, and similar significant digits or resolution, or both are maintained.

1.6 All observed and calculated values shall conform to the guidelines for significant digits and rounding established in Practice D6026, unless superseded by this test method.

1.6.1 The procedures used to specify how data are collected/recorded and calculated in the standard are regarded as the industry standard. In addition, they are representative of the significant digits that generally should be retained. The procedures used do not consider material variation, purpose for obtaining the data, special purpose studies, or any considerations for the user's objectives; and it is common practice to increase or reduce significant digits of reported data to be commensurate with these considerations. It is beyond the scope of these test methods to consider significant digits used in analysis methods for engineering data.

1.7 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.8 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D653 Terminology Relating to Soil, Rock, and Contained Fluids
D698 Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3 (600 kN-m/m^3))
D2216 Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
D2434 Test Methods for Measurement of Hydraulic Conductivity of Coarse-Grained Soils
D2487 Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
D3740 Practice for Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction
D4318 Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
D4753 Guide for Evaluating, Selecting, and Specifying Balances and Standard Masses for Use in Soil, Rock, and Construction Materials Testing
D5084 Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter
D6026 Practice for Using Significant Digits and Data Records in Geotechnical Data
D6475 Test Method for Measuring Mass per Unit Area of Erosion Control Blankets
D6525/D6525M Test Method for Measuring Nominal Thickness of Rolled Erosion Control Products
D6567 Test Method for Measuring the Light Penetration of a Rolled Erosion Control Product (RECP)
D6818 Test Method for Tensile Properties of Rolled Erosion Control Products
D6913/D6913M Test Methods for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis
D6938 Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
D7367 Test Method for Determining Water Holding Capacity of Fiber Mulches for Hydraulic Planting
D7928 Test Method for Particle-Size Distribution (Gradation) of Fine-Grained Soils Using the Sedimentation (Hydrometer) Analysis
D7937 Test Method for In-situ Determination of Turbidity Above 1 Turbidity Unit (TU) in Surface Water
D8199 Test Method for Determining the Specific Strength of Hydraulically Applied Fiber Matrix Products for Erosion Control
E11 Specification for Woven Wire Test Sieve Cloth and Test Sieves

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

2.2 *Other Standards:*

Soil Science Division Staff, 2017. Soil Survey Manual. C. Ditzler, K. Scheffe, and H.C. Monger (eds.). USDA Handbook 18. Government Printing Office, Washington, DC[3]

3. Terminology

3.1 *Definitions:*

3.1.1 For definitions of common technical terms used in this standard, refer to Terminology D653.

3.1.2 *erosion control product (ECP), n—in erosion control*, a temporary degradable or long term, non-degradable material designed to reduce soil erosion and assist in the growth, establishment, and protection of vegetation.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *runoff, n—in erosion control*, sediment and water collected from the ECP covered test plots during testing.

4. Summary of Test Method

4.1 Before testing, the rainfall simulator system is calibrated for each type of rainfall intensity/slope combination intended for use. Once the rainfall simulator is calibrated, bare soil slope tests are conducted on test plots to determine the baseline soil loss, turbidity and sediment values. Three test plots are prepared and the ECP is applied by spraying, rolling, or dry application according to the manufacturer's recommended rate of application corresponding to the slope of the prepared test plots. After the ECP has been installed and cured (if needed) the rainfall simulator is started and runs for 30 minutes per day for a total of 3 days with a total time of 90 minutes. The total amount of runoff is collected at the end of each 30 minute period and a turbidity sample is taken every 15 minutes during testing using the collection procedure. Specimens are taken from the collected runoff and are analyzed for soil loss, turbidity and sediment concentrations.

5. Significance and Use

5.1 This test method utilizes large-scale testing equipment and procedures established at a variety of testing laboratories over the last 30 years.

5.2 This method is useful in evaluating ECPs and their installation to reduce soil loss and sediment concentrations when exposed to defined rainfall conditions and improving water quality exiting the area disturbed by earthwork activity by reducing suspended solids and turbidity.

5.3 This test method is a performance test, but can also be used for acceptance testing to determine product conformance to project specifications. For project-specific conformance, unique project-specific conditions should be considered. Caution is advised since information regarding laboratory specific precision is incomplete at this time, and differences in soil and other environmental and geotechnical conditions may affect ECP performance.

5.4 This standard can also be used as a comparative tool for evaluating the erosion control characteristics of different ECPs and can also be used to gain agency approvals.

NOTE 1—The quality of the result produced by this standard is dependent on the competence of the personnel performing it, and the suitability of the equipment and facilities used. Agencies that meet the criteria of Practice D3740 are generally considered capable of competent and objective testing/sampling/inspection/etc. Users of this standard are cautioned that compliance with Practice D3740 does not in itself assure reliable results. Reliable results depend on many factors; Practice D3740 provides a means of evaluating some of those factors.

6. Interferences

6.1 Raindrop distribution must be uniform when performing this test. Usually, indoor facilities provide environmental control such that wind velocity is below 1.0 mph [1.5 kph]; however, for locations using plastic sheeting for wind protection, partially outdoor, and outdoor locations the wind velocity can interfere with uniform raindrop distribution. Therefore, do not conduct testing and calibration in a non-enclosed or partially enclosed facility when the wind velocity exceeds 1.0 mph [1.5 kph]. Facilities sometimes use plastic sheeting or tarps as wind barriers and are therefore subject to the wind velocity requirements.

[3] The referenced Soil Survey Manual can be found by visiting the USDA website, www.nrcs.usda.gov, or call NRCS Customer Service at 888- 526-3227.

6.2 Sediment concentrations may be small, thus it is important to follow the standard carefully.

6.3 ECPs shall be free of extraneous foreign material, such as, metals or non-standard plastics, as they can interfere (for example, clogging a hose) with product application, see 8.2 for further details on how to check for foreign materials.

7. Apparatus

7.1 *Rainfall Simulators*—One of the following rainfall simulators shall be selected and setup with a fall height of no less than 8.0 ft [2.5 m] at the lowest point and must be able to produce a data point based on the Laws and Parson (1943)[4] raindrop size-intensity curve (Fig. 1) for the minimum distribution raindrop sizes corresponding to the appropriate target intensity as presented in Fig. 1. Points on or above the Laws & Parson curve and below the upper boundary curve are allowed, while points below the Laws & Parson curve are not allowed. The water used in the simulators must not contain deleterious material that could impair the simulators operation and as such should have a turbidity value of 10 or less as determined by Test Method D7937. Tap water is commonly acceptable for use as the water source for the simulators.

7.1.1 *Sprinkler*—Irrigation equipment that distributes water droplets into the air which fall on the test plot.

7.1.2 *Nozzle*—Irrigation equipment from which water is forced at a velocity by pressure downward toward the test plot.

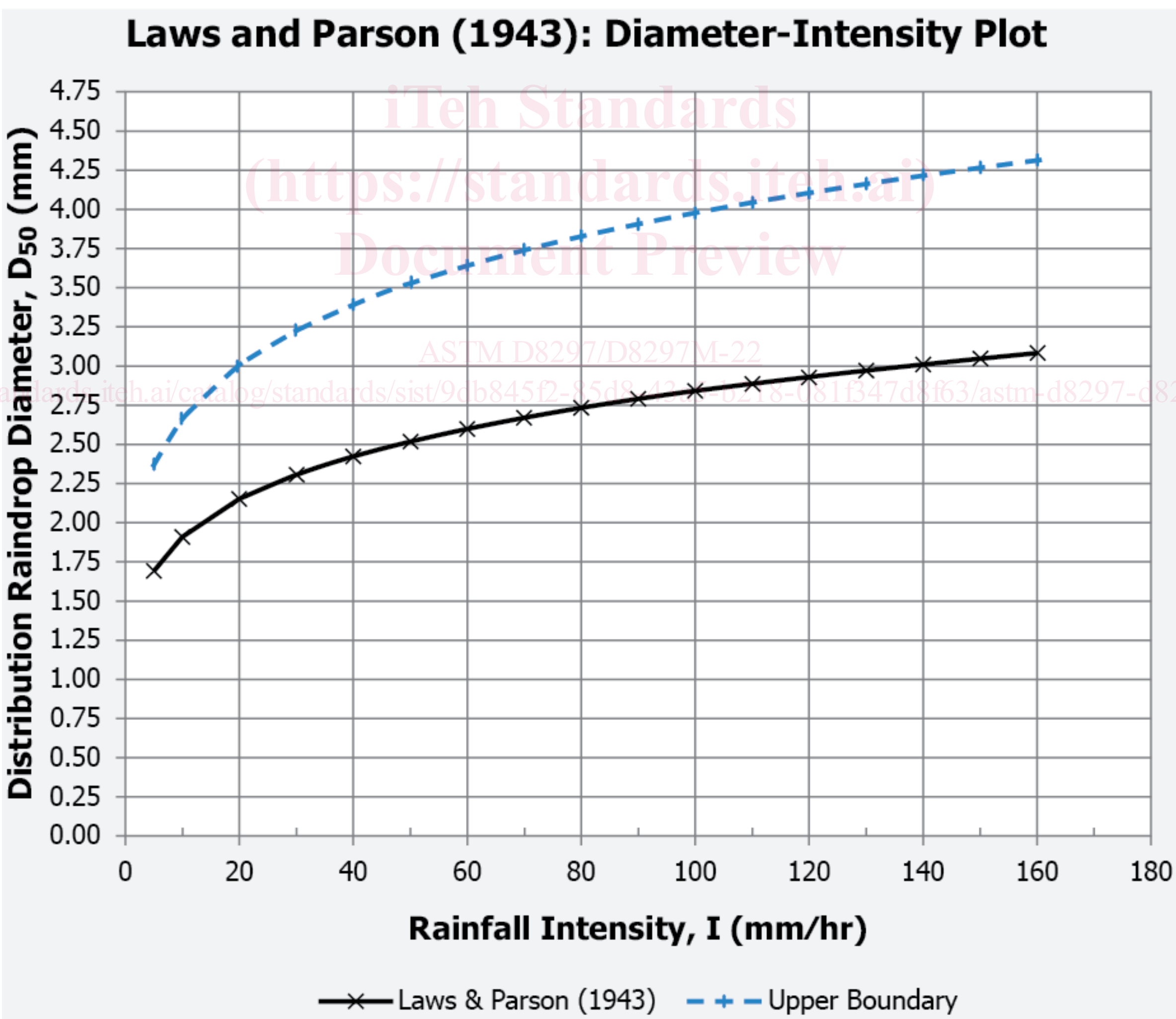

FIG. 1 Laws and Parson (1943) Diameter-Intensity Plot

[4] Laws, J.O., and Parsons, D.A., "The Relation of Raindrop-Size to Intensity." Transactions, American Geophysical Union., Vol. 24, Part 2, 1943, p. 452-460.

7.1.3 *Drop Emitters*—Irrigation equipment where drops form and fall from a tip starting at essentially zero velocity.

7.2 *Runoff Collection System*—This system should include flashing, collection apparatus, and a holding tank. Flashing shall be fabricated to direct runoff from the test plots into the collection apparatus and shall be continuous across the entire bottom edge of the test plot. It may be desirable to divert the runoff to a single collection point. The holding tank(s) connected to the collection apparatus shall be capable of temporarily containing all the runoff. Bins (with or without metal reinforcement), tubs, buckets, and similar containers are needed to capture the runoff from the collection system. Bulk bags used should be made of material that will retain sediment while allowing water to drain from the bag.

7.3 *Test Plots*—A metal tray fabricated to contain a minimum of 9.0 in. [0.2 m] depth of soil with a perforated bottom sheet covered with a geotextile fabric that has a water flow rate greater than or equal to 4 gal/min/ft^2 [163 L/min/m^2]. The necessary length to width ratio is 5 to 1 with the minimum test plot size of 30 by 6 ft [9.0 by 2.0 m].

7.3.1 *Test Plot Water Barriers*—The top edge and sides of the test plot must be isolated by a water barrier if individual testing trays are not used. The barrier shall be continuous such that joints do not allow outside flow to enter the test plot. Commercially available lawn edging or lumber are both suitable for use as barriers. In the case of individual test trays, side edging and test plot separation are not necessary.

7.4 *Hydroseeding/Mulching Apparatus*—This device shall be used when the ECP is installed by spraying and must be capable of uniformly applying it. One of the following devices should be used: 80 gal [300 L] mechanically agitated hydroseeder; 300 gal [1200 L] mechanically agitated hydroseeder; 500 gal [1900 L] mechanically agitated hydroseeder (Note 2). The 300 gal [1200 L] and 500 gal [1900 L] hydroseeder tanks shall be calibrated using a flowmeter and have permanent graduations marked on it. Any hydroseeder with a capacity between 80 gal [300 L] and 1100 gal [4160] must also be calibrated, marked, and meet the requirements of this standard.

NOTE 2—Historically, these three hydroseeders are the most commonly used for this type of testing. Other capacity hydroseeders up to 1100 gal [4160 L] can be used providing they meet the requirements set forth in this standard. This standard does not go into detail regarding the slurry levels or the use of other capacity hydroseeders.

7.5 *Turbidimeter*—A handheld or benchtop device capable of measuring values up to 4000 TU. The specifications for the turbidimeter are given in Test Method D7937.

7.6 *Timing Device*—A clock, stopwatch, digital timer, or comparable device readable to 1 second or better.

7.7 *Balance*—Balances shall conform to the requirements of Guide D4753 and shall be verified annually. The capacity of the balances must be sufficient to accommodate the total mass of the anticipated test masses.

7.7.1 For determining masses when the total mass is less than 20 lbm [9.1 kg], the balance shall have a readability without estimation to 0.0025 lbm [1 g]. For determining masses when the total mass is more than or equal to 20 lbm [9.1 kg], the balance shall have a readability without estimation to 0.25 lbm [0.1 kg]. For determining masses for raindrop size, the balance shall have a readability without estimation to 0.0001 g.

7.8 *Drying Oven*—Vented, thermostatically controlled oven capable of maintaining a minimum uniform temperature of 140°F [60°C] throughout the drying chamber. These requirements typically require the use of a forced-draft oven. For drying the flour pellets, the temperature of this oven will need to be 110 ± 8°F [43 ± 5°C].

7.9 *Measuring Devices*—A surveyor's rod, tape measure, or similar with enough length and divisions of 0.1 ft [0.05 m] or better to measure the rainfall distance and the test plot width and length.

7.10 *Specimen Container*—20 glass or plastic bottles with lids having a minimum capacity of 250 mL.

7.11 *Meteorological Equipment*—The following equipment is needed: thermometer (air temperature) readable to 1°F/C or better, hygrometer (humidity) readable to 1 % or better, anemometer equipped to measure wind speed, readable to 0.1 mph/kph or better, and direction. The anemometer is required for outdoor, partially outdoor, or facilities using wind protection. It is optional for indoor testing.

7.12 *Sieves*—Each sieve shall conform to the requirements of Specification E11. A 0.212 mm (No. 70) sieve, lid and pan, as well as the following sieves are needed: 6.3 mm (¼ in.), 4.75 mm (No. 4), 4.0 mm (No. 5), 3.35 mm (No. 6), 2.8 mm (No. 7), 2.36 mm (No. 8), 2.00 mm (No. 10), 1.7 mm (No. 12), 1.4 mm (No. 14), 1.0 mm (No. 18), 0.500 mm (No. 35), and 0.250 mm (No. 60).

7.13 *Rain Gauges*—Any type of container is allowed provided they meet the following specifications: each container must have identical dimensions (same diameters and depths); each container must be calibrated such that the marked graduation lines accurately measure the amount of rainfall within ±0.2 in. [5 mm]; and lines shall be marked every 0.2 in. [5 mm]. Clear plastic or glass containers are recommended. A holder or platform/rack is also needed to keep the rain gauge vertical during use.

7.14 *Miscellaneous Items*—The following items are also needed: flowmeter, waterproof barrier (plastic sheeting, lids), 9 in. [230 mm] wide by 1 in. [25 mm] deep cake pans, flour sifter, Pillsbury Best all-purpose flour, ruler/straightedge, evaporating dishes, desiccator (optional), sieve shaker (optional), heat resistant pans, digital camera, digital video recorder, lath board, and shovel or rototiller.

8. Materials

8.1 *Soil Types*—The soil type to be used in the test plots shall be one of the three types listed in Table 1. The soil types are based on USCS classification or the USDA textural triangle and have properties as shown in Table 1. The following soil testing is needed for every test according to the listed procedure. Record the results of the testing in accordance with the requirements of each individual standard.

8.1.1 Soil classification based on Practice D2487 (USCS) or the USDA textural triangle classification system from the USDA Soil Survey Manual.

8.1.2 Optimum water content and maximum dry unit weight as determined by Test Methods D698. In addition, determine and record the value corresponding to 85 % of the maximum dry unit weight when using sand; 75 % when using loam; and 65 % when using clay soil types.

8.1.3 Atterberg limits as determined by Test Methods D4318.

8.1.4 Particle-size distribution as determined by Test Methods D6913/D6913M and D7928.

8.1.5 Constant or falling head permeability as determined by Test Method D2434 or D5084, respectively.

8.2 *ECP*—All packages or rolls, or both of ECPs to be used in testing shall be checked for visible damage, such as tears, rips, and holes, prior to use. If the packaging is damaged, do not use it for testing. All ECPs shall be free of extraneous foreign materials, such as, metals or non standard plastics that could interfere with production application. The ECP shall be applied to the soil surface in accordance with the manufacturer's recommended application methods. For sprayed ECP installation, installers shall visually check the ECP as it is being fed into the mulching apparatus for extraneous foreign materials. A letter from the manufacturer shall be provided certifying the labeled ingredients and corresponding percentages, by mass, of the total product.

TABLE 1 Soil Properties

Property	Sand	Loam	Clay
D_{100} (mm)	$25 > D_{100} > 3.0$	$10 > D_{100} > 0.3$	$3.0 > D_{100} > 0.02$
D_{85} (mm)	$4.0 > D_{85} > 0.8$	$0.8 > D_{85} > 0.08$	$0.08 > D_{85} > 0.003$
D_{50} (mm)	$0.9 > D_{50} > 0.2$	$0.15 > D_{50} > 0.015$	$0.015 > D_{50} > 0.0008$
D_{15} (mm)	$0.3 > D_{15} > 0.01$	$0.03 > D_{15} > 0.001$	$D_{15} < 0.002$
Plasticity Index	Nonplastic	$2 < PI < 8$	$10 < PI$

9. Hazards

9.1 It is recommended that appropriate personal protection equipment be used by laboratory personnel when handling any ECP based upon recommendations outlined in the product's Safety Data Sheet (SDS).

10. Preparation of Test Plots

10.1 Three test plots consisting of identically prepared and installed soil and ECP are required. Select the soil to be used for testing as given in Section 8.

10.2 *Test Plot Construction*—Construct the test plot having the minimum dimensions given in 7.3. Determine and record the width (cross slope), length (downslope), and depth of the test plots to the nearest 0.1 ft [0.1 m]. Determine and record the area of the test plot to the nearest 0.1 ft^2 [0.1 m^2]. It is recommended to use individual trays for the test plots.

10.2.1 If not using individual trays, install water barriers as follows. Compact the soil as discussed in 10.3, then isolate the top edge and sides of each test plot by burying the bottom edge of the barrier approximately 4 in. [100 mm] to divert surface flow such that no intrusion of outside surface water ("run-on") onto the test plot occurs. The water barrier forms the boundaries of the test plots. Make sure to separate the test plots with dividers such that overspray from the rainfall simulators does not impact adjacent test plots. The use of individual trays does not require side edging and plot separation.

10.3 *Soil Compaction*—Roll or plate compact the surface of the test plot in 3 to 4 in. [75 - 100 mm] lifts to achieve a minimum total depth of 9 in. [230 mm]. This compaction is typically done horizontally with the trays placed on a level surface/ground. Table 2 lists the compaction maximum dry unit weight targets for the soil types as described in Section 8. Verify the compaction and water content targets were achieved using Test Method D6938, Procedure B along the center of each test plot at the top, middle, and bottom at the soil surface immediately after completing compaction. Record the compaction values to the nearest 1 % or 0.1 lbf/ft^3 [0.02 kN/m^3] and the water content to the nearest 1 %. If the target compaction/water content was not achieved, remove the soil making sure to thoroughly break up the soil aggregations, make adjustments, and repeat the process. If the test plots are not being used within 1 hour after compaction, cover to prevent moisture changes.

10.3.1 If the test plot was prepared but not used within 1 hour after compaction, verify the water content has not changed by repeating the applicable sections of Test Method D6938. Perform this verification within 1 hour prior to any testing. The water content shall be within ±2 % of the specified optimum water content. Determine and record the water content of the test plot to the nearest 1 %.

10.3.2 After verifying the compaction and water content targets have been achieved, repair depressions, voids, soft, or uncompacted areas. Free the test plot from obstructions or protrusions, such as roots, large stones, or other foreign material.

10.4 *Reuse of Test Plots*—If reusing test plots the following steps must be taken prior to the next use. Break up the top 8 in. [200 mm] with a shovel or rototiller, then discard the top 3-4 in. [75-100 mm] of soil. Using new soil to replace the discarded soil, follow the guidance given in 10.3 to compact the new soil into the test plots. When test plots have been used with an ECP containing chemicals or other additives, the soil must not be reused and must be replaced.

11. ECP Installation on Test Plots

11.1 There are three ways ECP can be installed on the test plots: sprayed (11.2), rolled (11.3), or applied dry (11.4). Document the ECP installation on the test plots by taking photos after initial application of the ECP and after curing, if applicable. ECP that is sprayed on can be installed using a hydroseeder. Typically one of the following capacity machines is used: 80 gal [300 L], 300 gal [1200 L], and 500 gal [1900 L] (Note 2).

11.2 *Sprayed Installation*—The rate of application of a sprayed ECP to a soil surface has a significant impact on its performance. Sprayed ECPs should be installed at the manufacturer's recommended rate corresponding to the slope of the prepared soil test

TABLE 2 Compaction Target Values by Soil Type

	SAND	LOAM	CLAY
Maximum Dry Unit Weight within ±2 % of Optimum Water Content	85 % ± 3 %	75 % ± 3 %	65 % ± 3 %

plots. Identify and record the rate of application. If a product is applied and tested at a rate different than what the manufacturer recommends, record the use of a differing rate. To check the application rate is achieved, place three 12 by 12 in. [0.3 by 0.3 m] lath board(s) between the test plots, or adjacent to the test plots, and spray the boards during application. Then, remove the ECP from the lath board and determine and record the mass and area of the sprayed ECP to calculate and check the application rate. Install the sprayed ECP using one of the following machines (Note 2).

11.2.1 *80 gal [300 L] Capacity Hydroseeder/Mulching Apparatus:*

11.2.1.1 Pre-wet the application hose by allowing water to flow through the hose.

11.2.1.2 Determine and remove the appropriate amount of ECP from the prepackaged bag or obtain appropriate lots of ECP and appropriate quantity of additives from the manufacturer if mixing onsite. Record the mixture quantities of ECP and chemical/additives if not using a prepackaged ECP.

11.2.1.3 Load and record the amount of ECP and chemical/additives, if any, and water to the tank corresponding to the required application rate and mixing ratio. Using the hydroseeder's agitator, mix the ECP and water together for 5 minutes or as recommended by the manufacturer.

11.2.1.4 While under agitation, discharge the hydroseeder away from the test plots to fill the hose with slurry. Bring the slurry level down by 5 gal [19 L] to make sure the hose is properly filled.

11.2.1.5 Once the hose is full, begin installation of the ECP to the test plots. Make sure to continue to agitate the slurry during installation. During installation, stop frequently to monitor the slurry level to make sure the target rate of slurry is applied to the test plot and to make sure uniform distribution across the test plot is achieved (Note 3). Design your rate per acre [m^2 or hectare] to accommodate approximately 5 % overspray of the test plot. Record the calculations that were used to determine the volumes along with the initial and final volume measurements to the nearest 0.1 gal [0.1 L].

11.2.1.6 Leave approximately 1 gal [4 L] of slurry to use for touch up installation and for coverage of areas of light application. Allow the sprayed ECP to cure based on the manufacturer's recommending wait time. Record the actual cure time and the manufacturers recommended cure time for testing to the nearest 1 min.

NOTE 3—It is desirable for the machine operator and application operator to coordinate signals to indicate the amount of application, such as ½, ¾, and stop application.

11.2.2 *300 gal [1200 L] or 500 gal [1900 L] Capacity Hydroseeder/Mulching Apparatus by Mass:*

11.2.2.1 Make sure the hydroseeder tank is calibrated using a flowmeter with permanent graduations marked by hand on the tank such that, the total volume can be monitored closely during mixing and spraying of the slurry before initial use. Then, assemble the hydroseeder on the verified balance.

11.2.2.2 Follow the steps in 11.2.1.2 and 11.2.1.3. Then, discharge the hydroseeder away from the test plots to fill the hose with slurry.

11.2.2.3 Calculate the amount by mass of slurry needed for each test plot plus 25 % for overspray. Then, zero the balance and add this calculated amount of mass to be placed into the hydroseeder. Measure and record the amount by mass of slurry using the appropriate balance (7.7.1). Record the mass to the nearest 0.0025 or 0.25 lbm [1 g or 0.1 kg] depending on the balance used and the anticipated mass of the slurry.

11.2.2.4 Once the hose is full, begin installation of the ECP to the test plots. Apply the calculated amount of slurry to each test plot. During installation, stop frequently to monitor the slurry mass to make sure the target amount of slurry is applied to the test plot and to make sure uniform distribution across the test plot is achieved (Note 3). Record the calculations that were used to determine the masses along with the initial and final mass measurements to the nearest 0.0025 or 0.25 lbm [1 g or 0.1 kg] depending on the total masses and balance used.

11.2.2.5 Leave approximately 9 lbm [4 kg] of slurry to use for touch up installation and for coverage of areas of light application. Allow the sprayed ECP to cure based on the manufacturer's recommending wait time. Record the actual cure time and the manufacturers recommended cure time for testing to the nearest 1 min.

11.2.3 *300 gal [1200 L] or 500 gal [1900 L] Capacity Hydroseeder/Mulching Apparatus by Volume:*

11.2.3.1 The amount of ECP applied is calculated based on volumes instead of by mass. When using the hydroseeder by volume, the installation instructions and application rate of the ECP provided by the manufacturer must be followed precisely. The exact amount of ECP and water is calculated based on the exact area of each test plot. An additional 25% is added to the batch to account for overspray and loss while hydroseeding. See Table 3 for an example calculation.

11.2.3.2 To make sure the total volume required is applied, the hydroseeder tank is calibrated using a flowmeter with permanent graduations marked by hand on the tank such that, the total volume can be monitored closely during mixing and spraying of the slurry. The volume of water placed in the hydroseeder for every batch is also monitored with a flowmeter which provides secondary quality assurance to make sure the total flow matches the volume shown by the gradations on the tank.

11.2.3.3 After calculating the mass of ECP and volume of water needed per test plot, use the verified balance to determine the mass of the ECP. Record the mass to the nearest 0.0025 or 0.25 lbm [1 g or 0.1 kg] depending on the anticipated total mass. Record the volume of water to the nearest 0.1 gal [0.1 L]. Fill the hydroseeder with the required volume of water and then add the ECP to the water.

11.2.3.4 Using the hydroseeder's agitator, mix the ECP and water together for at least 5 min or as recommended by the manufacturer. Once mixed, stop the agitation, then determine and record the total volume of the mixed slurry to the nearest 0.1 gal [0.1 L]. This volume is the amount in gal [L] that is sprayed on each test plot. Once this value is recorded, if desired, double the volume and record the doubled volume.

11.2.3.5 In order to aid in priming the hydroseeder lines, pumps, and hoses it is common practice to double the volume. Even though double the volume is made, the calculated total volume amount per test plot is what is actually applied. The extra volume is discarded.

11.2.3.6 Prime the hydroseeder by discharging the hydroseeder away from the test plots to fill the hose with slurry.

11.2.3.7 Apply the mixed slurry to the test plots using a standard fan nozzle as uniformly and evenly as possible. To prevent shadowing and to provide uniform test plot coverage, apply the slurry from multiple directions and angles (Note 3).

11.2.3.8 Allow the sprayed ECP to cure based on the manufacturer's recommending wait time (Note 4). Record the actual cure time and the manufacturers recommended cure time for testing to the nearest 1 min.

NOTE 4—It may be desirable to test sprayed ECP products in both a cured and uncured condition based on project requirements.

11.3 *Rolled Installation*—Install rolled ECP according to the manufacturer's instructions. Place rolled ECP so that no gaps are present along the perimeter barrier and make sure the ECP is cut to fit as necessary to cover the test plot. Record the installation methodology including the orientation applied to slope (longitudinal or lateral), placement (which side faces up), termination details, joint details, and anchor type and installation pattern as well as staple frequency.

11.4 *Dry Application Installation*—The rate of application of a dry applied ECP to a soil surface has a significant impact on its performance. Dry applied ECPs should be installed at the manufacturer's recommended rate corresponding to the slope of the prepared soil test plots. Identify and record the rate of application. If a product is applied and tested at a rate different than what the manufacturer recommends, record the use of a differing rate.

11.4.1 Install the dry applied ECP according to manufacturer's instructions. Record the installation methodology including the total amount of material applied per slope in lbm [kg], the application rate, and the method used for application (hand or spreader).

TABLE 3 Example Calculation

Manufacturer's specified rate	4000 lbm/acre	3900 kg/hectare
Water to ECP ratio	100 gal per 50.0 lbm of ECP	380 L per 22.7 kg of ECP
Test Plot Area	30.0 ft by 6.0 ft (30.0 × 6.0 =180 ft^2 (**0.0041 acre**))	9.1 m by 1.8 m (9.1 × 1.8 = 16.38 m^2 (**0.0016 hectare**))
Amount of ECP needed per test plot	4000 lbm × 0.0041 acre = 16.4 lbm 16.4*0.25 = 4.1 lbm → 16.4 + 4.1 = **20.5 lbm**	3900 kg × 0.0016 hectare = 6.24 kg 6.24*0.25 = 1.56 kg → 6.24 kg + 1.56 kg = **7.8 kg**
Water rate per kg	100 gal/50.0 lbm = **2.0** gal/lbm of ECP	380 L/22.7 kg = **16.7** L/kg of ECP
Amount of water needed per test plot	20.5 lbm × 2.0 gal/lbm = **41 gal**	7.8 kg × 16.7 L ⁄kg = **130.3 L**

12. Calibration of Rainfall Simulators and Average Soil Loss

12.1 Calibration of the rainfall simulators is made by operating the simulators in a controlled and documented environment while measuring and determining the average drop height of the raindrops, the rainfall intensity and distribution, and raindrop size. Most rainfall simulators are located indoors, however, outdoor or partially outdoor locations and facilities using wind protection locations are permissible. Do not conduct the calibration in a non-enclosed facility when the wind velocity exceeds 1.0 mph [1.5 kph]. Once the simulator parameters have been calibrated, identically prepared test plots using bare soil without an ECP are used to determine the average soil loss for bare soil. See Section 10 for test plot preparation, except do not apply an ECP to the test plots.

12.2 Calibration for each rainfall intensity, slope, and duration combination listed in Table 4 is then performed on bare soil. The data obtained from these bare soil tests provides information needed to calculate average soil loss for the bare soil tests (ASL_{BSOIL}). This calculation is then used as part of the event cover factor determination.

12.3 *Calibration Interval*—Perform a minimum of 3 bare soil slope tests for each rainfall intensity, slope, and duration combination listed in Table 4 that is expected for use. Annually thereafter, a minimum of 1 additional bare soil slope test shall be performed with additional data points as necessary following equipment maintenance work or change in any of the key parameters as discussed in 12.5. The annual bare soil slope data, as well as any additional data obtained is added to the overall bare soil data set to be used for analysis. All data obtained from this calibration process shall be kept on file by the rainfall testing facility and can be used to supplement any ECP testing data reports.

12.4 *Environmental Conditions*—Determine and record the following environmental conditions before each data point: air temperature to the nearest 1°F/C, humidity to the nearest 1 %, wind speed to the nearest 0.1 mph/kph, and the direction of the wind relative to the test plots. Wind speed and direction are not required to be measured when testing is located indoors.

12.5 *Rainfall Simulator System Calibration*—The following 4 key parameters shall be included in the calibration of the rainfall simulator system: Average drop height of raindrops, rainfall intensity, rainfall distribution, and raindrop size. Record the type of simulator used: sprinkler, nozzle, or drop emitters.

12.5.1 *Average Drop Height of Raindrops:*

12.5.1.1 Prepare the test plots in accordance with Section 10. Record the soil type used for each test plot as defined in Section 8. Do not reuse soil that has eroded off the test plot(s). Determine and record the width (cross slope), length (downslope), and depth of each test plot to the nearest 0.1 ft [0.05 m] using a tape measure.

12.5.1.2 The minimum drop height for the raindrops can be no less than 8.0 ft [2.5 m] at the lowest point of the simulator. Determine and record the drop height of the raindrops at the top, middle, and bottom of each test plot to the nearest 0.1 ft [0.05 m] using a surveyor's rod or tape measure.

12.5.2 *Rainfall Intensity:*

12.5.2.1 Place the desired number of test plots under the simulator at the slope to be tested (Table 4). Obtain and use 1 bin per test plot. Determine and record the mass of the bin, M_b, to the nearest 0.0025 or 0.25 lbm [1 g or 0.1 kg] depending on the anticipated total mass of the bin plus runoff and the balanced used.

12.5.2.2 Cover all the test plots with plastic sheeting. Make sure the plastic sheeting does not have any rips, tears, or holes that would allow water to penetrate through to the test plot. Turn on the water source and allow the rainfall system to come to equilibrium. Once equilibrium has been reached, place the bin(s) under the test plot(s). Then allow the runoff collection system

TABLE 4 Rainfall Intensity, Slope, and Duration Combinations

Type	Rainfall Intensity in./h [mm/h]	Slope (H:V)	Duration (min)
1	3.5 [90]	2:1	One 30 min period 24 ± 2 h apart for 3 days (90 min total)
2	3.5 [90]	3:1	One 30 min period 24 ± 2 h apart for 3 days (90 min total)
3	3.5 [90]	4:1	One 30 min period 24 ± 2 h apart for 3 days (90 min total)

to capture the water in a bin for a period of 1 minute. The bin must have enough capacity to hold the runoff that has collected over a 1 minute period. Record the start and end time of each 1 min period.

12.5.2.3 After each 1 min period, remove each bin out from under the collection apparatus of the test plot and determine and record the mass of each bin plus water, M_{bw}, to the nearest 0.0025 or 0.25 lbm [1 g or 0.1 kg]. Then subtract the mass of the bin from the mass of bin plus water to determine the mass of the water, M_w, collected from each test plot. Record the mass of water to the nearest 0.0025 or 0.25 lbm [1 g or 0.1 kg].

12.5.2.4 Use the following equation to determine and record the rainfall intensity, I, in in./h for the test plot.

$$I = \frac{M_w \times 720}{A_p \times \rho_w} \tag{1}$$

where:

I = rainfall intensity, nearest 0.1 in./h.
M_w = mass of water, lbm ($M_{bw} - M_b = M_w$); nearest 0.0025 or 0.25 lbm,
A_p = area of the test plot, nearest 0.1 ft^2,
ρ_w = conversion factor, 62.4 lbf/ft^3, and

12.5.2.5 Use the following equation to determine and record the rainfall intensity, I, in mm/h for the test plot.

$$\frac{M_w \times 60}{A_p} = I \tag{2}$$

where:

I = rainfall intensity, nearest 0.1 mm/h.
M_w = mass of water, kg ($M_{bw} - M_b = M_w$); converted to volume, m^3 (nearest 1 m^3),
A_p = area of the test plot, m^2, and

NOTE 5—Converting from kg to m^3 divides the mass of water by 1000. Converting from m^2 to mm then multiplies the mass of water by 1000. These conversions are not shown.

12.5.2.6 Compare the rainfall intensity for each test plot to the desired or target intensity listed in Table 4. If necessary, adjust the rainfall simulator and repeat the above steps to make sure the correct intensity value is obtained prior to bare soil testing.

12.5.3 *Raindrop Distribution:*

12.5.3.1 Divide the test plot into 20 equal sections when using the minimum test plot area as shown in Fig. 2. When the test plot is larger than the minimum, more equal sections must be used. It is desirable to have more equal sections than exactly 20 sections of unequal dimensions.

12.5.3.2 Place a rain gauge in the center of each section. Make sure the rain gauge is, and remains, vertical for the duration of the calibration. The use of a holder or platform is recommended to keep the rain gauge vertical as long as the device allows for the free collection of the rainfall. Cover each rain gauge with a waterproof barrier to prevent the initial collection of rainfall.

12.5.3.3 Set the target intensity and slope, then turn on the simulator and allow it to reach equilibrium. Once equilibrium is reached, allow the simulator to run for 3 min at the target condition. Remove the waterproof barrier from each rain gauge. Start the timer after the first rain gauge is uncovered. Record the start time. Remove the waterproof barriers from the remaining rain gauges in a set order. If using one large piece of plastic sheeting to cover all the rain gauges, remove the plastic sheeting in one single motion in one direction.

12.5.3.4 Allow the rainfall to continue for 10 min after uncovering the first rain gauge. At the end of 10 min, cover the rain gauges in the same order they were uncovered. If using one large piece of plastic sheeting, replace the sheeting in the opposite direction that it was removed in a single motion. Record the time at the end of the calibration. The intent is to allow each rain gauge to be exposed to the rainfall for a period of 10 min each. After covering, turn off the simulator.

12.5.3.5 Measure and record the amount of water collected in each rain gauge to the nearest 0.2 in. [5 mm].