

Tennessee Department of Transportation Division of Materials and Tests

Quality Assurance Program for the Sampling and Testing of Materials and Products (SOP 1-1)

Purpose: The purpose of this document is to establish the procedures and **minimum** requirements for the acceptance, verification, and certification of materials and products used on Tennessee Department of Transportation (TDOT) projects and projects under the oversight of TDOT (Local Projects, Grants, etc. that include Federal Funds).

Background: [Federal Law \(23 CFR 637\)](#) requires each state develop a quality assurance program which assures all materials, on projects where Federal Funds are used, conform to the requirements of the approved plans and specifications. In addition, these procedures assure projects using state funds will also be constructed using approved materials.

Policy: All materials used on TDOT projects must be accepted **prior to use**. Acceptance of materials is by:

- A. Testing before product placement (e.g. hot mix asphalt, Portland cement concrete, base materials, pre-packaged concrete mixture).
- B. Manufacturers' certifications followed by random verification testing (e.g. grey iron castings, cement, liquid asphalt).
- C. Producer List pre-approval and testing of a product or its components (e.g. aggregate quality, reinforced concrete pipe, corrugated metal pipe).
- D. The Qualified Products List (QPL) with certifications (e.g. sign sheeting, erosion control blankets, pavement marking materials, patching material).

Sampling and Testing Materials and Products

1. Test Types

There are three basic types of sampling and tests routinely conducted: acceptance, verification, and assurance. All testing shall be performed by a certified technician.

1.1 Acceptance Sampling and Testing

These tests are conducted to approve or accept a product, or combination of materials (systems), by comparing the test results to specification requirements. Acceptance tests are based on a lot or frequency, during the production and/or placement of that product, to ensure specification compliance. There are products that are sampled, tested, and accepted at the manufacturer's facility and then delivered to TDOT projects for use.

1.2 Verification Sampling and Testing

These tests are conducted to verify/validate that products accepted by manufacturers' certifications are in compliance with the applicable Tennessee Department of Transportation Standard Specifications for Road and Bridge Construction (TDOT Standard Specifications). In accordance with Federal Law (23 CFR 637), "The verification sampling shall be performed on samples that are taken independently of the quality control samples."

1.3 Independent Assurance Sampling and Testing

These are tests conducted to assure that acceptance sampling and testing procedures are done in accordance with the specified procedures and to compare testing equipment. Further guidance is provided within SOP 1-2: Independent Assurance Program.

2. Material Certifications

- 2.1 All materials accepted on certification must have a Material Certification and/or Sampling Testing Record DT-0044 (T-2) form, completed by the Contractor, showing contract number, project number, county, item number, quantity of material being accepted, etc. Attach the T-2 form to the manufacturer's certification and forward to the Materials and Tests (M&T) Supervisor. The Manufacturer's certification shall state that materials have been tested and inspected and that the manufacturer certifies that TDOT Standard Specifications have been met. The Manufacturer's certification shall contain at a minimum the manufacturer's name, contact information, and specifications that the material meets.
- 2.2 The manufacturer's certification may not be project specific (i.e. it will not have the contract or project number on the certification). When this occurs, do not write the contract or project number on the certification. Instead, require the contractor to complete, and have notarized, a T-2 form, and attach the manufacturer's certification. Copies of certifications will be acceptable provided originals are kept on file by the contractor, supplier, or manufacturer and available for inspection.
- 2.3 Any material that is on the Department's QPL may be accepted by a certification, unless otherwise noted, from the manufacturer stating that the material furnished to the project is the same as the material evaluated for the QPL. The Contractor shall forward the certification and a T-2 form to the Project Supervisor for review.
- 2.4 It is the project personnel's responsibility to provide the final inspection on all material. If for any reason the material is suspect, it should not be used until further evaluation is conducted. Contact the M&T Supervisor for further evaluation(s).
- 2.5 All manufacturers' certifications must be signed; however, for seed, sod, and nursery materials, the Tennessee Department of Agriculture will provide the certification. Any certification that is not project specific shall be notarized.

- 2.6 Miscellaneous materials used on special projects (e.g., rest areas) that are overseen by an architect or consulting engineer for the Architecture Department may be accepted by a blanket certification stating that all materials meet specification requirements.
- 2.7 Material (e.g., tack) transfer shall be completed by the contractor and sent to the Project Supervisor(s) overseeing the projects. The project office(s) will verify that the quantity of material is available for transfer. The contractor shall complete the T-2 form and transfer request with all of the project information needed including applicable bill of lading and the material certification.
- 2.8 At completion of the project, the Project Supervisor must submit a signed Materials and Tests Certification (DT-1696) form to Regional Operations and the Regional M&T Supervisor(s). The form shall then be forwarded to the Headquarters (HQ) M&T.
- 2.9 The Contractor shall forward ALL certifications and T-2 forms to the Project Supervisor for review. The Project Supervisor will forward to Regional M&T for review and copies will be forwarded to HQ M&T as necessary.

3. Buy America Certifications

All iron and steel and applicable construction products **shall** meet TDOT Special Provision 106A/106BA, Special Provision Regarding Buy America Requirements, as set forth in the contract.

4. Using the Tables

- 4.1 There are four parts to this procedure; each part has a specific purpose and must be checked for any material to be put in use. **If field personnel are unsure as to how a material is accepted, they need to contact their M&T representative for clarification to assure that acceptable material is utilized on projects.**

Part 1 - Sampling and Testing Guide is a field guide that lists the materials that are accepted based off certification or QPL listing, by acceptance tests, and/or verification tests.

Part 2 - Acceptance Sampling and Testing Schedule lists construction materials, test(s) to be performed, who takes the sample, how frequently a sample is taken, and where to take the sample.

Part 3 - Verification Sampling and Testing Schedule gives the details for verification test requirements. All verification samples must be submitted for testing within two weeks of the sample date.

Part 4 - Using Random Numbers for Sampling and Testing will help personnel choose random and representative test locations when performing tests using random number tables, calculators, spreadsheet program, etc.

- 4.2 Any reference to sampling by M&T refers to TDOT Regional M&T, and HQ M&T refers to TDOT Headquarters M&T.
- 4.3 Project Inspector references TDOT personnel performing project inspection or, for projects that include Federal Funds constructed under the oversight of TDOT (Local Programs, Grants, etc.), the Agency's Construction Engineering Inspection (CEI) or certified sampling and testing technician assigned by the Department.
- 4.4 **All samples** should be taken at random test locations (see Part 4).

5. Useful Links

5.1. [M&T Forms](#)

All required DT Forms mentioned in Part 1 can be found here.

5.2. [QPL](#)

Materials with a QPL requirement as shown in Part 1 are listed here along with all requirements a product must meet to be on the QPL.

5.3. [Producer List](#)

Producers of these materials must be approved **prior to use**. All requirements to be on the Producer List are available at the link provided.

5.4. [TDOT Specifications & Special Provisions](#)

5.5. [TDOT Standard Operating Procedures](#)

All required Standard Operating Procedures can be found here.

Part One: Sampling and Testing Guide

Material Information	Cert. (X) or QPL T-2 Req.	Accept (Part 2)	Verify (Part 3)
AGGREGATE PRODUCTS			
<i>Required Paperwork:</i> Project Inspector is responsible for requesting a Fine and Coarse Aggregate Inspection Report (DT-0275) form from M&T for each size or type of aggregate before material is shipped to the job site. When applicable, contact M&T to ensure proctors have been performed.			
<p>General Aggregate (e.g., Underdrains) 903 Gradation testing and quality samples will be taken at a point in production which ensures that representative sampling and testing occurs.</p> <p>Rip-Rap from a Quarry: M&T will issue test reports for quality and quantity only. The Project Inspector is responsible for size at time of placement.</p> <p>Rip-Rap from a Job Site: The Project Inspector will notify M&T so that a quality sample may be obtained and a Coarse Aggregate Quality Report (DT-0320) form issued. The Project Inspector will be responsible for size at time of placement.</p>		X	
<p>Aggregate-Cement Base: 309 <i>Additional Paperwork:</i> Project Inspector will complete a Daily Report on Soil and Aggregate Stabilization (DT-0298) form.</p>		X	X
<p>Aggregate - Lime - Fly Ash Stabilized Base: 312 <i>Additional Paperwork:</i> Project Inspector will complete a Daily Report on Aggregate-Fly Ash Stabilization (DT-1411) form.</p>		X	X
<p>Borrow Excavation (Solid Rock)/(Graded Solid Rock): 203, SOP 2-2 <i>Additional Paperwork:</i> The Project Inspector will notify M&T so that a quality sample may be obtained and a Coarse Aggregate Quality Report (DT-0320) form issued. The contractor shall submit a certified letter stating the material does not contain acid producing material.</p>			X
<p>Granular Backfill: 204.06 <i>Additional Paperwork:</i> Project Inspector will complete a Density Worksheet – Nuclear Method (DT-0314) form.</p>		X	
<p>Mineral Aggregate Base: 303 <i>Additional Paperwork:</i> Project Inspector will complete a Daily Report on Mineral Aggregate Base (DT-0307) form for Type A and Type B aggregate.</p>		X	X
<p>AGRICULTURAL LIMESTONE: 918.04 <i>Required Paperwork:</i> The Contractor shall provide an invoice and documentation that the agricultural limestone meets the Department of Agriculture Tennessee Liming Materials Act.</p>	X		

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Material Information	Cert. (X) or QPL T-2 Req.	Accept (Part 2)	Verify (Part 3)
ASPHALT (GENERAL)			
Before taking samples of asphalt cement (A.C.) and emulsion, a one-gallon minimum shall be discarded to flush the sampling pipe of possible contaminants. All precautions must be taken to avoid sample contamination.			
<p>Asphalt Aggregate: 903 <i>Required Paperwork:</i> The TDOT Plant Inspector will complete the Daily Report from the workbook.</p>		X	X
<p>Asphalt Cement: 904.01 <i>Required Paperwork:</i> Each shipment from the asphalt terminal shall be accompanied by a completed (DT-0293 PG) form.</p> <p>Terminal Samples: Refer to SOP 3-1.</p> <p>Contract Samples: All samples from asphalt plants shall be taken from the sampling valve on storage tanks and not from transport units. Samples taken, from projects utilizing liquid anti-stripping additives (ASA), should either contain ASA or be accompanied by an ASA sample.</p>	X		X
<p>Asphalt Emulsion: 904.03 <i>Required Paperwork:</i> Each shipment from the asphalt terminal shall be accompanied by a completed (DT-0293 Emulsion) form.</p> <p>Terminal Samples: Refer to SOP 3-2.</p> <p>Contract Samples: Refer to Sampling Asphalt Emulsions (pdf) and Sampling Asphalt Emulsions (pptx) for detailed sampling guidance. Field samples of emulsion shall be taken from sample valves, not distributor spray bars.</p> <p>For field samples, sieve test results < 0.3 will be considered passing. Field samples with sieve results > 0.3 will be evaluated on a case by case basis by the M&T Supervisor and the State Bituminous Engineer to determine if the sample passes or fails. For failing sieve test results, the Project Supervisor shall make a note as to whether or not an acceptable uniform spread was achieved.</p>	X		X
<p>Asphalt Mix: 407 <i>Required Paperwork:</i> When required, the Project Inspector will complete a Daily Asphalt Density Report (DT-0315) form.</p>		X	X

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Material Information	Cert. (X) or QPL T-2 Req.	Accept (Part 2)	Verify (Part 3)
<p>BOLT AND NUT ASSEMBLIES FOR HIGH STRENGTH STEEL STRUCTURES: 908.04 & 602.17.E The manufacturer/distributor shall furnish, for each heat number and/or assembly lot number, a mill test report, and/or a manufacturer/distributor certified test report. TDOT will issue a lab reference number for each manufacturer/distributor submittal.</p> <p><i>Additional Paperwork:</i> Shipments to the project shall be accompanied by a copy of the TDOT lab reference number identifying each heat/lot number. Project Inspector will complete a Rotational Capacity Test (MT-0328) form.</p>	X		X
<p>BRICK (CLAY OR SHALE, CONCRETE, SEWER): 912 <i>Additional Paperwork:</i> All brick shall be certified with test reports by the manufacturer stating that specification requirements are met. The Contractor shall submit the certifications and list the type of brick on T-2 form.</p>	X		X
<p>BRIDGE DECK SEALS (MEMBRANES): 906.01</p>	QPL 2		
<p>BRIDGE PAINT</p>	QPL 3		X
<p>CALCIUM CHLORIDE: 921.02 <i>Required Paperwork:</i> The Contractor shall provide a completed Report on Sample of Calcium Chloride (DT-0325).</p>	X		
<p>CONCRETE (GENERAL) <i>Required Paperwork:</i> The Project Inspector will complete a sample record in SiteManager for each set of cylinders.</p> <p>Cylinders made for Class CP concrete shall be two (2) 6"x12" cylinders. Cylinders for all other concrete shall be two (2) 4"x8" cylinders. Perform all field tests using the same sample. Refer to SOP 4-4 for submittal and approval of concrete mixtures.</p>			
<p>Aggregate: 903.01 & 903.03 <i>Additional Paperwork:</i> The Project Inspector will check the Contractor's Daily Report of Concrete Inspection (DT-0311) form that is completed by the contractor's certified Concrete Field Testing Technician to ensure that gradation, wash, and Fineness Modulus (FM) requirements are met and tests are performed in accordance with the approved process control plan.</p>			X

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Material Information	Cert. (X) or QPL T-2 Req.	Accept (Part 2)	Verify (Part 3)
<p>Cast in Place (e.g., drainage structures) <i>Additional Paperwork:</i> The contractor shall provide a Contractor’s Daily Report of Concrete Inspection (DT-0311) form and a T-2 form that includes: each structure item number, type of structure, Standard Drawing Number, and the code number per structure. Contractor certification(s), stating that the item number was constructed in accordance with the Standard Drawing(s) and specifications, and mill certification(s) shall be attached.</p> <p>Cubic yards of concrete and reinforcing steel shall be identified per structure as incidental items.</p>	X		
<p>Cement, Fly Ash, & Slag Cement: 901.01, 921.15, & 921.16</p>	X		X
<p>Chemical Admixture: 921.06</p>	QPL 4		
<p>Closure Pour</p>	QPL 43	X	
<p>Coatings, Curing Compounds (White or Clear): 604.21 & 913.05</p>	QPL 12		
<p>Flowable Fill: 204.06 <i>Additional Paperwork:</i> The producer shall furnish a Contractor’s Daily Report of Concrete Inspection (DT-0311) form per day’s production.</p>		X	
<p>Grout: 921.09 & SOP 4-4 <i>Additional Paperwork:</i> The producer shall furnish a Contractor’s Daily Report of Concrete Inspection (DT-0311) form per day’s production.</p>			
<p><i>Non-Structural Grout</i> The producer will furnish a mix design to the Project Supervisor. The mix design will be reviewed and approved according to SOP 4-4.</p>	X		
<p><i>Structural Grout</i> If the grout has a strength requirement, a mix design shall be submitted to Materials and Tests.</p>		X	
<p><i>Patching Material</i></p>	QPL 13		
<p><i>Non-Structural Patching Material</i> The producer will furnish a mix design to the Project Supervisor. The mix design will be reviewed and approved by M&T. OR a QPL 13 item may be used in place of a mix design approval.</p>	X		
<p><i>Structural Patching Material</i> If the patching material has a strength requirement, a mix design shall be submitted to M&T OR a QPL 13 item, meeting strength requirements stated in the contract plans, and extended with aggregate in accordance</p>		X	

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Material Information	Cert. (X) or QPL T-2 Req.	Accept (Part 2)	Verify (Part 3)
with the manufacturer’s recommendations, may be used in place of mix design approval.			
Pre-Packaged Grout	QPL 16		
Pre-Packaged Concrete Mixture: 604.03	QPL 15	X	
Precast Products: SOP 5-3 & Reinforced Concrete Facing Panels <i>Additional Paperwork:</i> Each shipment shall be accompanied with a producer’s certification.	X	X	X
Sound Absorbing Noise Walls: SP 718NB & Noise Walls <i>Additional Paperwork:</i> Each shipment shall be accompanied with a producer’s certification.	X	X	
Prestressed Products: 615, SOP 5-4 <i>Additional Paperwork:</i> Beams and piling will be stamped by Regional M&T and include Report on Precast or Prestressed Concrete (DT-0289)(SiteManager M022) form.	X	X	X
Ready Mix: 501 & 604 <i>Additional Paperwork:</i> The producer shall furnish a Contractor’s Daily Report of Concrete Inspection (DT-0311) form per day’s production.		X	
Concrete Paving: 501 & 604 <i>Additional Paperwork:</i> The producer shall furnish a Contractor’s Daily Report of Concrete Inspection (DT-0292) form per day’s production.		X	
Volumetric Mix: 501 & 604 <i>Additional Paperwork:</i> The producer shall furnish a Contractor’s Daily Report of Concrete Inspection (DT-0311) form per day’s production.		X	
Performance Engineered Mixture (PEM) Ready Mix: 604, SOP 4-4 <i>Additional Paperwork:</i> The producer shall furnish a Contractor’s Daily Report of Concrete Inspection (DT-0311) form per day’s production.		X	X
Shotcrete: 622 <i>Additional Paperwork:</i> The producer/contractor shall furnish third party test results indicating compressive strength (28-day) and boiled water absorption results.		X	
CORRUGATED METAL PIPE (CMP): 915.02 <i>Required Paperwork:</i>		X	X

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Material Information	Cert. (X) or QPL T-2 Req.	Accept (Part 2)	Verify (Part 3)
<p>Certified mill test report and galvanization report shall accompany sample. Approved pipe will be stenciled "TDOT" and reported on Inspection of Corrugated Metal Pipe (DT-0280) form by M&T.</p> <p>The Producer shall notify the M&T prior to shipping.</p>			
<p>EARTH RETAINING STRUCTURES: SP 624</p>	X	X	X
<p>ELECTRICAL ITEMS/ITS COMPONENTS/LIGHTING/TRAFFIC SIGNALS: 730 <i>Additional Paperwork:</i> The Contractor shall submit a certificate of compliance and certifications stating that all materials meet TDOT specifications with a T-2 form including all final quantities. In addition, the Contractor shall also provide an approval letter from the owner/maintaining agency stating acceptance of the completed system.</p> <p>For temporary traffic signal systems, the Contractor shall furnish certifications stating that all materials furnished meet Standard Specifications.</p>	X		
<p>EROSION CONTROL ITEMS: 209</p>	QPL 17		
<p>FENCING MATERIALS: 909 <i>Additional Paperwork:</i> The Contractor shall furnish certifications citing all applicable ASTM or AASHTO Specifications.</p>	X		
<p>FIBER EXPANSION JOINT MATERIALS</p>	QPL 5		
<p>FLEXIBLE SURFACE & GROUND MOUNTED DELINEATOR POST</p>	QPL 1		
<p>GEOTEXTILES: 740, 921.12 Each unique geotextile shall be marked with a legible print showing, as a minimum, the manufacturing plant (or manufacturing plant ID code numbers). This marking shall be located on the roll edge of the product at a frequency of once per 5 meters (16.4 feet). The marking shall be unique for each manufacturer and manufacturing plant facility.</p>	QPL 36 OR QPL 17	X	
<p>GRAY IRON CASTINGS: 908.07 <i>Additional Paperwork:</i> The manufacturer shall provide notarized certification(s) of material, including quantity, item, weight, and heat date, signed by the manufacturer stating compliance with Standard Specifications and Standard Drawings.</p>	X	X	X

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Material Information	Cert. (X) or QPL T-2 Req.	Accept (Part 2)	Verify (Part 3)
Castings to be incorporated into the work shall be accompanied with a certified mill test report that includes: the heat number or ID, description of the casting (including TDOT Standard Drawing Number), the weight of each casting, and the number cast from each ID. All castings shall have a traceable ID number cast into the product.			
GUARDRAIL, POSTS, BLOCKS, BOLTS, WASHERS, ETC Refer to SOP 6-1 (Procedures and Qualifications for Guardrail Manufacturer and Supplier) .	X		
GUARDRAIL END TERMINAL: 705	QPL 34 OR QPL 45		
HIGHWAY SIGNING (PERMANENT): 713 The manufacturer's identification markings must be on back of each sign. <i>Additional Paperwork:</i> The Contractor shall provide mill test reports on all materials and certifications from the manufacturer showing project information and quantities. All sign supports shall have a certified mill test report and a galvanization report submitted.	X OR QPL 33		
HIGHWAY SIGNING MATERIALS (REFLECTIVE SHEETING): 916	QPL 10		
HYDRATED LIME: 921.04	X		
IMPACT ATTENUATOR Additional Paperwork: The Contractor shall provide shop drawings and certification to the Project Supervisor for review prior to delivery.	QPL 34 OR QPL 45		
JOINT SEALANT (NON-FIBER)	QPL 5		

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Material Information	Cert. (X) or QPL T-2 Req.	Accept (Part 2)	Verify (Part 3)
LANDSCAPING MATERIALS			
<p>Commercial Fertilizer: 918.02 <i>Additional Paperwork:</i> The Contractor shall provide invoices.</p>	X		
<p>Hay, Straw (baled plant material) <i>Additional Paperwork:</i> If shipped from an Imported Fire Ant (IFA) quarantine area in Tennessee, shall be accompanied by a permit from the Tennessee Department of Agriculture or other appropriate regulatory agency; the permit must state the location from which the materials originated and that the material has been inspected and found to be free of IFA. A permit is not required when shipping these materials from a non-quarantine area. The Tennessee Department of Agriculture website has county-by-county information of quarantine areas. https://www.tn.gov/agriculture/businesses/plants/plant-pests--diseases-and-quarantines/ifa.html</p>	X		
<p>Seed, Grass: 918.01 <i>Additional Paperwork:</i> The Contractor shall provide a Report on Sample of Grass Seed and Grass Seed Certification (DT-0333) form from the producer. Each bag will be labeled in accordance with Section 43-10-106 of the Tennessee Seed Law of 1986.</p>	X		
<p>Sod: 803 <i>Additional Paperwork:</i> The Contractor shall provide a copy of the Department of Agriculture authorization prior to removing the sod. Nursery certificates do not indicate that sod is certified.</p>	X		
<p>Trees and Shrubs: 802.02 <i>Additional Paperwork:</i> Before performing any work, the Contractor shall provide a nursery dealer's certificate with each shipment of plants. When the project is complete, the Contractor shall submit certifications.</p>	X		

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Material Information	Cert. (X) or QPL T-2 Req.	Accept (Part 2)	Verify (Part 3)
<p>PAVEMENT MARKERS (RAISED & SNOWPLOWABLE), THERMOPLASTIC ALTERNATES, PREFORMED TAPE: 716 <i>Additional Paperwork:</i> The Contractor shall provide a Daily Pavement Marking (DT-1296) form on the marking materials/tape used. The Project Inspector will verify quantities, sign the daily form, and submit the form to the M&T office weekly. At completion, the marking contractor shall provide a T-2 form listing quantities of marking materials used for each pay item, colors' batch numbers, and QPL numbers used on the project.</p>	QPL 1		
<p>PAVEMENT MARKINGS (PAINT, THERMOPLASTIC, & BEADS): 716 <i>Additional Paperwork:</i> The Contractor shall provide a Daily Pavement Marking (DT-1296) form on the marking materials/ beads used. The Project Inspector will verify quantities and thicknesses, sign the daily form, and submit the form to the M&T office weekly. At completion, the marking contractor shall provide a T-2 form listing quantities of marking materials and beads used for each pay item, colors' batch numbers, and lab reference numbers used on the project. Samples shall be submitted to M&T by the manufacturer to obtain lab reference numbers.</p>	X OR QPL 1		X
<p>PVC / HDPE / SRTRP / PP PIPE: 914 <i>Additional Paperwork:</i> The Contractor shall provide certifications of compliance from the producer or manufacturer of all plastic pipe and tubing.</p>	X		
<p>SOIL <i>Required Paperwork:</i> Project Inspector will submit a Proctor Density Report (DT-0332) form along with the sample. Densities shall be reported on Density Worksheet – Nuclear Method (DT-0314) form.</p>			
<p>Embankment & Subgrade: 205, 207 <i>Additional Paperwork:</i> Project Inspector will complete a Daily Report on Embankment (DT-0304) form.</p>		X	
<p>Soil-Lime Subgrade Treatment: 302</p>		X	
<p>Soil-Cement Base: 304 <i>Additional Paperwork:</i> Project Inspector will complete a Daily Report on Soil and Aggregate Stabilization (DT-0298) form</p>		X	X
<p>STEEL Assembly to be in accordance with project drawings.</p>			
<p>Dowel & Tie Bars: 907.02</p>	X		

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Material Information	Cert. (X) or QPL T-2 Req.	Accept (Part 2)	Verify (Part 3)
<p>Steel Reinforcement (black bar & epoxy coated): 907.01 <i>Additional Paperwork:</i> Each shipment shall consist of a certified mill test report including size and heat number of the bars furnished along with a report listing contract number, size, heat number, and quantity of bar. For epoxy coated bar, an additional certificate of compliance for the coating along with a daily coating manufacturing worksheet is required.</p>	X		X
<p>Steel Structures: 908.01 <i>Additional Paperwork:</i> All steel structure items (lump sum) shall have Structural Steel Shop Inspection Reports approved by TDOT M&T Division. The item numbers on the report must match the item numbers on the steel at the project site.</p>	X		
<p>Welded Wire Mesh (precast): 907.03 <i>Additional Paperwork:</i> The Contractor shall provide a certified mill test report. Additional certification and independent lab results are required for drawn down wire.</p>	X		X
<p>Strands (prestressed): 907.04 <i>Additional Paperwork:</i> Each shipment must have stress/strain curves and manufacturer's certification. Each reel or pack must have identification tags showing size, grade, and reel number.</p>	X		X
<p>Structural Steel (pipe endwalls, catch basins, bridge repair items, etc.): 908.01 <i>Additional Paperwork:</i> Each shipment shall consist of a certified mill test report and a notarized certification of material signed by the manufacturer stating compliance with Standard Specifications and Standard Drawings including the following: contract number, contractor, shop order number, location of use, drawing number, quantity, item, type of steel, heat number, and manufacturer. If applicable, paint batch certifications and galvanization reports shall be included. The Project Inspector will check the dimensions when steel is delivered to the project site.</p>	X		
<p>Structural Steel Piles: 908.15 <i>Additional Paperwork:</i> Steel piles shall be accompanied by certified mill test reports showing correct heat numbers and a T-2 form including correct quantities and heat numbers used. The T-2 form and mill test report will be checked for accuracy. If the mill test report is not job specific, then the Contractor shall include documentation showing the purchase of the piling.</p>	X		
<p>Structural Steel Pile Tips <i>Additional Paperwork:</i></p>	QPL 28		

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Material Information	Cert. (X) or QPL T-2 Req.	Accept (Part 2)	Verify (Part 3)
Steel pile tips shall be accompanied by certified mill test reports showing correct heat numbers.			
TEMPORARY TRAFFIC CONTROL ITEMS: 712			
<i>Additional Paperwork:</i> The Contractor shall submit all certifications/acceptance letters stating that all products used meet the TDOT specifications and comply with NCHRP 350 criteria. If selected from the QPL, the Contractor/Supplier shall certify that products furnished are identical to the product evaluated for the QPL.			
Barricades	X		
Cones	X		
Delineators	QPL 1		
Flexible Drums	QPL 1		
Ground Mounted Sign Supports: 916	X		
Longitudinal Channelizing Barriers and Barricades	QPL 34 OR QPL 45		
Portable Barrier Rail	QPL 34 OR QPL 45		
Portable Sign Stands	QPL 33		
Signs	X		
Temporary Pavement Marking Material	QPL 1		
Trailer Mounted Devices (changeable message signs, flashing arrow boards)	QPL 29 OR QPL 30		
Truck or Trailer-Mounted Attenuators	QPL 45		
Vertical Panels	X		
WATER, SEWER, AND OTHER UTILITY ITEMS			
All utility items shall be accepted in accordance with the TDOT Construction Circular Letter 105.07-04, Utility Diaries and Inspection Procedures, or as required in other Contract documents. The utility representative shall complete the proper forms and submit to the Project Supervisor.	X		
WATER STOPS: 604.26 & 921.08			
<i>Additional Paperwork:</i> The Contractor shall provide a certified test report. The Project Inspector will check all shipments for inspection tags.	X		
WOOD TIMBERS AND POSTS (TREATED): 911			
<i>Additional Paperwork:</i> The Contractor shall provide treatment reports and inspection reports on all wood timber and posts.	X		

Part Two: Acceptance Samples and Tests

Type of Construction	Material	Test	Sampled By	Frequency	Location or Time of Sampling	Remarks
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AGGREGATE						
Aggregate for Underdrains	Aggregate	Gradation	M&T	Per month	Project site or plant stockpile	Project Inspector to notify M&T
Base Courses (Aggregate-Cement OR Aggregate-Lime-Fly Ash)	Aggregate	Gradation	Project Inspector	Every 2,500 tons	Plant stockpile	First sample should be taken at beginning of day.
		Moisture		Every 2,500 tons or two per day	At time of weighing	
	Aggregate-Cement Mixture, & Aggregate-Lime-Fly Ash Mixture	Density, Gauge Moisture		Five tests per 10,000 square-yard lot	Immediately following compaction	
		Thickness		Every 500 linear feet		
Bedding, Backfill	Aggregate for Bridges, Box Culverts, & other major structures	Gradation, Moisture	Project Inspector	At beginning of project and every 2500 tons thereafter (Minimum of 1 per week)	Plant or roadway	
		Density, Gauge Moisture		Three tests per layer	Immediately following compaction	
	Aggregate for Pipe Culverts	Gradation, Moisture		At beginning of project and as material changes	Plant or roadway	
		Density, Gauge Moisture		Per layer every 50 linear feet	Immediately following compaction	
Mineral Aggregate Base	Mineral Aggregate	Gradation, Moisture	Project Inspector	At beginning of project and every 2500 tons thereafter (Minimum of 1 per week)	Plant or roadway	First sample should be taken at beginning of day.
		Density, Gauge Moisture		Five tests per 10,000 square-yard lot	Immediately following compaction	Refer to Section 310 for Conditioning Mineral Aggregate Base

ASPHALT						
Asphalt Plant Mix Pavements	Aggregate	Fractured Face Count	Project Inspector	Per project	Coarse aggregate stockpiles	Plus No. 4 (4.75 mm) sieve material, gravel mixes only.
		Glassy Particles by mass				Plus No. 4 (4.75 mm) sieve material, slag mixes only.
	All Plant Mix Asphalt	Mix Temperature	Every 5 th load	From the truck prior to leaving the plant and on the roadway prior to deposit into the paver or the material transfer device	Temperatures on the roadway are to be recorded on the delivery ticket.	
	Plant Mix Asphalt (Grading A, B, BM, BM2, C, CW, D, E, E-Shoulder)	Density	Every 1,000 tons	As soon as practical after compaction	Each lot shall be divided into 5 equal sub-lots, and one test shall be performed per sub-lot.	
	Plant Mix Asphalt (Grading B, BM, BM2, C, CS, CW, D, E, TL, TLD, TLE, and OGFC)	Loss on Ignition (Surface Mix with Limestone Only)	Per day	Completed mix in truck	LOI testing is to be run on the extracted aggregate reclaimed from the completed plant mix.	
		Asphalt Content: AASHTO T-164, Method E-II by extraction, or AASHTO T-308 by ignition oven.				
		Aggregate Gradation: AASHTO T-30 and AASHTO T-11				
			Every 1,000 tons		If testing completed mix, perform extraction using AASHTO T-164 Method E-II utilizing nested sieves (No. 16 and No. 200) AASHTO T-164 Method A may be used for modified asphalt or when problems are encountered filtering according to Method E-II Not required on production days of less than 100 tons Ignition oven may be utilized to determine gradation	

Part Two: Acceptance Samples and Tests

Type of Construction	Material	Test	Sampled By	Frequency	Location or Time of Sampling	Remarks
ASPHALT						
Asphalt Plant Mix Pavements	Plant Mix Asphalt (Grading A, AS, ACRL, and Asphalt Treated Permeable Base (TPB))	Aggregate Gradation: AASHTO T-30 and AASHTO T-11	Project Inspector	Every 1,000 tons	Combined RAP and aggregate belt samples OR Sample completed mix in truck or on roadway.	If testing completed mix, perform extraction using AASHTO T-164 Method E-II utilizing nested sieves (No. 16 and No. 200). AASHTO T-164 Method A may be used for modified asphalt or when problems are encountered filtering according to Method E-II. Not required on production days of less than 100 tons. Ignition oven may be utilized to determine gradation.
		Thickness: Cores (Asphalt TPB Only)		Every 1,000 feet	Prior to being overlaid	Refer to Section 313 of the specification for tolerance guidelines.
	Small Quantities	Visual Inspection		Not to exceed 1,000 tons of each mix type	Placement site	
Asphalt Surface Treatments: Cape Sealing, Fog Sealing, Microsurfacing, Slurry Sealing, Scrub Sealing, etc.	Aggregate	Gradation and Washing	Project Inspector	At beginning of project and every 500 tons thereafter	At source or project site prior to incorporating into work	
		Fractured Face Count		Per project		Plus No. 4 (4.75 mm) sieve material, gravel mixes only
		Glassy Particles by mass				Plus No. 4 (4.75 mm) sieve material, slag mixes only
		Loss on Ignition			From stockpiled materials	For microsurfacing only. If blended aggregate, then after blending
CONCRETE						
Ready Mix, Volumetric Mix, Closure Pour, Grout, Pre-Packaged Mix, Flowable Fill, Polymer Modified	Minor Structures	Cylinders (28-day),	Project Inspector	Every 25 cubic yards or less weekly	Placement site	Refer to Standard Specification 604.3. B.
		Slump, Air Content, & Mix Temperature		Per Day		
	Class A, , S, X	Cylinders (28-day), Slump, Air Content, & Mix Temperature		Every 100 cubic yards placed per day per structure		Sampling frequency for Class X may be otherwise specified
	Class CP			Every 400 cubic yards placed per day		Determine depth measurement per Standard Specification 501.24. Complete set of tests shall be performed on the initial load for informational purposes, not for acceptance.
	Class PEM			Every 100 cubic yards placed per day per structure		Refer to Standard Specification 604.03 A.1. d.
	Class D, DS, L			Test first three loads and every 50 cubic yards thereafter per day per structure		Refer to SOP 4-1 for acceptance of concrete for bridge decks
	Class SCC, SH-SCC			Cylinders (28-day), Slumpflow, Air Content, Mix Temperature, Passing Ability by J-Ring, VSI, & T-50		One pair of cylinders shall be cast from one of the first three passing loads
	Closure Pour Mix	Cylinders (28-day)		Beginning, middle, and end of the pour		Test/Record acceptance cylinders in accordance with AASHTO T22 Use limited to 2 cubic yards per day
	Structural Grout			Per day		
	Pre-packaged Concrete Mixture					
	Flowable Fill	Slumpflow, Mix Temperature, & Cylinders (28-day)		Every 100 cubic yards placed per day		Cylinders required for excavatable only
Polymer Modified (PMC)	Cylinders (28-day), Slump, Air Content	Every 200 square yards placed per structure				

Part Two: Acceptance Samples and Tests

Type of Construction	Material	Test	Sampled By	Frequency	Location or Time of Sampling	Remarks
Prestressed	Prestressed Products	Visual Inspection	M&T	After casting and before shipment		Refer to SOP 5-4
CONCRETE						
Precast	Precast Products, Reinforced Concrete Pipe	Acceptance by Certification in accordance with SOP 5-3				Each item shall be inspected after delivery to the project for cracks, spalls and/or appearance by project personnel prior to incorporating product into the project. After proper installation, the inspector shall determine if the product fitment is in accordance to contract plans.
		Visual Inspection	Project Inspector	Per Product	Project Site	
	Sound Absorbing Noise Walls	Acceptance by certification in accordance with SP 718NB				
	Noise Walls/ Reinforced Concrete Panels	Acceptance by certification that product meets compressive strength, air, slump or slump flow, and dimensional tolerances as outlined below				
Cylinders (28-day)		Producer	A pair of 4"x8" cylinders shall be made at a minimum of three (3) random points during production.	Production Facility		
Air, Slump or Slumpflow		Producer	One (1) test each per day	Production Facility		
		Dimensional Check	Producer	Per Product	Production Facility	
Shotcrete	Shotcrete	Production Test Panel OR Shotcrete facing	Producer/ Contractor	At beginning of project and every 5000 SF thereafter	Project Site	Minimum nine 3-inch diameter cores are required for testing Producer/Contractor shall provide third party test results for compressive strength (28-day) and boiled water absorption testing
EARTH RETAINING STRUCTURES						
Earth Retaining Structures	Select Granular Backfill (Soil)	Proctor Density & Optimum Moisture	Project Inspector	As required by material changes	Prior to Construction	
		Density, Gauge Moisture		Every 500 tons	Project site	
		Electro-Chemical Analysis, Plasticity Index, Internal Angle of Friction	Producer	At beginning of project and every 2 years thereafter	Aggregate plant	
	Select Granular Backfill (Sized Aggregate)	Gradation	M&T	At beginning of project and per month	Aggregate plant or roadway	
		Unit Weight		At beginning of project and annually thereafter	Aggregate plant	
All Retaining Wall Products	Accept in accordance with Special Provision 624 Retaining Walls				Materials not listed in this table	
EMBANKMENT/SUBGRADE						
Embankment	Soil	Proctor Density & Optimum Moisture	Project Inspector	As required by material changes	Cuts sampled prior to construction. Borrow pits sampled as required prior to placement	Submit 50 - 75 pound sample to M&T

Part Two: Acceptance Samples and Tests

Type of Construction	Material	Test	Sampled By	Frequency	Location or Time of Sampling	Remarks
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		Density, Gauge Moisture		Every 300 linear feet or 1000 cubic yards per lift	During construction, immediately after compaction	Density tests will not be required for embankment containing more than 50% of plus ¼ inch sieve material Within 50 feet of a bridge end (deck or box), one test will be performed for each lift. The test will be performed alternately on the embankment and on the backfill material.
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EMBANKMENT/SUBGRADE

Subgrade Preparation	Soil	Proctor Density & Optimum Moisture	Project Inspector	As required by material changes	May be sampled before grading construction or after grading prior to sub-grade preparation	Submit 50 - 75 pound sample to M&T	
		Density, Gauge Moisture		Five tests per 10,000 square-yard lot for top 6 inches			Immediately before placing pavement
Subgrade Treatment (Lime) OR Soil-Cement Base	Soil-Cement Mixture OR Soil-Lime Mixture	Proctor Density & Optimum Moisture	Project Inspector	Prior to beginning of construction	At beginning of compaction	Additional tests may be required to account for material changes Submit 50 - 75 pound sample to M&T	
		Pulverization		Every 10,000 square yards			After mixing, before compaction
		Density, Gauge Moisture		Five tests per 10,000 square-yard lot			Immediately following compaction
		Thickness		Every 500 liner feet			

MISCELLANEOUS

Miscellaneous	Corrugated Metal Pipe	Laboratory Analysis	Producer	Per heat number	Producer's plant	Samples shall be submitted to HQ M&T Lab prior to use
	Geotextiles (Type IV only)	Laboratory Analysis	Project Inspector	Per project	Project site prior to installation	Submit a sample 100 inches in length by the width of the roll, containing at least one NTPEP manufacturing mark, to HQ M&T Lab
	Gray Iron Castings	Dimensional Check	Project Inspector	Upon product placement	Project site	Check dimensions against standard drawings

Part Three: Verification/Check Samples and Tests

Type of Construction	Material	Test	Sampled By	Frequency	Location or Time of Sampling	Remarks
AGGREGATE						
Base Courses (Aggregate-Cement OR Aggregate-Lime-Fly Ash)	Aggregate	Quality	M&T	Annually	At source	Quality report required for each project.
	Cement	Laboratory Analysis	Project Inspector	Every six months	Mixing site	Mixture dosage rate should be checked.
	Fly Ash, Lime					
Borrow Excavation (Solid Rock and Graded Solid Rock)	Aggregate	Quality	Project Inspector or M&T	Every 100,000 tons or 50,000 cubic yards	At source	Quality report required for each project.
Mineral Aggregate Base	Aggregate	Quality	M&T	Annually	At source	Quality report required for each project.
ASPHALT						
Asphalt Binder (All Grades)	Performance Graded Asphalt Cement	Laboratory Analysis	Contractor monitored by TDOT personnel	Beginning of project and weekly thereafter	Asphalt plant	One-quart sample shall be sent to HQ M&T Lab.
			M&T or drop shipment	Per month	Asphalt terminal	One-quart sample shall be sent to HQ M&T Lab.
Asphalt Plant Mix Pavements	Plant Mix Asphalt (Grading B, BM, BM2, C, CW, D, E, TL, TLD, and TLE)	Air Voids, Volumetric Properties, and TSR: AASHTO T-166, AASHTO T-209, AASHTO T-269, and ASTM D4867	Project Inspector or M&T	During Test Strip Construction or Mix Verification	Completed mix in truck	Exempt small quantities (< 1,000 tons).
	Plant Mix Asphalt (Grading OGFC)	Asphalt Draindown and Cantabro: AASHTO T-305, AASHTO T-401	M&T			
Asphalt Surface Treatments: Cape Sealing, Fog Sealing, Microsurfacing, Slurry Sealing, Scrub Sealing, etc.	Emulsion	Laboratory Analysis	Contractor monitored by TDOT personnel	At beginning of project and every week thereafter	Distributor truck	One-quart sample must be received at HQ M&T Lab less than two weeks after sampling. Minimum of five days between samples is required.
Prime and Tack Coat	Emulsion	Laboratory Analysis	Contractor monitored by TDOT personnel	At beginning of project and every week thereafter	Distributor truck	One-quart sample must be received at HQ M&T Lab less than two weeks after sampling. Minimum of five days between samples is required. If material is greater than one week old, run sieve and residue tests at Contractor's Lab instead of HQ M&T Lab.
			M&T or drop shipment	Per month	Asphalt terminal	One-gallon sample shall be sent to HQ M&T Lab.
CONCRETE						
Ready Mix, Closure Pour, Grout, Flowable Fill, Prestressed, & Precast	Cement, Fly Ash, Slag Cement	Laboratory Analysis	M&T	Every three months	Concrete plant	Cement: Two-pint sample shall be sent to HQ M&T Lab. Fly Ash: 2 oz sample shall be sent to HQ M&T Lab.
	Aggregate: Coarse & Fine	Quality		Annually	Aggregate plant	Also, as appearance changes or locations in quarry are changed. Additional samples to be obtained when production exceeds normal output.

Part Three: Verification/Check Samples and Tests

Type of Construction	Material	Test	Sampled By	Frequency	Location or Time of Sampling	Remarks
		Gradation and Wash		Per month	Concrete plant	Perform wash test on fine aggregate only when percent passing the No. 200 sieve dry exceeds 2.0%
CONCRETE						
Ready Mix, Closure Pour, Grout, Pre-Packaged Mix, Flowable Fill, Prestressed, & Precast	Precast Products, Reinforced Concrete Pipe	Fitment	Project Inspector	Per Product	Project Site	Verification is based on the final acceptance of the product(s) meeting the requirements of the contract plans.
	Verification in accordance with SOP 5-3					
	Class PEM	SAM number, Surface Resistivity, Resistance of Concrete to Rapid Freezing and Thawing, Resistivity of Concrete	M&T	With every PEM design submission	Project Site	Refer to Standard Specification 604.03 A.1.d. All information for data collection only
	All Classes	Maturity	M&T	During Trial Batch	Producer Facility	Refer to AASHTO T 325 for guidance Must be witnessed by M&T Intended for data collection for designs on select projects
	Prestressed Completed Mix	Cylinders (28-Day) for Beams, Panels, and piling	M&T	Per Bed	Prestress plant	
	Prestressed Products	Visual Inspection	Project Inspector	Per shipment	Project Site	On arrival at site
Polymer Modified (PMC)	Aggregate: Coarse & Fine	Gradation	Project Inspector or M&T	At beginning of project and every 500 tons	Project stockpile	Refer to Standard Specification 619.04.A
		Moisture		Per day		
EARTH RETAINING STRUCTURES						
Earth Retaining Structures	Select Granular Backfill (Sized Aggregate)	Quality	M&T	Annually	Aggregate plant	
	Reinforced Concrete Facing Panels	Non-Destructive Testing and Dimensional Verification	M&T	Quarterly, when producing	Producer yard (In-State) OR Project site (Out-of-State)	When TDOT product is being produced, TDOT shall randomly select a minimum of one (1) precast product at each plant or project site for non-destructive testing and dimensional verification per quarter
		Compressive Strength	M&T	As needed	Producer yard	One pair of cylinders shall be retained for TDOT verification testing. These cylinders shall be retained for a minimum of 30 days unless testing is performed sooner by a TDOT Representative.
	Modular Block	Strength	M&T	Per production run	Producer yard (In-State) OR Project site (Out-of-State)	See SP 624 for additional verification guidance on manufacturing tolerances and visual defects of Modular Block
	All Retaining Wall Products	Verification in accordance with Special Provision 624 Retaining Walls				Materials not listed in this table

Part Three: Verification/Check Samples and Tests

Type of Construction	Material	Test	Sampled By	Frequency	Location or Time of Sampling	Remarks
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EMBANKMENT/SUBGRADE						
Soil - Cement Base	Cement	Laboratory Analysis	Project Inspector	Every six months	Mixing site	

MISCELLANEOUS						
Miscellaneous	Bolt/Nut/Washer Assemblies	Laboratory Analysis	Producer	Per heat number	Producer's plant	Prior to use, send a sample of three assemblies to HQ M&T Lab
	Brick	Strength	Project Inspector	At beginning of project	Project site	Prior to use, send a sample of five bricks to HQ M&T Lab
	Corrugated Metal Pipe	Dimensional Check	M&T	Per pipe	Producer's plant OR Project site (Out-of-State)	Verify dimensions of pipe and that heat numbers match lab acceptance
	Grey Iron Castings	Laboratory Analysis	M&T	Per quarter	Producer's plant	Send two heat numbers (test bars) to HQ M&T Lab
Dimensional & Weight Check		Check one assembly representing each structure device type				

PAVEMENT MARKINGS						
Pavement Markings	Glass Beads	Laboratory Analysis	Producer	Per lot number	Producer's plant	Prior to use, send one quart from each lot representing 44,000 pounds to HQ M&T Lab.
	Paint					Prior to use, send one pint to HQ M&T Lab.
	Thermoplastic					Prior to use, send one quart to HQ M&T Lab.

STEEL						
Steel	Steel Bars	Laboratory Analysis	M&T	Per inspection	Producer's plant or project site	Two bars 34 inches in length shall be sent to HQ M&T Lab.
					Precast plant	
	Prestressed plant					
Prestressing Strands					Prestressed plant	Two strands 40" ± 2" in length shall be sent to HQ M&T Lab.
Welded Wire Mesh					Precast plant	A two foot by two foot sample shall be sent to HQ M&T Lab.

Part Four: Using Random Numbers for Sampling and Testing (With Examples and Random Number Tables)

Significance

The selection of test locations is critical in ensuring control of materials and construction work. If the results from the test locations conform to specified tests, the rest of the work is likely to conform as well; therefore, test site locations shall be random and representative of the material in its entirety.

The procedures outlined below will help you to select random and representative test locations using random number tables, a random number function on a calculator, a spreadsheet program, etc.

Selecting Random Numbers

Randomness in transportation construction inspection indicates unpredictability in the time or location of sampling and testing of a material or procedure in a construction phase.

Random numbers occur in no pattern or sequence. When you review a series of random numbers, you do not know what number may come next; there is no particular order in which random numbers occur.

A sample random-number table is shown below.

	A	B	C	D	E						
1	0.814	0.759	0.651	0.947	0.965	0.994	0.581	0.877	0.500	0.208	1
	0.105	0.015	0.323	0.630	0.223	0.616	0.070	0.469	0.672	0.931	
	0.035	0.841	0.590	0.184	0.488	0.794	0.909	0.940	0.062	0.031	
	0.741	0.336	0.346	0.926	0.237	0.967	0.385	0.657	0.521	0.921	
2	0.278	0.697	0.423	0.365	0.010	0.210	0.264	0.745	0.378	0.337	2
	0.834	0.355	0.952	0.924	0.591	0.003	0.280	0.363	0.175	0.254	
	0.204	0.159	0.006	0.006	0.764	0.020	0.768	0.209	0.959	0.147	
	0.426	0.860	0.160	0.009	0.978	0.033	0.394	0.445	0.682	0.600	
3	0.990	0.330	0.581	0.946	0.129	0.047	0.384	0.363	0.038	0.275	3
	0.837	0.658	0.140	0.344	0.189	0.047	0.675	0.923	0.101	0.122	
	0.537	0.505	0.909	0.794	0.249	0.339	0.850	0.326	0.510	0.961	
	0.286	0.447	0.286	0.975	0.458	0.484	0.992	0.078	0.947	0.756	
4	0.492	0.633	0.262	0.660	0.451	0.511	0.255	0.439	0.185	0.712	4
	0.428	0.126	0.884	0.203	0.199	0.222	0.638	0.492	0.062	0.967	
	0.443	0.927	0.626	0.542	0.746	0.683	0.822	0.242	0.481	0.077	
	0.343	0.529	0.955	0.122	0.692	0.721	0.393	0.774	0.986	0.485	
5	0.070	0.948	0.408	0.338	0.921	0.355	0.252	0.916	0.255	0.456	5
	0.832	0.666	0.385	0.337	0.918	0.098	0.209	0.163	0.921	0.241	
	0.858	0.470	0.756	0.923	0.799	0.250	0.101	0.615	0.891	0.120	
	0.153	0.773	0.722	0.819	0.626	0.393	0.340	0.202	0.120	0.793	
5	0.142	0.636	0.217	0.005	0.597	0.628	0.994	0.150	0.375	0.969	5
	0.882	0.905	0.272	0.637	0.201	0.768	0.002	0.568	0.176	0.702	
	0.369	0.985	0.930	0.070	0.891	0.835	0.340	0.283	0.863	0.566	
	0.423	0.658	0.311	0.795	0.174	0.419	0.909	0.600	0.885	0.145	
	0.461	0.878	0.363	0.644	0.890	0.278	0.219	0.312	0.585	0.923	
	A	B	C	D	E						

Lot sizes vary depending on the type of construction and the material. For example, a lot for earthwork construction is defined by the width and length of roadway, while concrete tests for bridge decks (slump, temperature, and air content) are determined by the volume of concrete delivered to the site.

Determine the lot size and the number of samples and tests required per lot from the Sampling and Testing (S&T) Guide and Schedule (SOP 1-1).

Knowing the type of construction and the material to be tested, use the S&T Schedule to determine the type of test and frequency of testing.

Example 1: Moisture and density must be measured on a lift of soil for subgrade preparation of a roadbed. The proposed roadway is 48-feet wide.

According to the Sampling and Testing Schedule (SOP 1-1, Part 2, shown below), five tests for moisture and density are required for every 10,000 square-yard lot of soil placed.

Subgrade Preparation	Soil	Proctor Density & Optimum Moisture	Project Inspector	As required by material changes	May be sampled before grading construction or after grading prior to sub-grade preparation.	Submit 50-75 pound sample to Regional M&T.
		Density, Moisture		Five tests per 10,000 square-yard lot for top 6 inches	Immediately before placing pavement structure	

Since the project is 48 feet wide, the lot length will be, *at most*,

$$\frac{10000 \text{ yd}^2 \text{ area of aggregate} \times 9 \frac{\text{ft}^2}{\text{yd}^2}}{48 \text{ feet wide}} = 1875 \text{ feet per lot}$$

We decide to use 1000 linear feet of roadway as our designated lot since this is shorter than the allowable lot length of 1875 feet.

If using the random number table shown below, we randomly choose a block of numbers, say, block C2.

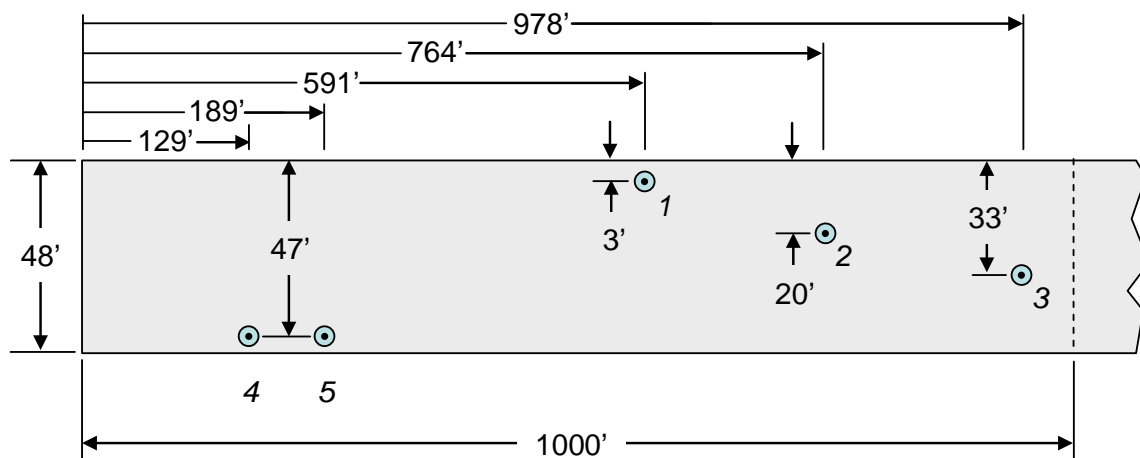
	A	B	C	D	E						
1	0.271	0.584	0.674	0.883	0.379	0.976	0.555	0.083	0.967	0.812	1
	0.185	0.905	0.686	0.491	0.424	0.566	0.724	0.582	0.393	0.176	
	0.283	0.202	0.692	0.475	0.436	0.304	0.375	0.660	0.731	0.384	
	0.567	0.800	0.642	0.205	0.827	0.129	0.598	0.216	0.124	0.787	
2	0.703	0.621	0.893	0.063	0.755	0.194	0.133	0.110	0.795	0.824	2
	0.103	0.338	0.620	0.594	0.591	0.069	0.639	0.203	0.313	0.733	
	0.536	0.826	0.362	0.321	0.764	0.408	0.487	0.515	0.591	0.676	
	0.017	0.218	0.365	0.209	0.978	0.688	0.546	0.490	0.795	0.241	
3	0.840	0.594	0.341	0.006	0.129	0.986	0.350	0.437	0.927	0.782	3
	0.161	0.720	0.366	0.219	0.189	0.985	0.899	0.501	0.793	0.889	
	0.251	0.496	0.741	0.314	0.014	0.839	0.124	0.209	0.292	0.099	
	0.380	0.901	0.262	0.180	0.459	0.843	0.640	0.720	0.131	0.132	
4	0.637	0.274	0.959	0.050	0.924	0.773	0.314	0.390	0.819	0.410	4
	0.310	0.324	0.111	0.760	0.706	0.165	0.930	0.515	0.639	0.116	
	0.568	0.379	0.600	0.362	0.697	0.006	0.080	0.680	0.028	0.206	
	0.378	0.392	0.910	0.202	0.512	0.156	0.336	0.465	0.813	0.471	
5	0.805	0.641	0.118	0.878	0.932	0.196	0.018	0.094	0.419	0.211	5
	0.830	0.106	0.643	0.706	0.720	0.299	0.252	0.598	0.955	0.021	
	0.367	0.538	0.050	0.448	0.896	0.669	0.968	0.984	0.890	0.117	
	0.274	0.509	0.848	0.645	0.890	0.998	0.389	0.611	0.586	0.137	
5	0.566	0.802	0.283	0.151	0.399	0.316	0.559	0.684	0.318	0.516	5
	0.078	0.505	0.541	0.962	0.868	0.007	0.192	0.610	0.255	0.081	
	0.458	0.811	0.454	0.476	0.156	0.385	0.198	0.102	0.762	0.372	
	0.486	0.345	0.786	0.759	0.465	0.222	0.487	0.355	0.935	0.223	
	0.783	0.432	0.275	0.218	0.942	0.054	0.641	0.278	0.957	0.778	
	A	B	C	D	E						

Using block C2, we have 10 random numbers that range between 0 and 1 carried to the thousandth decimal place. We will use these as multiplication factors to determine our test locations in the following table. The left-hand column of numbers in block C2 will be used to determine the longitudinal coordinates (length of the proposed roadway) by multiplying the lot length by the random number, then rounding to the nearest whole number. The right-hand column of numbers in block C2 will be used to determine the lateral coordinates (perpendicular to the proposed roadway) by multiplying the lot width by the random number, then rounding to the nearest whole number.

SAMPLE NO.	LENGTH	RANDOM NO.	LONGITUDINAL COORDINATE
1	1000	0.591	591
2	1000	0.764	764
3	1000	0.978	978
4	1000	0.129	129
5	1000	0.189	189

SAMPLE NO.	WIDTH	RANDOM NO.	LATERAL COORDINATE
1	48	0.069	3
2	48	0.408	20
3	48	0.688	33
4	48	0.986	47
5	48	0.985	47

Now, we simply match the first longitudinal coordinate with the first lateral coordinate to locate the first test location. Then, we match the remainder of the longitudinal and lateral coordinates to determine the remaining 4 test locations. The figure below shows the locations of the tests on the roadbed.



PLAN VIEW OF TEST AREA
(NOT TO SCALE)

Example 2: Nuclear gauge tests of density on 3.5 inches of Grading 307-A asphalt pavement that is 12 feet wide. The spread rate for 3.5 inches is 402.5 lbs/yd².

According to the Sampling and Testing Schedule (SOP 1-1, Part 2, shown below), five tests for density are required for every 1,000 ton lot of asphalt placed.

Asphalt Plant Mix Pavements	Plant Mix Asphalt Gradients A, B, BM, BM2, C, CW, D, E, and E Shoulder	Density	Project Inspector	Every 1,000 tons	As soon as practical after compaction	Each lot shall be divided into 5 equal sub-lots, and one test shall be performed per sub-lot.
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Since the lot size is 1,000 tons, the maximum lot size will be,

Converting this into square feet,

$$4,969 \text{ yd}^2 \times 9 \frac{\text{ft}^2}{\text{yd}^2} = 44,721 \text{ ft}^2$$

Since the project is 12 feet wide, the maximum lot will be,

$$44,721 \text{ ft}^2 \div 12 \text{ ft wide} = 3,726.8 \text{ ft}$$

Dividing this lot into five equal sub-lots,

LOT SIZE (yd ²)		LANE WIDTH (ft)			
		10	11	12	13
5,000	LOT LENGTH	4500	4091	3750	3462
	SUB-LOT LENGTH	900	818	750	692
10,000	LOT LENGTH	9000	8182	7500	6923
	SUB-LOT LENGTH	1800	1636	1500	1385

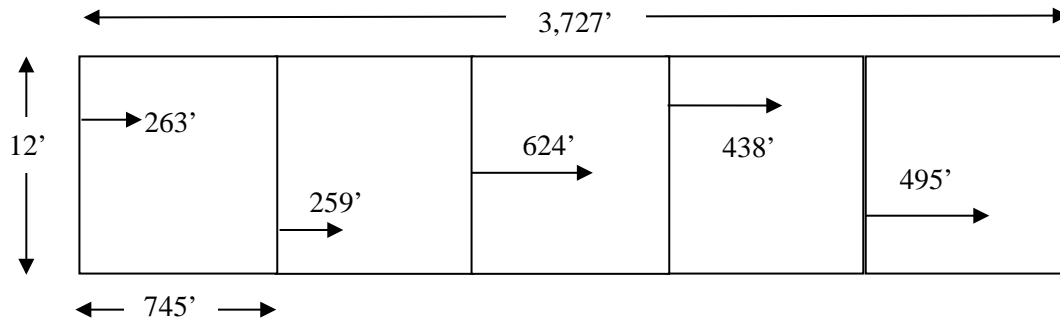
Using the table of random numbers shown below, we randomly choose a block of numbers, say, block D5.

	A	B	C	D	E						
1	0.781	0.437	0.811	0.662	0.105	0.135	0.509	0.792	0.137	0.779	1
	0.311	0.114	0.878	0.378	0.984	0.741	0.177	0.558	0.725	0.807	
	0.746	0.926	0.294	0.674	0.952	0.597	0.559	0.685	0.891	0.909	
	0.381	0.729	0.057	0.378	0.166	0.332	0.807	0.034	0.628	0.090	
	0.954	0.130	0.447	0.548	0.199	0.658	0.897	0.349	0.396	0.742	
2	0.265	0.732	0.808	0.566	0.484	0.163	0.114	0.631	0.992	0.934	2
	0.769	0.313	0.280	0.451	0.035	0.787	0.223	0.994	0.111	0.777	
	0.729	0.963	0.946	0.178	0.198	0.252	0.085	0.630	0.677	0.055	
	0.140	0.111	0.712	0.641	0.576	0.558	0.407	0.384	0.653	0.181	
	0.923	0.316	0.508	0.284	0.406	0.228	0.920	0.875	0.403	0.503	
3	0.602	0.516	0.251	0.954	0.268	0.197	0.809	0.004	0.769	0.678	3
	0.138	0.246	0.819	0.198	0.418	0.126	0.835	0.187	0.680	0.855	
	0.178	0.399	0.550	0.565	0.071	0.916	0.560	0.219	0.537	0.856	
	0.613	0.157	0.218	0.001	0.535	0.576	0.146	0.010	0.215	0.190	
	0.097	0.155	0.388	0.403	0.252	0.987	0.775	0.596	0.365	0.231	
4	0.373	0.974	0.929	0.104	0.447	0.449	0.447	0.147	0.424	0.195	4
	0.880	0.803	0.036	0.846	0.058	0.834	0.010	0.314	0.011	0.621	
	0.749	0.231	0.217	0.206	0.869	0.810	0.804	0.426	0.157	0.881	
	0.020	0.048	0.404	0.368	0.917	0.374	0.444	0.214	0.432	0.827	
	0.052	0.601	0.318	0.016	0.766	0.513	0.623	0.065	0.409	0.816	
5	0.777	0.941	0.140	0.401	0.171	0.139	0.353	0.481	0.209	0.735	5
	0.406	0.017	0.252	0.730	0.476	0.188	0.347	0.656	0.945	0.149	
	0.044	0.413	0.782	0.032	0.459	0.856	0.838	0.594	0.322	0.654	
	0.980	0.185	0.574	0.166	0.025	0.962	0.588	0.134	0.198	0.704	
	0.237	0.162	0.155	0.373	0.673	0.104	0.665	0.070	0.849	0.957	
	A	B	C	D	E						

Using block D5, we have 10 random numbers that range between 0 and 1 carried to the thousandth decimal place. We will use the multiplication factors in the left-hand column to determine our longitudinal test locations. Transverse locations are determined randomly with one test 12" off each edge, one test in each wheel path, and one test in the center of the lane.

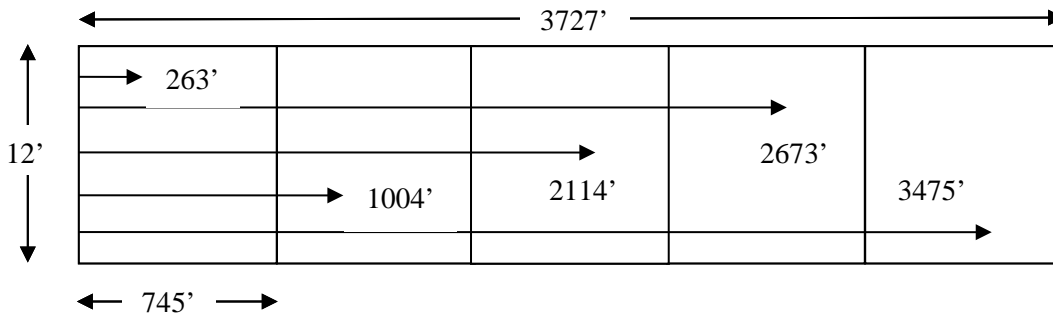
The distances into each subplot,

- 745 ft * 0.353 = 263 ft
- 745 ft * 0.347 = 259 ft
- 745 ft * 0.588 = 438 ft
- 745 ft * 0.838 = 624 ft
- 745 ft * 0.665 = 495 ft



If we wanted to know the total distance into the 3750' lot for each test:

- Test 1 = 263 ft
- Test 2 = 745 ft + 259 ft = 1004 ft
- Test 3 = 745 ft + 745 ft + 624 ft = 2114 ft
- Test 4 = 745 ft + 745 ft + 745 ft + 438 ft = 2673 ft
- Test 5 = 745 ft + 745 ft + 745 ft + 745 ft + 495 ft = 3475 ft



Example 3: Slump, temperature, and air content of concrete from mixing trucks delivering concrete to a bridge deck pour that is expected to use 1300 cubic yards of concrete.

According to the Sampling and Testing Schedule (SOP 1-1, Part 2, shown below), one complete set of tests for air content, slump, and temperature are required for the first three loads of concrete delivered.

One pair of cylinders must be cast from one of the three passing loads. For each additional 50 cubic yards of concrete, a pair of cylinders must be made and tests for air content, slump, and temperature must be performed.

Ready Mix, Closure Pour, Grout, Pre-Packaged Mix, Flowable Fill, Polymer Modified, Prestressed	Class D, DS, L	Cylinders (28-day), Slump, Air Content, & Mix Temperature	Project Inspector	Test first three loads and every 50 cubic yards thereafter per day per structure One pair of cylinders shall be cast from one of the first three passing loads.	Placement site	Refer to SOP 4-1 for acceptance of concrete for bridge decks.
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Now we'll use the random number tables in a different way. We must decide which loads of concrete to test. First, we'll assume each truck is hauling 10 cubic yards of concrete. Subsequent to the first 30 cubic yards, we'll test from truck loads by first choosing a random block of numbers from the following table. We'll choose block A3.

	A	B	C	D	E						
1	0.818	0.696	0.758	0.117	0.827	0.567	0.974	0.487	0.874	0.665	1
	0.565	0.826	0.141	0.229	0.996	0.003	0.783	0.079	0.145	0.827	
	0.926	0.785	0.743	0.669	0.411	0.702	0.949	0.460	0.434	0.201	
	0.776	0.529	0.397	0.450	0.851	0.569	0.157	0.571	0.097	0.556	
2	0.333	0.996	0.810	0.562	0.053	0.975	0.122	0.055	0.702	0.609	2
	0.626	0.783	0.145	0.210	0.591	0.003	0.493	0.136	0.036	0.223	
	0.291	0.607	0.048	0.788	0.764	0.020	0.991	0.719	0.948	0.727	
	0.950	0.570	0.324	0.232	0.978	0.033	0.803	0.534	0.367	0.897	
3	0.521	0.642	0.912	0.464	0.129	0.047	0.359	0.497	0.382	0.993	3
	0.235	0.611	0.262	0.783	0.189	0.047	0.241	0.252	0.706	0.886	
	0.537	0.505	0.557	0.919	0.939	0.579	0.351	0.525	0.304	0.092	
	0.286	0.447	0.366	0.025	0.454	0.643	0.647	0.958	0.887	0.702	
4	0.492	0.633	0.937	0.229	0.556	0.078	0.468	0.850	0.233	0.009	4
	0.428	0.126	0.767	0.250	0.740	0.976	0.835	0.280	0.808	0.401	
	0.443	0.465	0.666	0.947	0.372	0.412	0.408	0.589	0.170	0.211	
	0.970	0.183	0.800	0.534	0.702	0.508	0.295	0.397	0.391	0.421	
5	0.198	0.464	0.847	0.596	0.228	0.450	0.671	0.787	0.169	0.648	5
	0.727	0.087	0.544	0.354	0.630	0.454	0.687	0.320	0.852	0.593	
	0.272	0.647	0.553	0.886	0.761	0.396	0.059	0.207	0.014	0.331	
	0.284	0.210	0.344	0.355	0.060	0.158	0.536	0.940	0.365	0.546	
5	0.027	0.134	0.910	0.121	0.186	0.452	0.081	0.231	0.400	0.598	5
	0.818	0.052	0.867	0.848	0.497	0.386	0.485	0.976	0.283	0.388	
	0.010	0.387	0.919	0.694	0.693	0.272	0.859	0.959	0.613	0.065	
	0.112	0.245	0.158	0.294	0.690	0.704	0.273	0.389	0.075	0.676	
	0.949	0.172	0.810	0.381	0.307	0.129	0.552	0.162	0.016	0.047	
	A	B	C	D	E						

The table below shows one way to determine, using the random numbers above, the truck numbers from which samples will be taken.

SAMPLE NO.	DELIVERED CONCRETE (yd ³)	TOTAL AMOUNT OF CONCRETE (yd ³)	TOTAL LOADS OF CONCRETE (A)	RANDOM NO. (B)	LOAD NUMBER [(A _n -A _{n-1})×B]+A _{n-1}
1	10	10	1	NA	1
2	10	20	2	NA	2
3	10	30	3	NA	3
4	50	80	8	0.492	5
5	50	130	13	0.428	10
6	50	180	18	0.443	15
7	50	230	23	0.505	21
8	50	280	28	0.447	25
9	50	330	33	0.633	31
10	50	380	38	0.126	34

Example 4: Slump, temperature, and air content of concrete from mixing trucks delivering concrete to a structural footing that is expected to use 550 cubic yards of concrete.

According to the Sampling and Testing Schedule (SOP 1-1, Part 2, shown below), one complete set of tests for air content, slump, and temperature are required for the first load of concrete delivered each day for quality control/informational purposes. For each additional 100 cubic yards of concrete, a pair of cylinders must be made and tests for air content, slump, and temperature must be performed.

Ready Mix, Closure Pour, Grout, Pre-Packaged Mix, Flowable Fill, Polymer Modified, Prestressed	Class A, A Paving, S, X	Cylinders (28-day), Slump, Air Content, & Mix Temperature Complete set of tests shall be performed on the initial load for informational purposes, not for acceptance.	Project Inspector	Every 100 cubic yards placed per day per structure unless otherwise specified (i.e. Class X)	Placement site	
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Now we'll use the random number tables in a different way. We must decide which loads of concrete to test. First, we'll assume each truck is hauling 10 cubic yards of concrete. Subsequent to the first 10 cubic yards, we'll test from truck loads by first choosing a random block of numbers from the following table. We'll choose block C1.

	A	B	C	D	E						
1	0.015	0.125	0.006	0.653	0.614	0.455	0.968	0.103	0.150	0.154	1
	0.072	0.226	0.619	0.637	0.585	0.566	0.331	0.028	0.369	0.751	
	0.685	0.964	0.937	0.948	0.969	0.454	0.194	0.425	0.852	0.500	
	0.427	0.348	0.222	0.129	0.690	0.911	0.996	0.115	0.681	0.569	
	0.381	0.115	0.519	0.715	0.508	0.308	0.525	0.584	0.694	0.427	
2	0.917	0.628	0.054	0.928	0.817	0.812	0.264	0.776	0.756	0.610	2
	0.759	0.891	0.311	0.612	0.247	0.044	0.668	0.389	0.953	0.931	
	0.510	0.632	0.371	0.037	0.667	0.681	0.730	0.638	0.965	0.925	
	0.836	0.525	0.342	0.752	0.638	0.403	0.687	0.245	0.403	0.785	
	0.669	0.875	0.824	0.842	0.565	0.756	0.401	0.371	0.576	0.689	
3	0.931	0.450	0.955	0.323	0.696	0.790	0.021	0.127	0.753	0.550	3
	0.771	0.631	0.896	0.968	0.870	0.312	0.764	0.665	0.113	0.610	
	0.855	0.525	0.056	0.255	0.921	0.202	0.301	0.401	0.775	0.246	
	0.897	0.753	0.246	0.763	0.259	0.293	0.613	0.154	0.743	0.574	
	0.393	0.878	0.401	0.459	0.134	0.655	0.433	0.323	0.393	0.038	
4	0.965	0.130	0.181	0.909	0.940	0.399	0.200	0.724	0.673	0.397	4
	0.745	0.233	0.460	0.361	0.935	0.018	0.405	0.945	0.183	0.576	
	0.204	0.623	0.771	0.120	0.859	0.314	0.880	0.447	0.680	0.938	
	0.804	0.213	0.903	0.488	0.425	0.685	0.584	0.676	0.717	0.220	
	0.526	0.018	0.323	0.978	0.407	0.197	0.827	0.102	0.641	0.302	
5	0.620	0.343	0.587	0.878	0.922	0.977	0.162	0.523	0.011	0.409	5
	0.558	0.383	0.880	0.541	0.422	0.466	0.186	0.004	0.457	0.446	
	0.128	0.893	0.685	0.864	0.349	0.413	0.273	0.971	0.970	0.311	
	0.455	0.032	0.141	0.835	0.705	0.898	0.958	0.945	0.095	0.779	
	0.790	0.312	0.258	0.518	0.141	0.448	0.185	0.599	0.546	0.751	
	A	B	C	D	E						

The table below shows one way to determine, using the random numbers above, the truck numbers from which samples will be taken for acceptance.

SAMPLE NO.	TOTAL AMOUNT OF CONCRETE (yd ³)	TOTAL LOADS OF CONCRETE (A)	RANDOM NO. (B)	LOAD NUMBER [(A _n -A _{n-1}) x B]+A _{n-1}
1	0-100	10	0.273	3
2	101-200	20	0.614	16
3	201-300	30	0.585	26
4	301-400	40	0.969	40
5	401-500	50	0.690	47
6	501-550	55	0.383	52

Example 5: Assume the contractor is paving 411-D mix at 132.50 lbs/square yard at 12 feet wide. How long is the average lot and subplot?

In order to find those lengths, view the following table:

Spread (lb/SY)	Lot/ Sublot	Mat Width (Feet)									
		4	6	8	9	10	11	12	14	15	16
132.50	Lot	34000	22600	17000	15100	13600	12300	11300	9700	9100	8500
	Sublot	6800	4520	3400	3020	2720	2460	2260	1940	1820	1700
154.50	Lot	29100	19400	14600	12900	11700	10600	9700	8300	7800	7300
	Sublot	5820	3880	2920	2580	2340	2120	1940	1660	1560	1460
226.00	Lot	19900	13300	10000	8800	8000	7200	6600	5700	5300	5000
	Sublot	3980	2660	2000	1760	1600	1440	1320	1140	1060	1000
254.25	Lot	17700	11800	8800	7900	7100	6400	5900	5100	4700	4400
	Sublot	3540	2360	1760	1580	1420	1280	1180	1020	940	880
282.50	Lot	15900	10600	8000	7100	6400	5800	5300	4600	4200	4000
	Sublot	3180	2120	1600	1420	1280	1160	1060	920	840	800
310.75	Lot	14500	9700	7200	6400	5800	5300	4800	4100	3900	3600
	Sublot	2900	1940	1440	1280	1160	1060	960	820	780	720
345.00	Lot	13000	8700	6500	5800	5200	4700	4300	3700	3500	3300
	Sublot	2600	1740	1300	1160	1040	940	860	740	700	660
460.00	Lot	9800	6500	4900	4300	3900	3600	3300	2800	2600	2400
	Sublot	1960	1300	980	860	780	720	660	560	520	480

Find the row with the spread rate on the plans and follow it over to the column with the appropriate mat width. Where the row and column meet the lot/sublot lengths will be listed. For our example, find the row for 132.50 lbs/square yard and the column for 12 feet wide lanes. The values are **11,300 feet/2,260 feet** for the lot/sublot respectively.

Example 6: Assume the final lot is 500 tons. No matter how small, all lots will still require five equal sublots and five density tests. Instead of testing 500 tons five times consider combining the final two lots and halving the tonnage between the two lots. This will result in two lots of 750 tons.

You may still use the above table to find your lot and sublots. First locate the lot and subplot length for a 1000 ton lot based on the spread rate and lane width. For this example, use a spread rate of 132.5 lbs/square yard at 12 feet wide.

This would yield a Standard Lot of 11,300 feet and 2,260 feet respectively, but this needs to be modified based on the shorter lot.

Now that all of the givens are known, use the following equation to solve for the final lot/sublot lengths:

$$\left(\frac{\text{Lot Tonnage}}{1,000 \text{ tons}}\right) \times (\text{Standard Lot Length, in feet}) = \text{Lot Length, in feet}$$

$$\left(\frac{750 \text{ tons}}{1,000 \text{ tons}}\right) \times (11,300 \text{ feet}) = 8,475 \text{ feet} \sim \mathbf{8,500 \text{ feet}}$$

Once the lot length is determined for 750 tons, divide the new lot length by 5 for equal subplot lengths:

$$\left(\frac{8500 \text{ feet}}{5 \text{ sublots}}\right) = \mathbf{1,700 \text{ feet/sublot}}$$

These values are the new lot/sublot lengths. These values may be rounded to the nearest 100' for simplicity.

	A	B	C	D	E						
1	0.678	0.694	0.141	0.441	0.836	0.182	0.274	0.829	0.365	0.881	1
	0.023	0.158	0.948	0.763	0.555	0.741	0.157	0.869	0.811	0.789	
	0.504	0.635	0.730	0.899	0.719	0.357	0.284	0.140	0.644	0.082	
	0.704	0.941	0.361	0.863	0.882	0.404	0.704	0.933	0.667	0.571	
	0.830	0.617	0.154	0.081	0.109	0.741	0.503	0.974	0.301	0.911	
2	0.247	0.737	0.402	0.169	0.871	0.830	0.069	0.276	0.998	0.499	2
	0.710	0.346	0.012	0.836	0.233	0.885	0.077	0.341	0.607	0.719	
	0.205	0.290	0.040	0.804	0.638	0.987	0.353	0.539	0.208	0.676	
	0.980	0.629	0.424	0.081	0.002	0.761	0.185	0.940	0.997	0.568	
	0.360	0.766	0.117	0.032	0.588	0.049	0.407	0.388	0.535	0.464	
3	0.120	0.852	0.163	0.852	0.201	0.487	0.713	0.696	0.914	0.080	3
	0.413	0.327	0.839	0.949	0.724	0.728	0.508	0.471	0.327	0.850	
	0.955	0.924	0.285	0.028	0.299	0.064	0.953	0.791	0.437	0.745	
	0.131	0.616	0.223	0.213	0.027	0.024	0.484	0.030	0.533	0.552	
	0.037	0.500	0.803	0.546	0.093	0.401	0.750	0.189	0.417	0.078	
4	0.096	0.483	0.713	0.576	0.935	0.281	0.506	0.994	0.014	0.491	4
	0.818	0.855	0.950	0.195	0.142	0.392	0.380	0.786	0.063	0.423	
	0.689	0.685	0.742	0.863	0.906	0.966	0.617	0.375	0.908	0.685	
	0.443	0.857	0.239	0.770	0.181	0.241	0.982	0.373	0.150	0.316	
	0.020	0.898	0.158	0.365	0.497	0.139	0.864	0.937	0.392	0.026	
5	0.245	0.510	0.670	0.082	0.483	0.403	0.524	0.338	0.387	0.406	5
	0.658	0.596	0.690	0.737	0.899	0.567	0.655	0.231	0.508	0.374	
	0.107	0.682	0.077	0.763	0.593	0.877	0.094	0.929	0.268	0.973	
	0.057	0.478	0.230	0.623	0.339	0.942	0.239	0.839	0.074	0.854	
	0.312	0.193	0.428	0.947	0.185	0.197	0.642	0.537	0.590	0.876	

	A	B	C	D	E						
1	0.001	0.411	0.562	0.371	0.511	0.010	0.189	0.340	0.529	0.991	1
	0.095	0.690	0.070	0.561	0.412	0.123	0.060	0.580	0.614	0.151	
	0.742	0.355	0.526	0.217	0.848	0.774	0.923	0.542	0.653	0.385	
	0.914	0.676	0.912	0.868	0.085	0.281	0.924	0.704	0.371	0.600	
	0.257	0.536	0.951	0.713	0.939	0.987	0.637	0.536	0.129	0.917	
2	0.586	0.163	0.710	0.254	0.744	0.846	0.979	0.344	0.333	0.481	2
	0.271	0.577	0.487	0.484	0.408	0.704	0.901	0.347	0.850	0.286	
	0.480	0.538	0.017	0.074	0.427	0.225	0.452	0.049	0.233	0.846	
	0.967	0.187	0.657	0.775	0.251	0.877	0.169	0.977	0.879	0.635	
	0.471	0.416	0.107	0.334	0.565	0.735	0.549	0.763	0.850	0.113	
3	0.398	0.095	0.496	0.726	0.650	0.498	0.266	0.727	0.355	0.209	3
	0.265	0.801	0.509	0.718	0.181	0.286	0.928	0.200	0.588	0.881	
	0.937	0.348	0.446	0.688	0.955	0.834	0.796	0.045	0.292	0.019	
	0.999	0.804	0.217	0.945	0.601	0.122	0.897	0.535	0.170	0.606	
	0.871	0.270	0.269	0.056	0.555	0.907	0.732	0.709	0.224	0.424	
4	0.550	0.650	0.779	0.280	0.914	0.303	0.377	0.896	0.428	0.791	4
	0.262	0.325	0.785	0.248	0.748	0.291	0.552	0.560	0.806	0.450	
	0.194	0.754	0.700	0.244	0.521	0.673	0.196	0.495	0.227	0.995	
	0.484	0.315	0.295	0.267	0.637	0.202	0.082	0.750	0.626	0.107	
	0.925	0.002	0.940	0.406	0.756	0.942	0.745	0.665	0.398	0.519	
5	0.769	0.126	0.227	0.521	0.395	0.853	0.606	0.467	0.716	0.376	5
	0.786	0.339	0.246	0.850	0.310	0.413	0.966	0.387	0.222	0.035	
	0.121	0.278	0.807	0.006	0.872	0.081	0.317	0.163	0.942	0.763	
	0.794	0.721	0.766	0.883	0.285	0.936	0.363	0.154	0.021	0.304	
	0.138	0.381	0.875	0.566	0.802	0.077	0.888	0.634	0.880	0.916	

	A	B	C	D	E						
1	0.439	0.107	0.450	0.340	0.181	0.794	0.186	0.814	0.350	0.112	1
	0.460	0.661	0.706	0.123	0.648	0.988	0.750	0.968	0.955	0.196	
	0.631	0.799	0.355	0.746	0.842	0.268	0.445	0.942	0.430	0.324	
	0.398	0.177	0.993	0.666	0.377	0.609	0.533	0.840	0.271	0.270	
	0.258	0.732	0.905	0.314	0.200	0.640	0.736	0.970	0.804	0.352	
2	0.099	0.586	0.938	0.597	0.883	0.855	0.489	0.003	0.290	0.397	2
	0.024	0.789	0.120	0.111	0.274	0.627	0.731	0.654	0.482	0.637	
	0.536	0.280	0.146	0.968	0.044	0.326	0.097	0.326	0.228	0.370	
	0.087	0.955	0.770	0.328	0.492	0.940	0.554	0.913	0.888	0.758	
	0.192	0.771	0.968	0.688	0.247	0.770	0.194	0.621	0.847	0.848	
3	0.183	0.040	0.020	0.172	0.625	0.262	0.170	0.501	0.930	0.626	3
	0.605	0.948	0.688	0.893	0.686	0.840	0.799	0.047	0.936	0.752	
	0.924	0.795	0.113	0.148	0.316	0.956	0.536	0.701	0.440	0.702	
	0.569	0.213	0.626	0.960	0.240	0.823	0.196	0.335	0.663	0.630	
	0.799	0.128	0.560	0.843	0.951	0.600	0.609	0.256	0.292	0.681	
4	0.597	0.815	0.412	0.439	0.189	0.094	0.782	0.515	0.809	0.303	4
	0.014	0.033	0.240	0.170	0.824	0.248	0.118	0.570	0.344	0.203	
	0.916	0.958	0.802	0.089	0.958	0.677	0.515	0.843	0.127	0.868	
	0.989	0.291	0.184	0.927	0.089	0.780	0.214	0.277	0.105	0.138	
	0.545	0.849	0.884	0.192	0.617	0.416	0.763	0.558	0.027	0.098	
5	0.227	0.322	0.069	0.477	0.984	0.112	0.207	0.110	0.196	0.615	5
	0.342	0.472	0.531	0.716	0.337	0.880	0.593	0.881	0.195	0.188	
	0.059	0.058	0.688	0.504	0.418	0.197	0.894	0.298	0.843	0.959	
	0.056	0.926	0.214	0.016	0.050	0.692	0.256	0.966	1.000	0.084	
	0.033	0.489	0.768	0.354	0.855	0.839	0.670	0.853	0.934	0.012	

	A	B	C	D	E						
1	0.213	0.416	0.998	0.713	0.003	0.826	0.353	0.763	0.835	0.398	1
	0.761	0.812	0.959	0.598	0.771	0.105	0.414	0.251	0.305	0.385	
	0.071	0.848	0.185	0.978	0.881	0.329	0.822	0.690	0.779	0.126	
	0.745	0.888	0.662	0.041	0.589	0.145	0.125	0.617	0.474	0.200	
	0.619	0.972	0.230	0.780	0.224	0.463	0.846	0.098	0.541	0.002	
2	0.770	0.801	0.055	0.852	0.289	0.381	0.023	0.911	0.736	0.387	2
	0.794	0.193	0.499	0.827	0.235	0.046	0.168	0.789	0.543	0.594	
	0.768	0.053	0.915	0.063	0.541	0.687	0.848	0.742	0.891	0.091	
	0.752	0.363	0.172	0.583	0.183	0.234	0.105	0.650	0.456	0.330	
	0.746	0.920	0.088	0.285	0.125	0.514	0.795	0.366	0.144	0.758	
3	0.676	0.579	0.181	0.237	0.249	0.376	0.805	0.306	0.050	0.951	3
	0.524	0.502	0.975	0.401	0.741	0.518	0.312	0.284	0.444	0.002	
	0.408	0.575	0.505	0.360	0.774	0.546	0.635	0.758	0.440	0.299	
	0.875	0.176	0.145	0.011	0.174	0.516	0.317	0.560	0.775	0.488	
	0.045	0.320	0.449	0.079	0.726	0.455	0.934	0.341	0.912	0.963	
4	0.589	0.945	0.644	0.339	0.984	0.115	0.517	0.414	0.834	0.261	4
	0.338	0.428	0.777	0.803	0.755	0.264	0.481	0.030	0.186	0.953	
	0.034	0.715	0.499	0.896	0.934	0.827	0.601	0.527	0.282	0.758	
	0.642	0.976	0.896	0.449	0.361	0.777	0.297	0.484	0.949	0.629	
	0.864	0.440	0.059	0.265	0.072	0.879	0.779	0.421	0.657	0.146	
5	0.979	0.318	0.153	0.682	0.066	0.806	0.003	0.163	0.249	0.012	5
	0.253	0.995	0.678	0.459	0.166	0.223	0.132	0.558	0.377	0.663	
	0.922	0.764	0.313	0.247	0.330	0.167	0.098	0.416	0.378	0.585	
	0.711	0.516	0.731	0.061	0.387	0.520	0.865	0.596	0.456	0.745	
	0.341	0.350	0.431	0.984	0.583	0.321	0.142	0.508	0.040	0.741	

	A	B	C	D	E						
1	0.764	0.375	0.774	0.880	0.109	0.349	0.121	0.861	0.612	0.200	1
	0.614	0.527	0.172	0.266	0.018	0.374	0.036	0.623	0.341	0.427	
	0.017	0.694	0.456	0.638	0.812	0.271	0.423	0.329	0.644	0.041	
	0.823	0.132	0.112	0.039	0.319	0.312	0.565	0.634	0.124	0.199	
	0.001	0.938	0.180	0.639	0.207	0.918	0.905	0.490	0.938	0.019	
2	0.281	0.761	0.733	0.457	0.424	0.063	0.159	0.247	0.546	0.975	2
	0.503	0.360	0.556	0.533	0.829	0.490	0.527	0.286	0.557	0.078	
	0.689	0.948	0.589	0.816	0.370	0.794	0.913	0.324	0.529	0.041	
	0.260	0.313	0.841	0.771	0.752	0.282	0.669	0.749	0.420	0.451	
	0.204	0.118	0.165	0.209	0.865	0.429	0.366	0.493	0.509	0.945	
3	0.546	0.394	0.643	0.855	0.104	0.120	0.201	0.987	0.640	0.240	3
	0.230	0.569	0.865	0.696	0.044	0.494	0.030	0.699	0.204	0.105	
	0.808	0.107	0.645	0.308	0.094	0.288	0.391	0.885	0.069	0.994	
	0.423	0.022	0.370	0.008	0.125	0.774	0.091	0.523	0.700	0.599	
	0.819	0.415	0.405	0.856	0.065	0.079	0.408	0.541	0.723	0.309	
4	0.212	0.347	0.045	0.359	0.420	0.422	0.720	0.767	0.983	0.589	4
	0.444	0.389	0.427	0.634	0.055	0.337	0.519	0.444	0.644	0.703	
	0.224	0.571	0.271	0.859	0.636	0.175	0.255	0.080	0.027	0.797	
	0.840	0.401	0.917	0.099	0.600	0.715	0.332	0.335	0.405	0.983	
	0.233	0.580	0.966	0.419	0.092	0.243	0.175	0.179	0.743	0.611	
5	0.668	0.678	0.304	0.650	0.646	0.623	0.290	0.246	0.680	0.359	5
	0.430	0.392	0.388	0.807	0.455	0.004	0.586	0.442	0.179	0.162	
	0.309	0.373	0.239	0.392	0.490	0.549	0.773	0.695	0.917	0.797	
	0.681	0.901	0.637	0.195	0.392	0.093	0.091	0.642	0.389	0.492	
	0.134	0.119	0.276	0.503	0.096	0.319	0.135	0.225	0.953	0.169	
A	B	C	D	E							

	A	B	C	D	E						
1	0.772	0.571	0.975	0.511	0.489	0.398	0.089	0.964	0.379	0.313	1
	0.838	0.849	0.592	0.814	0.914	0.928	0.438	0.875	0.712	0.507	
	0.447	0.478	0.176	0.084	0.317	0.169	0.755	0.741	0.821	0.134	
	0.960	0.192	0.970	0.442	0.856	0.621	0.500	0.912	0.814	0.895	
	0.941	0.780	0.393	0.912	0.252	0.713	0.386	0.158	0.941	0.599	
2	0.819	0.432	0.555	0.447	0.866	0.737	0.363	0.382	0.615	0.705	2
	0.937	0.970	0.331	0.751	0.633	0.711	0.234	0.174	0.518	0.644	
	0.408	0.983	0.714	0.499	0.782	0.417	0.849	0.013	0.325	0.064	
	0.848	0.718	0.096	0.035	0.021	0.484	0.146	0.233	0.744	0.090	
	0.814	0.540	0.268	0.199	0.913	0.387	0.614	0.335	0.493	0.194	
3	0.373	0.229	0.458	0.544	0.138	0.753	0.825	0.441	0.521	0.304	3
	0.748	0.235	0.421	0.304	0.568	0.329	0.098	0.348	0.371	0.646	
	0.365	0.098	0.826	0.053	0.931	0.166	0.835	0.384	0.716	0.951	
	0.711	0.021	0.531	0.549	0.727	0.539	0.111	0.627	0.036	0.867	
	0.111	0.106	0.980	0.418	0.757	0.475	0.157	0.525	0.793	0.326	
4	0.171	0.226	0.276	0.734	0.265	0.190	0.452	0.998	0.520	0.857	4
	0.749	0.458	0.832	0.004	0.218	0.482	0.375	0.428	0.966	0.285	
	0.074	0.807	0.868	0.560	0.626	0.077	0.236	0.430	0.861	0.112	
	0.463	0.256	0.120	0.567	0.237	0.012	0.136	0.075	0.617	0.974	
	0.903	0.948	0.531	0.315	0.050	0.839	0.977	0.882	0.196	0.982	
5	0.611	0.524	0.293	0.749	0.367	0.958	0.348	0.109	0.780	0.254	5
	0.438	0.791	0.982	0.027	0.170	0.127	0.820	0.943	0.075	0.887	
	0.973	0.410	0.313	0.035	0.949	0.848	0.720	0.672	0.530	0.799	
	0.382	0.458	0.800	0.781	0.242	0.564	0.019	0.139	0.338	0.176	
	0.751	0.263	0.344	0.467	0.941	0.795	0.019	0.880	0.515	0.415	
A	B	C	D	E							

	A	B	C	D	E						
1	0.975	0.023	0.046	0.500	0.806	0.260	0.202	0.319	0.813	0.862	1
	0.600	0.130	0.373	0.995	0.048	0.501	0.552	0.519	0.846	0.403	
	0.536	0.018	0.935	0.372	0.090	0.931	0.311	0.579	0.466	0.979	
	0.567	0.042	0.182	0.483	0.143	0.473	0.838	0.578	0.894	0.070	
	0.956	0.913	0.130	0.915	0.895	0.415	0.558	0.554	0.975	0.636	
2	0.348	0.419	0.682	0.262	0.536	0.984	0.886	0.878	0.009	0.877	2
	0.141	0.217	0.422	0.261	0.384	0.716	0.326	0.212	0.353	0.610	
	0.625	0.370	0.164	0.966	0.722	0.236	0.548	0.137	0.851	0.053	
	0.357	0.688	0.676	0.757	0.630	0.527	0.817	0.041	0.235	0.790	
	0.114	0.741	0.129	0.805	0.802	0.800	0.615	0.417	0.741	0.455	
3	0.515	0.566	0.935	0.755	0.055	0.412	0.083	0.253	0.174	0.826	3
	0.557	0.484	0.163	0.242	0.221	0.150	0.397	0.763	0.868	0.113	
	0.787	0.758	0.735	0.302	0.391	0.540	0.043	0.991	0.537	0.459	
	0.111	0.507	0.695	0.634	0.251	0.587	0.386	0.533	0.585	0.449	
	0.824	0.682	0.521	0.056	0.088	0.302	0.128	0.562	0.334	0.244	
4	0.597	0.828	0.318	0.337	0.736	0.029	0.891	0.709	0.700	0.134	4
	0.768	0.644	0.400	0.481	0.528	0.573	0.928	0.824	0.537	0.445	
	0.778	0.664	0.687	0.607	0.493	0.515	0.269	0.363	0.662	0.947	
	0.833	0.812	0.289	0.346	0.923	0.478	0.941	0.580	0.976	0.509	
	0.635	0.995	0.723	0.558	0.349	0.432	0.155	0.276	0.129	0.326	
5	0.880	0.025	0.952	0.801	0.596	0.565	0.407	0.303	0.620	0.153	5
	0.624	0.276	0.934	0.715	0.372	0.111	0.823	0.740	0.650	0.676	
	0.084	0.459	0.616	0.230	0.955	0.787	0.486	0.817	0.420	0.599	
	0.028	0.943	0.707	0.336	0.442	0.751	0.009	0.025	0.406	0.638	
	0.257	0.953	0.580	0.071	0.474	0.137	0.481	0.277	0.533	0.292	
A	B	C	D	E							

	A	B	C	D	E						
1	0.817	0.093	0.254	0.779	0.563	0.409	0.263	0.244	0.026	0.340	1
	0.267	0.817	0.444	0.908	0.830	0.238	0.270	0.990	0.287	0.607	
	0.287	0.574	0.016	0.879	0.159	0.232	0.440	0.553	0.799	0.461	
	0.416	0.330	0.913	0.890	0.426	0.746	0.078	0.374	0.190	0.396	
	0.116	0.197	0.178	0.223	0.794	0.327	0.401	0.499	0.666	0.475	
2	0.554	0.784	0.841	0.113	0.606	0.687	0.319	0.268	0.793	0.461	2
	0.777	0.671	0.420	0.990	0.215	0.825	0.222	0.591	0.264	0.230	
	0.215	0.696	0.455	0.127	0.976	0.774	0.761	0.437	0.664	0.164	
	0.174	0.315	0.788	0.300	0.037	0.258	0.464	0.286	0.575	0.581	
	0.262	0.845	0.246	0.789	0.815	0.539	0.766	0.646	0.034	0.860	
3	0.372	0.973	0.530	0.319	0.021	0.337	0.755	0.423	0.182	0.877	3
	0.696	0.264	0.848	0.895	0.963	0.121	0.620	0.738	0.446	0.657	
	0.551	0.612	0.469	0.596	0.767	0.900	0.050	0.859	0.210	0.652	
	0.940	0.828	0.328	0.224	0.861	0.612	0.640	0.783	0.952	0.292	
	0.493	0.163	0.854	0.979	0.858	0.562	0.690	0.143	0.796	0.904	
4	0.963	0.877	0.075	0.714	0.414	0.351	0.829	0.246	0.447	0.060	4
	0.441	0.183	0.880	0.986	0.755	0.034	0.642	0.540	0.393	0.665	
	0.558	0.228	0.709	0.238	0.572	0.599	0.504	0.971	0.698	0.744	
	0.811	0.758	0.092	0.848	0.312	0.436	0.017	0.438	0.916	0.304	
	0.017	0.260	0.953	0.564	0.947	0.011	0.425	0.468	0.083	0.789	
5	0.178	0.881	0.468	0.731	0.604	0.324	0.398	0.753	0.278	0.130	5
	0.979	0.811	0.476	0.125	0.423	0.314	0.456	0.090	0.189	0.066	
	0.057	0.136	0.483	0.100	0.712	0.204	0.372	0.385	0.918	0.405	