

Pennsylvania Aggregate Technician Certification Program

COURSE OUTLINE

2019 Edition



Registration can be done using this form, OR online at *www.superpave.psu.edu*.

1. Fill in or attach information as indicated.
2. **Online registration is preferred, but if you choose to register using this form, submit by mail**, a separate copy of this form for each applicant for each certification course to NECEPT as the address below. **Credit card payments are accepted only if paid online (i.e. through online registration)**. If you choose to send the paper application, you must include payment by check or money order. Please make checks payable to *Pennsylvania State University*.
3. You **must** submit a completed Aggregate Checklist along with your application. The Checklist must be signed by a PennDOT DME/M, ACE/M, designee or PTC Materials Supervisor.
4. The applicant can attend the course **after** a confirmation of payment and registration is received from NECEPT. **All confirmation letters will be sent via email**. Therefore, it is imperative that at least one valid email address is listed.
5. **Registration will be accepted up to 10 business days prior to the course date**. PennDOT reserves the right to reschedule and/or cancel under-enrolled courses. Applicant has the option to cancel prior to course date. Registration fees will be refunded less a \$15 processing fee if received at least 10 business days prior to the course date. Refunds for emergency circumstances will be considered on a case-by-case basis. Applicants should allow 3-5 weeks after taking the course and exam to receive their certification card.

Falsification of information on this form may jeopardize your certification status.

NECEPT Contact Information:

Penn State University/The Thomas D. Larson PA Transportation Institute
NECEPT/PennDOT Technician Certification Program
201 Transportation Research Building
University Park, PA 16802
Phone: 814-863-1293
Fax: 814-865-3039
Email: superpave@psu.edu



2019 AGGREGATE CERTIFICATION SCHEDULE

SUBJECT:	DATES	VENUE—CITY	Catalog ID
<i>Certified Aggregate Technician</i>	November 15-16, 2018	Materials Testing Lab— Harrisburg	120957
	December 10-11, 2018	Materials Testing Lab— Harrisburg	120958
	January 14-15, 2019	Materials Testing Lab— Harrisburg	120959
	February 11-12, 2019	Materials Testing Lab— Harrisburg	120960
	March 11-12, 2019	Materials Testing Lab— Harrisburg	120961
	April 1-2, 2019	Materials Testing Lab— Harrisburg	120962

Materials Testing Lab
81 Lab Lane, Harrisburg, PA 17109
Phone # 717-787-1037



PENNDOT
CERTIFIED AGGREGATE TECHNICIAN
2019 APPLICATION FORM

- 1) Have you EVER taken a NECEPT Concrete, Bituminous, or Aggregate Course before? YES ____ NO ____
2) If you answered "Yes", please enter your 2-6 digit NECEPT ID number: ____
If you do not know this ID number, please call (814) 863-1293 BEFORE submitting this application.

Please select which option you are applying for: New Applicant ____ Recertification ____

If you chose New Applicant, you MUST:

- Have PennDOT "Aggregate Technician in Training" status
Do you have technician in training status? YES ____ NO ____
If Yes, you must attach a copy of your sign-off sheet.

If you chose Recertification:

- 1) What is your NECEPT ID number? ____
2) What is your current expiration date? ____

REFER TO PENNDOT PUB. 725 FOR REQUIREMENTS FOR INITIAL CERTIFICATION & CERTIFICATION RENEWAL

APPLICATION CATEGORIES: FEE

TECHNICIAN IN TRAINING N/A
(To be submitted directly to and retained by your local PennDOT District Office)

AGGREGATE TECHNICIAN \$85.00

Date/Location of 1st Choice ____

Date/Location of 2nd Choice ____

Applicant Name: _____

Email Address(es): YOU MUST ENTER AT LEAST ONE EMAIL ADDRESS TO RECEIVE CONFIRMATION EMAILS.

1 _____ 2 _____

Affiliation: PennDOT (District/Bureau) _____ Industry _____ Consultant _____ Other _____

Employer: _____ Job Title: _____

Mailing Address: _____ City: _____ State & Zip: _____

Daytime Phone: _____ Alternate Phone: _____ Fax Number: _____

For information regarding course cancellation or rescheduling due to inclement weather, call 814-863-1293 or visit www.superpave.psu.edu

BEFORE MAILING THIS FORM, PLEASE MAKE SURE YOU HAVE COMPLETED THE FOLLOWING:

- ◆ Enclose payment.
◆ Fill in the form completely and include copy of the Aggregate Technician in Training sign-off sheet if registering as a new applicant.

Incomplete applications will be returned!

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PENNSYLVANIA AGGREGATE TECHNICIAN

CERTIFICATION PROGRAM

COURSE OUTLINE

I. General Information

A. **Objective:**

The purpose of this course is to review aggregate testing and general information necessary to qualify as a certified aggregate technician. This course will address the day-to-day testing, record keeping, and quality control requirements necessary for an aggregate to meet PennDOT specifications. This course will address inherent properties of aggregate materials that influence quality test results. It will also review PennDOT specification documents and procedures including actions resulting from quality failures.

B. **Course Organization and Presentation:**

The course is organized into a two-day program. The first day will consist of a morning lecture and video with an afternoon hands-on laboratory session. The second day will consist of completing the day-one lab session, additional lectures, and a field trip to the PennDOT Materials Testing Laboratory. An open-book test will be given in the afternoon immediately after lunch, which should be completed by 4 pm. The test will be graded at submission so you will know if you passed the course when you leave. A score of at least 70% is necessary to pass the test.

C. **Certification:**

NECEPT will certify that you have completed and passed the course and will mail you a certificate within several weeks. Your certification will be registered into the NECEPT program. Certification is for a five-year period. Recertification is explained in Publication 725 "Aggregate Technician Certification Program". A recertification test will be performed at your site by a DME/DMM representative. The results of the test are pass/fail and the form must accompany your application for recertification. Recertification application can be obtained online at www.superpave.psu.edu.

AGGREGATE TECHNICIAN CERTIFICATION PROGRAM

**Initial Certification Requirements,
Recertification Requirements
and
Application Procedures**

January 2015

**Pennsylvania Department of Transportation
Bureau of Project Delivery
Innovation and Support Services Division
Laboratory Testing Section**

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I. BACKGROUND

This publication provides information concerning the minimum requirements needed to become a certified aggregate technician performing work for PennDOT. These requirements are part of the Department's technician certification program developed to satisfy the requirements circulated in the Code of Federal Regulations, 23 CFR, Part 637, Quality Assurance (QA) Procedures for Construction, issued June 29, 1995. These Federal Regulations contained the following statement:

“After June 29, 2000, all sampling and testing data to be used in the acceptance decision or the independent assurance program will be executed by qualified sampling and testing personnel.”

In response to this Federal regulation, the Department began development of an aggregate technician certification program in 1997. The program included the certification of aggregate technicians. Continuous improvements have been made to the aggregate technician certification program since 1997. As part of these improvements, the Department agreed upon minimum requirements for initial certification and recertification of aggregate technicians. Each applicant must meet these minimum requirements before they are eligible to become a certified aggregate technician.

This publication includes the minimum requirements for initial certification and recertification and the application procedures for applicants requesting to become certified aggregate technicians as follows:

- Aggregate Technician in Training
- Aggregate Technician

The initial certification and any subsequent recertification period will be five (5) years.

II. AGGREGATE TECHNICIAN IN TRAINING – CERTIFICATION

A. Certification Requirements

1. Applicant must have a minimum of 300 hours of documented work experience under the direct supervision of a PennDOT Certified Aggregate Technician.
2. Applicant must have the signature and the certification number of the PennDOT Certified Aggregate Technician who directly instructed and supervised them for the work experience required above.
3. The District Materials Engineer/ Manager (DME/DMM) or their representative will evaluate the applicant by administering the Aggregate Technician Certification/Re-Certification Test (on page 12). Upon satisfactorily completing the evaluation, the DME/DMM will sign the evaluation form and provide the applicant with the signed original.

4. The DME/DMM is to maintain a copy of the evaluation and forward a copy to:

PennDOT Aggregate Technician- in-Training Administrator
Bureau of Project Delivery
Innovation and Support Services Division
Laboratory Testing Section
81 Lab Lane
Harrisburg, PA 17110-2543

5. The PennDOT Certified Aggregate Technician-in-Training status is only valid from the date of issuance by the DME/DMM until the date of the last scheduled Aggregate Technician Certification Course in the same year and will be acceptable in all Districts for that period.
6. Applicant must take the next available Aggregate Technician Certification Course at Harrisburg Area Community College (HACC).
7. The Aggregate Technician in Training MUST become a PennDOT Certified Aggregate Technician by following the Initial Certification procedure in Section III.

III. AGGREGATE TECHNICIAN - INITIAL CERTIFICATION

A. Initial Certification Requirements

- 1 Applicant must have a valid Aggregate Technician-in-Training certification.
- 2 Applicant must attend and successfully complete PennDOT's Aggregate Technician Certification Program at HACC.

B. Initial Certification Application Procedures

1. Applicant must fill out and submit the completed registration form to HACC including a list of the quarries, dates, and the name of their immediate supervisor where they received one (1) year or more of experience in aggregate testing or a copy of their Aggregate Technician-in-Training certification.
2. Applicant must attend and successfully complete the PennDOT's Aggregate Technician Certification program.
3. The Department or its administrative representative will issue a wallet card upon successful completion of the above requirements. This card will be valid for a period of five (5) years.

Note: Should an individual allow their status as a PennDOT Certified Aggregate Technician to lapse, the Department will require them to retake and successfully complete the next available PennDOT's Aggregate Technician Certification Program at HACC. If the individuals certification is expired for more than two years, the individual will be required to repeat the process outlined in Section III, Initial Certification.

IV. AGGREGATE TECHNICIAN - RECERTIFICATION

A. Recertification Requirements

1. Applicant must have been a certified Aggregate Technician for the previous five (5) years prior to application for recertification.
2. Applicant must successfully complete the Aggregate Technician Recertification Test prior to the expiration date on the certified aggregate technician's wallet card..
3. Applicant must have performed 500 hours of technician experience.

B. Recertification Application Procedures

1. List the quarries, dates, and the name of applicant's immediate supervisor where applicant received 500 hours or more technician experience since date of last certification. Provide the list to the DME/DMM prior to taking the Aggregate Technician Recertification Test
2. The DME/DMM or their representative will evaluate the applicant as per the Aggregate Technician Recertification Test. Upon satisfactorily completing the evaluation and providing the list of the quarries, dates, and the name of applicant's immediate supervisor where applicant received 500 hours or more technician experience since date of last certification, the DME/DMM will sign the evaluation form and provide the applicant with the signed form.
3. Complete and submit the NECEPT Registration Form indicating the application is for recertification of an Aggregate Technician. Submit a copy of the signed Aggregate Technician Recertification Test
4. The Department or its administrative representative will issue a wallet card upon successful completion of the above requirements. This card will be valid for a period of five (5) years.

V. RETEST

Applicants may retest twice without success for the PennDOT Aggregate Technician before they are required to repeat the Aggregate Technician Course presented by HACC. There are two ways to retest. Applicants may register to take a retest along with the regularly scheduled certification examination on the last day of any scheduled PennDOT session, as long as there is sufficient space available in the classroom to accommodate them. The alternate is to wait until the end of the current PennDOT Aggregate Technician Certification Program. After all of the participants have had time to receive their test results and review their exams, a Retest Session will be scheduled and applicants for retest will be notified. Applicants must register for retests by submitting a completed current program registration form, using the current course schedule or retest announcement to indicate the specific date(s) and location(s) desired in order of preference, to assure that appropriate test forms will be available. Registration for retest applicants will be confirmed on a space-available basis. A fee will be charged for any retest with the fee amount and method of payment indicated on the current registration form.

VI. PERFORMANCE REVIEW PROCESS

A. Purpose and Makeup

The performance review process evaluates the performance of certified aggregate technicians, in accordance with the requirements outlined in Bulletin 14 and the Aggregate Technician Certification Program, to determine if their substandard performance or intentional misrepresentation requires any action to be taken against their current certification status. The review of a certified aggregate technician's substandard performance or intentional misrepresentation will be conducted by the Technician Certification Board (TCB). The TCB is composed of the representation shown in Table 1.

Organization	Number of Representatives
PennDOT- Innovation and Support Services Division (ISSD)	1
Pennsylvania Aggregates and Concrete Assoc. (PACA)	1
FHWA-PA Division	1

Representatives to the TCB will be identified by their organization through a scheduled meeting of the Aggregate Quality Improvement Committee (AQIC) or other official means. Each representative will serve for a three-year term. Representatives may serve on the TCB for an unlimited number of consecutive terms.

In general, the review process will rely on written documentation of a certified aggregate technician not following practices identified in the Aggregate Technician Certification Program or intentionally misrepresenting quality of the work. The written documentation should only be provided to the TCB after the certified aggregate technician has been verbally notified that they are not following practices identified in the Aggregate Technician Certification Program or that they have intentionally misrepresented quality of the work. The TCB will review the written documentation and allow for an interview prior to making a determination on the certification status of the certified aggregate technician under review.

B. Procedure

1. Certified Aggregate Technician Not Following Practices, Procedures and Specifications

The official procedure when a certified aggregate technician is not following, or has not followed, practices identified as acceptable PennDOT practices, procedures and specifications, is as follows:

- a. A PennDOT, Consultant, Industry or other certified aggregate technician, hereafter referred to as the Observer, observes another certified aggregate technician, hereafter referred to as the technician, not following a practice or practices identified in the Aggregate Technician Certification Program. Immediately, the Observer is to verbally

notify the technician that they are not following a practice or practices identified in the Aggregate Technician Certification Program. The Observer must record the verbal notification, including the time, date, location, technician's name and company or organization, and the specific practice or practices not being followed.

- b. If a second occurrence is observed where the same technician is not following a practice or practices identified in the Aggregate Technician Certification Program, immediately, the Observer is to again verbally notify the technician that they are not following a practice or practices identified in the Aggregate Technician Certification Program. In addition, the Observer must notify the technician's supervisor, by verbal or written communication, that the technician is not following a practice or practices identified in the Aggregate Technician Certification Program and that the technician has been verbally notified for two occurrences. The Observer is to record the second occurrence and the notifications given to the technician and the technician's supervisor as detailed in VI.B.1.a.. In addition, the Observer is to record the name of the technician's supervisor, the date, and the time (if verbal notification was given) that the supervisor was contacted.
- c. If a third occurrence is observed where the same technician is not following a practice or practices identified in the Aggregate Technician Certification Program, immediately, the Observer is to again verbally notify the technician that they are not following a practice or practices identified in the Aggregate Technician Certification Program. In addition, the Observer is to officially document the entire situation. The official documentation should provide as much detail as possible, providing as a minimum, the full name and certification number of the Observer, the S.R., Section, Contract Number, Quarry Name and Location, the full name and certification number of the technician, and the full name of the technician's supervisor. The Observer is to provide copies of all previously recorded verbal or written notifications and a detailed account of the entire situation. Only one document will be accepted by the TCB per situation and, for this reason, it is important to include all pertinent information in this documentation. Pending action by the TCB, the technician will be temporarily suspended.
- d. Upon the third occurrence of the same technician not following a practice or practices identified in the Aggregate Technician Certification Program, the technician will be removed from the project or plant, may be restricted in the work they can do, or may be temporarily suspended until the situation is reviewed by the TCB. If temporarily suspended, the technician must immediately forfeit their valid wallet-sized certification card to the DME/DMM or appropriate Department personnel. The DME/DMM or appropriate Department personnel will hold the confiscated wallet-sized certification card. The temporary suspension will restrict the technician from doing any technician work, including materials testing or materials certification, on Department construction or maintenance projects or any projects using liquid fuels tax monies.
- e. The Observer is to provide one photocopy of the documentation to the technician and retain one photocopy in their project or plant office files. The Observer is to submit the original copy of the documentation to the Chairperson of the Technician Certification Board at the following address:

Chairperson, Aggregate Technician Certification Board
PA Department of Transportation
Innovation and Support Services Division
81 Lab Lane
Harrisburg, PA 17110

Submit documentation within 14 calendar days of the date of the third occurrence. Documentation not received by the Innovation and Support Services Division within 21 calendar days of the third occurrence will be void.

- f. The technician will be afforded the opportunity to submit a written appeal to the Chairperson of the TCB at the address indicated in VI.B.1.e. and, the opportunity to appear before the TCB. The technician is to provide one photocopy of the appeal to the Observer and to retain one photocopy for their project files. Only one written appeal will be accepted by the TCB per situation and, for this reason, it is important to include all pertinent information in the written appeal. Submit written appeals to the Chairperson of the TCB within 35 calendar days of the documented third occurrence. Appeals received more than 40 calendar days after the third occurrence will be void.
- g. The documentation and written appeal (if provided) will be logged by the Innovation and Support Services Division and then forwarded to the chairperson of the TCB for action.
- h. The chairperson of the TCB will review the documentation and the appeal (if provided) with the other members of the TCB. The TCB will provide a written response to the Innovation and Support Services Division, Laboratory Testing Section within 21 calendar days from the date the documentation was sent to the TCB. The written response will provide the action that is to be taken concerning the situation. The written response of the TCB will be final and will be logged and filed by the Innovation and Support Services Division, Laboratory Testing Section. Possible actions of the TCB will include but are not limited to: TCB written warning; TCB written reprimand; TCB certification suspension (1, 2, or 3 months); TCB rescindment of certification. TCB suspension or rescindment of certification will require the technician to forfeit their wallet-sized certification card to the TCB.
- i. The Innovation and Support Services Division, Laboratory Testing Section will immediately forward the TCB's written response concerning certification status to the technician.

2. Certified Aggregate Technician Involved in Deceptive, Questionable or Unethical Activities.

- a. A PennDOT, Consultant, Industry or other certified aggregate technician, hereafter referred to as the Observer, observes or becomes aware of an action of another certified aggregate technician, hereafter referred to as the technician, which may be an attempt to mislead or deceive others about the quality of the materials, about materials testing, or about test results or, an action which may be questionable or unethical. Immediately, the Observer is to report the incident to the appropriate DME/DMM, or other appropriate Department personnel. Together the Observer and the DME/DMM, or other appropriate Department

personnel, are to immediately contact any member of the TCB. Initial contacts and information concerning these actions will be kept strictly confidential.

- b. The DME/DMM, or other appropriate Department personnel, will coordinate with the TCB to institute an investigation of the action. The investigation will determine whether or not the deceptive, questionable, or unethical action was willful. The investigation will be documented to support the final determination.
- c. With support from the TCB member initially contacted, and before the investigation is completed, the technician and the technician's supervisor or employer will be verbally notified immediately by the DME/DMM, or other appropriate Department personnel, that the technician will be restricted in the work they can do and will be temporarily suspended, until the investigation is completed and reviewed by the TCB. If temporarily suspended, the technician must immediately forfeit their valid wallet-sized certification card to the DME/DMM or appropriate Department personnel. The DME/DMM, or appropriate Department personnel, will hold the confiscated wallet-sized certification card pending the investigation by the TCB. Temporary suspension will restrict the technician from doing any technician work, including materials testing or materials certification, on Department construction or maintenance projects or any projects using liquid fuels tax monies.
- d. The DME/DMM, or other appropriate Department personnel, with coordination from the TCB, will complete the investigation and officially document the entire incident and subsequent investigation. The documentation should provide as much detail as possible and be similar to the documentation required in VI.B.1.c.. The DME/DMM or appropriate Department personnel will provide copies and submit the documentation as instructed in VI.B.1.e. above and within 21 calendar days of the verbal notification described in VI.B.2.c.
- e. The technician will be afforded the opportunity to submit a written appeal and request an interview with the TCB. Provide copies and submit written appeals as instructed in VI.B.1.f. and within 35 calendar days from the date of the verbal notification described in VI.B.2.c. Appeals received more than 40 calendar days after the verbal notification described in VI.B.2.c. will be void.
- f. The documentation and appeal (if provided) will be considered by the TCB as described in VI.B.1.g. to VI.B.1.i.

VII. AGGREGATE TECHNICIAN CODE OF ETHICS

The Technician Certification Board (TCB) has found that the following rules are necessary to establish and maintain the high standard of integrity and dignity in the aggregate technician profession and are necessary in the public interest to protect the public against unprofessional conduct on the part of the aggregate technician. Certified Aggregate Technicians are put on notice that an ethical violation by themselves or by an individual rendering or offering to render aggregate technician services under their supervision, as provided by this Publication, may result in disciplinary procedures against them in accordance with Section VI.B.2.

- A. Principle 1. Beneficence/Autonomy.** A certified aggregate technician will demonstrate a concern for the welfare and dignity of the recipients of the services, including Department personnel.

1. A certified aggregate technician will provide services without discriminating on the basis of race, creed, national origin, sex, age, handicap, disease, social status, financial status, or religious affiliation.
2. A certified aggregate technician will act for his/her client or employer in professional matters as a faithful agent or trustee, and will not accept a direct fee for services rendered as a certified aggregate technician from other than the technician's employer.
3. A certified aggregate technician will not attempt to injure falsely or maliciously, directly or indirectly, the professional reputation, prospects, or business of anyone.
4. A certified aggregate technician will not attempt to supplant another aggregate technician after definite steps have been taken toward his/her employment.
5. A certified aggregate technician will not compete with another aggregate technician for employment by the use of unethical practices.
6. A certified aggregate technician will not review the work of another aggregate technician for the same client, except with the knowledge of such aggregate technician, or unless the connection of such aggregate technician with the work has terminated.
7. A certified aggregate technician will not attempt to obtain or render technical services or assistance without fair and just compensation commensurate with the services rendered: Provided, however, the donation of such services to a civic, charitable, religious, or eleemosynary organization will not be deemed a violation.
8. A certified aggregate technician will not advertise in self-praising language, or in any other manner, derogatory to the dignity of the profession.

B. Principle 2. Competence. A certified aggregate technician will maintain high standards of professional competence.

1. A certified aggregate technician will not attempt to practice in work in which the aggregate technician is not proficient or practice in work outside the standards of the profession.
2. A certified aggregate technician will consult with other service providers when additional knowledge and expertise is required.
3. A certified aggregate technician will accurately record and report information related to aggregate technician services provided to the Department.
4. A certified aggregate technician will require those whom the technician supervises in the provision of aggregate technician services to adhere to this Code of Ethics.

C. Principle 3. Public Information. A certified aggregate technician will provide accurate information about aggregate technician services.

1. A certified aggregate technician will accurately represent their competence and training.

2. A certified aggregate technician will not use or participate in the use of a form of communication that contains a false, misleading, or deceptive statement or claim.
3. A certified aggregate technician will not use or permit the use of their signature on work over which the technician was not in responsible charge.

D. Principle 4. Professional Relationships. A certified aggregate technician will function with discretion and integrity in relations with colleagues and other professionals.

1. A certified aggregate technician will report illegal, incompetent or unethical practice by colleagues or other professionals to the appropriate authority.
2. A certified aggregate technician who employs or supervises colleagues will provide appropriate supervision as necessary to provide aggregate technician services in conformance with this Code of Ethics.

Aggregate Technician -Certification/Re-Certification Test

PASS / FAIL

NAME _____ DATE _____

NECEPT # _____ COMPANY _____

Technician must be able to perform the following:

- | | | |
|--|----------------------------|----------------------------|
| 1. Sample aggregates in accordance with AASHTO T-2. | Y <input type="checkbox"/> | N <input type="checkbox"/> |
| 2. Reduce sample of aggregate to testing size in accordance with AASHTO T-248. | Y <input type="checkbox"/> | N <input type="checkbox"/> |
| 3. Sieve analysis of aggregate in accordance with PTM No. 616. | Y <input type="checkbox"/> | N <input type="checkbox"/> |
| 4. Amount of material finer than No. 200 sieve in aggregate in accordance with PTM 100. | Y <input type="checkbox"/> | N <input type="checkbox"/> |
| 5. Determining the percentage of crushed fragments in gravel in accordance with ASTM D-5821. | Y <input type="checkbox"/> | N <input type="checkbox"/> |
| 6. Unit weight of aggregate in accordance with AASHTO T-19. | Y <input type="checkbox"/> | N <input type="checkbox"/> |
| 7. Total moisture in anti-skid material in accordance with PTM No. 513. | Y <input type="checkbox"/> | N <input type="checkbox"/> |
| 8. Knowledge of Plant Book Documentation. | Y <input type="checkbox"/> | N <input type="checkbox"/> |
| 9. Completion of CS-4171 Certification. | Y <input type="checkbox"/> | N <input type="checkbox"/> |
| 10. Plot test results on straight lines and establish action points. | Y <input type="checkbox"/> | N <input type="checkbox"/> |
| 11. Documentation of failures and action required according to their Quality Control Plan. | Y <input type="checkbox"/> | N <input type="checkbox"/> |
| 12. Knowledge of truck loading and weighing procedures. | Y <input type="checkbox"/> | N <input type="checkbox"/> |
| 13. Calibrate Equipment | Y <input type="checkbox"/> | N <input type="checkbox"/> |
| 14. Thin & Elongated particles in accordance with ASTM D 4791 | Y <input type="checkbox"/> | N <input type="checkbox"/> |

REMARKS _____

Witnessed By _____ Date _____
Signature

DME / DMM _____ Date _____
Signature

Introduction to Aggregate Rocks and Minerals

II. Introduction to Aggregates

A. Video:

“Aggregate Production and Stockpiling” by the Virginia Department of Highways. This is a general video, the information of which applies to Pennsylvania; 24 minutes.

B. General Statement:

The starting point for aggregate materials is what is mined in the quarry or pit. It is normally not the responsibility of the aggregate technician to control or direct the extraction of the materials. That responsibility is most often held by the quarry foreman and/or superintendent. Before mining is executed, the person(s) in charge of the extraction should have a practical understanding of the deposit characteristics, which is its geology. Very few aggregate deposits will be completely uniform in all directions. As variations occur, the aggregate quality may change, sometimes by a lot and sometimes hardly at all.

It is the responsibility of the aggregate technician to advise his supervisor if distinct changes in the aggregate characteristics, good or bad, are noticed. The aggregate technician can be the early warning system for subtle changes in geology that affects its quality.

It should not be the aggregate technician’s job to supervise geologic investigations concerning the deposit characteristics that result in judgments about future reserves. The practice of geology requires a trained geologist who has a specialized education. In the Commonwealth of Pennsylvania, the practice of geology is a regulated profession just like the practice of engineering. If aggregate technicians are asked to perform work which is outside the limits of their education or training, they should resist; otherwise they may find themselves blamed for circumstances that go wrong.

It will be useful the aggregate technician to have a brief understanding of basic geology as it may affect aggregate materials. This information s not given as a basis for practicing geology, but rather to acquaint the technician with the general range of geologic settings that may influence an aggregate deposit’s quality.

C. Introduction of Aggregate Rock and Minerals:

1. Minerals:

Publication 408, Section 703, specifically mentions the deleterious minerals: chert, gypsum, iron sulfide (pyrite), amorphous silica (i.e. chert), and hydrated iron oxide (limonite). The common minerals quartz, feldspar, and calcite will also be shown.

2. Rocks:

Rocks are generally defined as material composed of one or more minerals in varying amounts that have a similar origin.

3. Geologic origin:

- Igneous: diabase (trap rock), granite

These are rocks that have formed from molten material, magma or lava.

- Sedimentary: conglomerate, sandstone, siltstone, shale, limestone, dolomite

These are rocks that have been weathered from older rocks into fragments, transported by water and deposited in a quiet basin.

- Metamorphic: quartzite, slate, argillite, schist, serpentine, gneiss

These are older rocks that have been altered by heat and pressure changing the orientation and chemistry of the older rocks.

4. **Aggregate Sources for Pennsylvania:**

Sources of aggregate in Pennsylvania are from four distinct types of rock deposits, each of which has specific characteristics that determine the type of aggregate being mined.

Following are examples of aggregate deposits from each rock type and their typical characteristics.

a. **Sedimentary Rock Deposits:**

Sixty percent of the aggregates in Pennsylvania are derived from sedimentary rocks. Sediments are derived from chemical reactions in water, or from the weathering and erosion of preexisting rocks or soil, and the subsequent transportation, erosion, and deposition of the sediments, which are the consolidated, or lithified, to form sedimentary rocks. Limestone, dolomite, sandstone, and siltstone are the most commonly mined sedimentary rocks in Pennsylvania. Limestones and dolomites are typically found in the valleys of Pennsylvania whereas the sandstones and siltstones are usually found underlying ridges. Sedimentary rocks can grade into, or be interbedded, with each other.

Limestone and dolomite are referred to as “carbonate” rocks because they share the fundamental anionic structure of CO_3^{2-} . Carbonates make up a third of the aggregate used in Pennsylvania. Limestones are mainly composed of the mineral calcite (CaCO_3), and dolomite of the mineral dolomite ($\text{CaMg}(\text{CO}_3)_2$). There can be gradations between the two carbonate rocks, ranging from pure limestone (100% CaCO_3) to pure dolomite (45.7% MgCO_3). Generally, if the rock contains more than 25% MgCO_3 it is referred to as a dolomite. The difference between the two types is illustrated by their reaction to dilute hydrochloric acid (HCl): limestone reacts vigorously and dolomite much less so.

Limestone and dolomite can occur as distinct units or can be interbedded, or mixed, with each other. In carbonate rocks, a change in bedding may reflect a change in the rock chemistry. Limestones and dolomites will often contain non-carbonate sediments, which are referred to as acid-insoluble residue, because they do not dissolve in concentrated HCl. Acid-insoluble residue commonly consists of quartz and clay minerals. Because of the soft nature of limestone, skid resistance levels are generally low. However, increasing amounts of sand-sized acid-insoluble residue consisting of quartz and other hard minerals will improve skid resistance, thereby allowing safe use of carbonate aggregates in roads with higher amounts of traffic. Dolomites, which are harder than limestones, frequently have slightly higher skid resistance levels.

Limestones and dolomites usually have low sodium sulfate soundness and moderate Los Angeles abrasion losses. However, both may also have shaly partings and/or layers that can result in high sodium sulfate soundness losses.

Sandstone and siltstone are clastic sedimentary rocks composed of sand- to silt- sized grains set in a matrix of silt or clay and more or less firmly cemented by silica, iron oxide, calcium carbonate. Sandstones and siltstones make up a quarter of the aggregates used in Pennsylvania. They are primarily composed of quartz (SiO_2) with varying amounts of feldspar and clay minerals and are layered and can be interbedded with each other.

Sandstone composition ranges from quartzose sandstone (having trace to no matrix) to greywacke sandstone (having more than 15% matrix and consisting of poorly sorted fragments of quartz, feldspar, and other rock fragments). Generally, sandstones and siltstones have the highest skid resistance levels. Quartzose sandstones tend to be brittle and are subject to high Los Angeles abrasion and sodium sulfate soundness losses. Sandstones and siltstones may have shaly partings and/or layers, which can result in high sodium sulfate soundness losses. Weathering will also cause sandstones and siltstones to have high Los Angeles abrasion and sodium sulfate soundness losses. Further, absorption can become a problem with weathered sandstones and siltstones.

Clastic rocks with pebble-sized grains are called conglomerates. As with sandstones and siltstones, weathering or shale partings in conglomerates also reduce quality. Argillites are sedimentary rocks (mudstones) that have undergone mineral reactions due to an increase in heat and pressure. Argillites tend to have lower Los Angeles abrasion and sodium sulfate soundness losses than shale or most sandstones. Shale is a clastic sedimentary rock formed by the compaction of silt, clay, or mud. Shales are characterized by fine laminae that impact fissility subparallel to bedding and cause the rock to split apart. Shale that easily splits apart and is soft is not considered an acceptable aggregate.

b. Igneous Rock Deposits:

Igneous rocks make up one percent of the aggregates used in Pennsylvania. Igneous rocks form by the crystallization of molten rock (magma or lava) as it cools. Rocks that form from magma are intrusive, and rocks that form from lava (magma extruded at the earth's surface) are extrusive. Magma, or molten rock, can intrude into preexisting country rock (surrounding rock) and crystallize, forming dikes (cross-cutting bedding) and sills (parallel to bedding). Uplift and weathering cause these ancient magma chambers to become exposed at

the earth's surface. The two most common types of igneous rocks in Pennsylvania are diabase (traprock) and granite.

Diabase is an intrusive rock composed mainly of plagioclase feldspar and pyroxene. It is a very tough and durable aggregate material which has low Los Angeles abrasion and sodium sulfate soundness losses. It is used widely for railroad ballast.

Granite is an intrusive rock composed mainly of quartz, potassium feldspar, and plagioclase feldspar. Granite is a tough and durable aggregate. It usually has moderate Los Angeles abrasion and sodium sulfate losses, although weathered granite will have high losses in both tests.

c. Metamorphic Rock Deposits:

Metamorphic rocks make up two percent of the aggregates used in Pennsylvania. Metamorphic rocks form from any preexisting rock that has changed mineralogically, chemically, and/or structurally because of heat and/or pressure. Common metamorphic rocks in Pennsylvania include gneiss, serpentine, schist, amphibolite, greenstone, slate, quartzite, and marble. Some metamorphic rocks are foliated (contain layers resulting from directed stress) and have the appearance of bedding. In some instances, rocks are metamorphosed by magma that intruded into the country rock as dikes or sills. This is referred to as contact metamorphism and the rock that is formed is called a hornfels. Hornfels is typically a good construction aggregate with low Los Angeles abrasion and sodium sulfate soundness losses. Shale is metamorphosed into phyllite and slate, which have limited applications as construction aggregate because they split easily into thin layers, which do not compact well or meet shapes requirements.

The hard and crystalline nature of most metamorphic rocks usually results in good quality aggregates with low sodium sulfate soundness and moderate Los Angeles abrasion losses. Exceptions include some marbles (metamorphosed limestones or dolomites) which have high Los Angeles abrasion losses and schist, amphibolite, and greenstone, which are rarely used as aggregate because of poor performance in durability tests.

d. Sand and Gravel Deposits:

Gravel deposits in Pennsylvania are mined from glacial and alluvial deposits. They make up over a third of the aggregates used in Pennsylvania.

1). Glacial deposits range in age from 1.5 million to 20,000 years and were deposited under, next to, and in front of the glaciers that covered the northwest and northeast corners of Pennsylvania. The glaciers ground up and milled the underlying bedrock, and pushed the resulting sediment to their margins. Meltwater streams carried sediment long distances from

the glacier, resulting in extensive outwash deposits. The quality and gradation of the sand and gravel deposits improved with increased meltwater transport. Fine sediment, such as silt and clay, was deposited in lakes next to and in front of the glacial margin.

Glacial deposits are complex, poorly sorted, with rapid vertical and horizontal changes in grain size, gradation, and mineral composition. The quality of the material can change significantly as a deposit is mined. Gravelly outwash deposits frequently overlie older, more weathered outwash or fine-grained lake of deposits.

Controlling quality properties, such as fines or weathering, can be a challenge in glacial deposits. Areas of coarser-grained material must be utilized to meet the coarse aggregate crush count specifications. Sand production relies on the natural sand content of the glacial deposit, or can be facilitated by crushing boulders (manufactured sand). Mixtures of natural and manufactured sand can be used as well. Glacial deposits contain rock fragments from the landscape that the glaciers flowed across. Many of these rock fragments are not durable and can lower the overall quality of the aggregate.

2). Alluvial deposits are sand and gravel deposits mined from river and stream channels and the adjacent floodplains. In some places, ancient river terraces are mined for their sand and gravel deposits. These sediments are young, although the river terraces next to the stream can be quite a bit older. The older terrace deposits tend to be more weathered. Weathering usually diminishes the quality of the deposit. Many of the same variable characteristics of gradation content that affect glacial deposits are often true of alluvial deposits.

Form 408
Section 703 Aggregate

III. Publication 408, Section 703

PennDOT publication 408 defines the terms and specification for fine and coarse aggregate approval in “Section 703: Aggregates” for use in PennDOT projects. The following pages are copied from Publication 408: Section 703. It is important to always refer to the most recent edition of this publication which can be found at www.penndot.gov; enter Publication 408 in the search box.

SECTION 703—AGGREGATE

703.1 FINE AGGREGATE—

(a) General. Fine aggregate is natural or manufactured sand consisting of hard, durable, and uncoated inert particles reasonably free from clay, silt, vegetation, and other deleterious substances such as reactive chert, gypsum, iron sulfide, amorphous silica, and hydrated iron oxide. Substances that are present in amounts large enough to cause inconsistent performance in the properties of bituminous concrete or plastic or hardened Portland cement concrete are considered deleterious. Spent foundry sand may be used as fine aggregate in asphalt concrete and flowable fill.

Obtain fine aggregate with physical properties conforming to Table A from a source listed in Bulletin 14 or approved by the LTS before use.

1. Natural Sand. Natural sand is fine aggregate resulting from glacial or water action. Fine aggregate produced simultaneously with gravel coarse aggregate may contain crushed particles.

2. Manufactured Sand. Manufactured sand is fine aggregate from the controlled mechanical breakdown of rock, air-cooled blast furnace slag, or air-cooled steel slag into sound, approximately cubical particles. The Department will accept manufactured sand only if it is the primary product of the crushing operation and sized by a sand classifier. However, for fine aggregate used in bituminous concrete mixtures, a sand classifier is not required.

Fine aggregate manufactured from limestone may not be used in concrete wearing surfaces.

Fine aggregate manufactured from steel slag may not be used in cement concrete or mortar mixtures. Steel slag fine aggregate may only be used in bituminous wearing courses with the approval of the LTS; however, do not use steel slag fine aggregate in conjunction with steel slag coarse aggregate. Provide steel slag fine aggregate that is uniform in density and quality. Cure steel slag fine aggregate according to the following procedure:

- After gradation preparation, place steel slag fine aggregate, whether reclaimed from an old stockpile or processed directly from the steel-making process, in a controlled stockpile. Limit the stockpile size to a maximum of 30,000 tons. Completely soak the steel slag fine aggregate with water before or during stockpiling. Submit the method of constructing and controlling the stockpile to the Representative for review.
- Maintain the stockpile in a uniform moist condition for a period of not less than 6 months. After the minimum cure period, the Representative will sample and test the stockpile for expansive characteristics according to PTM No. 130. The Representative will approve the stockpile for use if the average total volumetric expansion according to PTM No. 130 is less than 0.50%.
- If the stockpile fails expansion criterion, continue curing the stockpile for a minimum of two additional months. The Representative will resample and retest the stockpile after the required additional cure period.

The LTS will evaluate the quality of fine aggregates by conducting petrographic analysis according to PTM No. 518 and other tests necessary to demonstrate that required construction of acceptable durability can be achieved.

(b) Production Testing.

1. Personnel and Equipment. Provide and assign to the work a PennDOT Certified Aggregate Technician who will test fine aggregate at the source according to the requirements listed in Bulletin 14.

Provide equipment for acceptance testing and for developing and maintaining a QC program to ensure compliance with specification requirements during production as required in Bulletin 14.

2. Testing and Documentation. Perform tests as required by Bulletin 14. Evaluate the test results to ensure the quality requirements are met.

Document the results of tests made during production and make them available to the Department upon request.

(c) Grading and Quality Requirements.

1. Gradation. Table A lists the extreme limits for determining the suitability of supply sources.

Control the grading of Type A Fine Aggregate so that the fineness modulus of at least nine out of ten consecutive test samples from a single source delivered to a project or plant varies less than ± 0.20 from the average fineness modulus of the consecutive test samples. Determine the fineness modulus according to PTM No. 501.

For bituminous mixtures:

- If directed, vary the gradations within the limits listed in Table A.
- A blend of fine aggregates may be used if the proposed gradation limits for blending are approved by the District Executive in writing.
- If filler is required, provide fine aggregate conforming to the gradation of Table A and use cement, cement dust, fly ash, or fines from the crushing of stone, gravel, or slag that are reasonably free of clay.

2. Material Finer than the 75 μm (No. 200) Sieve. Determine the loss by washing according to PTM No.100.

3. Minimum Strength Ratio. Determine the organic impurities in fine aggregate (Type A and Type C only) according to AASHTO T 21. If the color value result is greater than Organic Plate No. 3, determine the minimum strength ratio according to AASHTO T 71 and use fine aggregate meeting the strength ratio requirements of Table A.

4. Soundness Test. Determine the percentage loss after five cycles of immersion and drying using a sodium sulfate solution according to PTM No. 510.

5. Specific Gravity and Absorption. AASHTO T 84.

TABLE A
Fine Aggregate
Grading and Quality Requirements

Sieve Size	Cement Concrete Sand	Bituminous Concrete Sand Type B			Mortar Sand
	Type A	#1	#3	Filler	Type C
9.5 mm (3/8-inch)	100	100	100	—	—
4.75 mm (No. 4)	95-100	95-100	80-100	—	100
2.36 mm (No. 8)	70-100	70-100	65-100	—	95-100
1.18 mm (No. 16)	45-85	40-80	40-80	—	—
600 μm (No. 30)	25-65	20-65	20-65	100	—
300 μm (No. 50)	10-30	7-40	7-40	95-100	—
150 μm (No. 100)	0-10	2-20	2-20	90-100	0-25
75 μm (No. 200)	—	0-10	0-10	70-100	0-10
Material Finer Than 75 μm (No. 200) Sieve Max. Percent Passing	3	—	—	—	—
Strength Ratio Min. Percent	95	—	—	—	95
Soundness Test Max. Loss Percent	10	15	15	—	10
Fineness Modulus	2.30-3.15	—	—	—	1.6-2.5

703.2 COARSE AGGREGATE—

(a) **General.** Coarse aggregate consists of hard, tough, durable, and uncoated inert particles reasonably free from

clay, silt, vegetation, and other deleterious substances such as reactive chert, gypsum, iron sulfide, amorphous silica, and hydrated iron oxide. Substances that are present in amounts large enough to cause inconsistent performance in the properties of bituminous concrete or plastic or hardened Portland cement concrete are considered deleterious.

The LTS will evaluate the quality of coarse aggregates by conducting petrographic analysis according to PTM No. 518 and other tests necessary to demonstrate that required construction of acceptable durability can be achieved.

Furnish coarse aggregate crushed and prepared from one of the materials described below with physical properties conforming to Tables B, C, and D. Obtain coarse aggregate from a source listed in Bulletin 14 or approved by the LTS before use.

1. Stone. Durable stone free from slate texture or cleavage planes.

2. Gravel. Durable gravel particles. For use in cement concrete, wash thoroughly during production. For use in all bituminous wearing courses, unless otherwise specified, a minimum of 85% crushed particles with at least two faces resulting from fracture is required. For use as No. OGS, a minimum of 75% crushed particles with at least three faces resulting from fracture is required. For all Type A use, the maximum allowable absorption determined according to AASHTO T 85 is 3.0%; however, this restriction does not apply to dredged river gravel used in Portland cement concrete. For all Type B use, the maximum allowable absorption determined according to AASHTO T 85 is 3.5%.

3. Blast Furnace Slag. By-product of a pig-iron making process. Tough, hard, and durable pieces of air-cooled blast furnace slag. Blast furnace slag is excluded from the abrasion requirements. The density (unit weight) of blast furnace slag cannot be less than 70 pounds per cubic foot.

4. Steel Slag. By-product of a steel making process. Tough, hard, and durable pieces of steel slag reasonably uniform in density and quality. After crushing, grading, and forming a stockpile, take a sample from the stockpile and submit it to the LTS for testing of expansive characteristics. The LTS will accept the stockpile for use if the total expansion determined according to PTM No. 130 is less than 0.50%. Once a stockpile is accepted, do not add to it if it is for Department use. Limit the stockpile size to a maximum of 30,000 tons. If the stockpile fails expansion requirements, cure the aggregate stockpile as follows:

- Rework the stockpile and soak the aggregate completely with water.
- Submit the proposed method of constructing and controlling the stockpile during the cure period for review and acceptance.
- Maintain the aggregate in a uniformly moist condition in the stockpile for a period of at least 6 months. Take a sample after this curing period and submit it to the LTS for testing according to PTM No. 130.
- The Representative will accept the stockpile for use if the total expansion is less than 0.50%. If the stockpile still fails the expansion requirement, continue curing for at least two additional months before resampling and retesting.

Aggregate manufactured from steel slag is not acceptable for pipe or structure backfill or in cement concrete. Steel slag may be used for subbase, selected granular material, shoulders, selected material surfacing, and in bituminous surface courses.

5. Granulated Slag. By-product of an iron-making process. Granulated blast furnace slag is the granular glassy material formed when molten slag from iron-making is rapidly quenched by immersion in water and contains not more than 3% total iron reported as Fe_2O_3 . Provide material containing not more than 20% by mass (weight) of substances that are not granulated slag. Use material with a dry rodded density (unit weight) determined according to AASHTO T 19 of not more than 80 pounds per cubic foot. Provide uniform material having a maximum size of 50 mm (2 inches) and not more than 20% passing the 150 μ m (No. 100) sieve. Granulated slag may only be used for subbase material as specified in Section 350.

6. Lightweight Aggregate. Acceptable types of lightweight aggregate are as follows:

- Aggregate prepared by expanding, pelletizing, or sintering products such as blast-furnace slag,

diatomite, fly ash, clay, shale, or slate.

- Aggregate prepared by processing natural materials such as pumice, scoria, or tuff.

Furnish lightweight aggregate conforming to AASHTO M 195, the soundness and abrasion limits for Type A aggregate as specified in Table B, and the following durability requirements.

- Aggregate Absorption Factor (PTM No. 526) Max. % 2.5
- Freeze-Thaw Resistance of Concrete, Decrease of Dynamic Modulus at 300 Cycles (AASHTO T 161, Procedure B, except that after 14 days of moist cure, dry the beams 3 inches by 4 inches by 16 inches at $72F \pm 3F$ and approximately 50% relative humidity for 14 days. Then soak the beams in water for 3 days before starting the freezing and thawing test.) Max. % 60
- Freeze-Thaw Resistance of Aggregate (PTM No. 525) Max. % 25

TABLE B
Coarse Aggregate
Quality Requirements⁽⁸⁾

	Type A	Type B	Type C	Type S
Soundness, Max. %	10	12	20	16
Abrasion, Max. %	45 ⁽⁶⁾	45 ⁽⁶⁾	55 ⁽⁶⁾	55 ⁽⁶⁾
Freeze-Thaw Loss, Max %	—	—	—	7.0 ⁽⁷⁾
Thin and Elongated Pieces, Max. %	15	20	—	—
Material Finer Than 75 μm (No. 200) Sieve, Max. %	— ⁽¹⁾	— ⁽¹⁾	10	10
Crushed Fragments, Min. %	55 ⁽²⁾	55 ⁽²⁾	50	50
Compact Bulk Density (Unit Weight), lbs./cu. ft.	70	70	70	70
Deleterious Shale, Max. %	2	2	10	10
Clay Lumps, Max. %	0.25	0.25	3	3
Friable Particles, Max. % (excluding shale)	1.0	1.0	—	—
Coal or Coke, Max. %	1	1	5	5
Glassy Particles, Max. %	4 or 10 ⁽³⁾	4 or 10 ⁽³⁾	—	—
Iron, Max. %	3 ⁽⁵⁾	3 ⁽⁵⁾	3 ⁽⁵⁾	3 ⁽⁵⁾
Absorption, Max. %	3.0 ⁽⁴⁾	3.5 ⁽⁴⁾	—	2 ⁽⁴⁾
Total of Deleterious Shale, Clay Lumps, Friable Particles, Coal, or Coke Allowed, Max. %	2	2	15	15
Notes:				
(1) See Section 703.2(c)4.				
(2) See Section 703.2(c)5.				
(3) See Section 703.2(c)9.				
(4) Gravel only for Types A and B. See Section 703.2(c)2. All natural aggregates for Type S.				
(5) See Section 703.2(c)10.				
(6) Blast Furnace Slag excluded. See Section 703.2(a)3.				
(7) Natural coarse aggregates with an absorption less than 2% are considered freeze thaw resistant and not subject to testing according to AASHTO T 103, Procedure A.				

Natural aggregates with an absorption exceeding 2% shall be considered freeze thaw resistant if either their sodium sulfate soundness level is less than 16% or their AASHTO T 103 freeze thaw loss after 25 cycles (coarse fraction) does not exceed 7.0%. Type S 2A aggregate may be supplied where Type 2A aggregate for purposes other than subbase is specified at no additional cost to the Department.

- (8) Test methods to determine the quality requirements of Table B are indicated in Section 703.2 (c).

7. Recycled Concrete. Salvaged and crushed concrete pavements and concrete highway structures from Department, county, or municipal projects for use as aggregate in subbase only. Other recycled concrete may be used in subbase if the concrete was made using materials approved by the Department. Provide recycled concrete conforming to Table B and Table C, except soundness testing is not required.

(b) Production Testing.

1. Personnel and Equipment. Provide and assign to the work a PennDOT Certified Aggregate Technician who will test coarse aggregate at the source according to the requirements listed in Bulletin 14.

Provide equipment for acceptance testing and for developing and maintaining a QC program to ensure compliance with specification requirements during production as required in Bulletin 14.

2. Testing and Documentation. Perform tests as required by Bulletin 14. Evaluate the test results to ensure the quality requirements are met.

Document the results of tests made during production and make them available to the Department upon request.

(c) Quality Requirements. The following notes are applicable to Table B.

1. Soundness. Determine the percentage loss after five cycles of immersion and drying using a sodium sulfate solution according to PTM No. 510. The LTS may accept aggregate failing the test if it can be demonstrated in writing that the aggregate has a satisfactory service record in both pavements and structures. Acceptable aggregate produced from recycled concrete need not conform to soundness requirements since cementitious material cannot be evaluated with this test.

2. Abrasion. Determine the percentage of loss according to AASHTO T 96.

3. Thin and Elongated Particles. ASTM D4791, Method B, using the material retained on the 4.75 mm (No. 4) sieve. Measuring the ratio of 5:1, comparing the length to the thickness of the aggregate particles. Calculate the percentage of flat and elongate particles by mass.

TABLE C
Size and Grading Requirements for Coarse Aggregates
(Based on Laboratory Sieve Tests, Square Openings)

AASHTO Number	Total Percent Passing															
	100 mm (4")	90 mm (3 1/2")	63 mm (2 1/2")	50 mm (2")	37.5 mm (1 1/2")	25.0 mm (1")	19.0 mm (3/4")	12.5 mm (1/2")	9.5 mm (3/8")	4.75 mm (No. 4)	2.36 mm (No. 8)	1.18 mm (No. 16)	300 μm (No. 50)	150 μm (No. 100)	75 μm (No. 200) ***	
1	100	90-100	25-60		0-15		0-5									
3			100	90-100	35-70	0-15		0-5								
467				100	95-100		35-70		10-30	0-5						
5					100	90-100	20-55	0-10	0-5							
57					100	95-100		25-60		0-10	0-5					
67						100	90-100		20-55	0-10	0-5					
7							100	90-100	40-70	0-15	0-5					
8								100	85-100	10-30	0-10	0-5				
89								100	90-100	20-55	5-30	0-10	0-5			
9									100	85-100	10-40	0-10	0-5			
10									100	85-100				10-30		
2A**				100			52-100		36-70	24-50	16-38*	10-30				
OGS**				100			52-100		36-65	8-40		0-12				

* Applies only for bituminous mixtures.

** PennDOT Number – Only Type C will be listed in Bulletin 14.

*** For 75 μm (No. 200), see Table D.

Note A: A combination of No. 7 and No. 5 may be substituted for No. 57, provided that not more than 50% or less than 30% of the combination is No. 7 size.

Note B: Provide No. OGS material that has a minimum average coefficient of uniformity of 4.0. The average coefficient of uniformity is defined as the average of the sublots within each lot. Determine the coefficient of uniformity according to PTM No. 149 each time the gradation is determined. The required minimum coefficient of uniformity for individual samples is 3.5. If the coefficient of uniformity of any sample falls below 3.5, reject the lot. Do not use the coefficient of uniformity in the multiple deficiency formula.

4. Material Finer than the 75 µm (No. 200) Sieve. Determine the loss by washing according to PTM No. 100 and Table D.

This test is not required for aggregate processed through a mechanical dryer for use in bituminous concrete; however, the aggregate is required to be clean and free of fines that would adversely affect the coating of the aggregate with bituminous material.

This test is not required for AASHTO No. 10 aggregates.

TABLE D
Material Passing the 75 µm (No. 200) Sieve —
(Based on Laboratory Sieve Tests, Square Openings)

Section	Specification	% Maximum
350	Subbase (No. 2A)	10
350	Subbase (No. OGS)	5
470	Bit. Seal Coat	1.0
471	Bit. Seal Coat w/ Precoat. Aggr.	2.0
480	Bit. Surf. Treatment	1.0
704	Cement Concrete	1
—	All other uses	2

5. Crushed Fragments. ASTM D5821

6. Deleterious Shale. Determine the percentage of deleterious shale by four cycles of wetting and drying according to PTM No. 519. The LTS will use petrographic analysis to confirm the results.

7. Friable Particles. Percent loss according to PTM No. 620.

8. Coal or Coke. Determine the percentage of mass (weight) by visual identification and hand separation. If required, the LTS will use petrographic analysis to confirm the results.

9. Glassy Particles. Determine the percentage of mass (weight) by visual identification and hand separation. Pieces of slag containing more than 50% glass are considered to be glassy particles. Waste glass is also considered to be glassy particles. For coarse aggregate used in cement concrete, the maximum percentage of glassy particles allowed is 4%. For other uses, the maximum percentage of glassy particles allowed is 10%. Coarse aggregate containing glassy particles consisting of waste glass may not be used in cement concrete or bituminous wearing courses.

10. Metallic Iron. The LTS will use petrographic analysis to determine the content of metallic iron. Pieces of slag containing metallic iron are considered to be metallic iron. This requirement is waived when aggregate with metallic iron is used in bituminous mixtures or subbase. PTM No. 518.

11. Clay Lumps. Determine the percentage of mass (weight) by visual identification and hand separation. If required, the LTS will use petrographic analysis to confirm the results.

12. Specific Gravity and Absorption. AASHTO T 85.

13. Bulk Density (Unit Weight) and Voids. AASHTO T 19.

(d) Testing and Acceptance. Section 703.5(b)

703.3 SELECT GRANULAR MATERIAL (2RC)—

(a) General. Select granular material consists of durable bank or crushed gravel, stone, or slag mixed or blended with suitable filler materials to provide a uniform mixture. Obtain select granular material from a source listed in Bulletin 14. Stockpile, sample, and test material before it is used to ensure reasonable uniformity and acceptability. Use material free from vegetable or organic matter, lumps, or an excessive quantity of clay or other objectionable or foreign substances, and not more than 10% deleterious shale by mass (weight).

(b) Gradation. Conforming to the following gradation, determined according to AASHTO T 27:

- Passing 50 mm (2-inch) sieve—100%
- Passing 4.75 mm (No. 4) sieve—15% to 60%
- Passing 150 μ m (No. 100) sieve—0% to 30%

703.4 ANTI-SKID MATERIAL—

(a) General. For use on ice or snow-covered pavement surfaces, furnish anti-skid material conforming to Table E from a producer or agent listed in Bulletin 14. Do not use material containing metal, glass, or substances that may be harmful to automotive equipment and vehicles. Use material reasonably free of deleterious substances or foreign materials including, but not limited to, dirt, shale, slate, incinerated bituminous coal mine waste, and within the maximum limits of the individual deleterious and total deleterious materials as specified in Section 703.2(a), Table B, Type C.

(b) Description.

1. Type AS1. Either natural sand, manufactured sand (except slag aggregates), or a combination of the two conforming to the following requirements:

- Bulk Density (Unit Weight). Minimum 70 pounds per cubic foot and not exceeding 110 pounds per cubic foot determined according to AASHTO T 19.
- Crushed Fragments. If natural sand is furnished, not less than 35% of the fragments retained on the 2.36 mm (No. 8) sieve are required to be crushed fragments, determined according to ASTM D5821.
- Iron. Total of individual anti-skid particles containing metallic iron may not exceed 1.0% by mass (weight) of material, determined by dividing the mass (weight) of such particles retained on the 4.75 mm (No. 4) sieve by the total dry mass (weight) of the sample.

2. Type AS2 and AS3. Crushed stone or crushed gravel conforming to the following requirements:

- Bulk Density (Unit Weight). Minimum 70 pounds per cubic foot and not exceeding 105 pounds per cubic foot determined according to AASHTO T 19.
- Los Angeles Abrasion. Abrasion loss not exceeding 55%, determined according to AASHTO T 96, Gradation D.
- Crushed Fragments. If crushed gravel is furnished, not less than 60% of the fragments retained on the 4.75 mm (No. 4) sieve are required to be crushed, one face, determined according to ASMT D 5821.
- Iron. Total of individual anti-skid particles containing metallic iron may not exceed 1.0% by weight of material, determined by dividing the mass (weight) of such particles retained on the 4.75 mm (No. 4) sieve by the total dry mass (weight) of the sample.

3. Type AS4. Crushed slag conforming to the following requirements:

- Bulk Density (Unit Weight). Minimum 70 pounds per cubic foot and not exceeding 105 pounds per cubic foot determined according to AASHTO T 19.

- Los Angeles Abrasion. Abrasion loss not exceeding 55%, determined according to AASHTO T 96, Gradation D.
- Iron. Total of individual anti-skid particles containing metallic iron may not exceed 1.0% by mass (weight) of material, determined by dividing the mass (weight) of such particles retained on the 4.75 mm (No. 4) sieve by the total dry mass (weight) of the sample.

(c) **Gradations.** Conforming to Table E.

TABLE E
Anti-Skid Gradation

Anti-Skid Type	Maximum Percent Passing Sieve								
	31.5 mm (1 1/4")	19.0 mm (3/4")	12.5 mm (1/2")	9.5 mm (3/8")	4.75 mm (No. 4)	2.36 mm (No. 8)	300 µm (No. 50)	150 µm (No. 100)	75 µm (No. 200)*
Type AS1				100	60-100	0-80		0-8	0-5
Type AS2				100	35-80	0-45		0-6	0-3**
Type AS3			100	90-100		0-30		0-8	
Type AS4				100		0-30		0-8	0-5

* Determined by PTM No. 100.

** If the total percent passing the 2.36 mm (No.8) sieve is less than 25%, then the total percent passing the 75 µm (NO. 200) sieve is allowed to be 0-5.

(d) **Testing.** If shipping, test material for moisture content according to PTM No. 513. A minimum of two tests per day is required. If conditions exist that would cause a change in moisture content, conduct additional tests. A Department representative will verify the test results.

Document tests at the end of delivery quantity at the end of the day and determine the average moisture content. The Department will adjust the delivery quantity by deducting the average moisture content from the aggregate quantity shipped. Payment is based on the calculated oven dry mass (weight).

703.5 ACCEPTANCE OF CONSTRUCTION AGGREGATES—

(a) **General.** The following describes the certification acceptance of construction aggregates. Accept AASHTO No. 1 Coarse Aggregate as specified in Section 850.2(a)1.

(b) **Testing and Acceptance.** Certify each day's shipment of aggregate as specified in Section 106.03(b)3.

1. **QC.** Section 106.03(b)2 and as follows:

- Submit for annual review a QC Plan conforming to the minimum Department requirements for aggregate suppliers.
- Establish and positively identify aggregate stockpiles that have been tested according to the approved QC Plan and conform to Department Specifications. Material may be added to or shipped from stockpiles at the producer's discretion.

2. **Source Verification Samples.** Under the direction and supervision of the Representative, obtain a verification sample (n=3) from each stockpile to be tested. Obtain the sample from the stockpile according to AASHTO T 2 or from a mini-stockpile. If the mini-stockpile method is chosen, obtain the sample according to the following procedure:

- Place approximately 10 tons of aggregate into a mini-stockpile on a suitable surface. Use a loader to strike off the top of the mini-stockpile.
- Obtain sufficient material for sampling from random locations on the mini-stockpile using a square faced shovel.

If project verification samples or lot acceptance samples in Section 703.5(b)3 result in a Percent Within Limits (PWL) < 90, the Representative will direct additional source verification sampling of the stockpile(s) from which the failing material was shipped. In such instances, do not ship any additional materials from the stockpile(s) until test results from source verification samples have $PWL \geq 90$.

Immediately deliver the source verification sample to the Representative for testing using the equipment provided as specified in Sections 703.1(b) and 703.2(b). The Representative will test all three increments for compliance with Tables A, B, C, and D, as applicable. If the test results verify that the material conforms to the specifications, use the material under certification, unless project verification samples require lot acceptance.

If the material does not conform to the specifications, the Representative will determine the PWL according to Section 106.03(a)3. If source verification results indicate a $PWL < 90$, the Representative will reject the stockpile.

If a stockpile is rejected, increase QC testing according to the reviewed QC Plan. Construct another stockpile of the aggregate to be tested consisting of 300 tons to 500 tons of material or the remainder of the quantity identified for Department projects, whichever is less. The Representative will accept the material under certification if test results verify that the material from the new stockpile conforms to the specifications, unless project verification samples require lot acceptance.

3. Project Verification Samples. Under the direction and supervision of the Inspector, obtain verification samples ($n=3$) according to Table F for aggregates used for subbase applications under the roadway and shoulders as specified in Section 350. At the preconstruction conference provide the Representative estimated aggregate quantities for subbase applications under the roadway and shoulders. Other aggregate types or applications may be sampled for project verification if the Representative determines that the material is visually suspect. Obtain samples at the point of placement (loose aggregate sample on grade before trimming and compaction) and not from project stockpiles unless directed:

TABLE F
Verification Samples

Aggregate Quantities	Number of Samples (n=3)
1,000 tons or more, but less than 2,000 tons	1
2,000 tons or more, but less than 10,000 tons	2
10,000 tons or more, up to 25,000 tons	3
Each additional increment of 25,000 tons	1

The Inspector will select sample locations according to PTM No. 1.

Under the direction and supervision of the Inspector, immediately deliver the sample(s) to the test site at either the producers' location or the project site. The Inspector will test the sample(s) using the equipment provided as specified in Sections 703.1(b) and 703.2(b). The Inspector will test all three increments for compliance with Tables C and D, plus the Crushed Fragments Test of Table B when applicable. The Inspector will provide the test results within 5 days from the date of sampling. The Department will continue to accept material under certification if test results verify that the material conforms to the specifications.

If the material does not conform to the specifications, the Inspector will determine the average PWL of the material as specified in Section 106.03(a)3. If results indicate a $PWL < 90$ for the material, the Department will discontinue certification acceptance and begin project lot acceptance of the aggregate. Discontinue all operations using that size of aggregate until the Representative determines new lot sample locations according to PTM No. 1 and authorizes operations to continue. Conduct lot acceptance testing at the point of placement according to the following procedure:

- Under the direction and supervision of the Inspector, use a PennDOT Certified Aggregate Technician to obtain an acceptance sample ($n=3$) at the point of placement (loose aggregate sample on grade before trimming and compaction) for each 7,500 tons of material placed. The lot size of 7,500 tons will be divided into three equal sublots.
 - The Inspector will select sample locations according to PTM No. 1. The Inspector will take possession of the sample and immediately transport the sample from the sampling point to the testing site. The Inspector will test all three sample increments for compliance with

Section 703.2(c), Tables C and D plus the Crushed Fragments Test of Table B. Aggregates other than gravel will use 100 as the PWL for the Crushed Fragments Test of Table B. The Inspector will provide the test results within 5 days of sampling. Failure to provide test results within the targeted timeframe will not form a basis to dismiss the test results, and the test results will govern in all cases.

- When less than 7,500 tons remain for the project, the remaining quantity will be considered a lot. Divide the remaining approximated quantity into three equal sublots so that three increments are obtained.
- If a change in aggregate sources is made before three increments are obtained for a lot, obtain additional increments from remaining materials on the project to provide one full acceptance sample (n=3) from the first source.
- The Inspector will document the placement location(s) by station of material placed to clearly delineate the location of all material within the lot.
- The Department will continue project lot acceptance testing until five consecutive lots are accepted at ≥ 90 PWL. Once five consecutive lots are accepted at ≥ 90 PWL, acceptance may again be by producer certification and verification testing will begin again at the frequency in Table F for the remaining project quantity. The Contractor will be charged \$600 for each lot of material placed, for the project lot acceptance testing performed by the Inspector.
- For all test values, the Department will determine the lot PWL according to Section 106.03(a)3. If results indicate a $PWL \geq 90$, the lot is accepted at full payment. If results indicate a $PWL < 90$ for the material, the Department will determine the Degree of Non-Conformance (DNC) for the lot according to the following:
 - Lot average values for any sieve size which do not conform to the specified limits will be used to calculate the DNC. For each sieve where the average does not conform to specifications, the difference between the average test value and the closest specified limit will be computed (upper limit for average values where the upper limit has been exceeded or lower limit for average values where the lower limit was not reached). Each difference will be multiplied by the factor shown in Table G.
 - Crushed fragment average test results which do not conform to the specified limits will also be included in the DNC. The DNC will include the difference between the lower specified limit and the lot average crushed fragment test results.
 - The Department will determine the total DNC for the lot by summing of all the non-conformances for each sieve size and crushed fragments after each has been multiplied by applicable factors in Table G and Table H. The total DNC will be used to adjust the payment represented by the non-conforming lot as shown in Table I.

TABLE G
Multiplication Factors for DNC

Sieve Size	Multiplication Factor
4 inch to No. 4 inclusive	1.0
No. 5 to No. 80 inclusive	1.5
No. 100	2.0
No. 200 (Table D)	Table H
Crush Count	1.0

TABLE H
No. 200 Sieve Upper Limit and Multiplication Factor

% Maximum	Upper Limit To Calculate DNC	Multiplication Factor
10	10.49	2.5
5	5.49	2.5
2	2.49	2.5
1	1.49	2.5
2.0	2.05	5
1.0	1.05	5

TABLE I
DNC Pay Reduction Percent

Total Sum of DNC	Percent of Contract Unit Price Reduction
0.5 to 3.0	2%
3.1 to 5.0	4%
5.1 to 8.0	7%
8.1 to 12.0	11%
Greater than 12.0	**
**If the sum of the DNC is greater than 12.0, the Representative will direct that the material represented by the lot (n=3) be removed and replaced at no additional cost to the Department or left in place and final payment for the material will be at 70% of the contract unit price. Pending the decision by the Representative, do not place additional materials on or incorporated with the non-conforming material.	

4. QA Samples. CMD QA samples (n=3) may be taken at the source of supply or at the point of placement on the project. Submit samples to the LTS for testing. If results for any type of material indicate a PWT of less than 90, the District will immediately obtain an additional verification sample (n=3) at the appropriate site (project or source). The Department will test all three sample increments at either the producer's location or at the project site and determine the PWT for the material. If results indicate a PWT for the material of less than 90, obtain source verification samples and project verification samples as specified in Section 703.5(b)2 and Section 703.5(b)3.

(c) Weighing Responsibilities. Prepare weight slips and certifications attesting to the accuracy of the weights recorded and ensuring conformance with Section 107.23(b). Designate a licensed weigh person(s) to act as the Contractor's agent. Ensure that scales are calibrated annually by an independent agency acceptable to the Department. A Department Inspector may provide random checking.

Weigh empty trucks used to haul material measured by mass (weight) daily unless otherwise directed. If the invoice mass (weight) exceeds the net mass (net weight) determined by a Department mobile weigh team by more than 3%, the Department will consider the deviation to be excessive. Take immediate corrective action upon notification of an excessive deviation. Within 30 days of notification, provide the District Executive with a written description of corrective actions and safeguards and the time that they were implemented.

703.6 CERTIFICATION OF AGGREGATES AT BITUMINOUS AND CEMENT CONCRETE PLANTS—

(a) Certification. Certify aggregate at bituminous and cement concrete plants yearly for quality requirements as specified in Section 106.03(b)3 using Form CS-4171 or another acceptable form.

Material Quality Testing

IV. Material Quality Tests

Approved aggregate sources must demonstrate that their products meet the acceptability requirements established by PennDOT through a series of test. Among these are tests for soundness, durability, particle shape, chemical reactivity, and known deleterious materials. The quality requirements are itemized in Publication 408 in Section 703.1 (c), Table A for fine aggregate; and Section 703.2(a) Table B for coarse aggregate. On a periodic basis, “at intervals sufficient to ensure the quality of the material” (408, Section 703), certain tests, especially the Sodium Sulfate Soundness test and the Los Angeles Abrasion test, must be performed on the aggregate source. This quality control testing is in addition to the tests performed on material by the Pennsylvania Department of Transportation (PennDOT) as part of the routine biennial requalification. Some aggregate producers have the equipment and experienced personnel necessary to do these tasks themselves. If not, the test may be performed by a qualified testing laboratory that is accredited by the AASHTO Materials Reference Laboratory (AMRL).

The basic aggregate quality tests are discussed below.

a. Sodium Sulfate Soundness: PTM 510

Some rock types can disintegrate rapidly when subjected to repeated cycles of mechanical weathering such as wetting and drying or freeze-thaw conditions like we have in Pennsylvania. The soundness test was developed to predict which rock types are prone to freeze-thaw degradation. The soundness test is a substitute, in principle, for the Freeze-Thaw Test (AASHTO T-103).

The soundness test that is used in Pennsylvania is the Sodium Sulfate Soundness test, however, in some states, like New York, magnesium sulfate is used. Both coarse and fine aggregates are subjected to this test method.

A specified amount of specific sizes are first soaked in a sodium sulfate solution for 16-18 hours at $21^{\circ} \pm 1.0^{\circ}$ C and then dried for 5-5 ½ hours at $110^{\circ} \pm 5^{\circ}$ C. After cooling, the soaking and drying cycles are repeated for an additional 4 times, for a total of 5 cycles.

The sodium sulfate is then washed from the sample, which is then dried, sieved over a set of critical sieves and weighed. The “loss” represents the difference in weight before the start of the test and the weight retained on the critical sieves after the test.

b. Los Angeles Abrasion Test: AASHTO T96

The Los Angeles Abrasion Test, whose actual title is “Standard Test Method for Resistance to Degradation of Small Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine”, is a critical quality test that is performed on coarse aggregate only. The test is designed to measure the resistance the aggregate has to impact degradation, grinding, and abrasion.

The testing apparatus consists of a large steel drum that revolves with steel balls inside. A change of aggregate of a specified grading and weight is placed into the drum which revolves for 500 revolutions. The aggregate is then removed and screened over the #12 sieve. The material passing the sieve is the loss fraction. The test can be performed on various size distributions of aggregate that are called gradings. The grading used for PennDOT #8 qualification is the “C” grading and for the #57 it is the “B” grading.

Typical aggregates range between 15% to 30% loss with anything under 15%, and especially below 10%, being a very low (good) result, very few rock types will yield that low of a loss. The upper limit for PennDOT Type “A” and “B” aggregate is 55%.

c. Particle Shape:

The ideal shape for aggregates is cubical which promotes proper packing and resists segregation and undesirable aggregate layering within a concrete mix. Undesirable aggregate shape can manifest itself as too thin or too long. The method for determining thin and elongated pieces is found in Section 703.2 (c) 3, of Publication 408. The test method is ASTM D 4791, Method B, using the material retained on the 4.75 mm (No.4) sieve. Measuring the ratio of 5:1, comparing the length to the thickness of the aggregate particles. Calculate the percentage of flat and elongate particles by mass.

d. Crushed Fragments: ASTM D 5821

Coarse aggregate that is derived from glacial or alluvial sources may be somewhat rounded in shape and have smooth surfaces. These properties cause inefficient bonding between aggregate particles and cement in Portland cement concrete or may cause the aggregate to glide in asphaltic concrete, which causes rutting. For these reasons, PennDOT requires gravel sources to crush the coarse aggregate so that a certain percentage of the material has fresh broken faces.

The PennDOT specification for percentages of crushed particles, defined by one, two or three fresh faces, for various uses, is described in Section 703.2(a) 2 in Publication 408.

e. Deleterious Shale: PTM 519

Shale is a thinly bedded rock composed mainly of clay. It is generally an undesirable material for aggregate usage because it splits apart into thin wafers and may be subject to rapid disintegration. However, there are shaly rocks that are not strictly shale because they contain silt and have been hardened by geologic processes. Such thinly bedded shale-like rocks may or may not be acceptable for aggregate usage.

In addition to other standard test, such as Sodium Sulfate Soundness, PennDOT has developed a test to distinguish deleterious from non-deleterious shale. This procedure is the Wet-Dry Durability Test (PTM 519), which is conducted on +1/4" fragments.

f. Clay Lumps:

Clay lumps, which will disintegrate upon usage, are obvious undesirable material in aggregate. Clay lumps usually originate from overburden above rock or clay wedges that extend down into the rock in solution cavities or fractures.

g. Friable Particles: PTM 620

Friable particles are similar to clay lumps, but consist of soft or crumbly rock, usually resulting from weathering. There is a specific technique described by PTM 620, to determine if a suspected rock is friable.

h. Coal or Coke: PTM 518

Coal or coke are uncommon in aggregate materials, but may occur in some locations. In certain geologic sequences, coal layers can be found with layers of sandstone or siltstone that are quarried or mined for aggregate. In those circumstances, selective mining would be necessary to ensure that the coal was not incorporated into the aggregate materials.

Another instance of coal contamination can occur when coal-processing waste is reclaimed for aggregate. Both bituminous and anthracite coal are unsound aggregates, and can adversely affect the density of an asphalt mix. Coke, or chemically reduced coal (from heating at high temperatures in the absence of oxygen) might inadvertently find

its way into aggregate where old coke piles are near aggregate plants, but that situation is rare. Coke is also found in slag aggregates which are processed for use from old slag.

i. Glassy Particles: PTM 518

This is a quality issue for slag used for aggregate. In Pennsylvania, there are no natural glassy aggregates. Glassy particles are not desirable in aggregate because of potentially detrimental chemical reactions and other quality issues.

j. Iron:

Elemental iron (what a nail is made of) that can be detected with a hand magnet is another undesirable material that can be found in slag. This is not an issue in natural aggregates where the iron is chemically combined with other elements to form minerals such as iron oxide or iron carbonate. Elemental iron will rust and cause staining, which is an undesirable characteristic in aggregates, especially those used in Portland cement concrete. This prohibition against iron is usually waived for use in bituminous mixtures.

k. Absorption: AASHTO T84

Aggregates can absorb water or other liquids, such as asphalt. This tendency toward absorption will affect bituminous formulations and other aggregate properties. Highly absorptive aggregate is commonly thought to be more susceptible weathering. This is an intuitive conclusion. However, the specific proof of this relationship between absorption and quality is often difficult to demonstrate. In general, most highly absorptive aggregates are weathered.

l. Alkali Silica Reactivity (ASR): ASTM C1293

Aggregate materials are evaluated for their potential to react in the presence of a highly alkaline environment. Portland cement has such an environment, although the alkali content of cement paste can vary from source to source. The reaction that can occur between the aggregate and the cement is the dissolution of silica from the aggregate and the formation of silica gel which can coat the aggregate or extrude into cracks. These gels are very hygroscopic and absorb water, causing swelling, expansion, and the possible destruction of the concrete. This reaction can occur quickly or it may take years to develop.

There are a number of tests that have been used to evaluate aggregates to see if they are alkali reactive. The test method used by PennDOT is ASTM C1293. The test method measures the potential for expansion of a combination of aggregate and high

alkali cement that have been mixed and placed in a mold to form a prism. The prism is removed from its mold after approximately 24 hours. An initial length measurement of the prism is made after the prism is removed from the mold. Additional readings are performed at 7 days, 28 days, 56 days as well as 3, 6, 9, and 12 months. The length change is compared to the average length change of the other prisms being tested at each time interval. PennDOT has developed Special Provisions regarding ASR which is in Publication 408, Section 704 Cement Concrete, and is included here.

m. Skid Resistance Level:

PennDOT classifies all Type “A” aggregate for Skid Resistance Level (SRL). This classification specifies the permissible use of the aggregate for bituminous surface, or course, treatment depending on the Average Daily Traffic (ADT) of the roadway. The following chart from PennDOT Bulletin 14 shows the classification levels for various ADTs.

SRL is a measure of an aggregate’s resistance to polishing from traffic. Depending on an aggregate rock type, selective tests are used by PennDOT to determine its SRL. These include field testing of pavement surfaces with a skid trailer, or when that is not feasible, laboratory methods such as the British Wheel and Pendulum and insoluble residue analysis are use. PennDOT may also rate an aggregate based on geologic comparison to a known source.

STANDARD SPECIAL PROVISION

Detail

Index or Category: Changes to Specifications Related

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Header

CHANGES TO SPECIFICATIONS: SECTION 704

Provision Body

SECTION 704—CEMENT CONCRETE

- **Revise Section 704.1(c)2. Cement Factor. to read as follows:**

2. Cement Factor. For all classes of concrete, use the minimum cement factor (cement or cement and pozzolan combined) specified in Table A, except as follows:

Portland cement may be replaced with pozzolan (flyash or ground granulated blast furnace slag) weighing as much as or more than the Portland cement replaced. The maximum limit of the cement factor may be waived if pozzolan is added to the mix provided the Portland cement portion does not exceed the maximum cement factor specified. If flyash is used, the Portland cement portion may be reduced by a maximum of 15%. If ground granulated blast furnace slag is used, the Portland cement portion may be reduced by a minimum of 25% to a maximum of 50%. If Mechanically Modified Pozzolan-Cement combinations are used, the Portland cement portion may be reduced by a maximum of 50%.

For AAAP cement concrete, replace Portland cement with pozzolan (silica fume or flyash or ground granulated blast furnace slag) weighing as much as or more than the Portland cement replaced. The percentages of pozzolan applicable to AAAP concrete are as shown below. Limit pozzolan to not more than two of the three pozzolans listed below in any one mix design as long as one of the pozzolan supplements meets the minimum percentage of replacement.

Cement factor must include at least one of the following as a replacement for a portion of the cement:

Ground Granulated Blast Furnace Slag 25% (min)

(GGBFS) (Grade 100 or higher)

Fly Ash (Type C or Type F) 15% (min)

(Minimum cement content = 510 lb/cy)

Silica Fume 5%-10%

• **Revise Section 704.1(g)2. Aggregate Evaluation. to read as follows:**

2. Aggregate Evaluation. Consider all aggregates potentially reactive when combined with cements or cement-pozzolan combinations as specified in Section 704.1(g)3 irrespective of the aggregates' AASHTO T 303 value reported in Bulletin 14. This requirement applies to all permanent concrete used on Department projects.

Use aggregates that are deemed potentially reactive only with cements or cement-pozzolan combinations as specified in Section 704.1(g)3. If one or both of the aggregates (coarse or fine) used in a mix is reactive, mitigation is required as specified in Section 704.1(g)3. This requirement applies to all concrete used in paving or permanent structures on Department projects, including latex modified overlays and precast and prestress concrete products.

• **Revise Section 704.1(g)3. Cement/Cement-Pozzolan Requirements. to read as follows:**

3. Cement/Cement-Pozzolan Requirements. For use with all aggregates deemed potentially reactive as specified in Section 704.1(g)2, provide Portland cement, blended hydraulic cement, or Portland cement-pozzolan combinations conforming to the requirements of Section 704.1(b) and the following:

3.a Portland Cement. Conforming to the optional chemical requirement in AASHTO M 85 for a maximum alkali content of 0.60%.

3.b Blended Hydraulic Cement. Type IS or IP, ASTM C 595. From a manufacturer listed in Bulletin 15.

3.c Portland Cement-Pozzolan Combination. Furnish a combination of Portland cement with an alkali content no greater than 1.40% and flyash, ground granulated blast furnace slag, or silica fume tested and qualified by the LTS as follows:

- **Flyash**—Furnish flyash that conforms to the optional chemical requirement in AASHTO M 295 for a maximum alkali content of 1.5% and that produces a 50% minimum reduction in mortar expansion when tested by the LTS according to ASTM C 441. Use a quantity of flyash equal to a minimum of 15%, by mass, of the total cementitious material. If flyash is added to reduce alkali-silica reactivity, use a quantity of flyash between 15.0% and 25.0%, by mass, of the total cementitious material. If aggregate expansion, when tested according to AASHTO T 303, is greater than 0.40%, use a quantity of flyash equal to a minimum of 20%, by mass, of the total cementitious material. Flyash may replace no more than 15.0% of the Portland cement; the remaining flyash is to replace the fine aggregate.
- **Ground Granulated Blast Furnace Slag**—Furnish slag producing a 50% minimum reduction in mortar expansion when tested by the LTS according to ASTM C 441. Use a quantity of slag between 25.0% and 50.0%, by mass, of the total cementitious material. If aggregate expansion, when tested according to AASHTO T 303, is greater than 0.40%, use a quantity of ground granulated blast furnace slag equal to a minimum of 40%, by mass, of the total cementitious material.
- **Silica Fume**—Use a quantity of silica fume between 5% and 10%, by mass, of the total cementitious material. Use of silica fume will be allowed on an experimental basis only, until sufficient experience is gained.
- **Mechanically Modified Pozzolan-Cement combinations.** Use a quantity equal to or greater than that required for the base pozzolan, as specified above, but not greater than 50% by mass of the total cementitious material.

The Department may waive flyash or ground granulated blast furnace slag requirements if the Contractor presents test results from an independent laboratory showing that a lesser amount of pozzolan will mitigate alkali silica reactivity (ASR) expansion to below 0.04% when tested according to ASTM C 1293, or below 0.10% when tested according to ASTM C 1567.

Project Specific Details

Audit Information

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Petrographic PTM 518

LABORATORY TESTING SECTION

Method of Test for

HAND SPECIMEN PETROGRAPHIC EXAMINATION

1. SCOPE

1.1 This procedure covers petrographic testing methods for coarse aggregate, rock lining, and fine aggregate.

2. APPARATUS

2.1 Balance- A balance conforming to the requirements of AASHTO M-231, Class G2.

2.2 Sieves- Sieves conforming to the requirements of AASHTO M-92.

2.3 Common Rock Hardness materials:

2.3.1 Penny or Copper rod

2.3.2 Steel knife or nail

2.3.3 Glass Plate

2.3.4 Scratch plates (white and black) for determining the color of powdered material

2.3.5 Munsel Rock Color Chart or Munsel Soil Color Chart

2.3.6 Ruler, marked to 1/16th or 1/32nd of an inch. Also marked to 1 mm.

2.3.7 Dilute Hydrochloric Acid (1:4 concentration)

2.3.8 Magnet

2.3.9 Tweezers

2.3.10 Illuminated Magnifier

2.3.11 Hand lens

2.3.12 Binocular Microscope (0.7X to 3X, with 10X objectives)

2.3.13 Hammer, anvil, and pans

3. HAND SPECIMEN PETROGRAPHIC PROCEDURE

3.1 Coarse Aggregate (> 6.5 mm; 0.25 in)(Section 703.2 of Publication 408):

3.1.1 Sieve 800 to 2000 grams of washed and oven-dried aggregate. Remove material that is finer than the 6.5 mm (1/4 inch) screen.

3.1.2 Visually examine the aggregate retained on the 6.5 mm (1/4 inch) sieve.

3.1.3 Record the lithology, fresh and weathered colors, grain or crystal size, degree of weathering or alteration, mineralogy, nature of cement or matrix, presence of deleterious minerals, materials, or coatings, fossils, bioturbation, carbonaceous material, and presence of laminae, bedding, foliation, or fractures.

3.1.4 Determine the hardness of the individual clasts using a copper rod, glass plate, and knife blade.

3.1.5 Separate out the different lithologies.

3.1.6 Use dilute HCl to determine the presence of carbonate cements and types of carbonate (dolomite, calcite) and the presence of carbonaceous or argillaceous material.

3.1.7 Use the binocular microscope, magnifier, or hand lens to determine the mineralogy of small grains or crystals, degree of bedding, banding, and interlocking structure and degree of cementation or weathering on individual grains or between grains.

3.1.8 Classify *Carbonate Rocks* using ASTM C 294, Section 20 and Reference 5.6 in this PTM.

3.1.9 Classify *Conglomerates, Sandstones, and Quartzites* using ASTM C 294 Section 18, and Krynine's classification (Chart 1 in this PTM).

3.1.10 Classify *Claystone, Shales, Argillites, and Siltstones* using ASTM C 294 Section 19, and Table 1.

3.1.11 Classify *Igneous and Metamorphic Rocks* using ASTM C 294 Sections 15 and 23.

3.1.12 Classify *Blast Furnace and Steel Slags, Fly and Bottom Ash, and Recycled Concrete* based on training, experience, and using Chart 2 in this PTM.

3.1.13 Separate the potentially deleterious material (ferrous particles (use a magnet), coal, shale, shaley siltstone, shaley limestone, wood fragments, etc.).

3.1.14 If the potentially deleterious material exceeds the specifications for the aggregate in the current issue of PENNDOT Publication 408, submit the material for additional tests (wet/dry test using PTM 519, x-ray diffraction, etc.).

3.1.15 Determine the relative percentages of the lithologies by mass weighing the material to an accuracy of 0.1 gram:

$$3.1.15.1 \text{ Mass of Lithology/Total Mass of Sample} = \text{Relative Percentage of Lithology}$$

3.2 Rock Lining (Section 850 in PENNDOT Publication 408):

3.2.1 Wash and oven-dry the Rock Lining sample.

3.2.2 Measure the length, width, and thickness of the individual clasts. Note whether the ratio of length to either width or thickness exceeds 3:1 (Section 850.2(a) in PENNDOT Publication 408).

3.2.3 Visually examine the Rock Lining. Note the lithology, fresh and weathering colors, grain or crystal size, degree of weathering or alteration, presence of deleterious minerals, materials, or coatings, presence of laminae, bedding, fractures, and/or grain shape.

3.2.4 Determine the hardness of individual clasts using a copper rod, glass plate, and knife blade.

3.2.5 Separate out the different lithologies.

3.2.6 Use dilute HCl to determine the presence of carbonate cements and types of carbonate (exp. dolomite, calcite).

3.2.7 Classify *Carbonate Rocks* using ASTM C 294, Section 20 and Reference 5.6. in this PTM.

3.2.8 Classify *Conglomerates, Sandstones, and Quartzites* using ASTM C 294, Section 18, and Krynine's classification (Chart 1 in this PTM).

3.2.9 Classify *Claystone, Shales, Argillites, and Siltstones* using ASTM C 294, Section 19, and Table 1.

3.2.10 Classify *Igneous and Metamorphic Rocks* using ASTM C 294, Sections 15 and 23.

3.2.11 Classify *Blast Furnace and Steel Slags, Fly and Bottom Ash, and Recycled Concrete* based on training and experience and using Chart 2 in this PTM.

3.2.12 Separate the potentially deleterious material (ferrous particles (use a magnet), coal, shale, shaley siltstone, shaley limestone, woody fragments, etc.).

3.2.13 If the potentially deleterious material exceeds the specifications for the aggregate in the current version of PENNDOT Publication 408 submit the material for additional testing.

3.2.14 Determine the relative percentages of the lithologies by mass weighing the material to an accuracy of 1.0 gram:

$$3.2.14.1 \text{ Mass of Lithology/Total Mass of Sample} = \text{Relative Percentage of Lithology.}$$

3.3 Fine Aggregate (<6.5 mm; 0.25 in.) (Section 703.1 in Publication 408):

3.3.1 Sieve 250 to 500 grams of washed aggregate; examine material that passes the 6.5mm (1/4 inch) screen.

3.3.2 Count a minimum of 160 grains (where possible) from each of the Nos. 4, 8, and 16 screens (add the material retained on the #20 screen if insufficient material is present on the larger screens):

3.3.3 Visually examine the aggregate. Note the lithology, fresh and weathering colors, grain or crystal size, composition of cement or matrix, degree of weathering or alteration, presence of deleterious minerals, materials, or coatings, and presence of laminae, bedding, or fractures.

3.3.4 Determine the hardness of the individual clasts using a copper rod, glass plate, and knife blade.

3.3.5 Separate out the different lithologies.

3.3.6 Use a magnet to separate out ferrous particles.

3.3.7 Use dilute HCl to determine the presence of carbonate cements and types of carbonate (exp. dolomite, calcite).

3.3.8 Use the binocular microscope or a hand lense to determine the mineralogy of the small grains or crystals, degree of bedding or interlocking structure, and the degree of weathering on individual grains or between grains.

3.3.9 Classify *Carbonate Rocks* using ASTM C 294, Section 20 and Reference 5.6 in this PTM).

3.3.10 Classify *Conglomerates, Sandstones, and Quartzites* using ASTM C 294 Section 18, and Krynine's classification (Chart 1 in this PTM).

3.3.11 Classify *Claystone, Shales, Argillites, and Siltstones* using ASTM C 294 Section 19, and Table 1.

3.3.12 Classify *Igneous and Metamorphic Rocks* using ASTM C 294, Sections 15 and 23.

3.3.13 Classify *Blast Furnace and Steel Slags, Fly and Bottom Ash, and Recycled Concrete* based on training and experience and using Chart 2 in this PTM.

3.3.14 Separate the potentially deleterious material (coal, shale, shaley siltstone, shaley limestone, ferrous material etc.).

3.3.15 Weigh the deleterious particles and compare their weights to the weight of material retained on the 6.5 mm (1/4 inch) sieve.

3.3.16 Determine the relative percentages of the lithologies using point counts:

3.3.16.1 Point Count of Individual Lithology/Total Point Count of Sample = Relative Percentage of Lithology.

4. REQUIRED RECORDS

4.1 TR- 447 Sample Identification

4.2 TR- 4127 Petrographic Description Lab Report

4.3 Petrographic Data Tables/Spread Sheet

5. REFERENCE DOCUMENTS

5.1 ASTM C 294, Standard Descriptive Nomenclature for Constituents of Natural Mineral Aggregates

5.2 ASTM C 1005, Standard Specification for Reference Masses and Devices for Determining Mass and Volume for use in the Physical Testing of Hydraulic Cements

5.3 AASHTO M-92, Specification for Wire-Cloth Sieves for Testing Purposes

5.4 PENNDOT Specifications: Publication 408

5.5 PENNDOT PTM 519, Method of Test for Wet/Dry Durability Test

5.6 Folk, R.L., 1968. Petrology of Sedimentary Rocks: The University of Texas, Hemphill's, Austin, TX (pp. 152-168).

6. TRAINING

6.1 The Petrographer shall have a Bachelor's Degree in Geology, or its equivalent.

7. ATTACHMENTS

3.1 Chart 1- Rock Classification Chart Used by the Petrographic Unit

3.2 Chart 2 - Slag Classification Chart Used by the Petrographic Unit

CHART 1: ROCK CLASSIFICATION USED BY THE PETROGRAPHIC UNIT

Igneous and Metamorphic Rocks: Classification based on ASTM C 294, Sections 15 and 23

Sedimentary Rocks:

Carbonate Rocks: classification based on ASTM C 294, Section 20 with additional descriptions from Folk, R.L., 1968. *Petrology of Sedimentary Rocks: The University of Texas, Hemphill's, Austin, TX (pp. 152-168).*

Conglomerates, Sandstones, and Quartzites: classification based on ASTM C 294, Section 18 with further elaboration from Krynine's classification (below).

Conglomerate- quartz, graywacke, or arkosic with descriptive adjective relating to the size of particles (pebble, granule, etc.). Conglomerate includes any rock with particles over 2 mm (0.08 in.) in diameter.

Sandstone and Quartzite- grains ranging in diameter from 0.0625 mm (0.003 in.) to 2 mm (0.08 in.).

Quartzite- Quartz grains plus over 75% silica in the cement

Impure Quartzite- Quartz grains plus 51% to 75% silica in the cement

Quartzitic Sandstone- Quartz grains plus 25% to 50% silica in the cement

Quartzose Sandstone- Quartz grains plus less than 25% silica in the cement

Graywacke- Gray, greenish gray, to reddish gray sandstone, containing quartz, feldspar, and rock fragments in a matrix resembling claystone or shale

Claystone, Shales, Argillite, Siltstone- based on ASTM C 294, Section 19 with the following additions:

Shale and Siltstone Classification

TEST	LAMINATED (FISSILE)	NON-LAMINATED
Fingernail scratches rock	<i>Clay Shale</i>	<i>Claystone</i>
Penny barely scratches rock	<i>Shale with thin laminae (less than 5 mm; 0.2 in.), possibly silty or calcareous</i>	<i>Argillite</i>
Rock scratches glass with effort	<i>Shaley Siltstone with thick laminae (5 mm; 0.2 in)</i>	<i>Silty Argillite</i>
Rock scratches glass easily	<i>Laminated Siltstone</i>	<i>Siltstone</i>

CHART 2: SLAG CLASSIFICATION USED BY THE PETROGRAPHIC UNIT

BLAST FURNACE	OPEN HEARTH
Finely to Coarsely Crystalline	Finely Crystalline to Microcrystalline
Low Density	High Density
Highly Vesicular	Few Vesicles
Rotten Egg Smell	
Colors: olives, browns, blues, greens	Darker Colors: dark grays, brownish black

LOOK FOR:

- Fire Brick
- Flux (LS, SS, SH)
- Coal, Coke, glassy particles
- Friable Particles and Aggregates
- Iron Particles (highly magnetic) Removed from the matrix.
- Slightly Magnetic Aggregates
- Lime Particles (resembles *caliche*) and Lime Crystals

Use Section 703.2.a Table B in the PENNDOT Publication 408:

	Type A	Type B	Type C
Friable Particles	1 %*	1%	-----
Coal or Coke	1%	1%	5%
Iron	3%	3%	3%
Glassy Particles	4%** or 0%***	4%** or 0%***	-----

* Percent by Weight

** for cement or concrete

***for bituminous

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Wet Dry
PTM 519

LABORATORY TESTING SECTION

Method of Test for

WET-DRY DURABILITY TEST

1. SCOPE

1.1 This test is used to determine the resistance of shaley material to splitting and cracking under conditions of successive and alternating exposure to wetting and then drying. The test is generally performed on processed coarse aggregate samples (except for AASHTO #10's) which have been found to contain, through petrographic analysis of a hand sample specimen, total amounts of shaley material exceeding the allowed specification limits for deleterious shale as stated in Table B, Section 703.2 of Publication 408. This test can also be performed on unprocessed coarse aggregate samples, such as material intended for use in embankments and backfill, in order to give the potential user an indication of how the material may perform through time. This test is also applicable to coarse aggregate extracted from a bituminous overlay, in order to evaluate the current durability and quality of the aggregate present in the overlay, and to help evaluate whether or not the overlay will perform as expected during the remainder of its anticipated life span.

1.2 This test is not applicable to processed fine aggregates and AASHTO # 10's.

1.3 For the purposes of this test only, the term "shaley material" includes the following categories of rock types:

1.3.1 shale - a very fine-grained detrital sedimentary rock composed of silt-sized and clay-sized particles, that are thinly bedded and which tend to part along the bedding planes.

1.3.2 shaley limestone - limestone, which is composed mainly of CaCO_3 , that is thinly bedded and has thin beds of shale intercalated between the thin layers of limestone, and which tends to part along the bedding planes.

1.3.3 shaley laminated siltstone- a fine-grained to very fine-grained detrital sedimentary rock, thinly bedded, which consists of intercalated beds of predominantly silt-sized material and shale, and which tends to part along the bedding planes.

Note 1- It is assumed that the person who performs the petrographic analysis or identifies the presence of shaley material in the sample is qualified by education and experience to describe and classify the individual constituents of an aggregate sample.

1.4 This test is not applicable to fine-grained detrital sedimentary rocks that are massive and show absolutely no signs of bedding on a fine scale, such as massive argillites, mudstones, and claystones.

2. APPARATUS

2.1 Pans - Pans shall be composed of metal or a plastic, durable at the required oven temperature (see Section 2.3), and shall be deep enough to allow the sample to be completely covered by at least 6.4 mm (1/4") of water.

2.2 Syringe or aspirator - A syringe consisting of a rubber squeeze bulb and nozzle with a capacity of at least 80 cc has been found to be satisfactory.

Note 2- A satisfactory style of syringe may be found in automotive supply stores which supply batteries and battery accessories. Such stores usually stock a syringe or bulb aspirator for adjusting the level of acid in unsealed batteries that can be used in this test without any alterations.

2.3 Ovens

2.3.1 Oven - An oven which shall be capable of maintaining a temperature of 60 ± 3 °C (140 ± 5 °F), and shall be large enough to hold as many samples as are likely to be tested at the same time.

2.3.2 Oven - An oven which shall be capable of maintaining a temperature of 110 ± 5 °C (230 ± 9 °F), and shall be large enough to hold as many samples as are likely to be washed at the same time.

2.4 Sieves - A 4.75 mm (#4), 6.3 mm (1/4"), 25.0 mm (1"), and 50.0 mm (2") sieves, conforming to AASHTO M-92.

2.5 Balance - The balance shall conform to Class G2 of AASHTO M-231 for samples less than 2000 g (4.4 lbs.); or Class G5, AASHTO M-231, for samples 2000 g (4.4 lbs.) or more, but less than 5000 g (11 lbs).

2.6 Brush - A brush of sufficient size and with sufficiently heavy bristles to loosen dried, fine particles from the bottom of the pan at the end of the test.

3. SAMPLE

3.1 Processed coarse aggregate samples

3.1.1 Processed coarse aggregate samples on which this test may be performed shall be obtained in accordance with AASHTO T-2. Any processed coarse aggregate samples coarser in gradation than an AASHTO #467 shall be treated as an unprocessed coarse aggregate sample (Section 3.2).

3.1.2 The sample shall be reduced in size by AASHTO T-248 to a weight slightly higher than the minimum desired weight (Section 3.1.5).

3.1.3 Wash the reduced sample in order to remove all fines and adhering dust, and dry in an oven capable of maintaining 110 ± 5 °C (230 ± 9 °F). This is the standard temperature range used in preparing aggregate samples for various tests.

3.1.4 Grade the sample from Section 3.1.3 over a 6.3 mm (1/4") sieve and discard the material that passes this sieve.

Note 3- Sections 3.1.3 and 3.1.4 may be performed in reverse order, if desired.

3.1.5 The final test sample of processed coarse aggregate shall meet the minimum weight requirement given below:

<u>Original Gradation</u>	<u>Minimum Weight</u>
AASHTO #8 and #7	800 g
AASHTO #467, #5, #57, & #67	1000 g
PA 2A or OGS	1200 g

Record the weight (W_o) of the final test sample to the nearest tenth of a gram (ounce).

3.1.6 After obtaining the final test sample, it may be prepared for the wet-dry test in one of two ways:

3.1.6.1 If the final test sample contains a fraction identified as shaley material (Note 1), check each piece of shaley material for cracks. Set any cracked pieces of shaley material aside, after noting their total weight (C_s) to the nearest tenth of a gram. The bulk of the sample is now ready for the wet-dry test.

3.1.6.2 Instead of performing the wet-dry test on the entire final test sample of processed coarse aggregate; the following procedure may be followed:

3.1.6.2.1 Perform a petrographic analysis on the final test sample (Note 1), and record the weights of each of the rock types present in the sample to the nearest tenth of a gram.

3.1.6.2.2 Calculate the percentage, by total sample weight, of the portion of the final test sample comprised of shaley material. For example:

Weight of the final test sample (W_o)	1010.0 g
Weight of shaley material in the test sample (S_o)	100.0 g

% shaley material in the test sample

$$\frac{S_o}{W_o} \times 100 = \frac{100g}{1010g} \times 100 = 9.9\%$$

3.1.6.2.3 The wet-dry test will be performed if the percentage of shaley material present in the final test sample exceeds the allowed limit of deleterious shale for the designated quality level of the aggregate (see Table B, Section 703.2, Publication 408 (Specifications), Deleterious Shale, Max. %, for Types A, B, and C coarse aggregates). Otherwise, discard the entire test sample, and do not proceed with the remainder of the test procedure.

3.1.6.2.4 Prepare the shaley material for the wet-dry test by checking each piece of shaley material for cracks. Set aside the cracked pieces after noting their total weight (C_s) to the nearest tenth of a gram. The shaley material fraction of the final test sample is now ready for the wet-dry test.

3.2 Unprocessed coarse aggregate samples (and processed coarse aggregate samples coarser than AASHTO #467's)

3.2.1 Samples shall be obtained in the field in accordance with AASHTO T-2.

3.2.2 Pieces of the sample larger than 50.8 mm (2") (maximum dimension) shall be broken down to less than 50.8 mm (2"). The whole sample shall be passed over a 50.0 mm (2") and a 25.0 mm (1") sieve. Only the material passing the 50.0 mm (2") and retained on the 25.0 mm (1") sieve shall be utilized in the wet-dry test. If necessary, reduce the amount of sized material by AASHTO T-248 to obtain a workable test sample, and set the remainder of the minus 50.0 mm (2") plus 25.0 mm (1") material to one side.

3.2.3 Wash the test sample to remove fines and adhering dust, and dry in an oven capable of maintaining 110 ± 5 °C (230 ± 9 °F). If during the process of washing the sample of unprocessed rock, pieces of the sample begin to disintegrate, immediately stop the

washing process, discard the sample, and split out a new sample from the remaining minus 50.0 mm (2") plus 25.0 mm (1") material from Section 3.2.2. For the new sample, immediately go from Section 3.2.2 to Section 3.2.4, and do not attempt to wash the new sample.

3.2.4 The sample from Section 3.2.3 or Section 3.2.2 (if unwashed) shall not weigh less than 800 g (1.75 lbs).

3.2.5 After obtaining the final test sample, prepare it for the wet-dry test as follows (Note 1):

3.2.5.1 If the final test sample contains a fraction identified as shaley material, check each piece of shaley material for cracks. If it does not contain shaley material, do not proceed with this test.

3.2.5.2 Discard any cracked pieces of shaley material, and check the weight of the remaining sample, which shall not be less than 800 g (1.75 lbs).

3.2.5.3 If the sample now weighs less than 800 g (1.75 lbs.), combine this material with the remaining minus 50.0 mm (2") plus 25.0 mm (1") fraction from Section 3.2.2, and resplit the sample to produce a test sample of sufficient size that will weigh at least 800 g (1.75 lbs.) when any cracked pieces of shaley material are removed.

3.2.5.4 Note the weight of the final test sample (W_o) to the nearest tenth of a gram.

3.2.5.5 The sample is now ready for the wet-dry test, if you wish to perform the test on the bulk sample.

3.2.6 If you wish to subject only the shaley material portion of the prepared, unprocessed rock sample to the wet-dry test, remove the shaley material from the prepared sample (Note 1), and record the weight of the shaley material fraction (S_o) from the prepared sample to the nearest tenth of a gram.

3.3 Coarse aggregate samples extracted from bituminous overlays

3.3.1 Take the extracted aggregate sample, which usually includes the coarse and the fine aggregate fractions, and sieve it over a 6.3 mm (1/4") sieve, saving the material finer than the 6.3 mm (1/4") sieve. Weigh the plus 6.3 mm (1/4") aggregate. If this material weighs more than 400 g (14 ounces), proceed to Section 3.3.2. If the plus 6.3 mm (1/4") material weighs less than 400 g (14 ounces), recombine it with the minus 6.3 mm (1/4") material, and resieve the entire sample over the 4.75 mm (#4) sieve. If the sample of plus 4.75 mm (#4) material weighs 400 g (14 ounces) or more, proceed with the test. If the plus 4.75 mm (#4) material weighs less than 400 g (14 ounces), do not proceed with the remainder of the test.

3.3.2 Wash the aggregate sample in acetone to remove as much of the remaining asphalt binder as possible, and dry the sample to a constant weight in an oven capable of maintaining 60 ± 3 °C (140 ± 5 °F).

3.3.3 Resieve the aggregate sample over the 4.75 mm (#4) sieve to remove any fines released from the coarse aggregate particles by the acetone bath. Reweigh the plus 4.75 mm (#4) aggregate. If the plus 4.75 mm (#4) aggregate sample weighs less than 400 g (14 ounces), do not proceed with the remainder of the test. If the plus 4.75 mm (#4) aggregate sample weighs 400 g (14 ounces) or more, record the sample weight (W_o) to the nearest tenth of a gram, and proceed with the test.

3.3.4 Perform a petrographic analysis of the sample. Note the different types of rocks present, record the weight of each individual rock type present to the nearest tenth of a gram (S_o , for the shaley material fraction), and calculate the percentages, by total sample weight (W_o), of each type of rock present in the sample (Note 1). Since the color of the rock types present will have been distorted somewhat by the use of an asphalt binder, only the general color ranges of the rock types present should be noted.

3.3.5 The wet-dry test shall be performed on the shaley material from the extracted aggregate sample if the total percentage of shaley material present in the extracted coarse aggregate sample exceeds the allowed limit of deleterious shale for the designated quality level of the coarse aggregate (see Table B, Section 703.2, Publication 408 (Specifications), Deleterious Shale, Max. %, for Types A, B, and C coarse aggregates). Otherwise, there is no point in continuing with the remainder of the test procedure.

3.3.6 Prepare the shaley material for the wet-dry test by checking each piece of these materials for cracks. Set aside any cracked pieces, after noting their total weight (C_s) to the nearest tenth of a gram. The shaley material fraction of the extracted aggregate sample is now ready for the wet-dry test.

4. PROCEDURE

4.1 Place the test sample in a pan and cover the sample with at least 6.4 mm (1/4") of water. If necessary, split a sample between 2 or more pans in order to achieve the necessary amount of water coverage. Soak the sample for 17 ± 2 hours. After this period is over, remove the water by first pouring the water off, and then by suction using the syringe or aspirator. While removing the water from the pans, be very careful not to lose any material, large or small, from the pan(s).

4.2 After removing the water from the sample(s), place the sample(s) in an oven at 60 ± 3 °C (140 ± 5 °F) and dry the sample(s) for 7 ± 1 hours.

4.3 Repeat the cycle of wetting and drying three (3) more times. After removing the samples from the oven, allow them to cool to room temperature before they are covered with water again.

4.4 After the end of the fourth cycle, remove the sample(s) from the oven, and allow the pan(s) to cool to room temperature.

4.5 Remove any pieces of shaley material from the sample that show the following characteristics:

4.5.1 Splitting or cracking apart, which is apparent through simple visual inspection, or which occurs through application of moderate manual pressure to the piece of aggregate.

NOTE 4- Sometimes an aggregate particle may split apart during the test, and the resulting smaller pieces will become separated from each other. Such pieces of aggregate are considered to be part of the "deleterious" fraction, and can be detected by looking for pieces of aggregate with freshly exposed surfaces that can be matched so that the smaller pieces fit together to form one larger piece of aggregate.

4.5.2 Complete or partial disintegration to minus 4.75 mm (#4) sieve-sized material.

NOTE 5- Pieces of shaley material which undergo partial disintegration typically lose their sharper edges in the process, and end up with rounded areas that have fresher, darker colors, that are interspersed with more weathered areas that represent the centers of the original fractured faces. The disintegrated material frequently ends up as minus 4.75 mm (#4) sieve-sized material, and may have to be brushed out of the pan into the container of "deleterious" shale with a stiff-bristled brush.

Where a piece of shaley material has completely disintegrated during the test, the disintegrated material will have to be brushed out of the pan into the container of "deleterious" shale with a stiff-bristled brush.

The shaley material that shows these characteristics is considered as being the "deleterious" shale fraction. Weigh the shale, and record the weight (D_s) to the nearest tenth of a gram. Weigh the remaining "non-deleterious" fraction, and record its weight to the nearest tenth of a gram.

NOTE 6- Depending on how the sample was processed, this "non-deleterious" fraction may consist only of "non-deleterious shaley material" (N_s), or it may consist of "non-deleterious shaley material and other rock types" (N_{sr}) (Section 3).

5. CALCULATIONS

5.1 Check for excessive loss of material during the pour-off of water

5.1.1 Bulk processed aggregate samples (Section 3.1.6.1)

- W_o = weight of the final test sample
 C_s = weight of cracked pieces of shaley material removed before the start of the test
 D_s = weight of deleterious shale after the end of the test
 N_{sr} = weight of non-deleterious shaley material and other rock types after the end of the test

Add together the following weights: C_s , D_s , and N_{sr} . These three weights, when added together, normally do not differ from W_o , the final test sample weight, by more than 2 g. If the total of these three weights is more than 3 g less than W_o , then material has been lost during the pour-off of water at the end of the soaking periods. The sample shall be discarded and the test repeated using a fresh sample.

5.1.2 Bulk unprocessed aggregate samples (Section 3.2)

- W_o = weight of the final test sample
 D_s = weight of deleterious shale after the end of the test
 N_{sr} = weight of non-deleterious shaley material and other rock types after the end of the test

Add together the following weights: D_s and N_{sr} . These two weights, when added together, normally do not differ from W_o , the final test sample weight, by more than 2 g. If the total of these two weights is more than 3 g less than W_o , then material has been lost during the pour-off of water at the end of the soaking periods. The sample shall be discarded, and the test repeated using a fresh sample.

If the sample was not washed, the total of D_s and N_{sr} shall be no more than 4 g less than W_o . Otherwise, the test shall be repeated using a fresh sample.

5.1.3 Shaley material fraction from processed aggregate samples (Section 3.2), and shaley material fraction from asphalt-extracted aggregate samples (Section 3.3).

- S_o = weight of the shaley material fraction of the sample
 C_s = weight of the cracked pieces of shaley material removed before the start of the test
 D_s = weight of deleterious shale after the end of the test
 N_s = weight of non-deleterious shaley material after the end of the test

Add together the following weights: C_s , D_s , and N_s . These three weights, when added together, normally do not differ from S_o , the original weight of the shaley material fraction, by more than 1 g. If the total of these three weights is more than 2 g less than S_o , then material has been lost during the pour-off of water at the end of the soaking periods. The sample shall be discarded, and the test repeated using a fresh sample.

5.1.4 Shaley material fraction from unprocessed aggregate samples (Section 3.2).

S_o = weight of the shaley material fraction of the sample

D_s = weight of deleterious shale after the end of the test

N_s = weight of non-deleterious shaley material after the end of the test

Add together the following weights: D_s and N_s . These two weights, when added together, normally do not differ from S_o , the original weight of the shaley material fraction, by more than 1 g. If the total of these two weights is more than 2 g less than S_o , then material has been lost during the pour-off of water at the end of the soaking periods. The sample shall be discarded, and the test repeated using a fresh sample.

If the sample was not washed, the total of D_s and N_s shall be no more than 4 g less than S_o . Otherwise, the test shall be repeated using a fresh sample.

5.2 Percent deleterious shale calculation

W_o = original total weight of the entire sample

D_s = weight of deleterious shale found in the sample after the test

P_{ds} = percent deleterious shale in the sample

Calculate the percent of deleterious shale in the sample, using the following formula:

$$P_{ds} = \frac{D_s}{W_o} \times 100$$

6. REPORT

6.1 Report the percent of deleterious shale found in the sample to the nearest tenth of a percent. Specify the type of sample on which the test was performed (Section 3), and state how the sample was prepared for the test. If a specification limit for deleterious shale applies to the sample, state whether the sample meets or fails to meet the applicable specification limit. Finally, state in a clear and concise manner the qualifications of the person who performed the petrographic analysis or identified the presence of shaley material in the sample.

7. REFERENCES

Publication 408 (Specifications)
AASHTO M-92
AASHTO M-231
AASHTO T-2
AASHTO T-248

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Bulletin 14

VII. Bulletin 14 (PennDOT Publication 34) Approved Aggregate Producers:

Bulletin 14 can be accessed on the web at: www.penndot.gov ; Forms and Publications; Bulletin 14 (Publication 34) Aggregate Producers.

**COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF TRANSPORTATION**

**Bureau of Project Delivery
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**BULLETIN 14
Publication 34
AGGREGATE PRODUCERS**

1. DESCRIPTION

A. General.

The aggregate producers listed in this Bulletin have demonstrated their capability to produce material meeting the Department's specification requirements for the type and source listed. Listing in this Bulletin does not provide assurance that the material from these sources will meet the requirements of the specifications at all times.

B. Meaning of Terms

For the purpose of this Bulletin, the term "producer" is any individual, firm, partnership, corporation, joint venture or other entity manufacturing aggregate with the intent of meeting the Department Publication 408, Section 703 requirements. A source is a single, specific quarry, pit, or bank location. An agent is any individual, firm, partnership, corporation, joint venture or other entity distributing aggregates with the intent of meeting the Department Publication 408, Section 703 requirements.

The language in this bulletin is generally written in the imperative mood. In sentences using the imperative mood, the subject, "the Producer" is implied. Also implied in this language are "shall", "shall be", or similar words and phrases. The word "will" generally pertains to decisions or actions of the Department and/or the Engineer. The following words, or similar words, refer to actions of the Department and/or the Engineer, unless otherwise stated: "directed", "required", "permitted", "ordered", "designated", "prescribed". Also, the words "approved", "acceptable", "satisfactory", "considered", or words with similar intent, mean by, or to, the Department and/or the Engineer, subject in each case to the final determination of the Secretary, and subject to further review, as permitted by law or permitted elsewhere in this bulletin or the Department's specifications, Publication 408.

2. PRELIMINARY APPROVAL PROCEDURE

Aggregate Producers:

Prospective aggregate producers offering a source for approval shall request an investigation from the appropriate District Materials Engineer/Manager (DME/DMM) responsible for the source location. All available information relative to the exploratory work conducted in developing the source shall be made accessible for review by the DME/DMM. Test results shall be provided from an independent testing agency indicating the quality of the aggregate being offered meets Department requirements as set forth in Section 703 of Pub. 408. The DME/DMM will review this information and, if satisfactory, will proceed with the investigation. The Bureau of Project Delivery, Innovation and Support Services Division, Laboratory Testing Section (LTS) has the responsibility to approve the listing and assign the codes for the aggregate producers in this Bulletin following the investigation and recommendation for approval by the DME/DMM. It is not the policy of the Department to provide exploratory testing to qualify sources offered by prospective suppliers. The LTS, however, will provide a preliminary Skid Resistance Level rating for coarse aggregate samples completely identified as to source and location. The producer is solely responsible for determining if any

federal or state approval or permit is required for the material and for applying for and obtaining all required federal and state approvals and permits. Any material sold to the Department must be in full compliance with all federal and state laws and regulations and must have state approvals and permits that allow the material to be sold and used for the Department's required use. This includes verification, where applicable, that a specific material is a "co-product" in relation to the Department of Environmental Protection residual waste regulations. Producers of non-natural occurring aggregate material particularly must be sure they are complying with regulations issued by the PA Department of Environmental Protection regarding slag, cinders, bottom ash, etc. This applies to all aggregate sources listed in this Bulletin, regardless of when they were originally approved.

Agents:

Prospective aggregate agents offering an aggregate distributing source location for approval shall request an investigation from the appropriate District Materials Engineer/Manager (DME/DMM) responsible for the aggregate distributing source location.

A. Facility Requirements

At each source, provide a building of sufficient size with all of the following equipment at the quarry site. The facility and equipment must be in place prior to receiving the recommendation for approval from the DME/DMM and must be maintained to continue the source listing in the bulletin:

(1) Equipment

a. Fine Aggregate

No.	Equipment
1	F.A. Mechanical Sieve Shaker with Timer
1	Sample splitter having an even number of equal width chutes that discharge alternately to each side of the splitter. A minimum of twelve total chutes is required. The minimum width of the individual chutes is to be at least 50 percent larger than the largest particles in the sample and the maximum width of the individual chutes is to be 20 mm (3/4-inch). Include two receptacles to hold the samples following splitting. Splitter design must allow samples to flow smoothly without restriction or loss of material.
2	Set of Standard Sieves for F.A., meeting ASTM E11 standards
1	Balance conforming to the requirements of AASHTO M 231 for the class of general purpose scale required for the principal sample mass (weight) of the sample being tested, PTM No. 616.
1	Oven capable of maintaining a uniform temperature of 110 °C ± 5 °C (230F ± 9F)
1	Thermometer, ASTM E1.

b. Coarse Aggregate

No.	Equipment
1	C. A. Mechanical Sieve Shaker with Timer
1	Sample splitter having an even number of equal chutes that discharge alternately to each side of the splitter. A minimum of eight total chutes is required. The minimum width of the individual chutes is to be at least 50 percent larger than the largest particles in the sample. Include two receptacles to hold the samples following splitting. Splitter design must allow samples to flow smoothly without restriction or loss of material.
2	Set of Standard Sieves for C. A., meeting ASTM E11 standards
1	Cylindrical Metal Measure [25 L (1 cu. Ft.)] AASHTO T 19
1	Balance conforming to the requirements of AASHTO M 231 for the class of general purpose scale required for the principle sample mass (weight) of the sample being tested, AASHTO T 85
1	Platform scale conforming to the requirements of AASHTO M 231 for the class of general purpose scale required for the principle sample mass (weight) of the sample being tested,

- PTM No. 616.
- 1 Oven capable of maintaining a uniform temperature of 110 °C ± 5 °C (230F ± 9F).
- 1 Thermometer, ASTM E1.

Provide a separate set of sieves for exclusive use by the Department. The remaining equipment is to be shared by the producer and the Department. If time or space conflicts arise, or if the Department does not have consistent access to shared equipment when testing is to be performed, provide a separate set of equipment for the Department.

During production, provide the necessary incidental equipment to conduct and document the tests. The equipment and test result documentation is a condition for source acceptance, source re-qualification, and continued listing in this Bulletin.

(2) Facility and Maintenance

Perform routine maintenance and repair all equipment whether shared or for exclusive Department use. Have balances calibrated annually by an independent agency acceptable to the Department. Verify oven temperatures every 120 days using the thermometer supplied as required equipment. Maintain accurate records of calibration and temperature checks. Have back-up equipment available so that no tests are missed.

Provide a source of clear, running water satisfactory to the DME/DMM.

Provide a complete library of all pertinent PTMs, Pub. 408 Specification Sections, ASTM and AASHTO standards, and Pub. 194 (Trucker Handbook).

Provide the following office equipment in the facility for exclusive Department use:

No.	Equipment
1	Desk and chair
1	Electronic calculator with tape and statistical function
1	Work table 760 mm x 2100 mm x 760 mm high (2 ½ feet x 7 feet x 2 ½ feet high)
1	4 drawer, fire resistant (D-label) metal file cabinet (A two drawer fire resistant cabinet may be substituted with permission of the DME/DMM).
1	Closet or locker for storage

If testing equipment is to be shared, provide a minimum of 14 m² (150 square feet) of office and workspace. If a separate set of testing equipment is provided for the Department, provide a minimum of 22 m² (240 square feet) of office and workspace to accommodate both the office and the testing equipment. The office and work space area provided must be heated/air-conditioned and have on-site access to a water cooler, telephone, fire extinguisher, and sanitary toilet facilities. Clean office area and work space routinely as required.

Agents are to provide an approved pad for all stockpiles. The stockpiles are to be clearly identified with aggregate supplier code and material type.

3. QUALITY CONTROL

This section outlines the minimum measures that must be implemented and maintained. Measures exceeding these minimum standards may be required by the DME/DMM or the LTS.

A. Quality Requirement Tests

(1) Quality Control Tests

Perform strength ratio, soundness, and abrasion tests at intervals sufficient to ensure the quality of the material. The tests for strength ratio, soundness, and abrasion tests may be performed by the producer or by an independent laboratory. Document the results of tests made during production and make them available to the Department upon request.

(2) Annual Quality Requirement Tests

Obtain and test samples of the source product for the various quality requirements of Pub. 408, Section 703, at the minimum frequency as indicated below. Testing may be performed by the producer or by an independent laboratory. Provide copies of the producer or independent laboratory test results to the DME/DMM and LTS. Take appropriate action to assure that only materials meeting Department requirements are provided to the Department.

Coarse Aggregate-

If requalification samples are not scheduled to be collected during the calendar year, obtain and test materials according to the following table for that calendar year (samples may be collected at anytime during the calendar year).

Quality Parameter	Test Method	AASHTO No. 8 Coarse Aggregate	All Other Sizes of Coarse Aggregates
Specific gravity and absorption	AASHTO T 85	Required	Required
Sodium sulfate soundness	PTM No. 510	Required	Required
Los Angeles abrasion	AASHTO T 96	Required	Required
Crushed fragments	ASTM D5821	Required	Required
Unit weight	AASHTO T 19	Required	Required
Thin and elongated	AASHTO D4791	Required	Required
Petrographic analysis	PTM No. 518	Required	Not Required

If requalification samples are scheduled to be collected during the calendar year, a split sample of the requalification sample must be tested for specific gravity and absorption, sodium sulfate soundness, and Los Angeles abrasion.

Fine Aggregate-

If requalification samples are not scheduled to be collected during the calendar year, obtain and test materials according to the following table for that calendar year (samples may be collected at anytime during the calendar year):

Quality Parameter	Test Method	Cement Concrete Sand Fine Aggregate	Bituminous Concrete Sand Fine Aggregate
Specific gravity and absorption	AASHTO T 85	Required	Required
Sodium sulfate soundness	PTM No. 510	Required	Required
Uncompacted voids	AASHTO T 96	Required	Required
Unit weight	AASHTO T 19	Required	Required
Petrographic analysis	PTM No. 518	Required	Required
Strength ratio	AASHTO T 21	Required	Not Required
Sand equivalency	AASHTO T 176	Not Required	Required

If requalification samples are scheduled to be collected during the calendar year, a split sample of the requalification sample must be tested for specific gravity and absorption, and sodium sulfate soundness.

B. Quality Control Plan

Prepare and submit a Quality Control Plan (QCP), for initial source approval and annually thereafter or as otherwise required, to the DME/DMM for the aggregate production and testing process to assure compliance with specification requirements. A new QCP must be submitted if there are changes made to production, such as the addition of AASHTO # 57 or AASHTO #8. Meet the minimum QCP requirements as set forth in Pub. 2, Project Office Manual, for Aggregate Suppliers. Establish and positively identify aggregate stockpiles which have been tested in accordance with the approved QCP and meet Department specifications. Ensure that material not meeting Department specification is isolated from all stockpiles intended for Department use. Assure that all personnel involved in the production, stockpiling, and the shipping process are advised of quality control measures and proper stockpile identification.

C. Quality Control Technician

Provide, and assign to the work, a PENNDOT Certified Aggregate Technician properly instructed and trained to perform all required quality control tests. Allow the technician(s) sufficient time, free of any additional unrelated conflicting work, to assure compliance with the specification requirements and the QCP. Publication 725 outlines the aggregate technician certification requirements and process. The technician is responsible for, but not limited to, the following duties:

- Assist in development of the QCP as required
- Be cognizant of production quality levels of the source and quality parameters required to maintain source approval
- Lift and test quality control samples
- Document test results made during production in plant records within 24 hours of obtaining results
- Review and discuss test results and production processes with Department representatives as needed
- Assist the Department representatives in sampling and testing as needed
- Take appropriate action to ensure that the production process is controlled so that aggregate is in compliance with the specifications and requirements.
- Prepare and supply certifications for material shipped when required.
- Control and direct loading operations so that only aggregates from identified and approved stockpiles are shipped to the appropriate Department projects
- Control and direct loading operations so that stockpiles are properly mixed to provide consistent, non-segregated aggregate to the Department.
- Control and direct loading operations so that aggregate is properly loaded in trucks with beds sufficiently clean to prevent any contamination of the aggregate.
- Delegate to other properly trained personnel these duties when necessary, while maintaining supervision and responsibility.
- Identify and reject any aggregate not meeting specifications and take appropriate action to prevent shipment of any non-specification aggregate to any Department project.
- Maintain and calibrate test equipment as required.
- Maintain necessary skills and qualifications to perform QC technician duties to the satisfaction of the DME/DMM.

SAMPLES

A. Sample Types

(1) Preliminary Samples (Sample Class: PS) are obtained from a prospective aggregate source where there is no crushing and screening plant in operation and the material is processed at some other location. It is permissible to have several truckloads of the unprocessed material hauled to another operating plant location to be processed into the appropriate aggregate sizes. These test results, however, will not constitute final approval.

(2) Qualification Samples (Sample Class: QS) are obtained from new aggregate sources where a crushing and screening plant is in operation and sufficient material (minimum 200 tons of each aggregate size intended to be produced) has been processed and stockpiled. QS samples could also be obtained from an existing approved aggregate source for any aggregate size not currently approved, but where the producer is seeking approval of this aggregate size for approval. Such samples will not be evaluated more frequently than quarterly and will not be evaluated if the existing approved source has previous failing test results on approved aggregate products that have not been addressed. Address previous failing test results by conducting an investigation and submitting an investigation report to the DME with a copy forwarded to LTS. Include in the investigation report: cause of failure, corrective action, passing independent lab results, site map with area of work, etc. After the report is approved by the District in consultation with the LTS, and corrective action is taken, the District will resample the material.

(3) Requalification Samples (Sample Class: RS) are obtained at least biennially from each aggregate source and of each aggregate material or size approved and listed in Bulletin 14 to maintain approval in Bulletin 14 for each source and material. The requalification samples may be obtained at any time during the year from the source of supply. For those sources that have a previous test result history showing test results at or near the acceptable limits of the specification requirements, or when there is any indication that the quality of the material has changed, the frequency of requalification or investigational sampling will be increased to a level that will assure the Department of acceptable quality.

(4) Quality Assurance (Sample Class: QA) samples may be obtained by the Construction Quality Assurance Section (CQAS), Bureau of Project Delivery. QA samples are obtained at the discretion of the Department to assure quality levels.

(5) Independent Assurance (Sample Class: IA) samples may be obtained by the Quality Assurance Section (CQAS), Bureau of Project Delivery. IA samples are obtained at the discretion of the Department to provide an unbiased, independent evaluation of the technicians, sampling and testing procedures, and the equipment used in the acceptance program.

All Preliminary, Qualification and Requalification Samples will be tested at the LTS, in Harrisburg, PA. The sampling must be performed by or witnessed by Department personnel. The samples must be accompanied by a correctly completed Form TR-447 - Sample Identification. The TR-447 Forms for Requalification samples must also show the Bulletin 14 Supplier Code for the source. In addition, Form TR-430A, "Aggregate Source Evaluation Report", shall be completed and sent to the LTS. A file copy shall be retained by the DME/DMM. Sources will not be listed in Bulletin 14 without Form TR-430A on file at the LTS with the DME/DMM's recommended approval indicated on the Form TR-430A.

B. Sample Size

Sample size includes the number of sample increments (i.e., bags) and the quantity of material in each bag and is dependent on the type of aggregate (fine or coarse), aggregate quality, sample classification, and aggregate size (e.g., AASHTO No. 8). Obtain the sample increments by random sampling procedures from stockpiles at either the source or at point of delivery. When specified, use PTM No. 1 for selecting random samples. When obtaining samples of aggregate, the stockpiles of processed material must be sampled according to PTM No. 607 so that the gradation of the samples will accurately represent the gradation of the stockpiled material. Obtain aggregate samples consisting of the following minimum quantities for each type and size listed below:

TABLE 3				
Sample Size by Aggregate Type, Quality Level, Sample Class, and Size Designation				
Aggregate	Aggregate Quality Type (Type A, B, C, or S)	Sample Class (QS or RS)	Aggregate Size	No. of Bags (50 lbs./bag)
Fine Aggregate	A, B, and C	Qualification Sample (QS)	Each Size	3
		Requalification Sample (RS)	Each Size	1
Coarse Aggregate	A and B	Qualification Sample (QS)	AASHTO No. 8 (# 8)*	7 or 3*
			AASHTO No. 57 (# 57)*	8
	C and S	Qualification Sample (QS)	AASHTO No. 8 (# 8)	3
			AASHTO No. 57 (# 57)	4
			PennDOT No. 2A	6
	A and B	Requalification Sample (RS)	AASHTO No. 8 (# 8)	3
			AASHTO No. 57 (# 57)	4
	C and S	Requalification Sample (RS)	AASHTO No. 8 (# 8)	3
			AASHTO No. 57 (# 57)	4
			PennDOT No. 2A	6
Select Granular Material (2RC)	All Types	All Sample Classes (QS and RS)**	2RC	2
Anti-Skid Material	All Types	All Sample Classes (QS and RS)	Each Size	2
Rock Lining	All Types***	All Sample Classes (QS and RS)	Submit R-3 Size to Represent all Sizes	2
* If both AASHTO No. 8 (#8) and AASHTO No. 57 (#57) are submitted at the same time, four sample increments (i.e., 4 bags) may be omitted from the AASHTO No. 8 (#8).				
** If the Select Granular Material (2RC) source location is an existing approved aggregate source listed in Bulletin 14, no samples are required to be obtained for quality testing.				
*** If the Rock Lining source location is an existing approved Type A, Coarse Aggregate source listed in Bulletin 14, no samples are required to be obtained for quality testing.				

C. Test Results

Aggregate quality testing will require at least 60 days for completion and reporting from time of arrival of samples at the LTS. Upon completion of all required quality testing, an evaluation of the test result data will be made to determine the acceptability of the aggregate for its intended use.

Conformity with the specified gradations of Publication 408 Section 703 is required. When the gradation or wash test of the sample deviate significantly from the specified limits, the results of the quality testing may be affected. The DME/DMM will be notified to resample when it is determined that the results are questionable.

The value (test results) shown for specific gravity and absorption are as recent as the Lab number code indicates (the first two numbers are the year code). Test results from samples will be sent from the LTS to the producer and the DME/DMM submitting the samples. These results will be used to determine conformance with the specifications.

If the sample fails, the producer may contact the DME/DMM to discuss the areas in which the aggregate failed to comply.

FINAL APPROVAL PROCESS

Source approval will be granted when the facilities, equipment and processing plant are in place, as required, and material from actual production has been tested for quality and gradation and found to be in compliance with all specification requirements.

AGGREGATE SOURCE LISTING\QUALITY TEST FAILURE PROCESS

Step 1. Initially, the District approves the aggregate source based upon its investigation of the source and the LTS test results. Form TR-430A and a letter requesting listing in Bulletin 14 are to be sent to the Bureau of Project Delivery.

Step 2. Requalification samples are taken by the DME/DMM biennially (every two years) as a minimum. Samples may be taken and tested for quality requirements more frequently depending on the source's historical test results. Samples are subject to testing based on the requirements of Pub. 408, Section 703. QA samples may be taken on a random basis and may be tested for quality requirements.

Step 3. If a qualification, requalification, or QA sample fails on the gradation or wash test, the failure is to be investigated at the source by the District. After making some minor changes in processing, samples of newly processed material are tested either at the source or at the LTS to verify the material meets specification requirements for these tests.

Step 4. If a qualification, requalification or QA sample fails on sulfate soundness, deleterious shale, L.A. abrasion, crush count, or other quality tests (other than gradation and wash), the DME/DMM is to notify the source to take immediate corrective action. After corrective action has been taken the DME/DMM is to resample (N=3) the material as soon as possible and notify the LTS.

Step 5. If all the resamples pass, resample (N=3) the source at least quarterly for the next six months to ensure there is not a quality problem. Calculate the percent within limits (PWL) for the material based on the last 5 year history and if it is below 90%, go to STEP 6. PWL is based on only LTS test results for sulfate soundness, deleterious shale, L.A. abrasion, crush count, and other quality tests.

Step 6. If any one of the three resamples fails or if the PWL (based on the last five year history) for the material falls below 90%, LTS may suspend the source from Bulletin 14 for the particular material involved. The source is to investigate the problem and present a written report to the District and a copy is to be forwarded to LTS. The report is to include: causes of failures, corrective actions, passing private lab results, site map with area of work, etc. After the report is approved by the District in consultation with the LTS, and corrective action is taken, the District will resample (N=3) the material. If warranted the Bureau of Project Delivery may recommend the establishment of a new historical data base.

Step 7. If all resamples from STEP 6 pass, the suspension of the source may be lifted. Resample (N=3) at least quarterly for the next twelve months to ensure there is not a quality problem. If any samples fail during this twelve months period, LTS may suspend the source. Go to STEP 8.

Step 8. If any samples from STEP 6 or 7 fail, calculate the PWL (based on the last ten years history) and if it is below 90%, the source is to be downgraded to a level where the material passes or the source will be removed from Bulletin 14. The Bureau of Project Delivery will notify the source regarding downgrading or removal.

MAINTAINING APPROVAL STATUS

After approval by the LTS, by letter, the source will remain on the approved list until such time as it is removed for any of the following reasons:

1. Any actions or inactions that may affect the quality of the product, the integrity of the testing results or the applicable quality control plan.

2. Material fails to meet specification requirements.
3. Failure to maintain an effective quality control plan.
4. Operations remain inactive for two years.
5. Major changes are made in processing equipment or operating procedures that degrade the quality of the aggregate.
6. Failure to meet/comply with Publication 408, Section 106.03(a)2.a thru 2.f.
7. Actions relative to the Aggregate Source Listing\ Quality Test Failure Process listed above.
8. Failure to have a PennDOT certified aggregate technician perform and document testing, and manage the quality control process as required in the QUALITY CONTROL section above.
9. At the request of the aggregate producer to be removed.

The DME/DMM will recommend source approvals, suspensions, removals, or quality type downgrades or upgrades to the LTS. The LTS will have final authority regarding approvals, suspensions, removals, quality downgrades or upgrades.

UPGRADING AN AGGREGATE TYPE

The request to upgrade an aggregate type must be submitted in writing to the DME/DMM. Along with this request, the aggregate producer must submit a written report to the District and a copy is to be forwarded to the LTS. The report is to include: corrective action (if upgrade request is due to a previous downgrading of aggregate type), passing independent lab results meeting the upgraded quality type specification requirements, site work with area of work where the aggregate is being mined, dredged, or acquired, QC Plan, etc.

After the report is approved by the District in consultation with the LTS and corrective action is taken (if required), one sample will be obtained by a Department Representative once per month for six consecutive months for a total of 6 samples. All six samples will be tested for quality at the LTS.

The percent within limits (PWL) will be calculated on the six samples. If the PWL is above 90%, the aggregate will be upgraded. If warranted the Bureau of Project Delivery may recommend the establishment of a new historical data start point (date) to represent the current quality of material or production process of the aggregate source.

BIDDING

To receive bid proposals, request an application from the Department of General Services, Bureau of Procurement, 555 Walnut Street, 6th floor Forum Place, Harrisburg, PA 17101

CODE IDENTIFICATION

Supplier Code:

XXX01ABB

XXX – Producer
01 – County or State code
A – Source Identification
BB- Bulletin Code

Materials Code:

203 = Coarse Aggregate
207 = Fine Aggregate
249 = Antiskid (Numbers following are Type e.g. AS1, AS2, AS3 and AS4 etc.)
283 = Rock Lining

Materials Class

A = Stone Type A
B = Stone Type B
C = Stone Type C

Rock Type:

GL = Gravel
SL = Slag
RL = Rock Lining
LW 3/4 = Coarse Aggregate, Lightweight
LW 1/2 = Coarse Aggregate, Lightweight
LW4 = Fine Aggregate, Lightweight
If None Shown the Default is Stone

Examples:

203 A8 = coarse aggregate #8 stone
203 C2A = coarse aggregate #2A stone
203 A8SL = coarse aggregate #8 slag
203 A57GL = coarse aggregate #57 gravel
203 LW3/4 = coarse aggregate light weight 19.0mm (3/4 in.) nominal
207 B = fine aggregate type B
249 AS1, AS2, AS3, AS4 = antiskid type(s) AS1, AS2, AS3, AS4

MATERIAL CLASSIFICATION BY COMPOSITION

AR = Argillite	PH = Phyllite
BA = Bottom Ash (Cinders)	QZ = Quartzite
BL = Basalt	QS = Quartz Sand
BS = Boiler Slag (Wet Bottom)	RD = Anthracite Red Dog
CH = Chert	RSG = Reclaimed Granulated Slag
CB = Coal Mine Waste (CULM BANK)	SB = Blast Furnace Slag
CS = Calcareous Sandstone	SBMA = Spent Bed Mat'l. - Anth.
DI = Diabase	SBMB = Spent Bed Mat'l. - Bit.
DO = Dolomite	SC = Schist
FS = Foundry Sand	SG = Granulated Slag
GB = Gabbro	SH = Shale
GD = Granodiorite	SL = Silt Stone
GL = Gravel	SR = Serpentine
GN = Gneiss	SS = Sandstone
HF = Hornfels	SO = Steel Slag (Open Hearth)
LS = Limestone	SSCG = Sandstone & Conglomerate
LW = Light Wt. Aggregate	SM = Molybdenum Slag
MB = Marble	RC = Recycled Concrete

NOTE: Petrographic comparison (P) with samples of satisfactory quality from the same source may be substituted for sodium sulfate soundness (SODS) at the discretion of LTS. Otherwise results are given as Percent (%) Loss.

COUNTY CODE IDENTIFICATION

County	Dist. No.	County	Dist. No.
01 Adams	8-1	34 Juniata	2-9
02 Allegheny	11-1	35 Lackawanna	4-2
03 Armstrong	10-1	36 Lancaster	8-7
04 Beaver	11-2	37 Lawrence	11-4
05 Bedford	9-1	38 Lebanon	8-8
06 Berks	5-1	39 Lehigh	5-3
07 Blair	9-2	40 Luzerne	4-3
08 Bradford	3-9	41 Lycoming	3-2
09 Bucks	6-1	42 McKean	2-5
10 Butler	10-2	43 Mercer	1-4
11 Cambria	9-3	44 Mifflin	2-7
12 Cameron	2-4	45 Monroe	5-4
13 Carbon	5-2	46 Montgomery	6-4
14 Centre	2-1	47 Montour	3-3
15 Chester	6-2	48 Northampton	5-5
16 Clarion	10-3	49 Northumberland	3-4
17 Clearfield	2-2	50 Perry	8-9
18 Clinton	2-3	51 Pike	4-4
19 Columbia	3-1	52 Potter	2-6
20 Crawford	1-1	53 Schuylkill	5-6
21 Cumberland	8-2	54 Snyder	3-5
22 Dauphin	8-5	55 Somerset	9-7
23 Delaware	6-3	56 Sullivan	3-6
24 Elk	2-8	57 Susquehanna	4-5
25 Erie	1-2	58 Tioga	3-7
26 Fayette	12-1	59 Union	3-8
27 Forest	1-3	60 Venango	1-5
28 Franklin	8-3	61 Warren	1-6
29 Fulton	9-4	62 Washington	12-4
30 Green	12-2	63 Wayne	4-6
31 Huntingdon	9-5	64 Westmoreland	12-5
32 Indiana	10-4	65 Wyoming	4-7
33 Jefferson	10-5	66 York	8-4
		67 Philadelphia	6-5

STATE CODE IDENTIFICATION

The same as the Postal two letter code, e.g. NY = New York and OH = Ohio
For Canadian or other foreign sources the following code(s) are used: OT = Ontario

SKID RESISTANCE LEVEL (SRL)

Aggregate Friction Guidelines for Bituminous Wearing Surfaces

The course aggregate used in bituminous wearing surfaces or the fine aggregate, in the case of FJ-1 Wearing surfaces, shall have the following aggregate Skid Resistance Level (SRL) letter designation based on the current Average Daily Traffic (ADT) for resurfacing and anticipated initial Daily Traffic on new facilities.

ADT	SRL
20,000 and above	E
5,000 to 20,000	E, H, Blend of E & M, or Blend of E & G.
3,000 to 5,000	E, H, G, Blend of H & M, or Blend of E & L
1,000 to 3,000	E, H, M, G, Blend of H & L, or Blend of G & L OR Blend of E & L
1,000 and below	A N Y

*All blends are 50% by weight and shall be made by an approved method of blending.

Using the above guidelines, special provisions for contracts or purchase orders shall be prepared stating the aggregate SRL letter designation and/or SRL Blend requirements.

SKID RESISTANCE AGGREGATE TYPES

SRL	Aggregate Type
E	Sandstones; siltstones; Loyalhanna Limestone sources (calcareous sandstones) which consistently contain more than 30% + #200 acid insoluble residue; gneisses and igneous rocks which contain high amounts of micas; several quartzite sources which have been sheared so that they have softer, sheared microcrystalline quartz surrounding the remaining intact quartz grains; and gravels which contain either a.) < 25% carbonates, < 10% chert, and high percentages of dirty sandstones and siltstones; or b.) < 10% carbonates, < 15% chert, and high percentages of dirty sandstone and siltstones.
H	Argillites; diabases, gneisses, granites and granodiorites, basalts, and gabbros which do not contain large amounts of micas; open hearth slag; blast furnace slag; metamorphic quartzites (no difference in hardness between quartz cement and quartz grains); sandy limestones; a few coarsely crystalline dolomites (e.g., the Ledger dolomite); and gravels which contain either: a.) > 25% and < 34% total carbonates, and <10% chert; or b.) > 15% chert and < 25% chert, and < 10% carbonates; or c.) large amounts of quartzite.
G	Siliceous limestone and dolomite; limestones and dolomites with consistent wide textural variation (i.e., they always contain finely to moderately or coarsely crystalline dolomite or limestone); gravels which contain more than 34% carbonates and more than 10% chert; and serpentinites.
M	Many dolomites and some limestones that are not consistently finely textured all the time.
L	Most limestones and some dolomites that are very finely textured, and contain very little, if any, acid insoluble residue retained on the #200 sieve

RE-EVALUATING SRL RATINGS USING RIBBED TIRE SKID DATA PROCESS

Aggregate Producer Responsibilities:

1. Compile a list of at least ten to twelve 9.5 mm (3/8") Nominal Maximum Aggregate Size (NMAS) asphalt mixture wearing courses, including the following information for each roadway:
 - a. State Route (S.R.) Number (4-digit number) or, if Municipal roadway, roadway name (e.g., Murphy Road) and/or designation (e.g., T-321),
 - b. County
 - c. Municipality (if roadway / roadway segments are Municipal roadways),
 - d. Beginning and ending roadway Segment/Offsets or, if Municipal Roadway, beginning and ending points (landmarks, intersecting roadways, etc.),
 - e. Bituminous Job Mix Formula (JMF) for each roadway / roadway segment,
 - f. Average Daily Traffic (ADT) of the roadway / roadway segments.
 - i. If the ADT is unknown (e.g., Municipal roadways), a consultant engineering service must be hired by the Producer to measure the ADT. The privately-obtained traffic counts must be conducted over a 24-hour period of maximum traffic, preferably during the period of a Tuesday through Thursday from midnight to midnight. The traffic count shall be a combination of a classification count and a volume count (see Note 1).
 - g. The 10-12 roadways / roadway segments must meet the requirements listed in the Requirements of the roadway / roadway segments section below.

Note 1:

- A. Classification count – counts the number of different classes of vehicles in each lane in each direction.
 - B. Volume count – for a divided road, a volume count obtains a count for each direction across all lanes, but not on individual lanes. For an undivided road, a volume count obtains the total volume on all lanes in both directions.
2. Gather and prepare roadway maps detailing location of each roadway /roadway segment and specifically showing the beginning and ending points of each roadway / roadway segments in each direction.
 3. Prepare a letter to the responsible District Materials Engineer/District Materials Manager (DME/DMM) requesting SRL re-evaluation. The letter is to include the aggregate supplier company name, location, and supplier code of the aggregate source to be evaluated as identified in PennDOT Publication 34, Bulletin 14. The letter is to be addressed to the DME/DMM responsible for the aggregate source location.
 4. Submit the letter and two copies of both the list of roadways and maps to the DME/DMM. It is highly recommended to submit the list of roadways and maps at the beginning of the calendar year as ribbed tire testing for SRL re-evaluation is only performed from June 15 to November 15 each year.
 5. When requested, obtain 6-inch diameter pavement core samples from the roadways / roadway segments and/or specific locations as requested by the Department for further Department analysis. Coordinate obtaining the pavement cores with the Engineering District (RMS Unit) responsible for the roadways / roadway segments. A Department Representative from the Pavement Design Unit must be present during drilling of the pavement cores and will take immediate possession of the pavement cores.

Requirements of the roadway/roadway segments to be submitted for SRL reevaluation:

1. Must have a wearing course with a 9.5 mm (3/8") NMAS.
2. Must be under traffic for at least one year.
3. Must be at least ¼ mile long.
4. Virgin coarse aggregate in the wearing course asphalt mixture must be 100% from the aggregate source for which producer wants the SRL rating re-evaluated. If any of the wearing courses that

- the aggregate producer wants to submit for SRL re-evaluation contain RAP, the mix design and the gradation of all the aggregates and the RAP used in the mix design must be submitted to the LTS for evaluation of the suitability of the mix design for skid testing before any wearing courses laid using that mix design can be accepted for skid testing. Any JMF-containing RAP in which aggregate from the RAP contributes 10% or more of the total blended aggregate retained on the #4 sieve will be rejected for use for SRL re-evaluations.
5. ADT of entire length of roadway where the wearing course is located must be known. ADT along a length of roadway may be affected and different due to intersecting roadways located between the beginning and ending points of the roadway. If a selected roadway / roadway segment contains intersecting roadways, provide the ADT of the selected roadway / roadway segment between each of the intersecting roadways.
 6. Cannot have rutting exceeding a maximum depth of 3/8" at any location (includes rutting from buggy traffic, farm traffic, plastic deformation of the pavement layers under traffic, or improper or inadequate pavement base support).
 7. Cannot have more than 10% of the area of the wheel paths that consist of repairs or patching.
 8. Cannot have any cracking due to base failure.
 9. Within the 10-12 roadways / roadway segments submitted for the SRL re-evaluation, the roadways must have a range of ADTs in order to assist the analysis with extrapolating the SRL above the existing SRL level.

Department Responsibilities:

1. The Engineering District responsible for the roadways / roadway segments will review the list of roadways / roadway segments and maps submitted and verify or complete the ADT for each roadway / roadway segment using ADT data from the Roadway Management System (RMS) or other District ADT data.
2. LTS will request locked-wheel skid testing from the Bureau of Maintenance & Operations on all the roadways / roadway segments.
3. LTS will analyze the skid data.
 - a. If the data has a defined aggregate performance, then a letter is sent to the producer with results of the re-evaluation.
 - b. If the data gives inconclusive aggregate performance, then a letter is sent notifying the producer of what additional work needs done. This typically includes obtaining 6-inch diameter pavement cores from each of the 10-12 roadways / roadway segments submitted or from a specific number of the 10-12 roadways / roadways segments submitted.
 - c. The Engineering District (RMS Unit) responsible for the roadways / roadway segments will submit any collected pavement core samples to the District Construction Materials Unit. The District Materials Engineer/Manager will submit the pavement cores to LTS. Submit pavement core sample identification information through eCAMMS using Material Code 218 (Concrete Core), Material Class BTMNS, and Sample Class IF-Information.
 - i. Upon submission of requested pavement cores from the roadway segments that were skid-tested. The LTS will extract the asphalt from the cores using solvent extraction. The extracted aggregates will be evaluated. A letter will be sent to the producer with the results of the re-evaluation.



- Click a tab to locate approved materials in Bulletin 14 (Aggregate), Bulletin 15 (Qualified Products List for Construction), Bulletin 41 (Bituminous) or Bulletin 42 (Concrete).
- Enter search criteria in one or more fields. Click Search to view the results. Click Reset to start over.
- Map views are not available for searches performed with the Address filter. Map views only display results for Suppliers who have map coordinates on file and may not represent all search results.

Bulletin – Search Criteria

Bulletin 14 (Aggregate)
Bulletin 15 (Qualified Products List for Construction)
Bulletin 41 (Bituminous)
Bulletin 42 (Concrete)

Supplier Name: [Supporting Information \(PDF\)](#)

Supplier Code: ▼

Material Code/Class: ▼

To search all Suppliers, regardless of location, do not include a Map or Address filter.

Map Location / Address: Map Location Address

Search Results

7 Products Found

- To display item details, click the arrow (>) beside one or more rows. To view the details for all rows, click the arrow (>) at the top of grid.
- To compare details side-by-side, click the checkboxes beside two or more rows. Click Compare.
- Click Select All to select all results. Click Clear Selection to clear all selections.

> <input type="checkbox"/>	Supplier Name	Supplier Code	Material Code	Material Class	Location	Status
> <input type="checkbox"/>	Hanson Aggregates PA, Inc.	HAP47A14	203	A57	MILTON #2	Approved
> <input type="checkbox"/>	Hanson Aggregates PA, Inc.	HAP47A14	203	A8	MILTON #2	Approved
> <input type="checkbox"/>	Hanson Aggregates PA, Inc.	HAP47A14	249	AS1	MILTON #2	Approved
> <input type="checkbox"/>	Hanson Aggregates PA, Inc.	HAP47A14	249	AS2	MILTON #2	Approved
> <input type="checkbox"/>	Hanson Aggregates PA, Inc.	HAP47A14	249	AS3	MILTON #2	Approved
> <input type="checkbox"/>	Hanson Aggregates PA, Inc.	HAP47A14	207	B3	MILTON #2	Approved
> <input type="checkbox"/>	Hanson Aggregates PA, Inc.	HAP47A14	203	C2A	MILTON #2	Approved



- Click a tab to locate approved materials in Bulletin 14 (Aggregate), Bulletin 15 (Qualified Products List for Construction), Bulletin 41 (Bituminous) or Bulletin 42 (Concrete).
- Enter search criteria in one or more fields. Click Search to view the results. Click Reset to start over.
- Map views are not available for searches performed with the Address filter. Map views only display results for Suppliers who have map coordinates on file and may not represent all search results.

Bulletin – Search Criteria

Supplier Name: [Supporting Information \(PDF\)](#)
 Supplier Code:
 Material Code/Class:
 Map Location / Address: Map Location Address
 To search all Suppliers, regardless of location, do not include a Map or Address filter.

Search Results

7 Products Found

- To display item details, click the arrow (>) beside one or more rows. To view the details for all rows, click the arrow (>) at the top of grid.
- To compare details side-by-side, click the checkboxes beside two or more rows. Click Compare.
- Click Select All to select all results. Click Clear Selection to clear all selections.

>	<input type="checkbox"/>	Supplier Name	Supplier Code	Material Code	Material Class	Location	Status
∨	<input type="checkbox"/>	Hanson Aggregates PA, Inc.	HAP47A14	203	A57	MILTON #2	Approved
<div style="border: 1px solid black; padding: 5px;"> <p>Approval Date: 8/2/2017</p> <p>Primary Address: Hanson Aggregates PA, Inc. 7660 Imperial Way Allentown, PA 18195</p> <p>Physical Address:</p> <p>Phone Number:</p> <p>Fax Number:</p> <p>Lab Number: L17030414</p> <p>Restrictions:</p> <p>Bulk Specific Gravity (SSD): 2.688</p> <p>Bulk Specific Gravity: 2.665</p> <p>Absorption: 0.86</p> <p>Sodium Sulfate Soundness: 3 %</p> <p>Alkali-Silica Reactivity (ASR) AASHTO T303 :</p> <p>Alkali-Silica Reactivity (ASR) ASTM C1293 :</p> <p>AASHTO T303 Reactivity Class :</p> <p>ASTM C1293 Reactivity Class : R1</p> <p>Uncompacted Voids:</p> <p>Sand Equivalency:</p> <p>Rock Compositions & Order Of Abundance: LS (Limestone): 1 SH (Shale): 2</p> <p>Skid Resistance Level Type: L</p> <p>Los Angeles Abrasion: 21</p> <p>Micro-Deval Loss: 16</p> <p>Crush Count % 1-Face:</p> <p>Crush Count % 2-Face:</p> <p>Thin & Elongated Pieces (5:1): 1</p> </div>							
>	<input type="checkbox"/>	Hanson Aggregates PA, Inc.	HAP47A14	203	A8	MILTON #2	Approved
>	<input type="checkbox"/>	Hanson Aggregates PA, Inc.	HAP47A14	249	AS1	MILTON #2	Approved
>	<input type="checkbox"/>	Hanson Aggregates PA, Inc.	HAP47A14	249	AS2	MILTON #2	Approved



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Bulletin – Search Criteria

Bulletin 14 (Aggregate)
Bulletin 15 (Qualified Products List for Construction)
Bulletin 41 (Bituminous)
Bulletin 42 (Concrete)

Supplier Name:

Supplier Code: ▼

Material Code/Class: ▼

Map Location / Address: Map Location Address

To search all Suppliers, regardless of location, do not include a Map or Address filter.

[Supporting Information \(PDF\)](#)

Search Results

Compare
Select All
Clear Selection

7 Products Found

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- To compare details side-by-side, click the checkboxes beside two or more rows. Click Compare.
- Click Select All to select all results. Click Clear Selection to clear all selections.

	>	<input type="checkbox"/>	Supplier Name	Supplier Code	Material Code	Material Class	Location	Status
>	>	<input type="checkbox"/>	Lopke, F. S., Contracting, Inc.	LOPNYB14	207	A	OWEGO	Approved
>	>	<input type="checkbox"/>	Lopke, F. S., Contracting, Inc.	LOPNYB14	203	A57GL	OWEGO	Approved
>	>	<input type="checkbox"/>	Lopke, F. S., Contracting, Inc.	LOPNYB14	203	A8GL	OWEGO	Approved
>	>	<input type="checkbox"/>	Lopke, F. S., Contracting, Inc.	LOPNYB14	249	AS1	OWEGO	Approved
>	>	<input type="checkbox"/>	Lopke, F. S., Contracting, Inc.	LOPNYB14	249	AS2	OWEGO	Approved
>	>	<input type="checkbox"/>	Lopke, F. S., Contracting, Inc.	LOPNYB14	249	AS3	OWEGO	Approved
>	>	<input type="checkbox"/>	Lopke, F. S., Contracting, Inc.	LOPNYB14	207	B3	OWEGO	Approved



- Click a tab to locate approved materials in Bulletin 14 (Aggregate), Bulletin 15 (Qualified Products List for Construction), Bulletin 41 (Bituminous) or Bulletin 42 (Concrete).
- Enter search criteria in one or more fields. Click Search to view the results. Click Reset to start over.
- Map views are not available for searches performed with the Address filter. Map views only display results for Suppliers who have map coordinates on file and may not represent all search results.

Bulletin – Search Criteria

Bulletin 14 (Aggregate)
Bulletin 15 (Qualified Products List for Construction)
Bulletin 41 (Bituminous)
Bulletin 42 (Concrete)

Supplier Name:

Supplier Code:

Material Code/Class:

Map Location / Address: Map Location Address

[Supporting Information \(PDF\)](#)

To search all Suppliers, regardless of location, do not include a Map or Address filter.

Search Results

7 Products Found

- To display item details, click the arrow (>) beside one or more rows. To view the details for all rows, click the arrow (>) at the top of grid.
- To compare details side-by-side, click the checkboxes beside two or more rows. Click Compare.
- Click Select All to select all results. Click Clear Selection to clear all selections.

> <input type="checkbox"/>	Supplier Name	Supplier Code	Material Code	Material Class	Location	Status
> <input type="checkbox"/>	Lopke, F. S., Contracting, Inc.	LOPNYB14	207	A	OWEGO	Approved
v <input type="checkbox"/>	Lopke, F. S., Contracting, Inc.	LOPNYB14	203	A57GL	OWEGO	Approved
<div style="border: 1px solid black; padding: 5px;"> <p>Approval Date: 11/16/2017</p> <p>Primary Address: Lopke, F. S., Contracting, Inc. 3430 State Route 434 Apalachin, NY 13732</p> <p>Physical Address: Lopke, F. S., Contracting, Inc. NY</p> <p>Phone Number: _____ Fax Number: _____</p> <p>Lab Number: L17030773 Restrictions: _____</p> <p>Bulk Specific Gravity (SSD): 2.639 Bulk Specific Gravity: 2.603</p> <p>Absorption: 1.40 Sodium Sulfate Soundness: 2 %</p> <p>Alkali-Silica Reactivity (ASR) 0.37 Alkali-Silica Reactivity (ASR) 0.032</p> <p>AASHTO T303 : _____ ASTM C1293 : _____</p> <p>AASHTO T303 Reactivity Class : _____ ASTM C1293 Reactivity Class : R0</p> <p>Uncompacted Voids: _____ Sand Equivalency: _____</p> <p>Rock Compositions & Order Of Abundance: GL (Gravel): 1 Skid Resistance Level Type: H</p> <p>Los Angeles Abrasion: 21 Micro-Deval Loss: 15</p> <p>Crush Count % 1-Face: 85 Crush Count % 2-Face: 77</p> <p>Thin & Elongated Pieces (5:1): _____</p> </div>						
> <input type="checkbox"/>	Lopke, F. S., Contracting, Inc.	LOPNYB14	203	A8GL	OWEGO	Approved
> <input type="checkbox"/>	Lopke, F. S., Contracting, Inc.	LOPNYB14	249	AS1	OWEGO	Approved

Quality Control

VIII. Quality Control/Quality Assurance

A. QC/QA Implementations:

The aggregate technician will be testing the material in the plant lab in amounts and intervals prescribed by their approved Quality Control Plan. The plant will also receive inspections from the District Materials Engineer or a member of his staff under the provisions of the District Quality Assurance Plan. They will take District Quality Assurance (D.Q.A.) samples to be sent to the Laboratory Testing Section (LTS) of PennDOT. The Bureau of Project Delivery Construction Quality Assurance Section will administer the Independent Assurance program at aggregate sources supplying PennDOT construction projects. The Independent Assurance program provides an unbiased and independent evaluation of the sampling and testing personnel, the testing equipment, and the sampling and testing procedures used in PennDOT's aggregate acceptance program. Independent Assurance samples will be tested at PennDOT's LTS and the test results will be compared with companion test results run at the aggregate source to verify the results are within established tolerance limits for gradation Material finer than 200 sieve and crush count (where applicable) and durability.

B. Aggregate Technician Record Keeping:

There are three (3) categories of record keeping that every aggregate supplier must comply with to maintain State approval which are described below. Records are written in black ink and kept in the **Construction Aggregate Source Documentation Book**, sometimes referred to as **the Material Plan Book** or **State Book**. It is important to understand that charts and records documenting quality control inspections and tests are the property of PennDOT. The specifications for Aggregate Plant Records and Documentation are found in the PennDOT "Project Office Manual, Part B, Section 7, pages 15-1-2". Current copies of forms for record keeping can found at www.pendot.gov under "Forms and Publications."

1. Plant Production:

- a)** Have on file a **Quality Control Program** approved by PennDOT. The specifications for Minimum Quality Control Plan for Aggregate suppliers are found in the PennDOT Project Office Manual, Part B, Section 7, pages 14-1,2.
- b)** Have on file a copy of the **Aggregate Source Evaluation Report** (Form TR 430A).

- c) Have on file records for testing of all material being produced for State consumption. These results are kept, using **Form CS 4211-A**.
- d) All gradation recorded on Form CS 4211-A are than plotted on a **straight-line analysis graph**. A straight-line graph must be maintained for sieve. Additional documentation should be provided detailing procedures that were taken to correct problems. This information can be entered on the back of the appropriate Plant Book Form.
- e) The equipment is to be calibrated in accordance with specification requirements and the technician must **record calibration results on Form CS 4221-E**.
- f) The aggregate technician must also maintain a record of samples submitted to the Laboratory Testing Section (LTS) using **Form CS 4211-E**. Some of the information requested on this form will not be available until the results are returned to the plant.

2. **Shipments to PennDOT:**

- a) The aggregate technician must maintain a record of all material being shipped and who released the material. This information is to be recorded on **Form CS 4221-C**. **All material shipped to PennDOT must be released by a PennDOT representative.**
- b) **A project summary will be maintained** recording the total tonnage shipped to each job, by type of material shipped. This information is recorded on **Form CS 4211-B**.
- c) The aggregate technician will provide a **Certificate of Compliance using the most current Form CS 4171** for each product and each job which has received shipments(s) daily. **This is a signed, legal document, certifying that all appropriate testing has been performed and that the material meets specification requirements.**
- d) The aggregate technician is also responsible for maintaining a **plant summary (combined daily shipments) on Form CS 4211-D**.
- e) When anti-skid is being shipped to PennDOT, the aggregate technician is also responsible for obtaining **testing and recording samples for moisture on Form CS 4221-G**.

3. Source Records for Quality Requirements:

Each aggregate producer is required to perform, or have performed by an independent lab, such occasional quality tests as may be necessary to ensure that the product consistently meets the quality requirements for fine or coarse aggregates.

This is in addition to biennial requalification testing done by PennDOT.

- a) Records of these tests will be kept in an ongoing file, and available for the review with Department representatives at any time.
- b) If testing is done on “splits” of PennDOT samples, it will be noted in the report with results included.
- c) The reports will indicate date sampled, part of quarry from which the production came, the geological unit, and any other distinctions which are considered important (selective mining situations).

4. District Quality Assurance Aggregate Source Inspections:

This form must be signed by the aggregate technician.

Aggregate Source Documentation Book

WE WILL NOW REVIEW EACH FORM IN DETAIL IN THE SAME SEQUENCE DESCRIBED ABOVE.

REPLACES B.7.15	PENNSYLVANIA DEPARTMENT OF TRANSPORTATION	PART B	SECTION 7	PAGE 15-1
DATED 04/01/2017	PROJECT OFFICE MANUAL	DATE April 2, 2018		
SUBJECT AGGREGATE PLANT RECORDS AND DOCUMENTATION				

The Material Plant Book must have the producer's name and plant location on the outside cover. It should be maintained as one book containing one set of test records as documentation for all projects supplied. Form [CS-4211](#), Table of Contents, lists all forms required for plant book.

The producer is responsible for source documentation and production control in accordance with the approved quality control plan. All testing procedures are found in Publication 19, Field and Laboratory Testing Manual or appropriate AASHTO or ASTM test methods.

Plant Inspector's Documentation

The plant inspector should keep, on a daily basis, Form [CS-4346](#), Items Quantity Book, as a Plant Master Diary, in black ink, and shall include the following information:

1. Date, Weather, Temperature Range
2. Inspector's Name, Title, Hours Worked
3. Visitors
4. Material Tests Performed
5. Material Deviations
6. Unusual Occurrences, Comments Concerning Plant Operation, Conditions and Record Keeping
7. Inspector's Signature

Producer's Documentation

The producer is responsible for completing the following forms which constitute the Material Plant Book:

- Form [CS-4211](#) Table of Contents
 - Form [CS-4211A](#) Material Test Result Records
- Separate copies must be used for each aggregate size.

PART	SECTION	PAGE	DATE
B	7	15-2	April 2, 2018

Form [CS-4211B](#) Project Summary Record
 Separate sheet for each aggregate type.

Form [CS-4211D](#) Plant Summary *
 Form [CS-4211E](#) MTD Sample Submission Record
 Form [CS-4211I](#) Aggregate No. 57
 Form [CS-4211J](#) Aggregate No. 8
 Form [CS-4211K](#) Fine Aggregate
 Form [CS-4211L](#) Aggregate No. OGS
 Form [CS-4211M](#) Aggregate No. 67
 Form [CS-4211N](#) Aggregate No. 2A
 Form [CS-4221C](#) Daily Orders and Releases Record
 Form [CS-4221E](#) Equipment Calibration Record (Including PTM 608)
 Form [CS-4221G](#) Anti-Skid Summary & Moisture Record

* - The CS-4211D Plant Summary is available as part of the eCAMMS ESB.

The Plant Technician will also establish straight line diagrams or statistical quality control charts for each aggregate size which will also include action points for critical test values.

Plot all District/Central Office Quality Assurance samples results along with all the companion sample results conducted by the Plant Technician. Comments will be made and documented on all LTS test results compared to companion sample results as to uniformity between laboratories.

Form [TR-430A](#) - Aggregate Source Evaluation Report, Technicians Evaluation and the Quality Control Plan shall be on file at the Plant.

Production Acceptance

The original producer delivery ticket (or a copy of the recordation ticket) must accompany material released from a plant or accepted on a project. The ticket must contain the following information:

1. Contract Number, State Route and Section or Purchase Order
2. County and District
3. Type Aggregate
4. Date
5. Truck Number
6. Mass (Weight), Gross, Tare, Net
7. Lot Number
8. Signature of Licensed Public Weighmaster

REPLACES B.7.14	PENNSYLVANIA DEPARTMENT OF TRANSPORTATION PROJECT OFFICE MANUAL	PART B	SECTION 7	PAGE 14-1
DATED 01/01/2008		DATE March 1, 2011		
SUBJECT MINIMUM QUALITY CONTROL PLAN FOR AGGREGATE SUPPLIERS				

The producer must submit a quality control plan to the District Materials Engineer/Manager annually. The purpose of this requirement is to ensure that the producer will consistently produce a uniform and high quality product within Department specifications.

The following Quality Control Plan is a minimum plan designed to these standards.

A. Sampling and Testing Frequencies

The minimum testing frequency for all aggregate types will be at least one sample daily for the first 500 tons and one sample for each additional 1,000 tons. Tests are to include, if applicable:

1. Gradations PTM No. 616
2. Wash Test PTM No. 100
3. Crush Count ASTM D 5821
4. Unit Weight AASHTO T 19 (To be tested twice a year or as required)

Tests other than gradations may be reduced to once weekly after uniformity has been established. For high volume aggregate production such as subbase material, sampling frequency may be increased to 1,000 tons daily and one for each additional 2,000 tons. All changes to sampling/testing frequencies must be approved by the District Materials Engineer/Manager.

B. Department Stockpiles

Establish and positively identify aggregate stockpiles intended for Department use. At a minimum, the respective grading (AASHTO or PennDOT) and specific use (if appropriate) will be provided.

C. Material Failures

Increase production testing frequencies to at least double the minimum required in Section A above until uniformity is established over five consecutive production days. Document all actions taken when failures are noted.

D. Certification

Certify each day's shipments for each aggregate size to each project shipped, in accordance with Section 106.03(b)3, Publication 408.

E. Calibration of Mechanical Sieve Shaker

Calibrate mechanical sieve shaker in accordance with PTM No. 608 at the start of the season and when directed.

PART B	SECTION 7	PAGE 14-2	DATE March 1, 2011
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QUALITY CONTROL PROGRAM - 2017
Hard Stone Co., Inc.
Quality Control Plan for Aggregate -HSC00B14

The following Quality Control Plan is a minimum for control and acceptance of construction aggregates.

A. Sampling and testing frequencies -

The minimum testing frequency for all aggregate types including Anti-skid will be at least one sample daily for the first 500 tons and one sample for each additional 1,000 tons or portion of. High volume aggregate production such as subbase material sampling frequency may be increased to 1,000 tons daily and one for each additional 2,000 tons.** Tests are to include, if applicable:

** If approved by DME

1. Gradations - PTM 616 (AASHTOT-27)
2. Wash Test- PTM 100 (AASHTO T-11)
3. Crush Count - PIM 621 (ASTM-D5821)
4. Urut Weight - AASHTO T-19
5. Moisture Content - PTM 513
6. Minimum Strength Ratio - AASHTO-T21 (Requalification year and at least one per month while producing)

Tests other than gradations may be reduced to once per calendar week after uniformity has been established, unless material is used for Concrete, then a wash test **MUST** be run on every grading. All changes to sampling/testing frequencies must be approved by the District Materials Engineer. For Type A Sand and anti-skid that requires a wash test one is required with every gradation, follow PTM 616. All gradations will be lifted from either conveyor belt (if able) or mini stockpile adjacent to pile to control gradation (AASHTO T-2).

In the event of blending any aggregates, a front-end loader will mix the material into 500 ton (maximum) stockpiles. They will be tested prior to incorporating into Penn DOT stockpile s.

A minimum of two moisture tests per day will be conducted when shipping Anti-skid. Additional tests will be conducted when conditions exist which would cause a change in moisture content. Record moisture results and tonnage shipped on Form CS-4171.

B. Documentation -

The Plant Technician will be responsible for maintaining the following forms in the plant book:

1. Table of Contents
2. TR 430A
3. Technicians Certification
4. QC Plan
- *5. Calibration of Equipment {scales, oven, etc.}
- *6. Orders and Releases
- *7. Project Summaries
- *8. Plant Summaries
- *9. Aggregate Gradations and Straight Lines
- *10. Anti-skid Summary and Moisture
- *11. MTD Sample Submission Record
- *12. Estimate of daily production of aggregate sizes.
- *13. Annual calibration of mechanical shakers (PTM608) (start of season)

*In electronic plant book (backed up daily)

All entries must be complete by the next working day.

B. (1) Documentation-

All District/Central Office quality assurance sample results along with all companion sample results conducted by the Plant Technician will be plotted. Comments will be made and documented on all MTD test results compared to companion sample results as to uniformity between laboratories.

C. Department Stockpiles -

Aggregate stockpiles intended for Department use will be established and positively identified. At a minimum, the respective grading (AASHTO or PDOT) and specific use (if appropriate) will be provided. Mote-paver and 1% wash spec #8 will be designated when applicable. When shipping from approved isolated stockpiles, test for gradation and wash test, at least once per week.

Driving Surface Aggregate (DSA) - When producing DSA for a state or municipal project, construct the stockpile and notify the District Materials Unit to perform source verification prior to shipping. The stockpile cannot be added to after approval by the District for gradation.

D. Material Failures -

Production testing frequencies will be increased to at least double the minimum required in Section A above until uniformity is established over five consecutive production days. Document all actions taken when failures are noted.

A material failure is defined as follows:

If any single test value is out of specification, immediately resample and test. If the retest passes, no action is required. If the retest fails, another sample and test is required. Evaluate the three test values in accordance with Section 106.03(a)3 to determine the percent within limits. If the sample results indicate a PWL of less than 90 a new stockpile will be constructed. Increased production testing frequencies will be followed as stated above.

E. Action Points -

Action points will be established on the straight-line diagrams or control charts. Documented action will be taken anytime the N=3 plot falls into the established action area. Action is also, required whenever the N=3 value is within 1% of the specification limit for all critical sieves that have a \pm tolerance. Document the action taken.

The following action points from critical test sieves are to be used as a minimum for these aggregate types.

#57-1/2" sieve $\pm 7\%$ from established target value (42% -target, min. 35% passing-Slip Form Pavement)

- #200 sieve 1.0% **max** for cement concrete
- 0.8% max. for seal coat and surface treatment
- 2.0% max. for all other uses

#67 - 3/8" sieve $\pm 7\%$ from established target value

- #200 sieve - same as #57

#8 - #4 sieve $\pm 4\%$ from established target value

- #200 sieve same as #57

#10 - #100 sieve $\pm 4\%$ from established target value

- #200 sieve 8% maximum (if used for flowable fill)

2A - #4 sieve $\pm 7\%$ from established target value

- #16 sieve $\pm 4\%$ from established target value
- #200 sieve 8% maximum

Anti-Skid (All Types)

- #4 and #8 sieve when within 5% of any spec. limit
- #200 sieve (if required) when within 1% of spec limit

DSA -#4 sieve $\pm 7\%$ from established target value

- #16 sieve $\pm 4\%$ from established target value
- #200 sieve 11% minimum, 14% maximum

F. Certification -

CS-4171 (Dated 8-16)

The technician will certify each day's shipments for each aggregate size to each project shipped in accordance with Section 106.03(b)3. Use Form CS-4171, include supplier code and aggregate quality type (ie: A57, C2A).

For anti-skid shipments show wet tonnage, dry tonnage and percent of moisture.

G. Delivery Ticket-

1. SR and Section or P.O.
2. County and District
3. Type of Aggregate

ADDENDUM SHEET

TRUCK WEIGHT VERIFICATION

Scope:

As a way of establishing truck weight verification at all locations in District 7-0, Hard Stone Co., Inc. will randomly select three units per location per month for purposes of checking axle weights. The goal will be to eliminate any vehicles leaving any location with axle weights that do not meet the axle weight standards as set forth by the Department of Transportation. Any vehicles that are found to have deviant axle weights will be required to make immediate adjustments prior to being released from the plant.

Each location will have an individual assigned to oversee this program and ensure that it is carried out to its fullest. The Truck Weigh Record supplied by the Department will be used to record the data.

Also, it is our intention to provide training for the loader operators that will incorporate many issues including the importance of proper truck axle weights.

A. Sampling and Testing Frequency

1. Samplers will be:
 - a. Plant licensed weighmaster
 - b. and/or Certified Plant Technician

2. Frequency will be:
 1. One test series/month (day selected by samplers)
 2. Three trucks/test (selected by PTM1)

Note: The intent is to test 3 trucks/day/test
However, 1 truck/day on 3 different days
could be substituted by mutual agreement.

8. Documentation

1. Penn DOT form TWR (6-0) revised 11/97
2. Prepared by Plant Technician
3. Maintained in separate section of plant book

C. Reference

1. Truckers Handbook

D. Overview

This program will be monitored by:

1. Transportation Manager Trucker Joe
2. Technical Services Manager Mark Services



AGGREGATE SOURCE EVALUATION REPORT

Purpose: Preliminary () Qualification ()
Requalification (x) Investigation ()
Research () Project ()

District 8-0 Date 6/15/17

County Dauphin

Twp. or Boro. Washington

Lab. No. EAF, 22A14

PERMANENT SOURCE

Producer NES & L -- PO Box 77, New Enterprise, PA 16664

(NAME AND ADDRESS)

Location Elizabethville Quarry

(AS LISTED OR TO BE LISTED IN BULLETIN)

TEMPORARY SOURCE

Contractor

L.R. Section

Location of Aggregate Source: 1 miles from Elizabethville on L.R. or T.R. SR 0225

Sec. Lt. or Rt. Township on Mile Post Pool on River

Processing Plant. Permanent (x) Portable (), None (). If none, name of producer and location where material was processed to provide the samples submitted, if any.

Superintendent or other contact: Name Steve Glenny Tel. 814-386-3809

A. This source is proposed for new or continued listing in Bulletin 13 (), Bulletin 14 (x), a temporary or project source (), or Bulletin 16, () for one or more of the following materials.

1. Coarse Aggregate: Type A (x), Type A, Bituminous Only (), C (x); Stone (), Gravel (), or Slag (), Recent (), or Reclaimed (), Blast Furnace (), Open Hearth (), Basic Oxygen () Granulated ()

2. Fine Aggregate: Type A (), B-Bituminous Only (x) White (); Natural-Bank (), Pit () River () or Manufactured Sand from Conglomeratic Sandstone () Limestone () Other

3. Anti-Skid: AS Type 1 (), 2 (x), 3 (x), 4 ()

4. Mineral Filler ()

B. Quality Control: Producer's records indicate that samples are tested at the rate of about 1/1000 tons samples per week or one sample per ton(s). These tests are made at this location (x) or at by employees of

ALL

At this location, the following equipment is available for quality control testing:

None (), Mechanical shaker with timer for coarse aggregate (), For fine aggregate (), For Anti-Skid (), Standard sieves for coarse aggregate: 4" (), 3 1/2" (), 2 1/2" (), 2" (), 1 1/2" (), 1" (), 3/4" (), 1/2" (), 3/8" (), #4 (), #8 (), #16 (), #100 (), #200. For fine aggregate: 3/8" (), #4 (), #8 (), #16 (), #30 (), #50 (), #100 (), #200 (). For Anti-Skid 1 1/4" (), 1/2" (), 3/8" (), 5/16" (), #8 (), #100 (). Unit Weight container one cubic foot, PTM 609 (), Balance, 2kg x 1/10 gram, (), Platform scale, 200 lb. x 1/10 lb. (), Hot plate, 2 burner ().

Comments on the condition of the testing equipment and quality control records:

Excavation: The working face is being advanced in an N (), E (), S (), W () _____ly direction. The excavation is being carried out in such a way that contamination of the material by soil (), coal (), shale (), and or _____ () is a major (), minor (), no () problem. The method of excavating produces no (), few (), many () oversize pieces that are reduced by drop ball (), blasting (), or are wasted (). The excavated material is transported to the processing plant by belt (), truck (), barge (). For details on the processing and stockpiling, as well as excavating methods, use extra sheets.

Stockpiling: The aggregate is transported to the stockpiles and placed by truck (), belt (), clam-bucket (), movable stacker (). The stockpiles are built by casting and spreading (), dumping off a ramp pile (), layering (), other ().

Evaluation: Because of the excavating (), processing (), stockpiling () loading (), practices, the aggregate delivered to the job site or plant is expected to contain no (), little (), borderline (), excessive (), quantities of rock dust (), clay (), or other deleterious material such as _____

Particle shape is considered to be satisfactory (), unsatisfactory (), borderline ().

Samples for _____ Submitted on _____
(PURPOSE) (DATE)

If aggregate samples are within Specifications, source should be approved Yes () No ().

PennDER Interim or Final Permit Number _____

Additional Comments: _____

Reported by Daryl Hill Title _____ Date _____

MATERIAL PLANT BOOK TABLE OF CONTENTS

PLEASE TYPE OR PRINT IN BLUE OR BLACK INK ALL INFORMATION

FORM NO.	DESCRIPTION	AGGR. PLANT	BITC. PLANT	PCC PLANT
CS-4211	TABLE OF CONTENTS	X	X	X
CS-4211A	MATERIAL TEST RESULTS	X	X	X
CS-4211B	PROJECT SUMMARY	X	X	X
CS-4211C	SCALE CHECK	X	X	X
CS-4211D	PLANT SUMMARY	X	X	X
CS-4211E	MTD SAMPLE SUBMISSION RECORD	X	X	X
CS-4211F	COMPRESSION TESTS			X
CS-4211G	EXTRACTION TESTS		X	
CS-4211H	GRADATION OF HOT-BINS AGGREGATE BLEND		X	
CS-4211I	#57 AGGREGATE GRADATION	X	X	X
CS-4211J	#8 AGGREGATE GRADATION	X	X	X
CS-4211K	FINE AGGREGATE GRADATION	X	X	X
CS-4219A	DENSITY TEST RESULTS		X	
CS-4219C	ASPHALT PENETRATION RECORD		X	
CS-4221A	MOISTURE TESTS			X
CS-4221B	MATERIAL TEMPERATURES			X
CS-4221C	RECORD OF DAILY ORDERS AND RELEASES	X	X	X
CS-4221E	EQUIPMENT CALIBRATION RECORD	X	X	X
CS-4221F	401 LOT SAMPLES		X	
CS-4221G	ANTI SKID SUMMARY & MOISTURE RECORD	X		

MATERIAL TEST RESULTS AGGREGATE NO. 57

PLEASE TYPE OR PRINT IN BLUE OR BLACK INK ALL INFORMATION



DATE											
SIEVE	BAND	MASS (WGT)	% PASSING	MASS (WGT)	% PASSING	MASS (WGT)	% PASSING	MASS (WGT)	% PASSING	MASS (WGT)	% PASSING
37.5mm (1 1/2")	100										
25.0mm (1")	95-100										
12.5mm (1/2")	25-60										
4.75mm (#4)	0-10										
2.36mm (#16)	0-5										
U.C.											
WASH											
CRUSH											
ORIGINAL MASS (WGT.)											
% MASS (WGT.) LOSS											
TESTED BY											
REMARKS											

NOTE: MTD RECOMMENDED BREAKER SIEVES, 19mm (3/4") OR 16mm (5/8") AND 9.5mm (3/8")

MATERIAL TEST RESULTS AGGREGATE NO. 8

PLEASE TYPE OR PRINT IN BLUE OR BLACK INK ALL INFORMATION



DATE											
SIEVE	BAND	MASS (WGT)	% PASSING	MASS (WGT)	% PASSING	MASS (WGT)	% PASSING	MASS (WGT)	% PASSING	MASS (WGT)	% PASSING
12.5mm (1/2")	100										
9.5mm (3/8")	85-100										
4.75mm (#4)	10-30										
2.36mm (#8)	0-10										
1.18mm (#16)	0-5										
WASH											
CRUSH											
ORIGINAL MASS (WGT.)											
% MASS (WGT.) LOSS											
TESTED BY											
REMARKS											

NOTE: MTD RECOMMENDED BREAKER SIEVES, 6.5mm (1/4")

MATERIAL TEST RESULTS FINE AGGREGATE

PLEASE TYPE OR PRINT IN BLUE OR BLACK INK ALL INFORMATION



pennsylvania

DEPARTMENT OF TRANSPORTATION

www.dot.state.pa.us

DATE											
SIEVE	BAND	MASS (WGT)	PERCENT	MASS (WGT)	PERCENT	MASS (WGT)	PERCENT	MASS (WGT)	PERCENT	MASS (WGT)	PERCENT
9.5mm (3/8)											
4.75mm (#4)											
2.36mm (#8)											
1.18mm (#16)											
600µm (#30)											
300µm (#50)											
150µm (#100)											
75µm (#200)											
Fineness Modulus											
WASH											
TESTED BY											
REMARKS											

DATE											
SIEVE	BAND	MASS (WGT)	PERCENT	MASS (WGT)	PERCENT	MASS (WGT)	PERCENT	MASS (WGT)	PERCENT	MASS (WGT)	PERCENT
9.5mm (3/8)											
4.75mm (#4)											
2.36mm (#8)											
1.18mm (#16)											
600µm (#30)											
300µm (#50)											
150µm (#100)											
75µm (#200)											
Fineness Modulus											
WASH											
TESTED BY											
REMARKS											

MATERIAL TEST RESULTS AGGREGATE NO. OGS

PLEASE TYPE OR PRINT IN BLUE OR BLACK INK ALL INFORMATION



pennsylvania

DEPARTMENT OF TRANSPORTATION

www.dot.state.pa.us

DATE											
SIEVE	BAND	MASS (WGT)	% PASSING	MASS (WGT)	% PASSING	MASS (WGT)	% PASSING	MASS (WGT)	% PASSING	MASS (WGT)	% PASSING
50mm (2")	100										
19.0mm (3/4")	52-100										
9.5mm (3/8")	36-65										
4.75mm (#4)	8-40										
1.18mm (#16)	0-12										
U.C.*											
WASH	75% (3 face)										
CRUSH	0-5										
ORIGINAL MASS (WGT.)											
% MASS (WGT.) LOSS											
TESTED BY											
REMARKS											

NOTE: MTD RECOMMENDED BREAKER SIEVES, 37.5mm (1 1/2") AND 12.5mm (1/2")

* The required minimum coefficient of uniformity for individual samples is 3.5. Provide No. OGS material that has a minimum average coefficient of uniformity of 4.0.

MATERIAL TEST RESULTS AGGREGATE NO. 67

PLEASE TYPE OR PRINT IN BLUE OR BLACK INK ALL INFORMATION

DATE											
SIEVE	BAND	MASS (WGT)	% PASSING	MASS (WGT)	% PASSING	MASS (WGT)	% PASSING	MASS (WGT)	% PASSING	MASS (WGT)	% PASSING
50.0mm (2")	200										
19.0mm (3/4")	90-100										
9.5mm (3/8")	20-55										
4.75mm (#4)	0-10										
2.36mm (#8)	0-5										
WASH											
CRUSH											
ORIGINAL MASS (WGT.)											
% MASS (WGT.) LOSS											
TESTED BY											
REMARKS											

NOTE: MTD RECOMMENDED BREAKER SIEVES, 37.5mm (1 1/2") AND 12.5mm (1/2")

MATERIAL TEST RESULTS AGGREGATE NO. 2A

PLEASE TYPE OR PRINT IN BLUE OR BLACK INK ALL INFORMATION

DATE											
SIEVE	BAND	MASS (WGT)	% PASSING	MASS (WGT)	% PASSING	MASS (WGT)	% PASSING	MASS (WGT)	% PASSING	MASS (WGT)	% PASSING
50mm (2")	100										
19.0mm (3/4")	52-100										
9.5mm (3/8")	36-70										
4.75mm (#4)	24-50										
1.18mm (#16)	10-30										
75µm (#200)	DRY										
WASH	0-10										
CRUSH	(A) 55-100 (C) 50-100										
ORIGINAL MASS (WGT.)											
% MASS (WGT.) LOSS											
TESTED BY											
REMARKS											

NOTE: MTD RECOMMENDED BREAKER SIEVES, 37.5mm (1 1/2") AND 12.5mm (1/2")
NOTE: DRY 75µm (#200) SIEVE FOR INFORMATION ONLY. (NOT REQUIRED SPEC. SIEVE)



AGGREGATE REPORT

<input type="checkbox"/> FINE AGG. <input checked="" type="checkbox"/> COARSE AGG. <input type="checkbox"/> ANTI SKID		<input type="checkbox"/> ACCEPTANCE <input type="checkbox"/> VERIFICATION <input type="checkbox"/> INFORMATION		<input type="checkbox"/> CONSTRUCTION <input type="checkbox"/> MAINTENANCE		P.O./CONT. NO _____								
MAT'L SPEC TYPE _____		DATE SAMPLED _____		ITEM NUMBER _____		ITEM QUANTITY _____								
PRODUCER/LOCATION _____						LOT NO. _____								
SYS	SR/PO	SPUR	PHA	SEC	ORG	CO	TON(NES) _____ TO _____							
							TON(NES) SHIPPED: TODAY _____ TO DATE _____ BALANCE _____							
SUBLOT NO.		1		2		3		SPEC. LIMITS		STATISTICAL ANALYSIS		MATERIAL TYPE:		
TON(NE) SAMPLED												TESTED BY:		
SIEVE		MASS (WT)	%	MASS (WT)	%	MASS (WT)	%	L	U	X	S	PWL	DEPT. INSPECT.	
100 mm (4")													WITNESSED BY:	
90 mm (3 1/2")													SOURCE TECH.	
75 mm (3")													REVIEWED BY:	
63 mm (2 1/2")													COUNTY MGR.	
50 mm (2")													D.M. UNIT	
37.5 mm (1 1/2")													DIST. ENGR.	
31.5 mm (1 1/4")													PWL _____	
25.0 mm (1")													PAY _____ %	
19.0 mm (3/4")													WET MASS(WT)-DRY MASS(WT)	
12.5 mm (1/2")													DRY MASS (WT)	
9.5 mm (3/8")													X100 = % MOISTURE	
8.0 mm (5/16")														
4.75 mm (#4)														
2.36 mm (#8)														
1.18 mm (#16)														
600 µm (#30)														
425 µm (#40)														
300 µm (#50)														
150 µm (#100)														
75 µm (#200)														
INITIAL DRY MASS (WT)														

MAT'L FINER THAN 75µm (#200)(FINAL WGT)														
CRUSHED FRAG MASS (WT) % (FINAL WGT)														
UNIT WEIGHT KG/M³ (LBS/CF)														
COEFFICIENT OF UNIFORMITY														
WEIGHT USED FOR FINE GRADATION														
FACTOR														

$$\text{AVERAGE} = X = \frac{\sum_{i=1}^n X_i}{n}$$

$$\text{STANDARD DEVIATION} = S = \sqrt{\frac{\sum_{i=1}^n (X_i - X)^2}{n-1}}$$

$$Q_u = \frac{(U - X)}{S} \quad Q_L = \frac{(X - L)}{S}$$

$$\text{PWL} = (P_u + P_L) - 100$$

#200 Wash Start Wgt.			
Crush Cnt. Start Wgt.			

REMARKS

MATERIAL TEST RESULTS AGGREGATE NO. 8

PLEASE TYPE OR PRINT IN BLUE OR BLACK INK ALL INFORMATION



DATE											
SIEVE	BAND	MASS (WGT)	% PASSING	MASS (WGT)	% PASSING	MASS (WGT)	% PASSING	MASS (WGT)	% PASSING	MASS (WGT)	% PASSING
12.5mm (1/2")	100										
9.5mm (3/8")	85-100										
4.75mm (#4)	10-30										
2.36mm (#8)	0-10										
1.18mm (#16)	0-5										
WASH											
CRUSH											
ORIGINAL MASS (WGT.)											
% MASS (WGT.) LOSS											
TESTED BY											
REMARKS											

NOTE: MTD RECOMMENDED BREAKER SIEVES, 6.5mm (1/4")

CERTIFICATE OF COMPLIANCE

INSTRUCTIONS

Refer to Publication 2, Project Office Manual, Section B.6.3 for additional guidance in completing this Form.

1. COUNTY, LR/SR, SEC/SEG. ECMS#

To be completed by the party that will ship the material to the construction project, otherwise leave blank.

2. NAME OF MANUFACTURER, FABRICATOR, COATER, PRECASTER OR PRODUCER

- Check appropriate box; manufactured, fabricated, coated, precasted or produced as appropriate. If a single company performs more than one operation (e.g., a company manufactures and coats guiderail), more than one box may be checked.
- Also, provide the name and the supplier code of the manufacturer, fabricator, coater or precaster of the material listed in Bulletin #15 or the name and the supplier code of the Producer of material listed in Bulletin # 14, 41 or 42.
- To be completed by the party that is shipping approved material to the next destination.

3. MEETS SPECIFICATION REQUIREMENTS

To be completed by the party that is shipping approved material to the next destination.

4. SHIPPED TO

List the name of the company that material is being shipped to.

5. LOT NUMBER, QUANTITY, DESCRIPTION OF MATERIAL

To be completed by the party that is shipping approved material to the next destination.

6. CHECK THIS BLOCK IF YOUR PRODUCT CONTAINS IRON OR STEEL

To be completed by the party that is shipping approved material to the next destination.

7. VENDOR CLASSIFICATION (CHECK ONE BLOCK ONLY)

If you are a Manufacturer, Fabricator, Coater or Precaster listed in Bulletin #15, or a Producer listed in Bulletin # 14, 41 or 42, check block # 1.

If you are a *Distributor, *Supplier or *Private Label Company of Bulletin #15 items, check block # 2.

(* - These categories are not eligible for listing in Bulletin #15, however, you may provide material for PennDOT projects on condition that the material being shipped is listed in Bulletin #15.)

8. CERTIFICATION REQUIREMENTS, Name, Title, Date, Company Name, and Signature

Enter the required information and sign the Certificate of Compliance form.

9. COMPLETE LINE # 9 ONLY IF YOU CHECKED BLOCK # 2 ON LINE # 7, OTHERWISE LEAVE BLANK

List company that sold the material to you. (Company Name)

IN ADDITION:

- 2. & 5.** Private Label Companies who complete the Certificate of Compliance form CS-4171 must identify the true manufacturer (Line 2) and the approved material (Line 5) as it is listed in Bulletin # 15 under that manufacturers listing.

After completing the Certificate of Compliance form CS-4171, maintain the original at your company's location. A copy of the Certificate of Compliance form must accompany your material shipment to its next destination. Also, if you receive material shipments from other companies related to PennDOT projects, the accompanying Certificate of Compliance forms must be kept on file at your location. These files must be available for inspection and verification by a Department Representative for a period of not less than THREE years from the date of the last shipment.



CERTIFICATE OF COMPLIANCE

1. **◆COUNTY:** _____ **◆LR/SR:** _____ **◆SEC/SEG:** _____ **◆ECMS#:** _____
(◆ - To be completed by the party that will ship the material to the project, otherwise leave blank.)

2. I / WE hereby certify that the material listed on line 5 was:
If a single company performs more than one operation (e.g., a company manufactures and coats guiderail), more than one box may be checked.

- Manufactured Fabricated Coated Precasted Produced

By _____
(Name of Manufacturer, Fabricator, Coater, Precaster or Producer) (Supplier Code)

3. and the party listed above certifies that the material(s) on line 5 meets the requirements of
Publication 408, Section(s) _____

AASHTO, ASTM, Federal or other designation _____

4. The material listed below is being shipped to: _____
(Company Name)

5. LOT NO.	QUANTITY	APPROVED MATERIAL AS LISTED IN BULLETIN # 14 or 15 BULLETIN # 41 or 42 PRODUCERS, LIST HMA / PCC JMF.

6. **CHECK HERE IF YOUR PRODUCT CONTAINS IRON OR STEEL.** I certify the material identified above conforms to Sections 106.01 and 106.10(a) of Publication 408.

CHECK ONE OF THE TWO BOXES:

- Product is 100% US Steel. Product contains minimal foreign steel in accordance with Act 3 and Buy America Attach receipts verifying the cost of the product's foreign steel and domestic steel.

CHECK THE BOX THAT APPLIES TO YOUR PRODUCT:

- 'Identifiable Steel' - Steel products that contain permanent markings that identify that the material was melted and manufactured in the United States. **Only Form CS-4171 is required.**
- Steel Products with In-Plant Inspection by a Department Representative - Steel products and products containing steel which received in-plant inspection by the Department or Department representative where it was verified that the steel was melted and manufactured in the United States. **Only Form CS-4171 is required.**
- 'Unidentified Steel' – Steel products that do not meet the definition of "Identifiable Steel" and do not receive in-plant inspection as defined above. **Attach supporting documentation including invoices, bills of lading and mill test reports that positively identify that the steel was melted and manufactured in the United States.**

7. **VENDOR CLASSIFICATION (CHECK ONE BLOCK ONLY) -**

- #1 **Manufacturer, Fabricator, Coater, Precaster Listed in Bulletin # 15, or Producer Listed in Bulletin # 14, 41 or 42** #2 **Distributor, Supplier or *Private Label Company Not Listed in Bulletin # 15. Also, complete line 9**

I certify that the above statements are true and to the best of my knowledge, fairly and accurately describe the product(s) listed.

I certify that the material being supplied is one and the same as provided to us by the manufacturer listed on this document and quantities listed above are accurate.

8. **NAME (print) :** _____ **TITLE:** _____

COMPANY NAME : _____

SIGNATURE : _____ **DATE:** _____
By Responsible Company Official

9. List company that sold you the material(s) documented above: _____
(Complete if you checked Block # 2 on line # 7, otherwise leave blank.) (Company Name)

PART B	SECTION 7	PAGE 16-3	DATE April 1, 2014
------------------	---------------------	---------------------	------------------------------

**DISTRICT QUALITY ASSURANCE
AGGREGATE SOURCE INSPECTION CHECK-OFF LIST**

PRODUCER _____ LOCATION _____

REPORT # _____ DATE OF REVIEW _____

DATE OF LAST REVIEW _____

- | Y | N | N/A | |
|-----|-----|-----|--|
| () | () | () | 1. Is current TR-430A form on file at the source? |
| () | () | () | 2. Do Inspectors/Laboratory facilities meet Publication 408 requirements? |
| () | () | () | 3. Do Laboratory scales and balances have annual calibration stickers attached? |
| () | () | () | 4. Is all required lab equipment on hand and working properly? |
| () | () | () | 5. Does the plant technician have required PTMs, ASTM, or AASHTO Standards available for review and use? |
| () | () | () | 6. Is the Technician certified?
Certification # _____ Exp Date: _____ |
| () | () | () | 7. Is the plant technician performing the tests properly? |
| () | () | () | 8. Is the technician able to perform his/her technical duties without outside interference? |
| () | () | () | 9. Is a current copy of the approved Quality Control Plan on file? |
| () | () | () | 10. Is Quality Control Plan being followed? |
| () | () | () | 11. Are quarrying, dredging, or processing plant operations satisfactory? |

PART B	SECTION 7	PAGE 16-4	DATE April 1, 2014
------------------	---------------------	---------------------	------------------------------

- | Y | N | N/A | |
|-----|-----|-----|---|
| () | () | () | 12. Are stockpiles intended for Department use identified? |
| () | () | () | 13. Are source verification samples lifted in accordance with AASHTO T 2 ____, or Mini-stockpiles __? (Check one) |
| () | () | () | 14. If used, was mini-stockpile constructed and sampled properly? |
| () | () | () | 15. Are aggregate samples reduced to testing size, in accordance with AASHTO T 248? |
| () | () | () | 16. Is Unit Weight, in accordance with AASHTO T 19, tested twice a year or as required? |
| () | () | () | 17. Is the Plant Master Diary being kept current? |
| () | () | () | 18. Are Quality Assurance and District Verification sample results plotted on the straight-line charts? |
| () | () | () | 19. Are production samples and field verification samples documented on Form CS-4211 and plotted on the straight-line charts? |
| () | () | () | 20. Are production samples selected prior to stockpiling? |
| () | () | () | 21. Do straight-line charts have action points established on critical screens? |
| () | () | () | 22. Are CS-4171 certifications filled out properly? |
| () | () | () | 23. Does weighmaster have a valid license?
Exp Date: _____ |
| () | () | () | 24. Is licensed public weighmaster signing all delivery tickets or following the electronic signature security procedures in POM B/7/2? |
| () | () | () | 25. Do truck scales have a valid annual certification? |

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- | | | | |
|-----|-----|-----|--|
| Y | N | N/A | |
| () | () | () | 26. Were truck scales checked for zero balance, cleanliness, and freedom of action and documented in the Plant Master Diary? |
| () | () | () | 27. Are trucks tared by weighmaster once each day, or more when weather conditions warrant? |
| () | () | () | 28. Is the mechanical sieve shaker(s) calibrated per PTM No. 608? |
| () | () | () | 29. Do any unsafe conditions exist that warrant corrective action? |

DEVIATIONS
FOUND:

CORRECTIVE ACTION TAKEN: _____

FOLLOW-UP REVIEW REQUIRED: _____ (YES) _____ (NO)

ADDITIONAL COMMENTS: _____

INSPECTION CONDUCTED BY: _____ DATE: _____

*TECHNICIAN'S SIGNATURE: _____ DATE: _____

REVIEWED BY: _____ DATE: _____

* Technician's signature is required. Leave a copy of this review at the plant.

Quality Control

C. **Quality Control:**

The essence of an aggregate technician's job is ensuring and documenting the specification compliance of the materials to be used. This is the world of Quality Control and Quality Assurance, commonly referred to as QC/QA. The total concept of QC/QA has many manifestations. Generally, **Quality Control is what the producer does to assure compliance. Quality Assurance is what others do to make sure that the quality control plan has been followed.**

The activities of Quality Control are spelled out in the Plant's approved Quality Control Plan. The critical guidance document is PennDOT Publication 2, Project Office Manual. In the manual under Part B, Section 7, the subjects of "Minimum Records and Documentation (pages 15-1,2) and "Minimum District Quality Assurance Plan Aggregate Sources" (pages 16-1, 2, 3, 4, 5, 6) are discussed.

Once a Quality Control Plan has been submitted and approved, the quarry may proceed with aggregate production. The guidelines for this section is the Quality Control Plan discussed above. The entire part of the Publication 408 dealing with aggregates, which is Section 703, is provided in this manual. The actual procedures for recording data and recommended actions for certain data patterns are found in PennDOT Publication 25 – Quality Assurance Manual, in which aggregates are specifically discussed.

D. Verification and Quality Assurance Samples:

Type of Sample	Frequency/Quantity	Tested at any by Whom
1. Quality Control Plan	Minimum 1/day for first 500T; extra 1/day for each additional 1,000T	At source by Aggregate Tech.
2. Source Verification	Minimum 1/year; 1/month for 5,000T to 50,000T; additional visit for each additional 25,000T	At source by inspector. (Collected by Aggregate Tech.)
3. Project Verification: collected at point of placements.	1 sample for > 1,000T<2,000T 2 samples for > 2,000T<10,000T 3 samples for > 10,000T < 25,000T 1 sample for each additional 25,000T	At source by Aggregate Tech., or field lab if problems with PWL.
4. District Verification	Minimum 1/year; 1/month for 5,000T to 50,000T; additional visit for each additional 25,000T	At source by inspector. (Collected by Aggregate Tech.)
5. Quality Assurance, District and Regional		Laboratory Testing Section (LTS) Harrisburg

(b) **Gradation.** Conforming to the following gradation, determined according to AASHTO T 27:

- Passing 50 mm (2-inch) sieve—100%
- Passing 4.75 mm (No. 4) sieve—15% to 60%
- Passing 150 μ m (No. 100) sieve—0% to 30%

703.4 ANTI-SKID MATERIAL—

(a) **General.** For use on ice or snow-covered pavement surfaces, furnish anti-skid material conforming to Table E from a producer or agent listed in Bulletin 14. Do not use material containing metal, glass, or substances that may be harmful to automotive equipment and vehicles. Use material reasonably free of deleterious substances or foreign materials including, but not limited to, dirt, shale, slate, incinerated bituminous coal mine waste, and within the maximum limits of the individual deleterious and total deleterious materials as specified in Section 703.2(a), Table B, Type C.

(b) **Description.**

1. **Type AS1.** Either natural sand, manufactured sand (except slag aggregates), or a combination of the two conforming to the following requirements:

- Bulk Density (Unit Weight). Minimum 70 pounds per cubic foot and not exceeding 110 pounds per cubic foot determined according to AASHTO T 19.
- Crushed Fragments. If natural sand is furnished, not less than 35% of the fragments retained on the 2.36 mm (No. 8) sieve are required to be crushed fragments, determined according to ASTM D5821.
- Iron. Total of individual anti-skid particles containing metallic iron may not exceed 1.0% by mass (weight) of material, determined by dividing the mass (weight) of such particles retained on the 4.75 mm (No. 4) sieve by the total dry mass (weight) of the sample.

2. **Type AS2 and AS3.** Crushed stone or crushed gravel conforming to the following requirements:

- Bulk Density (Unit Weight). Minimum 70 pounds per cubic foot and not exceeding 105 pounds per cubic foot determined according to AASHTO T 19.
- Los Angeles Abrasion. Abrasion loss not exceeding 55%, determined according to AASHTO T 96, Gradation D.
- Crushed Fragments. If crushed gravel is furnished, not less than 60% of the fragments retained on the 4.75 mm (No. 4) sieve are required to be crushed, one face, determined according to ASMT D 5821.
- Iron. Total of individual anti-skid particles containing metallic iron may not exceed 1.0% by weight of material, determined by dividing the mass (weight) of such particles retained on the 4.75 mm (No. 4) sieve by the total dry mass (weight) of the sample.

3. **Type AS4.** Crushed slag conforming to the following requirements:

- Bulk Density (Unit Weight). Minimum 70 pounds per cubic foot and not exceeding 105 pounds per cubic foot determined according to AASHTO T 19.

- Los Angeles Abrasion. Abrasion loss not exceeding 55%, determined according to AASHTO T 96, Gradation D.
- Iron. Total of individual anti-skid particles containing metallic iron may not exceed 1.0% by mass (weight) of material, determined by dividing the mass (weight) of such particles retained on the 4.75 mm (No. 4) sieve by the total dry mass (weight) of the sample.

(c) **Gradations.** Conforming to Table E.

TABLE E
Anti-Skid Gradation

Anti-Skid Type	Maximum Percent Passing Sieve								
	31.5 mm (1 1/4")	19.0 mm (3/4")	12.5 mm (1/2")	9.5 mm (3/8")	4.75 mm (No. 4)	2.36 mm (No. 8)	300 µm (No. 50)	150 µm (No. 100)	75 µm (No. 200)*
Type AS1				100	60-100	0-80		0-8	0-5
Type AS2				100	35-80	0-45		0-6	0-3**
Type AS3			100	90-100		0-30		0-8	
Type AS4				100		0-30		0-8	0-5

* Determined by PTM No. 100.

** If the total percent passing the 2.36 mm (No.8) sieve is less than 25%, then the total percent passing the 75 µm (NO. 200) sieve is allowed to be 0-5.

(d) **Testing.** If shipping, test material for moisture content according to PTM No. 513. A minimum of two tests per day is required. If conditions exist that would cause a change in moisture content, conduct additional tests. A Department representative will verify the test results.

Document tests at the end of delivery quantity at the end of the day and determine the average moisture content. The Department will adjust the delivery quantity by deducting the average moisture content from the aggregate quantity shipped. Payment is based on the calculated oven dry mass (weight).

703.5 ACCEPTANCE OF CONSTRUCTION AGGREGATES—

(a) **General.** The following describes the certification acceptance of construction aggregates. Accept AASHTO No. 1 Coarse Aggregate as specified in Section 850.2(a)1.

(b) **Testing and Acceptance.** Certify each day's shipment of aggregate as specified in Section 106.03(b)3.

1. **QC.** Section 106.03(b)2 and as follows:

- Submit for annual review a QC Plan conforming to the minimum Department requirements for aggregate suppliers.
- Establish and positively identify aggregate stockpiles that have been tested according to the approved QC Plan and conform to Department Specifications. Material may be added to or shipped from stockpiles at the producer's discretion.

2. **Source Verification Samples.** Under the direction and supervision of the Representative, obtain a verification sample (n=3) from each stockpile to be tested. Obtain the sample from the stockpile according to AASHTO T 2 or from a mini-stockpile. If the mini-stockpile method is chosen, obtain the sample according to the following procedure:

- Place approximately 10 tons of aggregate into a mini-stockpile on a suitable surface. Use a loader to strike off the top of the mini-stockpile.
- Obtain sufficient material for sampling from random locations on the mini-stockpile using a square faced shovel.

If project verification samples or lot acceptance samples in Section 703.5(b)3 result in a Percent Within Limits (PWL) < 90, the Representative will direct additional source verification sampling of the stockpile(s) from which the failing material was shipped. In such instances, do not ship any additional materials from the stockpile(s) until test results from source verification samples have $PWL \geq 90$.

Immediately deliver the source verification sample to the Representative for testing using the equipment provided as specified in Sections 703.1(b) and 703.2(b). The Representative will test all three increments for compliance with Tables A, B, C, and D, as applicable. If the test results verify that the material conforms to the specifications, use the material under certification, unless project verification samples require lot acceptance.

If the material does not conform to the specifications, the Representative will determine the PWL according to Section 106.03(a)3. If source verification results indicate a $PWL < 90$, the Representative will reject the stockpile.

If a stockpile is rejected, increase QC testing according to the reviewed QC Plan. Construct another stockpile of the aggregate to be tested consisting of 300 tons to 500 tons of material or the remainder of the quantity identified for Department projects, whichever is less. The Representative will accept the material under certification if test results verify that the material from the new stockpile conforms to the specifications, unless project verification samples require lot acceptance.

3. Project Verification Samples. Under the direction and supervision of the Inspector, obtain verification samples ($n=3$) according to Table F for aggregates used for subbase applications under the roadway and shoulders as specified in Section 350. At the preconstruction conference provide the Representative estimated aggregate quantities for subbase applications under the roadway and shoulders. Other aggregate types or applications may be sampled for project verification if the Representative determines that the material is visually suspect. Obtain samples at the point of placement (loose aggregate sample on grade before trimming and compaction) and not from project stockpiles unless directed:

TABLE F
Verification Samples

Aggregate Quantities	Number of Samples (n=3)
1,000 tons or more, but less than 2,000 tons	1
2,000 tons or more, but less than 10,000 tons	2
10,000 tons or more, up to 25,000 tons	3
Each additional increment of 25,000 tons	1

The Inspector will select sample locations according to PTM No. 1.

Under the direction and supervision of the Inspector, immediately deliver the sample(s) to the test site at either the producers' location or the project site. The Inspector will test the sample(s) using the equipment provided as specified in Sections 703.1(b) and 703.2(b). The Inspector will test all three increments for compliance with Tables C and D, plus the Crushed Fragments Test of Table B when applicable. The Inspector will provide the test results within 5 days from the date of sampling. The Department will continue to accept material under certification if test results verify that the material conforms to the specifications.

If the material does not conform to the specifications, the Inspector will determine the average PWL of the material as specified in Section 106.03(a)3. If results indicate a $PWL < 90$ for the material, the Department will discontinue certification acceptance and begin project lot acceptance of the aggregate. Discontinue all operations using that size of aggregate until the Representative determines new lot sample locations according to PTM No. 1 and authorizes operations to continue. Conduct lot acceptance testing at the point of placement according to the following procedure:

- Under the direction and supervision of the Inspector, use a PennDOT Certified Aggregate Technician to obtain an acceptance sample ($n=3$) at the point of placement (loose aggregate sample on grade before trimming and compaction) for each 7,500 tons of material placed. The lot size of 7,500 tons will be divided into three equal sublots.
 - The Inspector will select sample locations according to PTM No. 1. The Inspector will take possession of the sample and immediately transport the sample from the sampling point to the testing site. The Inspector will test all three sample increments for compliance with

Section 703.2(c), Tables C and D plus the Crushed Fragments Test of Table B. Aggregates other than gravel will use 100 as the PWL for the Crushed Fragments Test of Table B. The Inspector will provide the test results within 5 days of sampling. Failure to provide test results within the targeted timeframe will not form a basis to dismiss the test results, and the test results will govern in all cases.

- When less than 7,500 tons remain for the project, the remaining quantity will be considered a lot. Divide the remaining approximated quantity into three equal sublots so that three increments are obtained.
- If a change in aggregate sources is made before three increments are obtained for a lot, obtain additional increments from remaining materials on the project to provide one full acceptance sample (n=3) from the first source.
- The Inspector will document the placement location(s) by station of material placed to clearly delineate the location of all material within the lot.
- The Department will continue project lot acceptance testing until five consecutive lots are accepted at ≥ 90 PWL. Once five consecutive lots are accepted at ≥ 90 PWL, acceptance may again be by producer certification and verification testing will begin again at the frequency in Table F for the remaining project quantity. The Contractor will be charged \$600 for each lot of material placed, for the project lot acceptance testing performed by the Inspector.
- For all test values, the Department will determine the lot PWL according to Section 106.03(a)3. If results indicate a $PWL \geq 90$, the lot is accepted at full payment. If results indicate a $PWL < 90$ for the material, the Department will determine the Degree of Non-Conformance (DNC) for the lot according to the following:
 - Lot average values for any sieve size which do not conform to the specified limits will be used to calculate the DNC. For each sieve where the average does not conform to specifications, the difference between the average test value and the closest specified limit will be computed (upper limit for average values where the upper limit has been exceeded or lower limit for average values where the lower limit was not reached). Each difference will be multiplied by the factor shown in Table G.
 - Crushed fragment average test results which do not conform to the specified limits will also be included in the DNC. The DNC will include the difference between the lower specified limit and the lot average crushed fragment test results.
 - The Department will determine the total DNC for the lot by summing of all the non-conformances for each sieve size and crushed fragments after each has been multiplied by applicable factors in Table G and Table H. The total DNC will be used to adjust the payment represented by the non-conforming lot as shown in Table I.

TABLE G
Multiplication Factors for DNC

Sieve Size	Multiplication Factor
4 inch to No. 4 inclusive	1.0
No. 5 to No. 80 inclusive	1.5
No. 100	2.0
No. 200 (Table D)	Table H
Crush Count	1.0

TABLE H
No. 200 Sieve Upper Limit and Multiplication Factor

% Maximum	Upper Limit To Calculate DNC	Multiplication Factor
10	10.49	2.5
5	5.49	2.5
2	2.49	2.5
1	1.49	2.5
2.0	2.05	5
1.0	1.05	5

TABLE I
DNC Pay Reduction Percent

Total Sum of DNC	Percent of Contract Unit Price Reduction
0.5 to 3.0	2%
3.1 to 5.0	4%
5.1 to 8.0	7%
8.1 to 12.0	11%
Greater than 12.0	**
**If the sum of the DNC is greater than 12.0, the Representative will direct that the material represented by the lot (n=3) be removed and replaced at no additional cost to the Department or left in place and final payment for the material will be at 70% of the contract unit price. Pending the decision by the Representative, do not place additional materials on or incorporated with the non-conforming material.	

4. QA Samples. CMD QA samples (n=3) may be taken at the source of supply or at the point of placement on the project. Submit samples to the LTS for testing. If results for any type of material indicate a PWT of less than 90, the District will immediately obtain an additional verification sample (n=3) at the appropriate site (project or source). The Department will test all three sample increments at either the producer's location or at the project site and determine the PWT for the material. If results indicate a PWT for the material of less than 90, obtain source verification samples and project verification samples as specified in Section 703.5(b)2 and Section 703.5(b)3.

(c) Weighing Responsibilities. Prepare weight slips and certifications attesting to the accuracy of the weights recorded and ensuring conformance with Section 107.23(b). Designate a licensed weigh person(s) to act as the Contractor's agent. Ensure that scales are calibrated annually by an independent agency acceptable to the Department. A Department Inspector may provide random checking.

Weigh empty trucks used to haul material measured by mass (weight) daily unless otherwise directed. If the invoice mass (weight) exceeds the net mass (net weight) determined by a Department mobile weigh team by more than 3%, the Department will consider the deviation to be excessive. Take immediate corrective action upon notification of an excessive deviation. Within 30 days of notification, provide the District Executive with a written description of corrective actions and safeguards and the time that they were implemented.

703.6 CERTIFICATION OF AGGREGATES AT BITUMINOUS AND CEMENT CONCRETE PLANTS—

(a) Certification. Certify aggregate at bituminous and cement concrete plants yearly for quality requirements as specified in Section 106.03(b)3 using Form CS-4171 or another acceptable form.

REPLACES B.7.16	PENNSYLVANIA DEPARTMENT OF TRANSPORTATION	PART B	SECTION 7	PAGE 16-1
DATED 04/25/2013	PROJECT OFFICE MANUAL	DATE April 1, 2014		
SUBJECT MINIMUM DISTRICT QUALITY ASSURANCE PLAN - AGGREGATE SOURCES				

1. The District Materials Engineer/Manager (DME/DMM) or a member of his staff will visit each source shipping for Department use at least once a year. Also, the District will conduct one visit per month to each source shipping a minimum of **10,000 tons** per size of aggregate for Department use.
2. A visit will include District verification sampling and testing and a detailed review of the quarry's quality control activities utilizing a District Quality Assurance check-off list. All findings and corrective actions will be documented in the Plant Master Diary and a copy of the check-off list will be filed with plant records.

For sources shipping less than 10,000 tons each month, perform a minimum of one visit for each 30 days of shipping for Department use. These visits will include a detailed review of the quarry's quality control activities utilizing a District Quality Assurance check-off list. All findings and corrective actions will be documented in the Plant Master Diary and a copy of the check-off list will be filed with plant records.

Assure that the District Verification sample test results are entered on the straight-line analysis charts for comparison purposes to the most recent production test results.

3. District Verification Sampling and Testing.

The District Representative will:

- a. Direct the supplier to obtain a sample (n=3) from the stockpiles designated for Department use. Assure that each sample from the stockpile is obtained in accordance with AASHTO T 2 or from mini stockpiles. When the mini-stockpile method is chosen, the following procedure will be used:
 - The District Representative will assure that the loader operator places approximately 10 tons of aggregate into a mini-stockpile on a suitable surface, and uses the loader bucket to strike off the top of the mini-stockpile.
 - The District Representative will assure that the supplier obtains sufficient material from random locations on the mini-stockpile using a square faced shovel to do the necessary sampling.

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- b. Assure that all required tests are performed on equipment provided for Department use under Sections 703.1(b) and 703.2(b), Publication 408. Evaluate material not meeting specifications in accordance with Section 106.03(a)3, Publication 408, to determine the percent within limits (PWL) for each sieve that does not meet the specifications, including the 75 µm (No. 200) sieve. Average the results of all sieve analysis tests and, when applicable, the crush count and wash test to determine the PWL. If results show less than 90% PWL, direct the supplier to immediately cease all shipments from that stockpile. Direct the supplier to build a new stockpile for that type of material for Department use.

Notify the supplier immediately to increase his quality control testing and to construct a minimum stockpile of 300 to 500 tons or the quantity remaining on the order. Do not permit shipments by certification from this stockpile until a Department representative evaluates all test data and verifies the test results.

4. Records Review:

The District Representative will:

- a. Assure that all quality control test results comply with approved QC Plan frequencies.
- b. Review straight-line charts and document any noted trends and whether appropriate action was taken.
- c. Compare the results of all previous Central Office Quality Assurance samples from LTS to the results of the companion samples performed by the technician for uniformity and document all comments.
- d. Assure that the technician's plant documentation system and plant delivery tickets comply with POM Section B.7.15.

REPLACES B.6.20	PENNSYLVANIA DEPARTMENT OF TRANSPORTATION	PART B	SECTION 6	PAGE 20-1
DATED 04/01/2014	PROJECT OFFICE MANUAL	DATE April 1, 2015		
SUBJECT INDEPENDENT ASSURANCE PROCEDURES - AGGREGATE SOURCES				

The Bureau of Project Delivery Construction Quality Assurance Section (CQAS) will administer the Independent Assurance program at aggregate sources supplying Department construction projects. The Independent Assurance program provides an unbiased and independent evaluation of the sampling and testing personnel, the testing equipment, and the sampling and testing procedures used in the Department's aggregate acceptance program. Independent Assurance samples will be tested by the Bureau of Project Delivery, and the test results will be compared with companion test results run at the aggregate source to verify that results are within established tolerance limits.

During each construction season, the Bureau of Project Delivery CQAS will perform a minimum of ten (10) Aggregate Independent Assurance reviews in each District at aggregate sources shipping material to Department projects. Included among these reviews are aggregate sources shipping material to federal-aid projects on the National Highway System meeting the following minimum project quantities:

No. 2A Aggregate Subbase: 1 Review > 50,000 yd²

No. 57 Structure Backfill: 1 Review > 5,000 yd³

Note: The source does not need to be producing or shipping material at the time of the review to satisfy this requirement. Material must be obtained from a Department approved stockpile. Sources shipping material for both items require only 1 review. Sources shipping to multiple projects meeting the above requirements require only one review per construction season.

Aggregate Independent Assurance reviews are not limited to aggregate sources shipping to federal-aid projects on the National Highway System. Independent Assurance reviews are not limited to No. 2A or No. 57 aggregate types.

The CQAS will determine the sources to be reviewed. Sampling and testing for Independent Assurance will be coordinated with the District Materials Engineer/District Materials Manager (DME/DMM) or his staff to coincide with a scheduled DQA review, or at a mutually agreed upon time with the DME/DMM or his staff, such as when the District is at the source to test project verification samples.

The following process will constitute an Independent Assurance review. An Independent Assurance sample (n=1) will be taken from an approved Department stockpile at a source supplying aggregate to a Department project, under the direction and supervision of the DME/DMM or his staff. The Independent Assurance sample will be split in accordance with

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AASHTO T 248 to obtain two (2) equivalent samples for testing. In addition, a representative sample will be obtained for an IA Wash Test by LTS.

To obtain the required minimum sample size after splitting, the initial sample for each aggregate type must be as follows:

Aggregate	Sample Size
No. 3	130 lbs.
No. 5	80 lbs.
No. 57	75 lbs.
No. 67	65 lbs.
No. 7	65 lbs.
No. 8	30 lbs.
No. 10	5 lbs.
No. 2A	100 lbs.
No. OGS	100 lbs.

Only one (1) aggregate type is required to be tested per each Independent Assurance review.

Sampling and testing at the source will be performed by certified aggregate technicians.

One sample will be tested by the DME/DMM or his staff at the source and one sample will be tested by the source technician, both using the same equipment. The sample tested by the source technician will then be re-bagged and sent for testing to the Bureau of Project Delivery, Laboratory Testing Section (LTS). Samples will be tested for compliance with Publication 408, Section 703, Tables C & D, plus the Crushed Fragments Test of Table B, when applicable.

A CQAS representative does not need to be present for the entire process of Independent Assurance sampling and testing at the source. Whenever a CQAS representative does not witness any portion of the process of Independent Assurance sampling and testing at the source, the test results obtained at the source by the DME/DMM or his staff and the source technician should be forwarded to the appropriate CQAS representative in a timely manner.

Arrangements for the transportation of the Independent Assurance sample to LTS will be coordinated by a CQAS representative with the DME/DMM or his staff. The CQAS representative coordinating the review will complete the TR-447 for the LTS sample and identify it as an Independent Assurance sample. The method used to perform the Wash Test (Manual or Automatic Aggregate Washer / Plain Water or Wetting Agent) should be reported in the remarks section of the TR-447.

Test results from the source will be compared to the Independent Assurance precision tolerances by CQAS immediately upon receipt from the District. Those results will then be

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compared with the test results obtained by LTS for compliance with the Independent Assurance precision tolerances.

Independent Assurance Precision Tolerances

		<u>Maximum Difference between Test Results</u>
	<u>Sieve Size</u>	
Gradation	2.36 mm (No. 8) sieve and larger	6 %
	1.18 mm (No. 16) through	
	150 µm (No. 100) sieves	4 %
	75 µm (No. 200) sieve	2 %
Coarse Aggregate Crush Count	---	12 %

When test results vary from the allowed precision tolerances or problems with sampling and testing personnel or equipment are discovered, CQAS will immediately inform the DME/DMM. The District will perform an investigation of the discrepancies and take appropriate corrective action where necessary. The District will inform CQAS with the results of their investigation and what corrective actions were taken. Where necessary, a CQAS representative will perform a follow-up review of the source to insure all deficiencies have been corrected.

Independent Assurance review results will be maintained by CQAS for each District. The Bureau of Project Delivery will summarize the Independent Assurance review results at the conclusion of each construction season and submit the results to FHWA in an annual report.

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PTM 6
Precent Within Limits
(PWL)

LABORATORY TESTING SECTION

Method of Test for

DETERMINATION OF PERCENT WITHIN LIMITS (PWL) FOR CONSTRUCTION AGGREGATE

1. SCOPE

1.1 For determination of Construction Percent Within Limits (PWL) using Statistical Method as in CAMMS.

2. DEFINITION OF A MAJOR/MINOR DEVIATION

2.1 Major Deviation - When a sample PWL is less than 90%.

2.2 Minor Deviation - When a sample PWL is greater than 90%, but less than 100%.

3. GENERAL STATEMENTS ABOUT PWL CALCULATIONS

3.1 If all results on a particular sieve or wash test are within the specification limits, then the construction PWL for that result is 100.

3.2 If one or more results of three are outside the specification range for a particular sieve the statistical PWL on the report is used to calculate the total sample PWL based on construction specifications.

3.3 On specification sieves that have an upper limit of 100, Q_U is not calculated. Q_L is the only value calculated and used to represent the PWL for that sieve.

3.4 On specification sieves that have a lower limit of 0, Q_L is not calculated. Q_U is the only value calculated and used to represent the PWL for that sieve.

3.5 On specification sieves that have both limits as 100, only use the upper limit and calculate only the upper Quality Index to represent the PWL for that sieve.

4. CALCULATIONS

Note: The following calculations are from the #4 sieve on the CAMMS report on page 5.

4.1 The lot (X) measurements are averaged to find \bar{X} .

$$\bar{X} = \sum_{i=1}^n \frac{X_i}{n}$$

Where:

\bar{X} = Average or mean value of the number of tests to the nearest whole number

n = Size of the sample in whole number increments

X_i = The ith value in a series of observations in whole numbers

Example: Calculations for the #4 sieve for 3 test results (See an example of a test report on page 5).

$$\bar{X} = \frac{28 + 22 + 33}{3} = \frac{83}{3} = 27.7 = 28$$

4.2 The standard deviation "s" of the sample increments for each sieve is calculated using whole numbers. The calculated value is to the nearest tenth.

$$s = \sqrt{\frac{\sum_{i=1}^n (X_i - \bar{X})^2}{n - 1}}$$

Where:

\bar{X} = Average or mean value of the number of tests to the nearest whole number

n = Size of sample in whole number increments

X_i = The ith value in a series of observations in whole numbers

s = The Standard Deviation of the lot of measurements

Example: With the \bar{X} calculated to be 28, "s" would be calculated.

$$s = \sqrt{\frac{(28 - 28)^2 + (22 - 28)^2 + (33 - 28)^2}{3 - 1}} = \sqrt{\frac{61}{2}} = 5.522 = 5.5$$

4.3 The Quality Index (Q_U) is found by subtracting the average (\bar{X}) of the measurements from the upper specification limits (U) and dividing the result by "s" and is expressed to the nearest ten thousandth.

$$Q_U = \frac{(U - \bar{X})}{s}$$

Where:

\bar{X} = Average or mean value of the number of tests

s = The Standard Deviation of the lot of measurements

U = Upper Specification Limit

Q_U = Quality Index of the upper specification limit

P_U = Estimate of the percentage of a lot which has values equal to or less than the upper specification limit

Example: With the upper specification limit equal to 50, Q_u would be calculated.

$$Q_U = \frac{50 - 28}{5.5} = \frac{22}{5.5} = 4.0000 \quad P_U = 100$$

NOTE - P_U was found in Table A of Publication 408, Section 106 for n=3.

4.4 The Quality Index (Q_L) is found by subtracting the lower specification limit (L) from the average (X) and dividing the result by "s". This value is expressed to the nearest ten thousandth.

$$Q_L = \frac{(\bar{X} - L)}{s}$$

Where:

L = Lower Specification Limit

\bar{X} = Average or mean value of the number of tests

s = The Standard Deviation of the lot of measurements

Q_L = Quality Index of the lower specification limit

P_L = Estimate of the percentage of a lot which has values equal to or greater than the lower specification limit

Example: With the lower specification equal to 24, Q_L is calculated.

$$Q_L = \frac{28 - 24}{5.5} = \frac{4}{5.5} = 0.7272 \quad P_L = 72$$

NOTE: P_L was found in Table A of Publication 408, Section 106 for $n=3$.

4.5 The percentage of material that will fall within the upper tolerance limit (U) is estimated by entering Table A in Publication 408 Section 106, with Q_u , using the column appropriate to the total number of measurements (n).

4.6 The percentage of material that will fall within the lower tolerance limit (L) is estimated by entering Table A in Publication 408 Section 106 with Q_L , using the column appropriate to the total number of measurements (n).

4.7 In cases where both upper (U) and lower (L) tolerance limits are considered, the percentage of material that will fall within tolerance limits is found by adding the percent (P_U) within the upper tolerance limit (U) to the percent (P_L) within the lower tolerance limit (L) and subtracting 100 from the sum.

Example:

$$\text{Percent within limits} = (P_U + P_L) - 100$$

$$\text{Percent within limits} = (100 + 72) - 100 = 72$$

Below is an example of how individual PWL's are calculated to determine the construction aggregate specification PWL on a CAMMS report. (See the CAMMS report on page 5.)

Sieve Size	Statistical PWL on Report	Internal Construction PWL Calculations
2"		+100
3/4"	100	+100
3/8"	100	+100
#4	72	+72
#16	30	+30
Wash Test	100	<u>+100</u>
		502/6
		results=83.5=84

Note - If all the test results on the #4 sieve were within the specification limits, it is possible that the statistical PWL on the report will be below 100%. If all the test results for the #4 sieve are within the specification limits, the construction PWL calculations will be 100%.

4.8 To determine the percentage within tolerance when the calculated Quality Index (Q.I.) value is between two tabular values in Table A, the following procedure is used.

4.8.1 The difference between the tabular Q.I. values on either side of the calculated Q.I. value will be determined.

4.8.2 The difference will be divided by 2 and the quotient added to the lower tabular Q.I. value, resulting in the interpolated Q.I. value.

4.8.3 If the calculated Q.I. is equal to or greater than the interpolated value, the higher listed percent within tolerance will be used.

4.8.4 If the calculated Q.I. is less than the interpolated value, the lower listed percent within tolerance will be used.

Note - When percent loss by wash is required, the (X) and (\bar{X}) calculations are rounded to the nearest hundredth. The standard deviation(s) is rounded to the nearest tenth.

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Percent Within Limits Calculations

SECTION 106—CONTROL OF MATERIAL

106.01 GENERAL—Use material complying with the requirements of these specifications. At the pre-construction conference, submit a list of material to be sampled and tested by the Contractor and a list of material to be sampled and tested by the Department.

Comply with the provisions of the Pennsylvania Trade Practices Act, 71 P.S. Section 773.101, et seq., concerning the purchase of aluminum and steel products produced in a foreign country. On Federal-Aid projects, also comply with the provisions specified in Section 106.10.

Comply with the provisions of the Steel Products Procurement Act, 73 P.S. Section 1881, et seq. in the performance of the contract or any subcontract.

Following contract execution, furnish to the Department a complete statement of the project construction material's origin, composition, and manufacture.

For Fabricated Structural Steel materials, as identified in Section 1105.01(a) and inspected in accordance with Section 1105.01(e), and any other fabricated aluminum, precast or prestressed concrete products inspected during manufacturing, stamped and approved for shipment by the Department's Representative, furnish Form CS-4171 to the Inspector-in-Charge. Certified mill test reports for any steel included will be reviewed by the Department's Inspector and retained by the fabricator.

For all other steel products or products containing steel that will serve a permanent functional use in the project, provide the Inspector-in-Charge the following when the product is delivered to the project site:

- For any "identifiable" steel products, certification that Section 4 of the Steel Products Procurement Act, 73 P.S. Section 1884, has been complied with. Identifiable steel products are steel products which contain permanent markings which indicate the material was both melted and manufactured in the United States.
- For all other "unidentifiable" steel products, documentation such as invoices, bills of lading, and mill certification that positively identify that the steel was melted and manufactured in the United States.

The provisions of the Steel Products Procurement Act will not be waived unless the Secretary has determined, under authority granted in Section 4(b) of the act, that a certain steel product or products is not produced in the United States in sufficient quantities to meet contract requirements. Such a determination will be set forth in a proposal for the Department's review and response. Include with the proposal a comprehensive list of sources, including names and contact information, for verification. The Secretary does not have the authority to waive the provisions specified in Section 106.10.

Steel products are defined as products rolled, formed, shaped, drawn, extruded, forged, cast, fabricated, otherwise similarly processed, or processed by a combination of two or more of these operations from steel made in the United States by the open hearth, basic oxygen, electric furnace, Bessemer, or any other steel-producing process. Included are cast iron products and machinery and equipment as listed in United States Department of Commerce Standard Industrial Classification 25, 35, and 37 and made of, fabricated from, or containing steel components. If a product, as delivered to the project, contains both foreign and United States steel, such product is considered to be a United States steel product only if at least 75% of the cost of the articles, materials, and supplies have been mined, produced, or manufactured, as the case may be, in the United States. On Federal-Aid projects, comply with the provisions specified in Section 106.10.

No payment will be made on the contract if unidentified steel products are supplied, until the hereinbefore requirements are met.

Any payments made that should not have been made may be recoverable from a manufacturer or supplier as well as from a contractor or subcontractor.

Any person who willfully violates the Steel Products Procurement Act will be prohibited from submitting bids for any contract for a period of 5 years from the date of determination that a violation has occurred. If a subcontractor, manufacturer or supplier, violates the Steel Products Procurement Act, such person will be prohibited from performing any work or supplying any materials to the Department for a period of 5 years from the date of determination that a violation has occurred.

If steel products are used as a construction tool or appurtenance and will not serve a permanent functional use in the project, compliance with the Steel Products Procurement Act is not required.

When standard manufactured items are specified and these items are identified by unit mass (unit weight), section dimensions, or similar characteristics, their identification will be considered to be nominal masses (weights) or dimensions. Unless more stringently controlled by specified tolerances, industry established manufacturing tolerances

will be accepted.

106.02 MATERIAL—

(a) Preliminary Acceptance and Approval. Have each material and material source of supply listed on Form CS-200 (Source of Supply – Materials) or Form CS-201 (Source of Supply – Traffic Control Devices) and approved before delivery to project. Department Bulletin listed material and material sources are available for use by the Contractor. If non-Bulletin material or material sources are proposed for use, the requirements specified in 106.02(a)2 must be met before these materials are delivered to the project. The Department reserves the right to obtain samples of any material provided by the Contractor for laboratory testing to verify compliance with specifications.

1. Bulletin Material, Material Application, and Material Source.

Defined as any of the following:

- Any material and material source listed in Bulletin 14 and used in the material application as specified in the Bulletin, Publication 408, or a Special Provision.
- Any material and material source listed in Bulletin 15 and used in the material application as specified in the Bulletin, Publication 408, or a Special Provision.
- Any bituminous material and material application specified in Publication 408 and produced at a source listed in Bulletin 41.
- Any cement concrete material and material application specified in Publication 408 and produced at a source listed in Bulletin 42.

Submit a CS-200 or CS-201 to the Representative with the following information: contract item number, item description, material description/type/class, product name, manufacturer/producer plant location, applicable Bulletin supplier code, Bulletin number, and Publication 408 or Bulletin Section.

If a previously submitted Bulletin material source no longer provides the specified material, submit a change in material to the Representative as outlined on Form CS-200 or CS-201. Once written acceptance is received, furnish material from another Bulletin material source listed in Bulletin 14, 15, 41, or 42.

2. Non-Bulletin Material, Material Application, or Material Source.

Defined as any of the following:

- Any material, product, or material source not listed in Bulletin 14 or Bulletin 15.
- Any material, product, or material source listed in Bulletin 14 or Bulletin 15 being used in an application not intended or specified in the Bulletin, Publication 408, or a Special Provision.
- Any bituminous material or product not produced at a source listed in Bulletin 41.
- Any bituminous material or product not specified in Publication 408 or a Special Provision.
- Any ready-mixed, cement concrete material or product not produced at a source listed in Bulletin 42.
- Any ready-mixed, cement concrete material or product not specified in Publication 408 or a Special Provision.

2.a. Construction-Aid Material. A necessary, temporary, or ancillary material that is not specified for use as part of a contract item or extra work item, but used by the Contractor only to aid in the completion of the work. The material is typically not a permanent part of the specified work (example: wood and nails for temporary formwork). The material need not be listed on Form CS-200 and does not require any Department approval for delivery to or use on the project. The Representative reserves the right to determine whether a material is a construction-aid material. Note temporary traffic control items are not construction-aid materials and do need listed on Form CS-201 since these items must be from Bulletin 15 listed sources and are specified for use as part of contract items or extra work items.

2.b. Project-Specific, LTS Approved Material. Non-Bulletin material proposed for use on a particular project as part of a contract item or extra work item, which requires approval by the LTS. Use of material is not meant to circumvent the use of available material sources listed in Bulletin 14, 15, 41, or 42. Have each material and material source listed on Form CS-200 or Form CS-201. The material is defined as any material, product, or material source that meets one or more of the following criteria:

- Meets specified requirements in Publication 408 or Special Provision, for the material and material application.
- Meets specified requirements in AASHTO or ASTM Standard for the material and material application.
- Meets specified requirements in project Special Provision for the material and material application.

Submit material to the LTS for evaluation and testing a minimum of 90 days before planned delivery to the project. Submit the following information to the LTS, with a copy to the Representative: source, description, specified use, QC Plan, independent lab test data showing material meets all specified requirements as determined on a single lot of material, and material samples of the kind and quality specified. Do not deliver material to the project until written acceptance is received from the Representative.

2.c. Project-Specific, Locally Approved Material. Non-Bulletin material proposed for use on a particular project as part of a contract item or extra work item, which does not require LTS approval because of the low risk to constructed Project performance, but does require local approval by the Representative (i.e. at the District or project level). This category of material is not meant to circumvent the use of available material sources listed in the Bulletins, or the requirements of Project-Specific, LTS Approved Materials. These materials must meet specification requirements and will be clearly identified in the specification as only needing local approval by the Representative. Have each material and material source listed on Form CS-200 or Form CS-201. Submit for local approval by the Representative all required information for the material, as indicated in the specification.

Examples of locally approved materials are project specific items, such as Section 860 (inlet filter bags), Section 867 (compost filter socks), and Section 868 (compost blanket and compost filter berms) where the specification indicates that these materials are to be locally approved. Bulletin 15 will reference specific Publication 408 Sections that apply to Locally Approved Materials. Bulletin 15 will not list actual materials or material sources for this category of materials as they will be accepted for use on a project-specific basis by local approval.

(b) Inspection. Inspect material delivered to the project and stockpile the material passing inspection for use. Do not incorporate questionable material, until material is tested by LTS and accepted in writing by the Representative. The Department reserves the right to reject questionable material delivered to the project when the LTS test results are not according to the specifications. Furnish assistance to the Inspector, as required to obtain samples.

Allow designated Department representatives to inspect material being used, or intended to be used, at any time before, during, or after material preparation, while being used during the progress of the work, or after the work has been completed. Furnish or arrange with producers or manufacturers to provide necessary material, labor, tools, and equipment for such inspection.

Inspections and tests, if made at any point other than the point of incorporation in the work, will not guarantee acceptance of the material. Inspection and testing performed by the Department will not relieve the Contractor's responsibility for QC.

106.03 TESTS AND ACCEPTANCE OF MATERIAL—

(a) Restricted Performance Specifications.

1. Responsibility. The Department will be responsible for determining the acceptability of the material and construction. Material will be reviewed for acceptance through the Department's specified acceptance procedures. Sample locations for acceptance testing will be determined by the Department.

Perform sampling and testing for acceptance in the presence of the Inspector, unless otherwise specified. Lot size will be specified. In the event that operational conditions cause work to be interrupted before the specified lot size has been achieved, the lot may be redefined by the Inspector. It is the intent of these specifications that each lot be evaluated based on the same number of samples. Transport acceptance samples from sampling point to testing site or other designated location in the presence of the Inspector.

The Contractor is responsible for the control and quality of the material and construction.

Prepare a QC Plan as specified in Section 106.03(a)2.a and submit it to the Inspector-In-Charge for review at the start of the project. Include QC sampling and testing frequencies and action points to initiate corrective measures. Notify the Inspector before performing QC sampling and testing. Perform QC sampling and testing and report results to the Inspector.

Obtain and test samples according to the Department's PTMs. If the required test method is not specified, use methods described in the AASHTO Standard Specifications for Transportation Materials and Methods of Sampling and Testing, and Supplements, Standards and/or Tentatives of ASTM, or other testing procedures adopted by the Department.

Verification sampling and testing will be performed by the District, unless otherwise specified.

QA sampling and testing will be performed or witnessed by the CMD.

Independent Assurance sampling and testing will be administered by the CMD.

2. QC.

2.a Maintain a QC system that provides reasonable assurance that materials, products, and completed construction, submitted for acceptance, conform to contract requirements whether self-manufactured, processed, or procured from subcontractors or vendors. When specified, submit for review, a plan of the QC system to be used. Have performed or perform the inspections and tests required to substantiate product conformance to contract requirements. Make the inspection and test results available for review throughout the contract life. Procedures will be subject to the review of the Department before the work is started. Charts and records documenting QC inspections and tests are the property of the Department. Submit a QC Plan for use in compliance with the following guidelines, as a minimum:

2.a.1 Raw Materials. List the source of material along with methods of documentation and testing performed to assure the material quality.

2.a.2 Production Control. List lot size and samples required; include sample selection, labeling and test procedure; also include manufacturing phase.

2.a.3 Product Testing. List type and frequency of tests to be performed, along with method of documenting and reporting test results. List test equipment and calibration procedure (frequency) required. List procedure for retesting or rejecting items failing the tests. List the disposal methods and location for test samples and rejected lots.

2.a.4 Personnel. List the personnel in charge of QC and define their areas of responsibility.

2.a.5 Packaging and Shipping. List method of identifying, storing, loading, transporting, and unloading to assure safe delivery of acceptable material and products.

2.a.6 Documentation. List the procedures used for documentation and certification.
The QC Plan and process are subject to periodic review and inspection by the Department.

2.b Promptly record conforming and non-conforming inspection and test results on acceptable forms or charts. Keep these records complete and keep them available for inspection at all times during the performance of the work.

2.c Promptly correct any errors, equipment malfunctions, process changes, or other assignable causes which have resulted or could result in the submission of material, products, and completed construction not conforming to specification requirements.

2.d When required, provide or have provided and maintain measuring and testing devices necessary to ensure that material and products conform to contract requirements. In order to ensure continued accuracy, calibrate these devices at established intervals against Department standards.

2.e When required, make the measuring and testing equipment available to the Representative for use in determining conformance of material, products, or completed construction with contract requirements. In addition, make personnel available for the operation of such devices and for verification of the accuracy and condition of the devices. Have calibration results available at all times. The Department reserves the right to conduct periodic inspections of the measuring and testing devices to confirm both calibration and condition of operation.

2.f Failure to comply with the QC Plan may result in suspension of approval to provide material for Department use and/or removal from the approved list of material suppliers in the applicable bulletins.

3. Acceptance Plans.

3.a Percent Within Tolerance. The percentage of each lot within the specified tolerances will be determined by the following procedures:

3.a.1 The “n” sampling positions on the lot will be located by use of the table of random numbers found in PTM No. 1.

3.a.2 A measurement will be made at each location, or a test portion taken and the measurement made on the test portion.

3.a.3 The lot (\bar{X}) measurements are averaged to find \bar{X} .

$$\bar{X} = \sum_{i=1}^n \frac{X_i}{n}$$

3.a.4 The Standard Deviation, “s,” of the lot measurements will be determined as follows:

$$s = \sqrt{\frac{\sum_{i=1}^n (X_i - \bar{X})^2}{n - 1}}$$

3.a.5 The Quality Index (Q_U) is found by subtracting the average (\bar{X}) of the measurements from the upper specification limit (U) and dividing the result by “s.”

$$Q_U = \frac{(u - \bar{X})}{s}$$

3.a.6 The Quality Index (Q_L) is found by subtracting the lower specification limit (L) from the average and dividing the result by “s.”

$$Q_L = \frac{(\bar{X} - L)}{s}$$

3.a.7 The percentage of material that will fall within the upper tolerance limit (U) is estimated by entering Table A or Table B with Q_U , using the column appropriate to the total number of measurements (n). Use Table A if Q_U has a negative value, or use Table B if Q_U has a positive value.

3.a.8 The percentage of material that will fall within the lower tolerance limit (L) is estimated by entering Table A or Table B with Q_L , using the column appropriate to the total number of measurements (n). Use Table A if Q_L has a negative value, or use Table B if Q_L has a positive value.

3.a.9 In cases where both upper (U) and lower (L) tolerance limits are concerned, the percentage of material that will fall within tolerance limits is found by adding the percent (P_U) within the upper tolerance limit (U) to the percent (P_L) within the lower tolerance limit (L) and subtracting 100 from the sum.

$$\text{Total percent within limits} = (P_U + P_L) - 100$$

3.a.10 When determining the percentage within tolerance when the calculated Quality Index (Q.I.) value is between two tabular values in Table A or Table B, the following procedure is used:

- The difference between the tabular Q.I. values on either side of the calculated value Q.I. value will be determined.

- The difference will be divided by 2 and the quotient added to the lower tabular Q.I. value, resulting in the interpolated Q.I. value.
- If the calculated Q.I. is equal to or greater than the interpolated value, the higher listed percent within tolerance will be used.
- If the calculated Q.I. is less than interpolated value, the lower listed percent within the tolerance will be used.

TABLE A
Estimating Percent of Lot Within Tolerance
(Standard Deviation Method)
Negative Values of Q_U or Q_L

Percent Within Tolerance	n=3	n=4	n=5	n=6	n=7
50	0.0000	0.0000	0.0000	0.0000	0.0000
49	0.0361	0.0300	0.0281	0.0272	0.0267
48	0.0722	0.0600	0.0562	0.0545	0.0535
47	0.1083	0.0900	0.0843	0.0818	0.0802
46	0.1444	0.1200	0.1124	0.1091	0.1070
45	0.1806	0.1500	0.1406	0.1364	0.1338
44	0.2158	0.1800	0.1689	0.1639	0.1608
43	0.2510	0.2100	0.1972	0.1914	0.1878
42	0.2863	0.2400	0.2256	0.2189	0.2148
41	0.3215	0.2700	0.2539	0.2464	0.2418
40	0.3568	0.3000	0.2823	0.2740	0.2689
39	0.3912	0.3300	0.3106	0.3018	0.2966
38	0.4252	0.3600	0.3392	0.3295	0.3238
37	0.4587	0.3900	0.3678	0.3577	0.3515
36	0.4917	0.4200	0.3968	0.3859	0.3791
35	0.5242	0.4500	0.4254	0.4140	0.4073
34	0.5564	0.4800	0.4544	0.4426	0.4354
33	0.5878	0.5101	0.4837	0.4712	0.4639
32	0.6187	0.5401	0.5131	0.5002	0.4925
31	0.6490	0.5701	0.5424	0.5292	0.5211
30	0.6788	0.6001	0.5717	0.5586	0.5506
29	0.7076	0.6301	0.6018	0.5880	0.5846
28	0.7360	0.6601	0.6315	0.6178	0.6095
27	0.7635	0.6901	0.6619	0.6480	0.6395
26	0.7905	0.7201	0.6919	0.6782	0.6703
25	0.8164	0.7501	0.7227	0.7093	0.7011
24	0.8416	0.7801	0.7535	0.7403	0.7320
23	0.8661	0.8101	0.7846	0.7717	0.7642
22	0.8896	0.8401	0.8161	0.8040	0.7964
21	0.9122	0.8701	0.8479	0.8363	0.8290
20	0.9342	0.9001	0.8798	0.8693	0.8626
19	0.9555	0.9301	0.9123	0.9028	0.8966
18	0.9748	0.9601	0.9453	0.9367	0.9315
17	0.9940	0.9901	0.9782	0.9718	0.9673
16	1.0118	1.0201	1.0125	1.0073	1.0032

TABLE A (continued)
Estimating Percent of Lot Within Tolerance
(Standard Deviation Method)
Negative Values of Q_U or Q_L

Percent Within Tolerance	n=3	n=4	n=5	n=6	n=7
15	1.0286	1.0501	1.0469	1.0437	1.0413
14	1.0446	1.0801	1.0819	1.0813	1.0798
13	1.0597	1.1101	1.1174	1.1196	1.1202
12	1.0732	1.1401	1.1538	1.1592	1.1615
11	1.0864	1.1701	1.1911	1.2001	1.2045
10	1.0977	1.2001	1.2293	1.2421	1.2494
9	1.1087	1.2301	1.2683	1.2866	1.2966
8	1.1170	1.2601	1.3091	1.3328	1.3465
7	1.1263	1.2901	1.3510	1.3813	1.3990
6	1.1330	1.3201	1.3946	1.4332	1.4562
5	1.1367	1.3501	1.4408	1.4892	1.5184
4	1.1402	1.3801	1.4898	1.5500	1.5868
3	1.1439	1.4101	1.5428	1.6190	1.6662
2	1.1476	1.4401	1.6018	1.6990	1.7615
1	1.1510	1.4701	1.6719	1.8016	1.8893

TABLE B
Estimating Percent of Lot Within Tolerance
(Standard Deviation Method)
Positive Values of Q_U or Q_L

Percent Within Tolerance	n=3	n=4	n=5	n=6	n=7
99	1.1510	1.4701	1.6719	1.8016	1.8893
98	1.1476	1.4401	1.6018	1.6990	1.7615
97	1.1439	1.4101	1.5428	1.6190	1.6662
96	1.1402	1.3801	1.4898	1.5500	1.5868
95	1.1367	1.3501	1.4408	1.4892	1.5184
94	1.1330	1.3201	1.3946	1.4332	1.4562
93	1.1263	1.2901	1.3510	1.3813	1.3990
92	1.1170	1.2601	1.3091	1.3328	1.3465
91	1.1087	1.2301	1.2683	1.2866	1.2966
90	1.0977	1.2001	1.2293	1.2421	1.2494
89	1.0864	1.1701	1.1911	1.2001	1.2045
88	1.0732	1.1401	1.1538	1.1592	1.1615
87	1.0596	1.1101	1.1174	1.1196	1.1202
86	1.0446	1.0801	1.0819	1.0813	1.0798
85	1.0286	1.0501	1.0469	1.0437	1.0413
84	1.0118	1.0201	1.0125	1.0073	1.0032
83	0.9940	0.9901	0.9782	0.9718	0.9673
82	0.9748	0.9601	0.9453	0.9367	0.9315
81	0.9550	0.9301	0.9123	0.9028	0.8966
80	0.9342	0.9001	0.8798	0.8693	0.8626
79	0.9122	0.8701	0.8479	0.8363	0.8290
78	0.8896	0.8401	0.8161	0.8040	0.7964
77	0.8661	0.8101	0.7846	0.7717	0.7642
76	0.8416	0.7801	0.7535	0.7403	0.7320
75	0.8164	0.7501	0.7227	0.7093	0.7011
74	0.7905	0.7201	0.6919	0.6782	0.6703
73	0.7635	0.6901	0.6619	0.6480	0.6395
72	0.7360	0.6601	0.6315	0.6178	0.6095
71	0.7076	0.6301	0.6018	0.5880	0.5846
70	0.6788	0.6001	0.5717	0.5586	0.5506
69	0.6490	0.5701	0.5424	0.5292	0.5211
68	0.6187	0.5401	0.5131	0.5002	0.4925
67	0.5878	0.5101	0.4837	0.4712	0.4639
66	0.5564	0.4800	0.4544	0.4426	0.4354
65	0.5242	0.4500	0.4254	0.4140	0.4073

TABLE B (continued)
Estimating Percent of Lot Within Tolerance
(Standard Deviation Method)
Positive Values of Q_U or Q_L

Percent Within Tolerance	n=3	n=4	n=5	n=6	n=7
64	0.4917	0.4200	0.3968	0.3859	0.3791
63	0.4587	0.3900	0.3678	0.3577	0.3515
62	0.4252	0.3600	0.3392	0.3295	0.3238
61	0.3912	0.3300	0.3106	0.3018	0.2966
60	0.3568	0.3000	0.2823	0.2740	0.2689
59	0.3215	0.2700	0.2539	0.2464	0.2418
58	0.2863	0.2400	0.2256	0.2189	0.2148
57	0.2510	0.2100	0.1972	0.1914	0.1878
56	0.2158	0.1800	0.1689	0.1639	0.1608
55	0.1806	0.1500	0.1406	0.1364	0.1338
54	0.1444	0.1200	0.1124	0.1091	0.1070
53	0.1083	0.0900	0.0843	0.0818	0.0802
52	0.0722	0.0600	0.0562	0.0545	0.0535
51	0.0361	0.0300	0.0281	0.0272	0.0267
50	0.0000	0.0000	0.0000	0.0000	0.0000

3.b Resampling of Lot. It is the intent of these specifications that lots will meet specification requirements at the time of submission. If permitted, nonconforming lots that can be corrected may be reworked and sampled.

3.c General Basis of Adjusted Payment. The related adjusted percentage of contract price will be determined by the method designated in the appropriate specification section.

(b) Specifications, Other than Restricted Performance.

1. Responsibility. The Department will be responsible for determining the acceptability of the material and construction. Material will be reviewed for acceptance through the Department's specified acceptance procedures. Sample locations for acceptance testing will be determined by the Department.

Perform sampling and testing for acceptance in the presence of the Inspector, unless otherwise specified. Transport acceptance samples from sampling point to testing site or other designated location in the presence of the Inspector.

The Contractor is responsible for the control and quality of the material and construction.

Prepare a QC Plan as specified in Section 106.03(a)2.a and submit it to the Inspector-In-Charge for review at the start of the project. Include QC sampling and testing frequencies and action points to initiate corrective measures. Notify the Inspector before performing QC sampling and testing. Perform QC sampling and testing and report results to the Inspector.

Do not incorporate any material into the work that is determined to be outside the specification limits.

Obtain and test samples according to the Department's PTMs. If the required test method is not specified, use methods described in the AASHTO Standard Specifications for Transportation Materials and Methods of Sampling and Testing, and Supplements, Standards and/or Tentatives of ASTM, or other testing procedures adopted by the Department.

Verification sampling and testing will be performed by the District, unless otherwise specified.

QA sampling and testing will be performed or witnessed by the BOPD.

Independent Assurance sampling and testing will be administered by the BOPD.

2. QC. Section 106.03(a)2. and as follows:

Provide a plan of the QC system to be used for all construction work requiring acceptance testing by the Department, including QC test frequencies and action points to initiate corrective measures. Submit a copy of the QC Plan to the Project Engineer, to be maintained at the Department's project field office, before the start of work. A QC Plan is not required for items specified in Section 901.

3. Compliance Certification of Bulletin Materials. The Contractor is responsible for the control and quality of all materials, both Bulletin and non-Bulletin materials, arriving at the project. Each Bulletin material must be certified to be from a Bulletin source and to be in compliance with the specification requirements for the material. A properly completed and submitted Form CS-4171, Certificate of Compliance, is the means for certification of Bulletin materials. Bulletin materials are defined in Section 106.02(a)1.

The Department reserves the right to sample and test any material for verification that specification requirements are met. Materials of questionable quality delivered to the project will be sampled, tested, and approved by LTS before incorporation in any work. Materials on a reduced certification level may be required to be sampled, tested, and approved by LTS before incorporation in any work. Random field verification samples of the material may be taken by the Representative at the material source, from delivered project material, or at the place of the last manufacturer, fabricator, or producer before delivery. Random QA samples may also be taken by the Representative from delivered project material, at the place of supply, or at the place of the last manufacturer, fabricator, or producer before delivery. The random samples will be sent to the LTS for testing.

3.a Form CS-4171 Completion. Form CS-4171 is completed by the manufacturer, fabricator, or producer (Producer) of Bulletin material provided to the project. The Producer maintains the original Form CS-4171 and provides a copy of Form CS-4171 with each direct shipment to the project.

When a Producer sells a Bulletin 15 material to a distributor/supplier (shipper), the Producer provides a copy of Form CS-4171 with each delivery to the shipper. When a shipper provides Bulletin 15 material directly to the project, the shipper completes and signs a new Form CS-4171 and provides a copy with each direct shipment to the project. The shipper will maintain the copy of the Producer's Form CS-4171 that they have received.

Form CS-4171 must be properly signed by a legally responsible company official.

3.b Form CS-4171 Submission for Project Shipments. Ensure that Form CS-4171 is received for each project shipment of Bulletin material. Submit to the Representative a properly completed and signed copy of Form CS-4171 for each project shipment. Do not incorporate any Bulletin material in the work until certification arrives on the project, unless otherwise approved by the Representative. Payment for material will be withheld until proper certification documentation is received.

Form CS-4171 may be submitted to the Department either in hard copy format or electronically. Contractors who wish to submit certification documentation to a project electronically, e.g. via e-mail, facsimile or through a PennDOT Project Collaboration Site, must notify the Department at the preconstruction meeting.

3.c Supplemental or Alternate Certification. Certain Bulletin materials require the submission of supplemental CS-4171 certification in addition to Form CS-4171, to provide traceability of materials in multi-step manufacturing processes.

- Epoxy coated or galvanized reinforcement steel requires the submission of supplemental certification Form CS-4171C (Epoxy Coating or Galvanizing Facility) and/or Form CS-4171F (Fabrication Facility).
- Structural steel, aluminum, or precast/prestressed concrete products, produced in a Bulletin 15 approved facility with an on-site Inspector or a Representative, must be stamped with an approved inspection stamp at the plant and certified with a Form CS-4171.

Certain Bulletin materials require a form of certification other than the Form CS-4171, as identified in the particular material specification.

- Section 701 and Section 702 materials require a properly completed vendor bill of lading.
- Certification of daily bituminous mixtures by submission of Form CS-4171B.
- Certification of locally approved non-Bulletin materials by submission of Form CS-4171LA.

Organize and submit only Forms CS-4171 and supplemental or alternate certifications for material supplied to the project. Submissions containing irrelevant forms or documentation for materials not incorporated into the project will not be accepted.

3.d CS-4171 Record Retention. Retain Form CS-4171 for a period of not less than 3 years from the date of the last project shipment. Make files available for inspection and verification by the Department.

Notify shippers that a certification file must be maintained for purchased Bulletin materials to provide an audit trail to the Producer. Certifications for purchased Bulletin materials must be maintained at their place of business for a period of not less than 3 years from the date of the last shipment to the project and must be available for inspection by the Department.

Notify Producers that all component certifications for purchased Bulletin materials must be maintained at their place of business for a period of not less than 3 years from the date of the last shipment to the project and must be available for inspection by the Department.

3.e Levels of Certification for Bulletin 15 Producers. The BOPD determines the Level of Certification for each Producer based on the Producer's ability to comply with the material specifications. The Levels of Certification are defined in Table C. Bulletin 15 will indicate if a Producer is at a certification level other than Level 1. Material provided by Producers listed in Bulletin 15 is approved for use only in its intended application(s).

TABLE C

Levels of Certification for Bulletin 15 Producers		Producer Material Shipment Procedure	Producer Additional Requirements
Level 1	Standard Certification	Ship on Certification with Form CS-4171*	None
Level 2	Standard Certification - Reduced	Ship on Certification with Form CS-4171*	See Section 106.03(b)3.e.2
Level 3	Lot Approval Certification	Ship only after Material Lot Approval using Modified Certification, with Form CS-4171*	See Section 106.03(b)3.e.3
Suspension or Removal	In accordance with the State's Contractor Responsibility Program: <ul style="list-style-type: none"> • Producer may be suspended or removed from Bulletin 15 for any of the reasons stated in the Bulletin 15 Preface, regardless of Producer certification level. • Failure of Producer to advance above Certification Level 3 will result in PennDOT's initiating action for suspension or removal from Bulletin 15. 		

* Certain Bulletin materials require supplemental or alternate forms of certification, refer to Section 106.03(b)3.c.

3.e.1 LEVEL 1 (Standard Certification).

- Initial Level of Certification typically issued to Bulletin 15 listed Producers.
- Material is produced and tested in accordance with the Producer's approved QC Plan.
- No known material performance or quality issues exist that warrant a reduced level of certification.
- Material is shipped on certification using Form CS-4171.

3.e.2 LEVEL 2 (Standard Certification - Reduced).

- Reduced Level of Certification issued to Bulletin 15 listed Producers who have exhibited minor/moderate material performance or quality issues.
- Producer is required to work with PennDOT on submission of an improvement plan that may include, but is not limited to, any or all of the following items: a revised QC Plan, a failure analysis/action plan to assess why failures are occurring and how to prevent these failures from

occurring in the future, correlation testing between in-house and independent lab testing to assist with validating results.

- Material is produced and tested in accordance with the improvement plan approved by PennDOT.
- Material is shipped on certification using Form CS-4171.

3.e.3 LEVEL 3 (Lot Approval Certification).

- This Level of Certification is issued to Bulletin 15 listed Producers who have exhibited major material performance or quality issues.
- Producer is required to work with PennDOT on an improvement plan as defined in Level 2.
- Material cannot be shipped to projects using the standard CS-4171 certification process.
- Producer must arrange for independent, in-plant acceptance testing (IPAT) that will be conducted side-by-side with “in-house” Producer testing at the designated frequencies in the revised QC plan. IPAT will be at the Producer’s expense. PennDOT’s LTS must approve the Producer’s proposed IPAT provider, before it begins.
- Any material lot to be used on a project must be tested and approved by the IPAT as meeting the required PennDOT specification prior to shipment to the project.
- Each material lot meeting the specification may be shipped to a project using a modified certification process as follows: submit, to both the Project Representative and LTS, Form CS-4171 along with a signed letter from the IPAT (on their official letterhead) indicating that the material lot meets testing and specification requirements.
- Correlate results from parallel “in-house” Producer testing and IPAT testing, and submit to the LTS on a monthly basis.

106.04 USE OF MATERIALS FROM WITHIN THE PROJECT—With written permission, material found in the excavation areas and meeting the Department’s specifications may be used in the project construction. Material used will be paid for, as specified in Section 110.01. However, replace any portion removed with suitable material, if required to complete the embankments. The replaced quantity will be 110% of the volume of stone or gravel removed and 100% of the volume of sand and other material removed. Do not use reserved material, as specified in Section 104.06, or as indicated in the proposal.

106.05 STORAGE OF MATERIAL—

(a) General. Store material to assure preservation of specified quality and fitness for the work.

Stored material, even though accepted before storage, may again be inspected before use in the work. Locate stored material to facilitate prompt inspection and control.

Adhere to the restrictions below for the storage of construction materials with known physical hazards (explosive, flammable, or combustible) or storage of any motorized equipment under any structure with vertical clearance measured:

- Less than 16 feet – No storage is allowed.
- Between 16 feet and 24 feet – Short term operational storage will be allowed provided the materials are stored in an enclosure which meets all ANSI and OSHA requirements for said material(s) and a fire prevention plan has been submitted for the short term operational storage. Short term operational storage is limited to the amount of material and/or equipment required for a 24-hour period.
- Greater than 24 feet – No restriction.

Vertical clearance is measured from the lowest structure member to the ground level below that member.

Do not use private property for storage purposes without written permission of the owner or lessee. Make copies of this permission available to the Department. Restore storage sites to conditions acceptable to property owners and the Department.

(b) Storage of Aggregates. Provide a separate stockpile for each aggregate size and type at cement concrete plants. Do not use aggregates that become segregated or mixed with earth or foreign material.

If divided aggregate bins are used for storage or for proportioning, take measures to prevent mixing of aggregates. Provide an area for storage of aggregates for use in Portland cement concrete and bituminous concrete. Store aggregates on one of the following constructed according to standard practice:

- Bituminous concrete base course, 4 inches minimum depth.
- Class C concrete, or better, 4 inches minimum depth.

(c) **Control of Aggregates.** Have aggregates available for use in cement concrete at the proportioning plant in enough time before batching to allow inspection and testing. Handle the aggregates so they may be field tested and accepted, before storing them with previously accepted aggregates. Batch fine and coarse aggregates separately. Properly control uniformity of moisture and uniformity of gradation. Provide a system of water sprays, then use when required, to maintain coarse aggregate moisture control.

During cool and cold weather concrete production, maintain aggregates required for individual concrete placements, whether stored in proportioning bins or stockpiles, at a temperature of not less than 40F before and during batching operations, for a sufficient length of time to eliminate the presence of frost in or around the aggregate particles.

(d) **Storage of Reinforcement.** Satisfactorily store reinforcement above ground, in a clean and dry condition on a platform, in an orderly manner, plainly marked to facilitate inspection.

106.06 HANDLING AND TRANSPORTATION OF MATERIAL—

(a) **General.** Carefully handle material to preserve quality and fitness for the work and to prevent loss, segregation, or inconsistency in quantities after weighing or measuring for incorporation in the work.

(b) **Aggregates.** In dry batching operations, measure aggregates or weigh before placing in the compartments of the vehicle, unless otherwise specified or permitted. Clean the vehicles and provide tight batch partitions at least 4 inches higher than the batched aggregate level being hauled, to prevent any spillage from one compartment to another.

(c) **Bulk Cement.** Bulk cement may be used, as specified in Section 701.

If bulk cement is used, transport to the mixer in acceptable metal, rubber, or plastic, watertight containers or compartments.

(d) **Bag Cement.** If bag cement is used, dump the contents of the correct number of bags required for each batch into the mixer skip. If permitted, bag cement may be transported from storage to the mixer by placing the correct number of bags per batch on the batched aggregate in the aggregate compartments. When transported, the bag cement may be dumped on the aggregate after having been checked by the inspector, and if done not more than 100 feet from the mixer. Bag cement that is allowed to lie on the batched aggregates longer than 2 hours, or cement dumped on the batched aggregate longer than 1 hour, will be rejected.

106.07 UNACCEPTABLE MATERIAL—

(a) **Restricted Performance Specifications.**

1. Acceptance or Rejection. Following the application of the appropriate acceptance plan, the Representative's decision will be final as to the acceptance, rejection, or acceptance at an adjusted price of sampled lots.

2. Disposition of Lots. If permitted, lots not conforming to specifications may be reworked and resubmitted for acceptance sampling. For nonconforming lots that are not adaptable to correction by reworking, remove and replace them, have them accepted without payment, or have them accepted at an adjusted price as stated in the specifications or, if not stated, as directed.

(b) **Specifications, Other than Restricted Performance.** Material not conforming to the requirements of the specifications, whether in place or not, will be rejected. Remove such material promptly from the site of the work, unless otherwise directed. Do not return rejected material to the work site until defects have been corrected and the

material has been accepted for use.

(c) Serviceable Precast or Prestressed Concrete, Fabricated Structural Steel and Aluminum Products. Plant produced fabricated materials or products having materials substitutions, dimensional deviations, specifications deficiencies, or damage which result in materials or products which may be serviceable but, do not meet all contract requirements will be addressed as follows:

1. Minor Deficiency or Defect. For materials or products with one or more minor deficiencies or defects, resolution of the deficiencies or defects will be made directly by the precaster or fabricator with the BDTD's Structural Materials Section. Minor defects and deficiencies are generally defined as those which will not require:

- engineering design review
- revisions to approved installation or erection plans or methods
- anticipated premature maintenance or rehabilitation

The Structural Materials Section may determine that one or more of the minor deficiencies or defects are actually significant deficiencies or non-conformances and require the precaster or fabricator to resolve the deficiency or defect as a significant deficiency or non-conformance as specified in Section 106.07(c)2.

2. Significant Deficiency or Non-Conformance. For materials or products having one or more significant deficiencies or non-conformances, which cannot be corrected to meet the contract specifications and which the Department determines may require one or more of the bulleted items listed in Section 106.07(c)1., submit documentation to support acceptance of the material or product (provided by the precaster or fabricator) and a request for Department evaluation and final disposition of the materials or products.

Where visible defects are present, or when otherwise requested, include detailed sketches, drawings, or photographs along with the supporting documentation from the precaster or fabricator to support acceptance of the material or product. Include a detailed repair procedure to correct the deficiency, if applicable.

For requests submitted for acceptance of the material or product "as is", provide supporting justification to demonstrate that the significant deficiency or non-conformance will not result in additional constructability issues during erection or construction or unanticipated premature maintenance work. Obtain approval of any revisions required to the shop drawings to reflect as built conditions prior to shipment.

Submit engineering calculations, when required or requested, to support the acceptability of the significant deficiency or non-conformance, sealed by a registered Professional Engineer that is licensed in the State. Submittals must include a statement by the Engineer that the defect will not compromise either the structural capacity or service life of the original design.

Submit the above to the District Assistant Construction Engineer with copies to the following:

- Chief Structural Materials Engineer, Bridge Design and Technology Division, Bureau of Project Delivery
- District Structural Control Engineer
- District Bridge Engineer
- Chief Bridge Engineer, Bridge Design and Technology Division, Bureau of Project Delivery (when calculations are required or requested).

Include the following minimum information on a cover page, attached to the submission:

- ECMS or other contract identification including State Route, Section and County
- Structure Number, if applicable
- Specific identification of the affected unit(s), i.e. girder-beam-culvert number, etc.
- Anticipated shipping date
- Detailed sketches, drawings or photographs of the defect, if visible or when requested.

After evaluation, the disposition of the material or product, including any conditions of acceptance, will be provided by the Chief Structural Materials Engineer from information provided by the Engineering District. Replace materials or products which are rejected via this policy with those complying with the contract specifications and requirements.

106.08 DEPARTMENT FURNISHED MATERIAL—The Department will furnish material, if specified in the proposal, in the quantities required. Material will be delivered or made available at the point specified.

The cost of handling and placing material after delivery will be included in the contract price for the item.

After delivery and acceptance by the Contractor, the cost of replacing material due to shortages, deficiencies, or damage, including demurrage charges, will be deducted from money due or to become due.

106.09 PENNSYLVANIA TRADE PRACTICES ACT—This section does not apply to projects which are partially or totally financed with Federal funds.

(a) General. Pursuant to the PA Trade Practices Act, Act 226-1968, the Department will not specify, purchase, or permit to be furnished or used in any contract aluminum or steel products as set forth below made in the countries set forth below.

The Department may utilize the discretionary waiver provision of Act 3-1978 as to steel products. As to aluminum products, if the sole source is from a banned country relief may be permitted under the Statutory Construction Act, 1 PA C.S. 1901 et seq.

1. Brazil. Welded carbon steel pipes and tubes; carbon steel wire rod; tool steel; certain stainless steel products including hot-rolled stainless steel bar; stainless steel wire rod and cold-formed stainless steel bar; pre-stressed concrete steel wire strand; hot-rolled carbon steel plate in coil; hot-rolled carbon steel sheet; and cold-rolled carbon steel sheet.

2. Spain. Certain stainless steel products, including stainless steel wire rod, hot-rolled stainless steel bars, and cold-formed stainless steel bars; pre-stressed concrete steel wire strand; certain steel products, including hot-rolled steel plate, cold-rolled carbon steel plate, carbon steel structural shapes, galvanized carbon steel sheet, hot-rolled carbon steel bars; and cold-formed carbon steel bars.

3. South Korea. Welded carbon steel pipes and tubes; hot-rolled carbon steel plate; hot-rolled carbon steel sheet; and galvanized steel sheet.

4. Argentina. Carbon steel wire rod and cold-rolled carbon steel sheet.

106.10 BUY AMERICA PROVISIONS AND CONVICT PRODUCED MATERIALS—This section only applies to projects partially or totally financed with Federal funds.

(a) Buy America Provisions. Furnish steel or iron materials, including coating for permanently incorporated work according to 23 CFR 635.410 and as follows:

- Pig iron and processed, pelletized, and reduced iron ore manufactured outside of the United States is acceptable for use in domestic manufacturing process for steel and/or iron materials.
- All manufacturing processes of steel or iron materials in a product, including coating; and any subsequent process that alters the steel or iron material's physical form or shape, or changes its chemical composition; are to occur within the United States. This includes rolling, extruding, machining, bending, grinding, drilling, and coating. Coating includes all processes that protect or enhance the value of the material, such as epoxy coatings, galvanizing or painting.
- Provide certification to the Inspector-in-Charge, that all manufacturing processes for steel and iron materials in a product, including coating, have occurred in the United States; certify as specified in Section 106.01.

Products manufactured of foreign steel or iron materials may be used, provided the cost of such products as they are delivered to the project does not exceed 0.1% of the total contract amount, or \$2,500, whichever is greater.

(b) Convict Produced Materials. Pursuant to 23 CFR 635.417, materials produced by convict labor after July 1, 1991 may not be used for Federal-aid highway construction projects, unless produced at a prison facility which had been producing convict-made materials for Federal-Aid construction projects before July 1, 1987.

Material produced by convicts who are on parole, supervised release, or probation from a prison may be incorporated in a Federal-Aid highway construction project.



AGGREGATE REPORT

<input type="checkbox"/> FINE AGG. <input checked="" type="checkbox"/> COARSE AGG. <input type="checkbox"/> ANTI SKID		<input type="checkbox"/> ACCEPTANCE <input checked="" type="checkbox"/> VERIFICATION <input type="checkbox"/> INFORMATION		<input checked="" type="checkbox"/> CONSTRUCTION <input type="checkbox"/> MAINTENANCE		P.O./CONT. NO							
MAT'L SPEC TYPE #57		DATE SAMPLED _____		ITEM NUMBER		ITEM QUANTITY							
PRODUCER/LOCATION Flint's Stone & Gravel						LOT NO. _____							
SYS	SR/PO	SPUR	PHA	SEC	ORG	CO	TON(NES) _____ TO _____						
							TON(NES) SHIPPED: TODAY _____ TO DATE _____ BALANCE _____						
SUBLOT NO.		1		2		3		SPEC. LIMITS		STATISTICAL ANALYSIS		MATERIAL TYPE: A57	
TON(NE) SAMPLED												TESTED BY: Rocco Crusher	
SIEVE	MASS (WT)	%	MASS (WT)	%	MASS (WT)	%	L	U	X	S	PWL	DEPT. INSPECT. Sam Stone	
100 mm (4")												WITNESSED BY:	
90 mm (3 1/2")												SOURCE TECH.	
75 mm (3")												REVIEWED BY:	
63 mm (2 1/2")												COUNTY MGR.	
50 mm (2")												D.M. UNIT	
37.5 mm (1 1/2")	27.00	100	25.00	100	25.40	100		100	100	0.0	100	DIST. ENGR.	
31.5 mm (1 1/4")												PWL ?	
25.0 mm (1")	26.80	99	24.70	99	25.20	99	95	100	99	0.0	100	PAY _____ %	
19.0 mm (3/4")												WET MASS(WT)-DRY MASS(WT) DRY MASS (WT) X100 = % MOISTURE	
12.5 mm (1/2")	6.20	23	4.70	19	8.60	34	25	60	25.3	7.8	?		
9.5 mm (3/8")													
8.0 mm (5/16")													
4.75 mm (#4)	0.60	2	0.60	2	0.60	2	0	10	2	0.0	100		
2.36 mm (#8)	0.50	2	0.40	2	0.50	2	0	5	2	0.0	100		
1.18 mm (#16)													
600 µm (#30)													
425 µm (#40)													
300 µm (#50)													
150 µm (#100)													
75 µm (#200)													
INITIAL DRY MASS (WT)	27.00		25.00		25.40								

MAT'L FINER THAN 75µm (#200)(FINAL WGT)	3733.40	0.47	3600.70	0.45	3499.10	0.50	0	1	0.47	0.0	100
CRUSHED FRAG MASS (WT) % (FINAL WGT)											
UNIT WEIGHT KG/M³ (LBS/CF)											
COEFFICIENT OF UNIFORMITY											
WEIGHT USED FOR FINE GRADATION											
FACTOR											

#200 Wash Start Wgt.	3750.90	3617.00	3516.80
Crush Cnt. Start Wgt.			

REMARKS

$$\text{AVERAGE} = X = \frac{\sum_{i=1}^n X_i}{n}$$

$$\text{STANDARD DEVIATION} = S = \sqrt{\frac{\sum_{i=1}^n (X_i - X)^2}{n-1}}$$

$$Q_u = \frac{(U - X)}{S} \qquad Q_L = \frac{(X - L)}{S}$$

$$\text{PWL} = (P_u + P_L) - 100$$

Percent Within Limits Calculations

a. Standard Deviation

$$S = \sqrt{\sum_{i=1}^n \frac{(x_i - \bar{x})^2}{n - 1}}$$

n = number of samples

x_i = individual sample

\bar{x} = average value of n samples:

$$\bar{x} = \frac{\sum_{i=1}^n x_i}{n}$$

- Standard Deviation Example n=5

$$x_i = \{10, 5, 50, 25, 35\}$$

$$\sum_{i=1}^n x_i = 125$$

$$\bar{x} = \frac{125}{n} = \frac{125}{5} = 25$$

x_i	\bar{x}	$x_i - \bar{x}$	$(x_i - \bar{x})^2$
10	-25	= -15	225
5	-25	= -20	400
50	-25	= 25	625
25	-25	= 0	0
35	-25	= 10	100

$$\sum_{i=1}^n ((x_i - \bar{x})^2) = 1,350$$

$$S = \sqrt{\frac{\sum_{i=1}^n (x_i - \bar{x})^2}{n - 1}} = \sqrt{\frac{1350}{4}} = \sqrt{337.5} \approx 18.4$$

- Same Average, Different Standard Deviation:

$$\begin{array}{r} 2 \\ 10 \\ +15 \\ \hline 27/3 = 9 \end{array} \quad \begin{array}{r} 2 - 9 = (-7)^2 = 49 \\ 10 - 9 = (1)^2 = 1 \\ 15 - 9 = (6)^2 = 36 \\ \hline 86 \end{array}$$

$$S = \sqrt{\frac{86}{3-1}} = \sqrt{43} \quad (\approx 6.56)$$

$$\begin{array}{r} 8 \\ 9 \\ +10 \\ \hline 27/3 = 9 \end{array} \quad \begin{array}{r} 8 - 9 = (-1)^2 = 1 \\ 9 - 9 = (0)^2 = 0 \\ 10 - 9 = (1)^2 = 1 \\ \hline 2 \end{array}$$

$$S = \sqrt{\frac{2}{3-1}} = \sqrt{1} \quad (\approx 1.00)$$

- Different Average, Same Standard Deviation:

$$\begin{array}{r} 38 \\ 39 \\ +40 \\ \hline 117/3 = 39 \end{array} \quad \begin{array}{r} 38 - 39 = (-1)^2 = 1 \\ 39 - 39 = (0)^2 = 0 \\ 40 - 39 = (1)^2 = 1 \\ \hline 2 \end{array}$$

$$S = \sqrt{\frac{2}{3-1}} = \sqrt{1} \quad (\approx 1.00)$$

- Average \div Standard Deviation:

$$\frac{9.0}{6.56} \approx 1.4 \quad \frac{9.0}{1.0} = 9.0 \quad \frac{39}{1.0} = 39.0$$

$\frac{\text{Average}}{\text{Standard Deviation}}$: The larger the number, the less variance

$$Q_L = \frac{\bar{x} - L}{s} \quad \text{or} \quad Q_u = \frac{U - \bar{x}}{s} \rightarrow \oplus \text{ or } \ominus \text{ values}$$

+ values \rightarrow less variability \rightarrow x falls between U and L
 - values \rightarrow more variability \rightarrow x falls outside U and L

b. Quality Index

$$Q_u = \frac{U - \bar{x}}{s} \qquad Q_t = \frac{\bar{x} - L}{s}$$

Q = Quality Factor
U = Upper Specification Limit
L = Lower Specification Limit

c. Verification Report Calculations

1. Calculate the average of three results for 1/2" screen: $n = 3$

$$\begin{array}{r} x_1 = 23 \\ x_2 = 19 \\ x_3 = \frac{+34}{76} \end{array} \qquad \bar{x} = \frac{76}{3} = 25.3$$

2. Calculate the standard deviation, s :

$$s = \sqrt{\frac{\sum_{i=1}^n (x_i - \bar{x})^2}{n - 1}}$$

x_i	$x_i - \bar{x}$		$(x_i - \bar{x})^2$
23	$23 - 25.3$	$= -2.3$	5.29
19	$19 - 25.3$	$= -6.3$	39.69
34	$34 - 25.3$	$= 8.7$	<u>+75.69</u>
			120.67

$$s = \sqrt{\frac{120.67}{2}} = \sqrt{60.34} \approx 7.76 \rightarrow 7.8$$

3. Calculate the Quality Index, Q :
Specifications out on low side $\rightarrow Q_L$

$$Q_L = \frac{\bar{x} - L}{s} = \frac{25.3 - 25}{7.8} = \frac{0.3}{7.8} \approx +0.0385$$

PWL Worksheet

Find the **Average** of three screens. Fill in the percent passing for each sample, (only for the screen size that failed)

$$\frac{\text{_____ (sample \#1)} + \text{_____ (sample \#2)} + \text{_____ (sample \#3)}}{3} = \text{_____ (Average)}$$

(Round off)

Find the **Standard Deviation** of three screens:

$$\text{_____ (sample \#1)} - \text{_____ (average)} = \text{_____ times itself} = \text{_____ (A)}$$

$$\text{_____ (sample \#2)} - \text{_____ (average)} = \text{_____ times itself} = \text{_____ (B)}$$

$$\text{_____ (sample \#3)} - \text{_____ (average)} = \text{_____ times itself} = \text{_____ (C)}$$

$$\text{_____ (A)} + \text{_____ (B)} + \text{_____ (C)} = \text{_____ divided by 2} = \text{_____ (D)}$$

$$\text{_____ (D)} \text{ then press } \sqrt{\text{ (square root button)}} \text{ to find } \text{_____ (Standard Deviation)}$$

If the failing screen exceeds the UPPER spec limit, then find QU.

$$\frac{\text{_____ (upper spec)} - \text{_____ (average)}}{\text{_____ (standard deviation)}} = \text{_____ (QU)}$$

If the failing screen exceeds LOWER spec limit, then find QL.

$$\frac{\text{_____ (average)} - \text{_____ (lower spec)}}{\text{_____ (standard deviation)}} = \text{_____ (QL)}$$

Estimated the **Screen PWL** from Table A (Negative numbers) or Table B (Positive numbers) in Pub 408, Section 106.03(a).

$$\text{_____ (Screen PWL)}$$

Average all the screen size PWL's to find the **Total PWL**.
(For all "In Spec" screen sizes, PWL = 100)

$$\text{_____ (Total PWL)}$$

4. Determine PWT:

Positive number: Go to chart in PennDOT Publication 408;
Section 106, Table B.

Look for Positive Value Q_t of 0.0385

Note 0.0361 is nearest value to 0.0385 → 51

PWT = 51

5. Calculate PWL:

All other screen splits are within specifications → 100

$$\begin{array}{r} 100 \\ 100 \\ 51 \\ 100 \\ 100 \\ \hline + 100 \\ \hline 551 \end{array}$$

$$\frac{551}{6} = 92\%$$

Aggregate Source Quality Failures; refer to Bulletin 14, page F-3

On requalification, Na₂SO₄ soundness loss = 11%

DME resamples n = 3 at least quarterly for next 6 months.

Calculate PWL for last 5 years:

(Two Examples)

- Example 1.

Last 5 years – assume n = 5 and Na₂SO₅ losses: {4,4,3,3,11}

x_i	$x_i - \bar{x}$	$(x_i - \bar{x})^2$
4	4 - 5 = -1	1
4	4 - 5 = -1	1
3	3 - 5 = -2	4
3	3 - 5 = -2	4
<u>+ 11</u>	11 - 5 = -6	<u>+ 36</u>
$\bar{x} = 25/5 = 5$		46

$$s = \sqrt{\frac{46}{4}} = \sqrt{11.5} \approx \textcircled{3.4}$$

$$Q_u = \frac{10 - 5}{3.4} = \textcircled{+1.5}$$

PWL = 96%, therefore passes

- Example 2.

n = 5, Na₂SO₄ losses: {8,9,9,8,11}

x_i	$x_i - \bar{x}$	$(x_i - \bar{x})^2$
8	8 - 9 = -1	1
9	9 - 9 = 0	0
9	9 - 9 = 0	0
8	8 - 9 = -1	1
<u>+ 11</u>	11 - 9 = 2	<u>+ 4</u>
$\bar{x} = 45/5 = 9$		6

$$s = \sqrt{\frac{6}{4}} = \sqrt{1.5} \approx \textcircled{1.22}$$

$$Q_u = \frac{10 - 9}{1.2} = \textcircled{+0.8}$$

PWL = 78% → Step 6; Written report required; may suspend from Bulletin 14.

APPENDIX

LABORATORY TESTING SECTION

Method of Test for

SIEVE ANALYSIS OF COARSE AND FINE AGGREGATE

This PTM is a modification of AASHTO T-27. The full standard is available from American Association of State Highway and Transportation Officials, 444 N. Capitol Street, N.W., Suite 249, Washington, D.C. 20001 (www.transportation.org).

The modifications to AASHTO T-27 are as follows:

6. APPARATUS

6.4 Oven- An oven of appropriate size capable of maintaining a uniform temperature of $110 \pm 5^{\circ}\text{C}$ ($230 \pm 9^{\circ}\text{F}$). Hot plates either electric or gas may be used when test results must be obtained quickly. Confirmation samples shall be tested using ovens as described in this section.

7. SAMPLING

7.1 Sample the aggregate in accordance with PTM 607.

7.3 Fine Aggregate - The size of the test sample of aggregate, after drying shall have an approximate mass of 500 grams.

7.4 Coarse Aggregate- The mass of the test sample of coarse aggregate shall conform with the following:

AASHTO / PA Number	Minimum Mass of Sample	
	Kg	lb.
# 1	Usual inspection per section 850.2 (a) 1 & 2, Pub. 408	
# 3	20	44
# 5	10	22
# 57	10	22
# 67	10	22
# 7	10	22
# 8	5	11
# 10	1	2
2A	15	33
OGS	15	33

- 7.7.1 Delete this section
- 7.7.2 Delete this section
- 7.7.3 Delete this section

8. PROCEDURE

8.4 (For Fine Aggregates) - Sieve for a sufficient period and in such a manner that, after completion, not more than 0.5 percent by mass of the total sample passes any sieve during 1 minute of continuous hand sieving performed as follows: Hold the individual sieve, provided with a snug fitting pan and cover, in a slightly inclined position in one hand. Strike the side of the sieve sharply with an upward motion while holding the sieve in the other hand, at the rate of about 150 times per minute. Turn the sieve about one-sixth of a revolution at intervals of about 25 strokes.

(For Coarse Aggregates) - Sieve for a sufficient period and in such a manner that, after completion, not more than 0.5 percent by mass of the total sample passes any sieve during 1 minute of continuous mechanical shaking as follows: Weigh the material retained on each individual sieve after the initial shaking period. Individually place each sieve with the material retained on the sieve back into the mechanical shaking device and sieve for an additional minute. In determining the sufficiency of sieving for sizes larger than 4.75 mm (No. 4) sieve, limit the material on the sieve to a single layer of particles.

Note- The Sufficiency of Sieving procedure is documented in PTM 608.

8.7 Determine the mass of each size increment by weighing on a scale or balance conforming to the requirements specified in Section 6.1 to the nearest 0.1 percent of the total original dry sample mass. The total mass of the material after sieving shall check closely with the original mass of sample placed on the sieves. If the amounts differ by more than 0.8 percent, based on the original dry sample mass, the results shall not be used for acceptance purposes.

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SIEVE ANALYSIS OF FINE AND COARSE AGGREGATE

Test Method Evaluated: AASHTO T27 _____ PTM 616 _____ ASTM C136 _____	
Person to be Evaluated	
Date the test method was read and understood	
Evaluator	
Date Evaluated	
Next Evaluation Date	

PROCEDURE

Fine Aggregate

1. Obtain sample by AASHTO T248 (ASTM C702)..... _____
2. Minimum sample weight is 500 g..... _____
3. Was AASHTO T11 (ASTM C117) used (*optional*)?..... Yes ___ No ___
 If so, use a No.200 sieve in the dry nest..... _____
4. Dry sample to constant weight at $110^{\circ} \pm 5^{\circ} \text{C}$ ($230^{\circ} \pm 9^{\circ} \text{F}$)..... _____
5. Inspect all sieves before testing, sieves should be clean and free of rips..... _____
6. *AASHTO*: Determine mass to nearest 0.1% of the original dry sample mass..... _____
 NOTE: If the specimen consists of material left over after AASHTO T11, step 5 does not apply because the total sample mass was determined as part of that test.
7. (a) *AASHTO and PTM*: Continue sieving until no more than 0.5% by weight of the total sample passes a given sieve in 1 minute of continuous hand sieving..... _____
 (b) *ASTM*: Continue sieving until no more than one per cent by mass of the residue passes a given sieve in 1 minute of continuous hand sieving..... _____
8. Weigh the residue on each sieve to 0.1% of the original dry sample mass..... _____
9. Do not overload the sieves, the weight of residue on each sieve (#4 or finer) should not exceed 7 kg/m² of sieving surface (200 g for a 8-inch sieve)..... _____
10. The total weight of the sieved sample should agree with the pre-sieved weight to within 0.3% for AASHTO and ASTM and 0.8% for PTM..... _____
11. Calculate the percentage retained on each sieve based on the original dry weight, including the material passing the No. 200 sieve..... _____

Coarse Aggregate and Mixture of Fine and Coarse Aggregate

1. Obtain test sample according to AASHTO T248 (ASTM C702), if the entire field sample is not used..... _____
2. Dry sample to constant weight at $110^{\circ} \pm 5^{\circ} \text{C}$ ($230^{\circ} \pm 9^{\circ} \text{F}$)..... _____
3. *AASHTO*: Determine mass to nearest 0.1% of the original dry weight..... _____
4. Minimum sample weight will be: #8= 11 lb, #57= 22 lb, #67= 22 lb, #2A = 33 lb per PTM..... _____
5. If hand sieving do not force particles through the sieve openings..... _____
6. (a) *AASHTO and PTM*: Continue sieving until no more than 0.5% by weight of the total sample passes a given sieve in 1 minute..... _____
 (b) *ASTM*: Continue sieving until no more than one per cent by mass of the residue passes a given sieve in 1 minute of continuous hand sieving..... _____
7. Weigh the residue on each sieve to 0.1% of the original dry weight..... _____
8. Do not overload the sieves, the weight of residue on each sieve should not exceed 2.5 times the sieve opening in mm times effective sieve area in m² (=kg/m² of sieving surface area)..... _____
9. The total weight of the sieved sample should agree with the pre-sieved weight to within 0.3% for AASHTO and ASTM and 0.8% for PTM..... _____
10. Calculate the percentage retained on each sieve based on the original dry weight..... _____
11. Calculate the percentages to the nearest 0.1%, and report to the nearest whole number..... _____

COMMENTS:

LABORATORY TESTING SECTION

Method of Test for

AMOUNT OF MATERIAL FINER THAN
75 μm (NO. 200) SIEVE IN AGGREGATE

This PTM is a modification of AASHTO T-11. The full standard is available from American Association of State Highway and Transportation Officials, 444 N. Capitol Street, N.W., Suite 249, Washington, D.C. 20001 (www.transportation.org).

The modifications to AASHTO T-11 are as follows:

1. SCOPE

1.2 Two procedures are included, one using only water for the washing operation, and the other including a wetting agent to assist the loosening of the material finer than the 75 μm (No. 200) sieve from the coarser material.

5. APPARATUS AND MATERIALS

5.4 Oven- An oven of sufficient size, capable of maintaining a uniform temperature of $110 \pm 5^\circ\text{C}$ ($230 \pm 9^\circ\text{F}$). Hot plates either electric or gas, maybe used when test results must be obtained quickly in the field. When test results are disputed, referee samples shall be tested using ovens as described above.

6. SAMPLING

6.1 Sample the aggregates in accordance with PTM 607.

6.2 Obtain a sample in accordance with PTM 607. Thoroughly mix the sample of aggregate to be tested and reduce the quantity to an amount suitable for testing using the applicable methods described in AASHTO T248. The sample for test shall not be less than the appropriate mass dried material as shown in the following table:

AASHTO / PA Number	Minimum Mass of Sample	
	Kg	lb
# 3	5.0	10.0
# 5	5.0	10.0
# 57	3.5	7.7
# 67	2.5	5.0
# 7	2.5	5.0
# 8	1.0	2.0
2A	4.0	8.8
OGS	4.0	8.8
Type A Fine Aggregate	0.5	1.0

11. REPORT

11.1 Report the percentage of material finer than the 75 μm (No. 200) sieve by washing to the nearest 0.01%.

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WASH TEST OF MATERIALS FINER THAN #200

Test Method Evaluated: AASHTO T11 _____ PTM 100 _____ ASTM C702 _____	
Person to be Evaluated	
Date the test method was read and understood	
Evaluator	
Date Evaluated	
Next Evaluation Date	

PROCEDURE

1. Obtain test sample by AASHTO T248 (ASTM C702).....
2. Minimum sample size for fine aggregate based on PTM will be 500g.....
3. Select sample size for PTM based on the following table.....

PTM No. 100	
AGGREGATE SIZE	MINIMUM SAMPLE WEIGHT in grams
#8	1000
#57	3500
#67	2500
2A, 2RC, OGS	4000

4. Dry sample to constant weight at $110^{\circ} \pm 5^{\circ} \text{C}$ ($230^{\circ} \pm 9^{\circ} \text{F}$).....
5. Determine mass of test sample to nearest 0.1% of the original dry sample mass.....
6. Place in container and cover with water.....
7. Vigorously agitate the contents of the container.....
8. Confirm complete separation of the fine and coarse particles.....
9. Pour wash water through nested sieves.....
10. Confirm wash water is free of coarse particles.....
11. Continue operation until wash water is clear.....
12. Return material retained on the nested sieves to the washed sample.....
13. Decant excess water from the washed sample through the No. 200 sieve.....
14. Dry sample to constant weight at $110^{\circ} \pm 5^{\circ} \text{C}$ ($230^{\circ} \pm 9^{\circ} \text{F}$).....
15. Determine mass to nearest 0.1% of the original dry sample mass.....
16. Calculate percentage of materials finer than 75- μm (No. 200) see Note:
17. Report the percentage of material finer than the 75- μm (No. 200) sieve to the nearest 0.01%.....

NOTE: $[(\text{original dry mass of sample} - \text{dry mass of sample after washing}) / \text{original dry mass of sample}] \times 100$

NOTE: Mechanical washing is permitted only if the results using the mechanical washing device are consistent with those obtained by manual washing and if degradation of the sample is avoided.

COMMENTS:

LABORATORY TESTING SECTION

Method of Test for

CALIBRATION OF MECHANICAL SIEVE SHAKER

1. SCOPE

1.1 This method of calibration describes a procedure to be used in determining the shaking efficiency of a mechanical sieve shaker.

2. APPARATUS

2.1 Balance- The balance or scale shall conform to the following criteria:

Class	Readability and Sensitivity	Accuracy ^a
G2	0.1 g	0.2 g or 0.1%
G5	1	2 g or 0.1%
G20	5 g	5 g or 0.1%
G100	20 g	20 g or 0.1%

^aAccuracy equal to the mass stated or 0.1% of the test load, whichever is greater, throughout the range of use.

NOTE 1- The balance shall have sufficient capacity to handle the greatest weighing made in conducting the test.

2.2 Sieves- The sieves shall be mounted on substantial frames constructed in a manner that will prevent loss of material during sieving. The sieves shall conform to the requirements of AASHTO M-92.

2.3 Mechanical Sieve Shaker- A mechanical sieve shaker shall impart a vertical, or lateral and vertical motion to the sieve, causing the particles to bounce and turn so as to present different orientations to the sieving surface.

2.4 Timers- Electric or mechanical timers shall be accurate and variable in 1 minute increments. The timers shall have a capacity of at least 15 minutes.

2.5 Oven- The oven shall be capable of maintaining a uniform temperature of $110 \pm 5^{\circ}\text{C}$ ($230 \pm 9^{\circ}\text{F}$).

NOTE 2- Hot plates may be used when test results must be obtained quickly. Confirmation samples shall be tested using ovens as described above.

3. SAMPLES

3.1 A representative sample sufficient to yield not less than the appropriate mass of dry material, as shown below, shall be selected in accordance with AASHTO T-248. The selection of samples of an exact pre-determined mass shall not be attempted.

3.2 After drying, sample fractions of fine aggregate shall have an approximate mass as follows:

Material with a minimum of 95 percent passing the 2.36 mm (No. 8) sieve.....100 g

Material with a minimum of 85 percent passing the 4.75 mm (No. 4) sieve, and more than 5 percent retained on a 2.36 (No. 8) sieve.....500 g

NOTE 3- In no case, however, shall the fraction retained on any sieve at the completion of the sieving operation weigh more than 200 g for the usual 203.2 mm (8") diameter sieve. The amount of material retained on the critical sieve may be regulated by the introduction of a larger sieve immediately above the critical sieve or by the selection of a sample of a proper size.

3.3 After drying, samples of coarse aggregate shall have a minimum mass as follows:

AASHTO Number	Minimum Mass of Sample	
	kg	lb.
#3	20	(44)
#5	10	(22)
#57	10	(22)
#67	10	(22)
#7	10	(22)
#8	5	(11)
PA No. 2A	15	(33)

NOTE 4- Samples failing to meet the mass requirements of Sections 3.2 and 3.3 shall be deemed to be insufficient to produce reliable results and shall not be tested. However, the intent of this method will be satisfied for samples of aggregate larger than 50 mm (2") nominal maximum size if a smaller mass of a sample is used, provided the criterion for acceptance or rejection of the material is based on the average of the results of at least three samples. The sample size used times the number of samples averaged shall equal the minimum mass of the

sample shown in Section 3.3. The differences in individual sample sizes shall not vary by mass by more than 20 percent from each other.

4. PROCEDURE

4.1 Coarse Aggregate

- 4.1.1 This procedure is to be used for each aggregate size produced. After obtaining a representative sample, shake the particular material at least one minute less than the time currently being used on the mechanical sieve shaker for a given aggregate size.
- 4.1.2 Weigh and record the amount retained on each individual sieve. Return the amount retained onto each one of the individual sieves where there is a significant amount of material retained. Typically, these are the middle sieves of the gradation.
- 4.1.3 Place the first sieve that has a significant amount of material retained on the sieve mesh into the shaking device. Shake for an additional minute. Weigh and record the amount retained on this sieve after one minute of additional mechanical shaking. Follow the same procedure for the remaining individual sieves that have been determined to have a significant amount of material retained.
- 4.1.4 Calculation to Determine Shaking Efficiency:

$$P = \frac{W_o - W_a}{W_t} \times 100$$

Where:

P = Percentage difference of weight retained on the individual sieve

W_o = Original weight retained on the individual sieve

W_a = Weight retained on the individual sieve after additional sieving

W_t = Total sample weight, dry

4.1.5 When the difference between the weights retained on each individual sieve after additional mechanical sieving and the original sieving is 0.5 %, or less, of the total oven dry sample weight, **FOR ALL SIEVE SIZES**, the shaking time used in Section 4.1.1 is sufficient. If any of the differences calculated are greater than 0.5 % of the total oven dry sample weight, repeat this process outlined above with a new representative sample. Increase the mechanical shaking time by one minute. Repeat the process as many times as necessary, but do not exceed 12 minutes of shaking time for any aggregate on any shaking device. If the shaking device cannot meet this requirement, replace or repair the shaking device.

4.1.6 Example of a Shaking Efficiency Determination:

No. 57 Coarse Aggregate
 Total Dry Sample Weight = 30.00 lbs

<u>Sieve</u>	<u>Weight Retained After 7 Minutes of Mechanical Shaking, lbs.</u>	<u>Weight Retained After 1 Minute of Additional Mechanical Shaking, lbs.</u>
5/8 in.	6.20	6.10
1/2 in.	12.10	12.00
3/8 in.	4.10	4.00

Calculation to Determine Shaking Efficiency

5/8 in. $6.20 \text{ lbs} - 6.10 \text{ lbs} = 0.10 \text{ lbs} \div 30.00 \text{ lbs} \times 100 = 0.3 \%$ difference
 1/2 in. $12.10 \text{ lbs} - 12.00 \text{ lbs} = 0.10 \text{ lbs} \div 30.00 \text{ lbs} \times 100 = 0.3 \%$ difference
 3/8 in. $4.10 \text{ lbs} - 4.00 \text{ lbs} = 0.10 \text{ lbs} \div 30.00 \text{ lbs} \times 100 = 0.3 \%$ difference

The results of this calculation to determine shaking efficiency for each of the three sieves indicate that all three sieves meet the 0.5% requirement stated in Section 4.1.5. In this example, therefore, a mechanical shaking time of 7 minutes is sufficient for this #57 coarse aggregate material on this shaking device.

4.2 Fine Aggregate

4.2.1 This procedure is to be used for each aggregate size produced. Retain the fine aggregate after the wash test and mechanically shake for at least 1 minute less than the time currently being used on the mechanical sieve shaker for a given aggregate size.

NOTE 5- Washing the sample before performing the shaking efficiency determination is not necessary for bituminous sands and Type 1, 1A, 2, 3, 3A, and 4 anti-skids.

4.2.2 Weigh and record the amount retained on each individual sieve. Return the amount retained onto each one of the individual sieves where there is a significant amount of material retained. Typically, these are the middle sieves of the gradation.

4.2.3 Hand sieve each individual sieve size in accordance with AASHTO T-27, Section 8.4 stated as follows: Hold the individual sieve, provided with a snug-fitting pan and cover, in a slightly inclined position in one hand. Strike the side of the sieve sharply and with an upward motion against the heel of the other hand at a rate of about 150 times per minute, turning the sieve about one-sixth of a revolution at intervals of about 25 strokes. Weigh and record the amount retained on each individual sieve after one minute of additional hand shaking.

4.2.4 Calculation to Determine Shaking Efficiency:

$$P = \frac{W_o - W_a}{W_t} \times 100$$

Where:

P = Percentage difference of weight retained on the individual sieve

W_o = Original weight retained on the individual sieve

W_a = Weight retained on the individual sieve after additional sieving

W_t = Total sample weight, dry

4.2.5 When the difference between the weight retained on each individual sieve after additional hand sieving and the original sieving is 0.5 %, or less, of the total oven dry sample weight, **FOR ALL SIEVE SIZES**, the shaking time used in Section 4.2.1 is sufficient. If any of the sieves have differences calculated that are greater than 0.5 % of the total oven dry sample weight, repeat this process outlined above with a new representative sample. Increase the mechanical shaking time by one minute. Repeat the process as many times as necessary, but do not exceed 12 minutes of shaking time for any aggregate on any shaking device. If the shaking device cannot meet this requirement, replace or repair the shaking device.

4.2.6 Example of a Shaking Efficiency Determination:

Type A Concrete Sand
 Total dry sample weight = 490.0 grams

<u>Sieve</u>	<u>Weight Retained After 7 Minutes of Mechanical Shaking, lbs.</u>	<u>Weight Retained After 1 Minute of Additional Mechanical Shaking, lbs.</u>
No. 8	120.0	115.0
No. 16	140.0	138.0
No. 30	100.0	98.0

Calculation to Determine Shaking Efficiency

No. 8 $120.0 \text{ g} - 115.0 \text{ g} = 5.0 \text{ g} \div 490 \text{ g} \times 100 = 1.0 \%$ difference
 No. 16 $140.0 \text{ g} - 138.0 \text{ g} = 2.0 \text{ g} \div 490 \text{ g} \times 100 = 0.4 \%$ difference
 No. 30 $100.0 \text{ g} - 98.0 \text{ g} = 2.0 \text{ g} \div 490 \text{ g} \times 100 = 0.4 \%$ difference

Although the No. 16 and the No. 30 sieves met the requirement of 0.5 % for this material, the No. 8 sieve did not. Therefore, increase the shaking time for this material to 8 minutes and repeat the process with another new representative sample.

5. REFERENCES

PTM 616
 AASHTO T- 27

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SPECIFIC GRAVITY AND ABSORPTION OF COARSE AGGREGATE

Test Method Evaluated: AASHTO T85 _____ ASTM C127 _____	
Person to be Evaluated	
Date the test method was read and understood	
Evaluator	
Date Evaluated	
Next Evaluation Date	

APPARATUS

1. Sample container a wire basket of 3.35-mm (No. 6) mesh or finer _____
2. Water tank capable of completely submerging the sample equipped with an overflow outlet _____
3. Suspension apparatus with center of suspension apparatus properly located with respect to center of balance pan or other point of contact with balance..... _____
4. Immersion water, temperature is $23.0 \pm 1.7^\circ\text{C}$ ($73.4 \pm 3^\circ\text{F}$)..... _____
5. Large absorbent cloth _____
6. Balance Class G5 _____
7. Sieves, 4.75 mm (No. 4) or other sizes as needed _____
8. Oven capable of maintaining $110 \pm 5^\circ\text{C}$ ($230 \pm 9^\circ\text{F}$)..... _____

PROCEDURE

1. Obtain sample by (T248 / C702) _____
2. Sieve out all –No.4 material..... _____
3. Sample mass as follows: #57 and #67 – 4200 grams and #8 – 2200 grams..... _____
4. Wash sample to clean surfaces of particles _____
5. Dried to constant mass at $110 \pm 5^\circ\text{C}$ ($230 \pm 9^\circ\text{F}$) and cooled to room temperature for 1 to 3 hours (for up to 1 ½-in. nominal maximum size, longer for larger sizes)..... _____
6. Cover with water for 15 to 19 hours _____
7. Roll in cloth to remove visible films of water _____
8. Wipe larger particles individually and avoid evaporation _____
9. AASHTO: If sample dries past SSD, immerse sample in water for 30 minutes and re-start drying _____
10. Weigh the material at SSD to nearest 1 g or 0.1% of sample mass (whichever is greater)..... _____
11. Place sample immediately in wire mesh basket and immerse into the water bath..... _____
12. Remove entrapped air before weighing by shaking container while immersed _____
13. Determine the mass in water at $23.0 \pm 1.7^\circ\text{C}$ ($73.4 \pm 3^\circ\text{F}$) to nearest 1 g or 0.1% of sample mass (whichever is greater)..... _____
14. Dry to constant mass at $110 \pm 5^\circ\text{C}$ ($230 \pm 9^\circ\text{F}$) and cool to room temperature for 1 to 3 hours (or until aggregate has cooled to comfortable handling temperature, approximately 50°C)..... _____
15. Determine the oven dried mass to nearest 1 g or 0.1% of sample mass (whichever is greater) _____

Comments:

Coarse Aggregate Gravity and Absorption

Sample			AVG
A			
B			
C			
BSG			
BSGSSD			
ASG			
ABS			

Sample			AVG
A			
B			
C			
BSG			
BSGSSD			
ASG			
ABS			

A = mass of oven-dry specimen in air, g (A on AW19)

B = mass of saturated surface-dry specimen in air, g (B on AW19)

C = mass of saturated surface-dry specimen in water, g (C on AW19)

$$\text{BSG} = A/(B-C)$$

$$\text{BSGSSD} = B/(B-C)$$

$$\text{ASG} = A/(A-C)$$

$$\text{ABS} = [(B-A)/A] \times 100$$

SPECIFIC GRAVITY AND ABSORPTION OF FINE AGGREGATE

Test Method Evaluated: AASHTO T84 _____ ASTM C128 _____	
Person to be Evaluated	
Date the test method was read and understood	
Evaluator	
Date Evaluated	
Next Evaluation Date	

PROCEDURE

SSD Sample Preparation

1. Obtain sample by AASHTO T248 (ASTM C702).....
2. Sample should weigh approximately 1000 g.....
3. Dry sample to constant weight at $110^{\circ} \pm 5^{\circ} \text{C}$ ($230^{\circ} \pm 9^{\circ} \text{F}$).....
NOTE: Oven drying is unnecessary if naturally moist condition is desired.
4. Allow to cool to comfortable handling temperature.....
5. Cover sample with distilled water.....
6. Allow to stand for 15 to 19 hours.....
7. Decant excess water without losing fines.....
8. Spread sample on flat, nonabsorbent surface.....
9. Dry by a current of warm air, stirring to ensure uniform drying.....
10. Gently break up agglomerations with finger pressure.....
11. Place mold wide side down on flat, nonabsorbent surface.....
12. Fill mold to overflowing with the sample.....
13. Tamp 25 times with 5 mm (0.2 inch) drop, distributing along surface of the sample.....
14. Allow tamper to free fall under gravitational attraction.....
15. Remove loose sand from around base and lift mold vertically.....
16. If sample slumps, add water, keep sample covered, and allow to stand 30 minutes.....
17. Continue drying and repeating slump test at frequent intervals until sample slumps slightly.....

Test Procedure

1. Partially fill pycnometer with water and $500 \pm 10\text{g}$ of sample.....
2. Record the mass of SSD sample to 0.1g.....
3. Fill pycnometer to 90% of capacity and agitate to eliminate air bubbles.....
4. Adjust temperature of contents to $23^{\circ} \pm 1.7^{\circ} \text{C}$ ($73.4^{\circ} \pm 3^{\circ} \text{F}$).....
5. Adjust water level to calibrated capacity, and weigh pycnometer and contents.....
6. Remove sample and dry to constant weight at $110^{\circ} \pm 5^{\circ} \text{C}$ ($230^{\circ} \pm 9^{\circ} \text{F}$).....
7. Air cool sample to room temperature for 1 ± 0.5 hour and weigh.....
8. Use the proper calibrated pycnometer weight in calculations.....
9. Determine all weights to nearest 0.1 g.....

Pycnometer Calibration

1. 500 ml Volumetric Flask (or larger).....
 - a. (or) a Fruit Jar with Pycnometer top.....
 - b. (or) a Le Chatelier Flask (AASHTO T133).....
 2. The apparatus shall have a space of at least 10 mL between the highest gradation mark and the lowest point of grinding for the glass stopper.....
 3. The apparatus shall be made of glass.....
 4. The neck of the Pycnometer shall be graduated from 0 to 1 mL and from 18 to 24 mL.....
 5. The bottle and stopper will have identical permanent identification marking.....
 6. The unit of volume (mL) will be marked above the highest graduation.....
 7. The container will be calibrated to a volume exceeding 50% than the volume required to accommodate the test sample.....
- The Pycnometer will be calibrated at $23^{\circ} \pm 1.7^{\circ} \text{C}$ ($73.4^{\circ} \pm 3^{\circ} \text{F}$).....

Fine Aggregate Gravity and Absorption

Sample				AVG
A				
B				
S				
C				
BSG				
BSGSSD				
ASG				
ABS				

Sample				AVG
A				
B				
S				
C				
BSG				
BSGSSD				
ASG				
ABS				

A = mass of oven-dry specimen in air, g
 B = mass of pycnometer filled with water, g
 S = mass of saturated surface-dry specimen, g
 C = mass of pycnometer with specimen and water to calibration mark, g

BSG = $A/(B+S-C)$
BSGSSD = $S/(B+S-C)$
ASG = $A/(B+A-C)$
ABS = $[(S-A)/A] \times 100$

Aggregate Gravity and Absorption Practice Data

Coarse	Oven Dry (A)	SSD in Air (B)	SSD in Water (C)
Sample 1	2256.7	2282.4	1439.7
Sample 2	2499.4	2518.4	1593.4
Sample 3	4483.9	4526.2	2822.5
Sample 4	4572.5	4613.9	2925.4
Sample 5	4498.5	4792.2	2782.8
Sample 6	4562.2	4618.4	2896.5

Fine	Oven Dry (A)	Pycnometer filled with water (B)	SSD Specimen (S)	Pycnometer with specimen and water to calibration mark (C)
Sample 1	491.6	679.8	502.3	993.4
Sample 2	494.7	678.7	505.6	991.1
Sample 3	488.8	675.8	500.3	983.8
Sample 4	493.2	677.7	501.2	987.1
Sample 5	498.6	679.8	504.2	1001.4
Sample 6	491.7	677.7	502.3	987.5

Answers

Coarse	Bulk Specific Gravity	Bulk Specific Gravity SSD	Apparent Specific Gravity	Absorption
Sample 1	2.678	2.708	2.762	1.14
Sample 2	2.702	2.723	2.759	0.76
Sample 3	2.632	2.657	2.699	0.94
Sample 4	2.708	2.733	2.776	0.91
Sample 5	2.239	2.385	2.622	6.53
Sample 6	2.650	2.682	2.739	1.23

Fine	Bulk Specific Gravity	Bulk Specific Gravity SSD	Apparent Specific Gravity	Absorption
Sample 1	2.605	2.662	2.762	2.18
Sample 2	2.561	2.617	2.714	2.2
Sample 3	2.542	2.602	2.704	2.35
Sample 4	2.571	2.613	2.683	1.62
Sample 5	2.731	2.761	2.817	1.12
Sample 6	2.554	2.609	2.703	2.16

PWL Worksheet

Find the **Average** of three screens. Fill in the percent passing for each sample, (only for the screen size that failed)

$$\frac{\text{_____ (sample \#1)} + \text{_____ (sample \#2)} + \text{_____ (sample \#3)}}{3} = \text{_____ (Average)}$$

(Round off)

Find the **Standard Deviation** of three screens:

$$\text{_____ (sample \#1)} - \text{_____ (average)} = \text{_____ times itself} = \text{_____ (A)}$$

$$\text{_____ (sample \#2)} - \text{_____ (average)} = \text{_____ times itself} = \text{_____ (B)}$$

$$\text{_____ (sample \#3)} - \text{_____ (average)} = \text{_____ times itself} = \text{_____ (C)}$$

$$\text{_____ (A)} + \text{_____ (B)} + \text{_____ (C)} = \text{_____ divided by 2} = \text{_____ (D)}$$

$$\text{_____ (D)} \text{ then press } \sqrt{\text{ (square root button)}} \text{ to find } \text{_____ (Standard Deviation)}$$

If the failing screen exceeds the UPPER spec limit, then find QU.

$$\frac{\text{_____ (upper spec)} - \text{_____ (average)}}{\text{_____ (standard deviation)}} = \text{_____ (QU)}$$

If the failing screen exceeds LOWER spec limit, then find QL.

$$\frac{\text{_____ (average)} - \text{_____ (lower spec)}}{\text{_____ (standard deviation)}} = \text{_____ (QL)}$$

Estimated the **Screen PWL** from Table A (Negative numbers) or Table B (Positive numbers) in Pub 408, Section 106.03(a).

$$\text{_____ (Screen PWL)}$$

Average all the screen size PWL's to find the **Total PWL**.
(For all "In Spec" screen sizes, PWL = 100)

$$\text{_____ (Total PWL)}$$

PWL Worksheet

Find the **Average** of three screens. Fill in the percent passing for each sample, (only for the screen size that failed)

$$\frac{\text{_____ (sample \#1)} + \text{_____ (sample \#2)} + \text{_____ (sample \#3)}}{3} = \text{_____ (Average)}$$

(Round off)

Find the **Standard Deviation** of three screens:

$$\text{_____ (sample \#1)} - \text{_____ (average)} = \text{_____ times itself} = \text{_____ (A)}$$

$$\text{_____ (sample \#2)} - \text{_____ (average)} = \text{_____ times itself} = \text{_____ (B)}$$

$$\text{_____ (sample \#3)} - \text{_____ (average)} = \text{_____ times itself} = \text{_____ (C)}$$

$$\text{_____ (A)} + \text{_____ (B)} + \text{_____ (C)} = \text{_____ divided by 2} = \text{_____ (D)}$$

$$\text{_____ (D)} \text{ then press } \sqrt{\text{ (square root button)}} \text{ to find } \text{_____ (Standard Deviation)}$$

If the failing screen exceeds the UPPER spec limit, then find QU.

$$\frac{\text{_____ (upper spec)} - \text{_____ (average)}}{\text{_____ (standard deviation)}} = \text{_____ (QU)}$$

If the failing screen exceeds LOWER spec limit, then find QL.

$$\frac{\text{_____ (average)} - \text{_____ (lower spec)}}{\text{_____ (standard deviation)}} = \text{_____ (QL)}$$

Estimated the **Screen PWL** from Table A (Negative numbers) or Table B (Positive numbers) in Pub 408, Section 106.03(a).

$$\text{_____ (Screen PWL)}$$

Average all the screen size PWL's to find the **Total PWL**.
(For all "In Spec" screen sizes, PWL = 100)

$$\text{_____ (Total PWL)}$$



AGGREGATE REPORT

<input type="checkbox"/> FINE AGG. <input checked="" type="checkbox"/> COARSE AGG. <input type="checkbox"/> ANTI SKID		<input checked="" type="checkbox"/> ACCEPTANCE <input type="checkbox"/> VERIFICATION <input type="checkbox"/> INFORMATION		<input checked="" type="checkbox"/> CONSTRUCTION <input type="checkbox"/> MAINTENANCE		P.O./CONT. NO.	
MATL SPEC TYPE #8-1%		DATE SAMPLED 1/5/18		ITEM NUMBER		ITEM QUANTITY Plant Stockpile	
PRODUCER/LOCATION						LOT NO.	
SYS	SR/PO	SPUR	PHA	SEC	ORG	CO	TON(NES) TO
							TON(NES) SHIPPED: TODAY TO DATE BALANCE
SUBLOT NO.		1	2	3	SPEC. LIMITS		MATERIAL TYPE:
TON(NE) SAMPLED							TESTED BY: Fred Flintstone
SIEVE	MASS (WT)	%	MASS (WT)	%	MASS (WT)	%	DEPT. INSPECT.
100 mm (4")							WITNESSED BY: Quinn C. Tester
90 mm (3 1/2")							
75 mm (3")							SOURCE TECH.
63 mm (2 1/2")							REVIEWED BY:
50 mm (2")							COUNTY MGR.
37.5 mm (1 1/2")							D.M UNIT
31.5 mm (1 1/4")							DIST. ENGR.
25.0 mm (1")							PWL PAY 0 %
19.0 mm (3/4")							
12.5 mm (1/2")	11.55		11.99		12.53	100	WET MASS(WT)/DRY MASS(WT) DRY MASS (WT) X100 = % MOISTURE
9.5 mm (3/8")	10.28		10.42		11.30	85 100	
8.0 mm (5/16")							
4.75 mm (#4)	2.42		2.49		4.11	10 30	
2.36 mm (#8)	0.29		0.33		0.41	0 10	
1.18 mm (#16)	0.14		0.17		0.26	0 5	
600 µm (#30)							
425 µm (#40)							
300 µm (#50)							
150 µm (#100)							
75 µm (#200)							
INITIAL DRY MASS (WT)	11.56		12.02		12.55		

MATL. FINER THAN 75 µm (#200) (FINAL WGT)	1067.4	1243.7	1143.4	0	1.0
CRUSHED FINAG MASS (WT) % (FINAL WGT)					
UNIT WEIGHT kg/m ³ (LBS/CF)					
COEFFICIENT OF UNIFORMITY					
WEIGHT USED FOR FINE GRADATION FACTOR					

#200 Wash Start Wgt.	1082.3	1259.2	1164.2
Crush Cnt. Start Wgt.			

REMARKS

Material being used for Seal-Coat

$$\text{AVERAGE} = \bar{X} = \frac{\sum_{i=1}^n X_i}{n}$$

$$\text{STANDARD DEVIATION} = S = \sqrt{\frac{\sum_{i=1}^n (X_i - \bar{X})^2}{n-1}}$$

$$Q_u = \frac{(U - \bar{X})}{S} \quad Q_L = \frac{(X - L)}{S}$$

$$PWL = (P_u + P_L) - 100$$



AGGREGATE REPORT

<input type="checkbox"/> FINE AGG. <input checked="" type="checkbox"/> COARSE AGG. <input type="checkbox"/> ANTI-SKID		<input checked="" type="checkbox"/> ACCEPTANCE <input type="checkbox"/> VERIFICATION <input type="checkbox"/> INFORMATION		<input checked="" type="checkbox"/> CONSTRUCTION <input type="checkbox"/> MAINTENANCE		P.O./CONT. NO.							
MAYL SPEC TYPE #8-1%		DATE SAMPLED 1/5/18		ITEM NUMBER		ITEM QUANTITY Plant Stockpile							
PRODUCER/LOCATION						LOT NO.							
SY5	SR/PO	SPUR	PHA	SEC	ORG	CO	TON(NES) TO						
							TON(NES) SHIPPED: TODAY _____ TO DATE _____ BALANCE _____						
SUBLOT NO.		1		2		3		SPEC. LIMITS		STATISTICAL ANALYSIS		MATERIAL TYPE:	
TON(NE) SAMPLED												TESTED BY: Fred Flintstone	
SIEVE		MASS (WT)	%	MASS (WT)	%	MASS (WT)	%	L	U	X	S	PWL	DEPT. INSPECT.
100 mm (4")													WITNESSED BY:
90 mm (3 1/2")													Quinn C. Tester
75 mm (3")													SOURCE TECH.
63 mm (2 1/2")													REVIEWED BY:
50 mm (2")													COUNTY MGR.
37.5 mm (1 1/2")													D.M. UNIT
31.5 mm (1 1/4")													DIST. ENGR
25.0 mm (1")													PWL
19.0 mm (3/4")													PAY 0 %
12.5 mm (1/2")		11.55	100	11.99	100	12.53	100	100					WET MASS(WT)/DRY MASS(WT) DRY MASS (WT) X100 = % MOISTURE
9.5 mm (3/8")		10.28	89	10.42	87	11.30	90	85	100				
8.0 mm (5/16")													
4.75 mm (#4)		2.42	21	2.49	21	4.11	33	10	30				
2.36 mm (#8)		0.29	3	0.33	3	0.41	3	0	10				
1.18 mm (#16)		0.14	1	0.17	1	0.26	2	0	5				
800 µm (#30)													
425 µm (#40)													
300 µm (#50)													
150 µm (#100)													
75 µm (#200)													
INITIAL DRY MASS (WT)		11.56		12.02		12.55							

MATS FINER THAN 75µm (#200) FINAL WGT	1067.4	1.39	1243.7	1.23	1143.4	1.79	0	1.0		
CRUSHED FRAG MASS (WT) % (FINAL WGT)										
UNIT WEIGHT 40M ³ (LBS/CY)										
COEFFICIENT OF UNIFORMITY										
WEIGHT USED FOR FINE GRADATION FACTOR										

#200 Wash Start Wgt.	1082.5	1259.2	1164.2
Crush Cnt. Start Wgt.			

REMARKS
Material being used for Seal-Coat

$$\text{AVERAGE} = \bar{x} = \frac{\sum_{i=1}^n x_i}{n}$$

$$\text{STANDARD DEVIATION} = s = \sqrt{\frac{\sum_{i=1}^n (x_i - \bar{x})^2}{n-1}}$$

$$Q_u = \frac{(U \cdot X)}{S} \quad Q_L = \frac{(X - L)}{S}$$

$$\text{PWL} = (P_u + P_L) - 100$$



AGGREGATE REPORT

<input type="checkbox"/> FINE AGG. <input checked="" type="checkbox"/> COARSE AGG. <input type="checkbox"/> ANTI SKID		<input checked="" type="checkbox"/> ACCEPTANCE <input type="checkbox"/> VERIFICATION <input type="checkbox"/> INFORMATION		<input checked="" type="checkbox"/> CONSTRUCTION <input type="checkbox"/> MAINTENANCE		P.O./CONT. NO.								
MAT'L SPEC TYPE <u>N8-1%</u>		DATE SAMPLED <u>1/5/18</u>		ITEM NUMBER		ITEM QUANTITY Plant Stockpile								
PRODUCER/LOCATION						LOT NO.								
SYS	SR/PO	SPUR	PHA	SEC	ORG	CO	TON(NES) TO							
							TON(NES) SHIPPED: TODAY _____ TO DATE _____ BALANCE _____							
SUBLOT NO.		1		2		3		MATERIAL TYPE:						
TON(NE) SAMPLED								TESTED BY: Fred Flintstone						
SIEVE		MASS (WT)	%	MASS (WT)	%	MASS (WT)	%	L	U	X	S	PWL	DEPT. INSPECT.	
100 mm (4")													WITNESSED BY:	
90 mm (3 1/2")													Quinn C. Tester	
75 mm (3")													SOURCE TECH.	
63 mm (2 1/2")													REVIEWED BY:	
50 mm (2")													COUNTY MGR.	
37.5 mm (1 1/2")													D.M. UNIT	
31.5 mm (1 1/4")													DIST. ENGR.	
25.0 mm (1")													PWL <u>79</u>	
19.0 mm (3/4")													PAY <u>0</u> %	
12.5 mm (1/2")		11.55	100	11.99	100	12.53	100	100	100	100			WET MASS (WT), DRY MASS (WT) DRY MASS (WT) X100 = % MOISTURE	
9.5 mm (3/8")		10.28	89	10.42	87	11.30	90	85	100	89				
8.0 mm (5/16")														
4.75 mm (#4)		2.42	21	2.49	21	4.11	33	10	30	25				
2.36 mm (#8)		0.29	3	0.33	3	0.41	3	0	10	3				
1.18 mm (#16)		0.14	1	0.17	1	0.26	2	0	5	1				
600 µm (#30)														
425 µm (#40)														
300 µm (#50)														
150 µm (#100)														
75 µm (#200)														
INITIAL DRY MASS (WT)		11.56		12.02		12.55								

MAT'L FINER THAN #200 (WT)	1067.4	1.39	1243.7	1.23	1143.4	1.79	0	1.0	1.47
CRUSHED FRAG MASS (WT) % INITIAL MASS									
UNIT WEIGHT kg/m ³ (lb/cf)									
COEFFICIENT OF UNIFORMITY									
WEIGHT USED FOR FINE GRADATION									
FACTOR									

#200 Wash Start Wgt	1082.5	1259.2	1164.2
Crush Cnt. Start Wgt.			

REMARKS

Material being used for Seal-Coat

$$\text{AVERAGE} = \bar{x} = \frac{\sum_{i=1}^n X_i}{n}$$

$$\text{STANDARD DEVIATION} = s = \sqrt{\frac{\sum_{i=1}^n (X_i - \bar{x})^2}{n-1}}$$

$$Q_u = \frac{(U - \bar{x})}{s} \quad Q_L = \frac{(\bar{x} - L)}{s}$$

$$\text{PWL} = (P_u + P_L) - 100$$



AGGREGATE REPORT

<input type="checkbox"/> FINE AGG <input checked="" type="checkbox"/> COARSE AGG <input type="checkbox"/> ANTI SKID		<input checked="" type="checkbox"/> ACCEPTANCE <input type="checkbox"/> VERIFICATION <input type="checkbox"/> INFORMATION		<input checked="" type="checkbox"/> CONSTRUCTION <input type="checkbox"/> MAINTENANCE		P.O./CONT NO							
MATL SPEC TYPE #8-1%		DATE SAMPLED 1/5/18		ITEM NUMBER		ITEM QUANTITY							
PRODUCER/LOCATION		Plant Stockpile		LOT NO		TON(NES) TO							
SYS	SR/PO	SPUR	PHA	SEC	ORG	CO	TON(NES) SHIPPED TODAY TO DATE BALANCE						
						<input type="checkbox"/> GRAVEL <input type="checkbox"/> SAND <input type="checkbox"/> SLAG <input type="checkbox"/> COKE <input checked="" type="checkbox"/> STONE <input type="checkbox"/> CINDERS							
SUBLOT NO.		1		2		3		SPEC. LIMITS		STATISTICAL ANALYSIS		MATERIAL TYPE	
TON(NE) SAMPLED												TESTED BY: Fred Flintstone	
SIEVE		MASS (WT) %		MASS (WT) %		MASS (WT) %		L	U	X	S	PWL	DEPT INSPECT
100 mm (4")													WITNESSED BY:
90 mm (3 1/2")													Quinn C. Tester
75 mm (3")													SOURCE TECH.
63 mm (2 1/2")													REVIEWED BY
50 mm (2")													COUNTY MGR.
37.5 mm (1 1/2")													DM UNIT
31.5 mm (1 1/4")													DIST ENGR.
25.0 mm (1")													PWL
19.0 mm (3/4")													PAY () %
12.5 mm (1/2")		11.55	100	11.99	100	12.53	100	100	100	0			WET MASS (WT) DRY MASS (WT) X100 = % MOISTURE
9.5 mm (3/8")		10.28	89	10.42	87	11.30	90	85	100	89	1.5		
8.0 mm (5/16")													
4.75 mm (#4)		2.42	21	2.49	21	4.11	33	10	30	25	6.9		
2.36 mm (#8)		0.29	3	0.33	3	0.41	3	0	10	3	0		
1.18 mm (#16)		0.14	1	0.17	1	0.26	2	0	5	1	0.6		
600 µm (#30)													
425 µm (#40)													
300 µm (#50)													
150 µm (#100)													
75 µm (#200)													
INITIAL DRY MASS (WT)		11.56		12.02		12.55							

WATER FINER THAN 150 µm (#200) (WT)	1067.4	139	1243.7	123	1143.4	179	0	1.0	1.47	0.3
CRUSHED FRAG MASS (WT) % (FRAG WT)										
UNIT WEIGHT AGG (LB/FT ³)										
COEFFICIENT OF UNIFORMITY										
WEIGHT USED FOR FINE GRADATION FACTOR										

#200 Wash Start Wgt.	1082.5	1259.2	1164.2
Crush Cnt. Start Wgt.			

REMARKS
Material being used for Seal-Coat

$$\text{AVERAGE} = \bar{x} = \frac{\sum_{i=1}^n x_i}{n}$$

$$\text{STANDARD DEVIATION} = s = \sqrt{\frac{\sum_{i=1}^n (x_i - \bar{x})^2}{n-1}}$$

$$Q_u = \frac{(U - X)}{S} \quad Q_L = \frac{(X - L)}{S}$$

$$\text{PWL} = (P_u + P_L) - 100$$



AGGREGATE REPORT

<input type="checkbox"/> FINE AGG. <input checked="" type="checkbox"/> COARSE AGG. <input type="checkbox"/> ANTI SKID		<input checked="" type="checkbox"/> ACCEPTANCE <input type="checkbox"/> VERIFICATION <input type="checkbox"/> INFORMATION		<input checked="" type="checkbox"/> CONSTRUCTION <input type="checkbox"/> MAINTENANCE		P.O./CONT. NO							
MAT'L SPEC TYPE #8-1%		DATE SAMPLED 1/5/18		ITEM NUMBER		ITEM QUANTITY Plant Stockpile							
PRODUCER/LOCATION						LOT NO							
SYS	SR/PO	SPUR	PHA	SEC	ORG	CO	TON(NES) TO						
							TON(NES) SHIPPED: TODAY TO DATE BALANCE						
SUBLOT NO.		1	2	3	SPEC. LIMITS		STATISTICAL ANALYSIS						
TON(NE) SAMPLED								MATERIAL TYPE:					
SIEVE		MASS (WT)	%	MASS (WT)	%	MASS (WT)	%	L	U	X	S	PWL	TESTED BY: Fred Flintstone
100 mm (4")													DEPT. INSPECT.
90 mm (3 1/2")													WITNESSED BY:
75 mm (3")													Quinn C. Tester
63 mm (2 1/2")													SOURCE TECH.
50 mm (2")													REVIEWED BY:
37.5 mm (1 1/2")													COUNTY MGR.
31.5 mm (1 1/4")													DM. UNIT
25.0 mm (1")													DIST ENGR.
19.0 mm (3/4")													
12.5 mm (1/2")		11.55	100	11.99	100	12.53	100	10		100	0	100	
9.5 mm (3/8")		10.28	89	10.42	87	11.30	90	85	100	89	1.5	100	
8.0 mm (5/16")													
4.75 mm (#4)		2.42	21	2.49	21	4.11	33	10	30	25	6.9	72	
2.36 mm (#8)		0.29	3	0.33	3	0.41	3	0	10	3	0	100	
1.18 mm (#16)		0.14	1	0.17	1	0.26	2	0	5	1	0.6	100	
600 µm (#30)													
425 µm (#40)													
300 µm (#50)													
150 µm (#100)													
75 µm (#200)													
INITIAL DRY MASS (WT)		11.56		12.02		12.55							

MAT'L SPEC TYPE	1067.4	1.39	1243.7	1.23	1143.4	1.79	0	1.0	1.47	0.3	0
CRUSHED FRAG MASS (WT) % (FRAIL VGT)											
UNIT WEIGHT KG/M ³ (LBS/CF)											
COEFFICIENT OF UNIFORMITY											
WEIGHT USED FOR FINE GRADATION											
FACTOR											

#200 Wash Start Wgt.	1082.5	1259.2	1164.2
Crush Cnt. Start Wgt.			

REMARKS
Material being used for Seal-Coat

$$\text{AVERAGE} = \bar{x} = \frac{\sum_{i=1}^n x_i}{n}$$

$$\text{STANDARD DEVIATION} = s = \sqrt{\frac{\sum_{i=1}^n (x_i - \bar{x})^2}{n-1}}$$

$$Q_u = \frac{(U - \bar{x})}{s} \quad Q_L = \frac{(\bar{x} - L)}{s}$$

$$\text{PWL} = (P_u + P_L) - 100$$



AGGREGATE REPORT

<input type="checkbox"/> FINE AGG. <input checked="" type="checkbox"/> COARSE AGG. <input type="checkbox"/> ANTI SKID		<input checked="" type="checkbox"/> ACCEPTANCE <input type="checkbox"/> VERIFICATION <input type="checkbox"/> INFORMATION		<input checked="" type="checkbox"/> CONSTRUCTION <input type="checkbox"/> MAINTENANCE		P.O./CONT. NO.							
MATL SPEC TYPE #8-1%		DATE SAMPLED 1/5/18		ITEM NUMBER		ITEM QUANTITY							
PRODUCER/LOCATION						Plant Stockpile							
SYS SR/PO SPUR PHA SEC ORG CO						LOT NO.							
						TON(NES) TO							
						TON(NES) SHIPPED:							
						TODAY							
						TO DATE							
						BALANCE							
SUBLOT NO.		1		2		3		SPEC. LIMITS		STATISTICAL ANALYSIS		MATERIAL TYPE:	
TON(NE) SAMPLED												TESTED BY: Fred Flintstone	
SIEVE		MASS (WT) %		MASS (WT) %		MASS (WT) %		L		U		X S PWL	
100 mm (4")													
90 mm (3 1/2")													
75 mm (3")													
63 mm (2 1/2")													
50 mm (2")													
37.5 mm (1 1/2")													
31.5 mm (1 1/4")													
25.0 mm (1")													
19.0 mm (3/4")													
12.5 mm (1/2")		11.55 100		11.99 100		12.53 100		100		100		0 100	
9.5 mm (3/8")		10.28 89		10.42 87		11.30 90		85		100		89 1.5 100	
8.0 mm (5/16")													
4.75 mm (#4)		2.42 21		2.49 21		4.11 33		10		30		25 6.9 72	
2.36 mm (#8)		0.29 3		0.33 3		0.41 7		0		10		3 0 100	
1.18 mm (#16)		0.14 1		0.17 1		0.26 2		0		5		1 0.6 100	
600 µm (#30)													
425 µm (#40)													
300 µm (#50)													
150 µm (#100)													
75 µm (#200)													
INITIAL DRY MASS (WT)		11.56		12.02		12.55							

WITNESSED BY:	
Quinn C. Tester	
SOURCE TECH.	
REVIEWED BY:	
COUNTY MGR.	
D.M. UNIT	
DIST. ENGR.	
PWL 79	
PAY 0 %	
NET MASS(WT)-DRY MASS(WT) DRY MASS (WT) X100 = % MOISTURE	

MATL FINES THRU 75µm (0.075) (FINAL WGT)	1067.4	1.39	1243.7	1.23	1143.4	1.79	0	1.0	1.47	0.3	0
CRUSHED FRAG MASS (WT) % (FINAL WGT)											
LINE WEIGHT (KG/M ³) (BASE)											
COEFFICIENT OF UNIFORMITY											
WEIGHT LOSS FOR FINE GRADATION FACTOR											

#200 Wash Start Wgt.	1082.5	1259.2	1164.2
Crush Cnt. Start Wgt.			

REMARKS

Material being used for Seal-Coat

#4 sieve: Because it was out of specification on the (U) upper side, do the following:
 30.25 (average) / 6.9 = 0.722. Because it is a positive value, use Table B, follow column N=3
 and interpolate to 72 PWL for that screen.
 Wash test: Because it is out of specification on the (U) upper side, do the following:
 1-1.47 (average) / 0.3 = -1.567. Because this is a negative value, use Table A, follow column N=3
 and interpolate to 0, since that value is below 1 (PWT). PWL for that is 0

$$\text{AVERAGE} = \bar{x} = \frac{\sum_{i=1}^n x_i}{n}$$

$$\text{STANDARD DEVIATION} = s = \sqrt{\frac{\sum_{i=1}^n (x_i - \bar{x})^2}{n-1}}$$

$$Q_u = \frac{(U - \bar{x})}{s} \quad Q_L = \frac{(X - L)}{s}$$

$$\text{PWL} = (P_U + P_L) \cdot 100$$



AGGREGATE REPORT

COARSE AGGREGATE				VERIFICATION				CONSTRUCTION				P.O./CONT. NO.		
MAT'L SPEC TYPE C2A				DATE SAMPLED 08/11/17				ITEM NUMBER				ITEM QUANTITY		
PRODUCER / LOCATION PENNSY SUPPLY / PRESCOTT												LOT NO.		
SYR	SR/PD	SPUR	FHA	SEC	DIST	CO	STONE				TON(NES) SHIPPED:			
											TODAY _____		TO DATE _____	
SUBLOT NO.		1		2		3		SPEC. LIMITS		STATISTICAL ANALYSIS		BALANCE _____		
SIEVE		MASS (WT)	%	MASS (WT)	%	MASS (WT)	%	L	U	X	S	PWL	MATERIAL TYPE: 2 A	
4"													TESTED BY: MAX	
3 1/2"													DEPT. INSPECTOR	
3"													WITNESSED BY:	
2 1/2"													SOURCE TECH.	
2"		35.80	100	36.53	100	34.94	100	100	100	100	0.0	100	REVIEWED BY	
1 1/2"													COUNTY MGR.	
1"													D.M.UNIT	
3/4"		29.50	82	31.59	88	29.77	83	52	100	84	3.2	100	DIST. ENGR.	
1/2"													PWL _____ %	
3/8"		21.16	59	20.15	56	16.99	47	36	70	54	6.2	100	PAY _____ %	
#4		11.62	32	11.91	33	7.00	20	24	50					
#8														
#16		4.7	13	4.6	13	4.8	14	10	30	13	0.7	100		
#30														
#40														
#50														
#100														
#200														
MASS (WT)														
"K" FACTOR														
WAT'L FINER THAN #20		206.5	4.40	255.6	5.58	228.9	4.87	0	10	4.95	0.6	100		
% CRUSHED FRACTIONS														
UNIT WEIGHT ROAD (LBS/CY)														
COEFFICIENT OF UNIFORMITY														
UNWASHED MASS (MT)		4690.0		4578.1		4700.5								
WASHED MASS (MT)		4483.5		4322.5		4471.6								
REMARKS: STOCKPILE VERIFICATION														

PWL Worksheet

Find the Average of three screens. Fill in the percent passing for each sample, (only for the screen size that failed)

$$\frac{32}{\text{(sample \#1)}} \text{ plus } \frac{33}{\text{(sample \#2)}} \text{ plus } \frac{20}{\text{(sample \#3)}} = \frac{85}{3} \text{ divided by 3} = \frac{28}{\text{(Round off)}} \text{ (Average)}$$

Find the Standard Deviation of three screens:

$$\frac{32}{\text{(sample \#1)}} \text{ minus } \frac{28}{\text{(average)}} = \frac{4}{1} \text{ times itself} = \frac{16}{1} \text{ (A)}$$

$$\frac{33}{\text{(sample \#2)}} \text{ minus } \frac{28}{\text{(average)}} = \frac{5}{1} \text{ times itself} = \frac{25}{1} \text{ (B)}$$

$$\frac{20}{\text{(sample \#3)}} \text{ minus } \frac{28}{\text{(average)}} = \frac{-8}{1} \text{ times itself} = \frac{64}{1} \text{ (C)}$$

$$\frac{16}{\text{(A)}} \text{ plus } \frac{25}{\text{(B)}} \text{ plus } \frac{64}{\text{(C)}} = \frac{105}{2} \text{ divided by 2} = \frac{52.5}{1} \text{ (D)}$$

$$\frac{52.5}{\text{(D)}} \text{ then press } \sqrt{\text{ (square root button) to find } \frac{7.2}{1} \text{ (Standard Deviation)}$$

If the failing screen exceeds the UPPER spec limit, then find QU.

$$\frac{\text{upper spec}}{\text{(upper spec)}} \text{ minus } \frac{\text{average}}{\text{(average)}} = \frac{\text{ }}{\text{(standard deviation)}} \text{ divided by } \frac{\text{ }}{\text{(standard deviation)}} = \frac{\text{ }}{\text{ }} \text{ (QU)}$$

If the failing screen exceeds LOWER spec limit, then find QL.

$$\frac{28}{\text{(average)}} \text{ minus } \frac{24}{\text{(lower spec)}} = \frac{4}{1} \text{ divided by } \frac{7.2}{1} \text{ (standard deviation)} = \frac{.5555}{1} \text{ (QL)}$$

Estimated the **Screen PWL** from Table A (Negative numbers) or Table B (Positive numbers) in Pub 408, Section 106.03(a).

$$\frac{66}{1} \text{ (Screen PWL)}$$

Average all the screen size PWL's to find the **Total PWL**.
(For all "In Spec" screen sizes, PWL = 100)

$$\frac{94}{1} \text{ (Total PWL)}$$

$$100 + 100 + 100 + 66 + 100 + 100 = 566 \div 6 = 94.33$$

AASHTO No. 57 Example #1		
Original Wt.	26.02	
Screen	Mass Passing	Total % Pass
1 1/2"	26.02	
1"	25.93	
5/8"	15.21	
1/2"	9.41	
3/8"	5.10	
#4	1.26	
#8	0.68	

AASHTO No. 57 Example #2		
Original Wt.	25.40	
Screen	Mass Passing	Total % Pass
1 1/2"	25.37	
1"	24.10	
5/8"	11.67	
1/2"	5.88	
3/8"	2.17	
#4	0.40	
#8	0.26	

AASHTO No. 57 Example #3		
Original Wt.	24.43	
Screen	Mass Passing	Total % Pass
1 1/2"	24.43	
1"	22.60	
5/8"	13.57	
1/2"	8.34	
3/8"	3.61	
#4	0.46	
#8	0.27	

AASHTO No. 57 Example #4		
Original Wt.	25.30	
Screen	Mass Passing	Total % Pass
1 1/2"	25.3	
1"	25.17	
5/8"	13.95	
1/2"	7.67	
3/8"	3.63	
#4	1.00	
#8	0.70	

AASHTO No. 57 Example #5		
Original Wt.	25.09	
Screen	Mass Passing	Total % Pass
1 1/2"	25.09	
1"	24.87	
5/8"	13.77	
1/2"	8.04	
3/8"	4.28	
#4	1.10	
#8	0.77	

AASHTO No. 57 Example #6		
Original Wt.	25.32	
Screen	Mass Passing	Total % Pass
1 1/2"	25.32	
1"	23.96	
5/8"	15.63	
1/2"	9.81	
3/8"	4.84	
#4	0.54	
#8	0.29	

AASHTO No. 57 Example #1		
Original Wt.	26.02	
Screen	Mass Passing	Total % Pass
1 1/2"	26.02	100
1"	25.93	100
5/8"	15.21	58
1/2"	9.41	36
3/8"	5.10	20
#4	1.26	5
#8	0.68	3

AASHTO No. 57 Example #2		
Original Wt.	25.40	
Screen	Mass Passing	Total % Pass
1 1/2"	25.37	100
1"	24.10	95
5/8"	11.67	46
1/2"	5.88	23
3/8"	2.17	9
#4	0.40	2
#8	0.26	1

AASHTO No. 57 Example #3		
Original Wt.	24.43	
Screen	Mass Passing	Total % Pass
1 1/2"	24.43	100
1"	22.60	93
5/8"	13.57	56
1/2"	8.34	34
3/8"	3.61	15
#4	0.46	2
#8	0.27	1

AASHTO No. 57 Example #4		
Original Wt.	25.30	
Screen	Mass Passing	Total % Pass
1 1/2"	25.3	100
1"	25.17	99
5/8"	13.95	55
1/2"	7.67	30
3/8"	3.63	14
#4	1.00	4
#8	0.70	3

AASHTO No. 57 Example #5		
Original Wt.	25.09	
Screen	Mass Passing	Total % Pass
1 1/2"	25.09	100
1"	24.87	99
5/8"	13.77	55
1/2"	8.04	32
3/8"	4.28	17
#4	1.10	4
#8	0.77	3

AASHTO No. 57 Example #6		
Original Wt.	25.32	
Screen	Mass Passing	Total % Pass
1 1/2"	25.32	100
1"	23.96	95
5/8"	15.63	62
1/2"	9.81	39
3/8"	4.84	19
#4	0.54	2
#8	0.29	1

AASHTO No. 8 Example #1		
Original Wt.	12.67	
Screen	Mass Passing	Total % Pass
1/2"	12.65	
3/8"	11.08	
1/4"	3.91	
#4	1.20	
#8	0.24	
#16	0.16	

AASHTO No. 8 Example #2		
Original Wt.	12.05	
Screen	Mass Passing	Total % Pass
1/2"	12.04	
3/8"	11.13	
1/4"	6.49	
#4	3.52	
#8	0.63	
#16	0.29	

AASHTO No. 8 Example #3		
Original Wt.	12.12	
Screen	Mass Passing	Total % Pass
1/2"	12.11	
3/8"	11.31	
1/4"	6.87	
#4	3.81	
#8	0.68	
#16	0.30	

AASHTO No. 8 Example #4		
Original Wt.	13.37	
Screen	Mass Passing	Total % Pass
1/2"	13.35	
3/8"	11.79	
1/4"	4.22	
#4	1.32	
#8	0.28	
#16	0.18	

AASHTO No. 8 Example #5		
Original Wt.	13.23	
Screen	Mass Passing	Total % Pass
1/2"	13.23	
3/8"	11.78	
1/4"	5.33	
#4	2.09	
#8	0.56	
#16	0.31	

AASHTO No. 8 Example #6		
Original Wt.	12.05	
Screen	Mass Passing	Total % Pass
1/2"	12.04	
3/8"	11.33	
1/4"	6.90	
#4	3.89	
#8	0.79	
#16	0.35	

AASHTO No. 8 Example #1		
Original Wt.	12.67	
Screen	Mass Passing	Total % Pass
1/2"	12.65	100
3/8"	11.08	88
1/4"	3.91	31
#4	1.20	9
#8	0.24	2
#16	0.16	1

AASHTO No. 8 Example #2		
Original Wt.	12.05	
Screen	Mass Passing	Total % Pass
1/2"	12.04	100
3/8"	11.13	92
1/4"	6.49	54
#4	3.52	29
#8	0.63	5
#16	0.29	2

AASHTO No. 8 Example #3		
Original Wt.	12.12	
Screen	Mass Passing	Total % Pass
1/2"	12.11	100
3/8"	11.31	93
1/4"	6.87	57
#4	3.81	31
#8	0.68	6
#16	0.30	2

AASHTO No. 8 Example #4		
Original Wt.	13.37	
Screen	Mass Passing	Total % Pass
1/2"	13.35	100
3/8"	11.79	88
1/4"	4.22	32
#4	1.32	10
#8	0.28	2
#16	0.18	1

AASHTO No. 8 Example #5		
Original Wt.	13.23	
Screen	Mass Passing	Total % Pass
1/2"	13.23	100
3/8"	11.78	89
1/4"	5.33	40
#4	2.09	16
#8	0.56	4
#16	0.31	2

AASHTO No. 8 Example #6		
Original Wt.	12.05	
Screen	Mass Passing	Total % Pass
1/2"	12.04	100
3/8"	11.33	94
1/4"	6.90	57
#4	3.89	32
#8	0.79	7
#16	0.35	3

PennDOT No. 2A Example #1		
Original Wt.	32.20	
Screen	Mass Passing	Total % Pass
1 1/2"	32.2	
1"	30.7	
3/4"	22.3	
1/2"	14.6	
3/8"	11.1	
#4	7.6	

Mass Split for Fine Gradation 520.6
 K Factor =

PennDOT No. 2A Example #2		
Original Wt.	35.60	
Screen	Mass Passing	Total % Pass
1 1/2"	35.6	
1"	32.9	
3/4"	22.5	
1/2"	15.6	
3/8"	10.2	
#4	8.8	

Mass Split for Fine Gradation 500
 K Factor =

PennDOT No. 2A Example #3		
Original Wt.	30.50	
Screen	Mass Passing	Total % Pass
1 1/2"	30.5	
1"	28.6	
3/4"	20.5	
1/2"	13.6	
3/8"	10.5	
#4	9.6	

Mass Split for Fine Gradation 525.2
 K Factor =

PennDOT No. 2A Example #4		
Original Wt.	38.50	
Screen	Mass Passing	Total % Pass
1 1/2"	38.5	
1"	32.6	
3/4"	29.3	
1/2"	19.9	
3/8"	12.5	
#4	10.2	

Mass Split for Fine Gradation 503.4
 K Factor =

PennDOT No. 2A Example #5		
Original Wt.	37.60	
Screen	Mass Passing	Total % Pass
1 1/2"	37.6	
1"	29.9	
3/4"	22.6	
1/2"	19.6	
3/8"	15.3	
#4	10.9	

Mass Split for Fine Gradation 514.6
 K Factor =

PennDOT No. 2A Example #6		
Original Wt.	35.50	
Screen	Mass Passing	Total % Pass
1 1/2"	35.1	
1"	27.6	
3/4"	20.5	
1/2"	18.3	
3/8"	12.5	
#4	7.6	

Mass Split for Fine Gradation 501.3
 K Factor =

TA Concrete Sand Example #1		
Wash test		
Original Wt.	550.7	
Final Wt.	547.2	
Loss		
% Loss		
Screen	Scale Reading	Total % Pass
3/8"	547.2	
#4	530.3	
#8	462.9	
#16	380.2	
#30	311.5	
#50	132.2	
#100	57.6	

TA Concrete Sand Example #2		
Wash test		
Original Wt.	515.6	
Final Wt.	507.8	
Loss		
% Loss		
Screen	Scale Reading	Total % Pass
3/8"	507.8	
#4	500.2	
#8	420.7	
#16	320.6	
#30	289.7	
#50	101.4	
#100	35.2	

TA Concrete Sand Example #3		
Wash test		
Original Wt.	510.5	
Final Wt.	501.4	
Loss		
% Loss		
Screen	Scale Reading	Total % Pass
3/8"	501.4	
#4	496.5	
#8	400.6	
#16	296.4	
#30	242.5	
#50	100.2	
#100	30.5	

TA Concrete Sand Example #4		
Wash test		
Original Wt.	500.2	
Final Wt.	489.2	
Loss		
% Loss		
Screen	Scale Reading	Total % Pass
3/8"	489.2	
#4	450.6	
#8	389.7	
#16	300.1	
#30	287.5	
#50	96.4	
#100	30.4	

TA Concrete Sand Example #5		
Wash test		
Original Wt.	520.6	
Final Wt.	505.3	
Loss		
% Loss		
Screen	Scale Reading	Total % Pass
3/8"	505.3	
#4	450.6	
#8	350.8	
#16	300.4	
#30	275.3	
#50	105.8	
#100	32.5	

TA Concrete Sand Example #6		
Wash test		
Original Wt.	526.7	
Final Wt.	520.7	
Loss		
% Loss		
Screen	Scale Reading	Total % Pass
3/8"	520.7	
#4	507.4	
#8	440.6	
#16	375.4	
#30	300.6	
#50	119.8	
#100	45.8	

TA Concrete Sand Example #1		
Wash test		
Original Wt.	550.7	
Final Wt.	547.2	
Loss	3.5	
% Loss	0.64	
Screen	Scale Reading	Total % Pass
3/8"	547.2	100
#4	530.3	97
#8	462.9	85
#16	380.2	70
#30	311.5	57
#50	132.2	25
#100	57.6	11

TA Concrete Sand Example #2		
Wash test		
Original Wt.	515.6	
Final Wt.	507.8	
Loss	7.8	
% Loss	1.51	
Screen	Scale Reading	Total % Pass
3/8"	507.8	100
#4	500.2	99
#8	420.7	83
#16	320.6	64
#30	289.7	58
#50	101.4	21
#100	35.2	8

TA Concrete Sand Example #3		
Wash test		
Original Wt.	510.5	
Final Wt.	501.4	
Loss	9.1	
% Loss	1.78	
Screen	Scale Reading	Total % Pass
3/8"	501.4	100
#4	496.5	99
#8	400.6	80
#16	296.4	60
#30	242.5	49
#50	100.2	21
#100	30.5	8

TA Concrete Sand Example #4		
Wash test		
Original Wt.	500.2	
Final Wt.	489.2	
Loss	11	
% Loss	2.20	
Screen	Scale Reading	Total % Pass
3/8"	489.2	100
#4	450.6	92
#8	389.7	80
#16	300.1	62
#30	287.5	60
#50	96.4	21
#100	30.4	8

TA Concrete Sand Example #5		
Wash test		
Original Wt.	520.6	
Final Wt.	505.3	
Loss	15.3	
% Loss	2.94	
Screen	Scale Reading	Total % Pass
3/8"	505.3	100
#4	450.6	89
#8	350.8	70
#16	300.4	61
#30	275.3	56
#50	105.8	23
#100	32.5	9

TA Concrete Sand Example #6		
Wash test		
Original Wt.	526.7	
Final Wt.	520.7	
Loss	6	
% Loss	1.14	
Screen	Scale Reading	Total % Pass
3/8"	520.7	100
#4	507.4	97
#8	440.6	85
#16	375.4	72
#30	300.6	58
#50	119.8	24
#100	45.8	10

Standard Deviation Sample Problem 1

$$\frac{5}{\text{(Sample \#1)}} + \frac{7}{\text{(Sample \#2)}} + \frac{10}{\text{(Sample \#3)}} + \frac{3}{\text{(Sample \#4)}} \div \underline{\hspace{1cm}} = \underline{\hspace{1cm}} \text{ (Average)}$$

$$\text{(Sample \#1)} - \text{(Average)} = \underline{\hspace{2cm}} \quad x^2 = \underline{\hspace{2cm}} \quad \text{(A)}$$

$$\text{(Sample \#2)} - \text{(Average)} = \underline{\hspace{2cm}} \quad x^2 = \underline{\hspace{2cm}} \quad \text{(B)}$$

$$\text{(Sample \#3)} - \text{(Average)} = \underline{\hspace{2cm}} \quad x^2 = \underline{\hspace{2cm}} \quad \text{(C)}$$

$$\text{(Sample \#4)} - \text{(Average)} = \underline{\hspace{2cm}} \quad x^2 = \underline{\hspace{2cm}} \quad \text{(D)}$$

$$\underline{\hspace{1cm}} \text{ (A)} + \underline{\hspace{1cm}} \text{ (B)} + \underline{\hspace{1cm}} \text{ (C)} + \underline{\hspace{1cm}} \text{ (D)} \div \underline{\hspace{1cm}} \text{ (n-1)} = \underline{\hspace{1cm}} \text{ (E)}$$

$$\sqrt{\text{(E)}} = \underline{\hspace{2cm}} \text{ (Standard Deviation)}$$

Standard Deviation Sample Problem 2

$$\frac{1.69}{\text{(Sample \#1)}} + \frac{1.87}{\text{(Sample \#2)}} + \frac{1.53}{\text{(Sample \#3)}} + \frac{1.72}{\text{(Sample \#4)}} + \frac{1.59}{\text{(Sample \#5)}} \div \underline{\hspace{1cm}} = \underline{\hspace{1cm}} \text{ (Average)}$$

$$\text{(Sample \#1)} - \text{(Average)} = \underline{\hspace{2cm}} \quad x^2 = \underline{\hspace{2cm}} \quad \text{(A)}$$

$$\text{(Sample \#2)} - \text{(Average)} = \underline{\hspace{2cm}} \quad x^2 = \underline{\hspace{2cm}} \quad \text{(B)}$$

$$\text{(Sample \#3)} - \text{(Average)} = \underline{\hspace{2cm}} \quad x^2 = \underline{\hspace{2cm}} \quad \text{(C)}$$

$$\text{(Sample \#4)} - \text{(Average)} = \underline{\hspace{2cm}} \quad x^2 = \underline{\hspace{2cm}} \quad \text{(D)}$$

$$\text{(Sample \#5)} - \text{(Average)} = \underline{\hspace{2cm}} \quad x^2 = \underline{\hspace{2cm}} \quad \text{(E)}$$

$$\underline{\hspace{1cm}} \text{ (A)} + \underline{\hspace{1cm}} \text{ (B)} + \underline{\hspace{1cm}} \text{ (C)} + \underline{\hspace{1cm}} \text{ (D)} + \underline{\hspace{1cm}} \text{ (E)} \div \underline{\hspace{1cm}} \text{ (n-1)} = \underline{\hspace{1cm}} \text{ (F)}$$

$$\sqrt{\text{(F)}} = \underline{\hspace{2cm}} \text{ (Standard Deviation)}$$

Standard Deviation Sample Problem 3

$$\frac{13}{\text{(Sample \#1)}} + \frac{21}{\text{(Sample \#2)}} + \frac{10}{\text{(Sample \#3)}} \div \underline{\hspace{2cm}} = \underline{\hspace{2cm}} \text{ (Average)}$$

$$\text{(Sample \#1)} - \text{(Average)} = \underline{\hspace{2cm}} \quad x^2 = \underline{\hspace{2cm}} \quad \text{(A)}$$

$$\text{(Sample \#2)} - \text{(Average)} = \underline{\hspace{2cm}} \quad x^2 = \underline{\hspace{2cm}} \quad \text{(B)}$$

$$\text{(Sample \#3)} - \text{(Average)} = \underline{\hspace{2cm}} \quad x^2 = \underline{\hspace{2cm}} \quad \text{(C)}$$

$$\frac{\underline{\hspace{2cm}}}{\text{(A)}} + \frac{\underline{\hspace{2cm}}}{\text{(B)}} + \frac{\underline{\hspace{2cm}}}{\text{(C)}} \div \underline{\hspace{2cm}} = \underline{\hspace{2cm}} \quad \text{(D)}$$

$$\sqrt{\text{(D)}} = \underline{\hspace{2cm}} \text{ (Standard Deviation)}$$

Standard Deviation Sample Problem 4

$$\frac{100}{\text{(Sample \#1)}} + \frac{113}{\text{(Sample \#2)}} + \frac{98}{\text{(Sample \#3)}} + \frac{103}{\text{(Sample \#4)}} + \frac{95}{\text{(Sample \#5)}} \div \underline{\hspace{2cm}} = \underline{\hspace{2cm}} \text{ (Average)}$$

$$\text{(Sample \#1)} - \text{(Average)} = \underline{\hspace{2cm}} \quad x^2 = \underline{\hspace{2cm}} \quad \text{(A)}$$

$$\text{(Sample \#2)} - \text{(Average)} = \underline{\hspace{2cm}} \quad x^2 = \underline{\hspace{2cm}} \quad \text{(B)}$$

$$\text{(Sample \#3)} - \text{(Average)} = \underline{\hspace{2cm}} \quad x^2 = \underline{\hspace{2cm}} \quad \text{(C)}$$

$$\text{(Sample \#4)} - \text{(Average)} = \underline{\hspace{2cm}} \quad x^2 = \underline{\hspace{2cm}} \quad \text{(D)}$$

$$\text{(Sample \#5)} - \text{(Average)} = \underline{\hspace{2cm}} \quad x^2 = \underline{\hspace{2cm}} \quad \text{(E)}$$

$$\frac{\underline{\hspace{2cm}}}{\text{(A)}} + \frac{\underline{\hspace{2cm}}}{\text{(B)}} + \frac{\underline{\hspace{2cm}}}{\text{(C)}} + \frac{\underline{\hspace{2cm}}}{\text{(D)}} + \frac{\underline{\hspace{2cm}}}{\text{(E)}} \div \underline{\hspace{2cm}} = \underline{\hspace{2cm}} \text{ (F)}$$

$$\sqrt{\text{(F)}} = \underline{\hspace{2cm}} \text{ (Standard Deviation)}$$

Standard Deviation Sample Problem 5

$$\frac{3}{\text{(Sample \#1)}} + \frac{7}{\text{(Sample \#2)}} + \frac{5}{\text{(Sample \#3)}} \div \underline{\hspace{2cm}} = \underline{\hspace{2cm}} \text{ (Average)}$$

$$\text{(Sample \#1)} - \text{(Average)} = \underline{\hspace{2cm}} \quad x^2 = \underline{\hspace{2cm}} \quad \text{(A)}$$

$$\text{(Sample \#2)} - \text{(Average)} = \underline{\hspace{2cm}} \quad x^2 = \underline{\hspace{2cm}} \quad \text{(B)}$$

$$\text{(Sample \#3)} - \text{(Average)} = \underline{\hspace{2cm}} \quad x^2 = \underline{\hspace{2cm}} \quad \text{(C)}$$

$$\frac{\text{(A)}}{\text{(A)}} + \frac{\text{(B)}}{\text{(B)}} + \frac{\text{(C)}}{\text{(C)}} \div \underline{\hspace{2cm}} = \underline{\hspace{2cm}} \quad \text{(D)}$$

$$\sqrt{\text{(D)}} = \underline{\hspace{2cm}} \text{ (Standard Deviation)}$$

Standard Deviation Sample Problem 6

$$\frac{1.26}{\text{(Sample \#1)}} + \frac{1.57}{\text{(Sample \#2)}} + \frac{1.98}{\text{(Sample \#3)}} + \frac{0.96}{\text{(Sample \#4)}} \div \underline{\hspace{2cm}} = \underline{\hspace{2cm}} \text{ (Average)}$$

$$\text{(Sample \#1)} - \text{(Average)} = \underline{\hspace{2cm}} \quad x^2 = \underline{\hspace{2cm}} \quad \text{(A)}$$

$$\text{(Sample \#2)} - \text{(Average)} = \underline{\hspace{2cm}} \quad x^2 = \underline{\hspace{2cm}} \quad \text{(B)}$$

$$\text{(Sample \#3)} - \text{(Average)} = \underline{\hspace{2cm}} \quad x^2 = \underline{\hspace{2cm}} \quad \text{(C)}$$

$$\text{(Sample \#4)} - \text{(Average)} = \underline{\hspace{2cm}} \quad x^2 = \underline{\hspace{2cm}} \quad \text{(D)}$$

$$\frac{\text{(A)}}{\text{(A)}} + \frac{\text{(B)}}{\text{(B)}} + \frac{\text{(C)}}{\text{(C)}} + \frac{\text{(D)}}{\text{(D)}} \div \underline{\hspace{2cm}} = \underline{\hspace{2cm}} \quad \text{(E)}$$

$$\sqrt{\text{(E)}} = \underline{\hspace{2cm}} \text{ (Standard Deviation)}$$

Standard Deviation Sample Problem 7

$$\frac{0.50}{\text{(Sample \#1)}} + \frac{0.90}{\text{(Sample \#2)}} + \frac{0.40}{\text{(Sample \#3)}} \div \underline{\hspace{2cm}} = \underline{\hspace{2cm}} \text{ (Average)}$$

$$\text{(Sample \#1)} - \text{(Average)} = \underline{\hspace{2cm}} \quad x^2 = \underline{\hspace{2cm}} \quad \text{(A)}$$

$$\text{(Sample \#2)} - \text{(Average)} = \underline{\hspace{2cm}} \quad x^2 = \underline{\hspace{2cm}} \quad \text{(B)}$$

$$\text{(Sample \#3)} - \text{(Average)} = \underline{\hspace{2cm}} \quad x^2 = \underline{\hspace{2cm}} \quad \text{(C)}$$

$$\underline{\hspace{2cm}} \text{ (A)} + \underline{\hspace{2cm}} \text{ (B)} + \underline{\hspace{2cm}} \text{ (C)} \div \underline{\hspace{2cm}} \text{ (n-1)} = \underline{\hspace{2cm}} \quad \text{(D)}$$

$$\sqrt{\text{(D)}} = \underline{\hspace{2cm}} \text{ (Standard Deviation)}$$

Standard Deviation Sample Problem 8

$$\frac{5.5}{\text{(Sample \#1)}} + \frac{3.6}{\text{(Sample \#2)}} + \frac{7.4}{\text{(Sample \#3)}} + \frac{8.1}{\text{(Sample \#4)}} + \frac{4.9}{\text{(Sample \#5)}} \div \underline{\hspace{2cm}} = \underline{\hspace{2cm}} \text{ (Average)}$$

$$\text{(Sample \#1)} - \text{(Average)} = \underline{\hspace{2cm}} \quad x^2 = \underline{\hspace{2cm}} \quad \text{(A)}$$

$$\text{(Sample \#2)} - \text{(Average)} = \underline{\hspace{2cm}} \quad x^2 = \underline{\hspace{2cm}} \quad \text{(B)}$$

$$\text{(Sample \#3)} - \text{(Average)} = \underline{\hspace{2cm}} \quad x^2 = \underline{\hspace{2cm}} \quad \text{(C)}$$

$$\text{(Sample \#4)} - \text{(Average)} = \underline{\hspace{2cm}} \quad x^2 = \underline{\hspace{2cm}} \quad \text{(D)}$$

$$\text{(Sample \#5)} - \text{(Average)} = \underline{\hspace{2cm}} \quad x^2 = \underline{\hspace{2cm}} \quad \text{(E)}$$

$$\underline{\hspace{2cm}} \text{ (A)} + \underline{\hspace{2cm}} \text{ (B)} + \underline{\hspace{2cm}} \text{ (C)} + \underline{\hspace{2cm}} \text{ (D)} + \underline{\hspace{2cm}} \text{ (E)} \div \underline{\hspace{2cm}} \text{ (n-1)} = \underline{\hspace{2cm}} \text{ (F)}$$

$$\sqrt{\text{(F)}} = \underline{\hspace{2cm}} \text{ (Standard Deviation)}$$

Standard Deviation Sample Problem 1

$$\frac{5}{\text{(Sample \#1)}} + \frac{7}{\text{(Sample \#2)}} + \frac{10}{\text{(Sample \#3)}} + \frac{3}{\text{(Sample \#4)}} \div 4 = \underline{6} \text{ (Average)}$$

$$\text{(Sample \#1)} - \text{(Average)} = \underline{-1} \quad x^2 = \underline{1} \quad \text{(A)}$$

$$\text{(Sample \#2)} - \text{(Average)} = \underline{1} \quad x^2 = \underline{1} \quad \text{(B)}$$

$$\text{(Sample \#3)} - \text{(Average)} = \underline{4} \quad x^2 = \underline{16} \quad \text{(C)}$$

$$\text{(Sample \#4)} - \text{(Average)} = \underline{-3} \quad x^2 = \underline{9} \quad \text{(D)}$$

$$\frac{1}{\text{(A)}} + \frac{1}{\text{(B)}} + \frac{16}{\text{(C)}} + \frac{9}{\text{(D)}} \div \frac{3}{\text{(n-1)}} = \underline{9} \quad \text{(E)}$$

$$\sqrt{\text{(E)}} = \underline{3} \text{ (Standard Deviation)}$$

Standard Deviation Sample Problem 2

$$\frac{1.69}{\text{(Sample \#1)}} + \frac{1.87}{\text{(Sample \#2)}} + \frac{1.53}{\text{(Sample \#3)}} + \frac{1.72}{\text{(Sample \#4)}} + \frac{1.59}{\text{(Sample \#5)}} \div \underline{5} = \underline{1.68} \text{ (Average)}$$

$$\text{(Sample \#1)} - \text{(Average)} = \underline{0.01} \quad x^2 = \underline{0.0001} \quad \text{(A)}$$

$$\text{(Sample \#2)} - \text{(Average)} = \underline{0.19} \quad x^2 = \underline{0.0361} \quad \text{(B)}$$

$$\text{(Sample \#3)} - \text{(Average)} = \underline{-0.15} \quad x^2 = \underline{0.0225} \quad \text{(C)}$$

$$\text{(Sample \#4)} - \text{(Average)} = \underline{0.04} \quad x^2 = \underline{0.0016} \quad \text{(D)}$$

$$\text{(Sample \#5)} - \text{(Average)} = \underline{-0.09} \quad x^2 = \underline{0.0081} \quad \text{(E)}$$

$$\frac{0.0001}{\text{(A)}} + \frac{0.0361}{\text{(B)}} + \frac{0.0225}{\text{(C)}} + \frac{0.0016}{\text{(D)}} + \frac{0.0081}{\text{(E)}} \div \frac{4}{\text{(n-1)}} = \underline{0.0171} \quad \text{(F)}$$

$$\sqrt{\text{(F)}} = \underline{0.13} \text{ (Standard Deviation)}$$

Standard Deviation Sample Problem 3

$$\frac{13}{\text{(Sample \#1)}} + \frac{21}{\text{(Sample \#2)}} + \frac{10}{\text{(Sample \#3)}} \div \frac{3}{\text{(Average)}} = \frac{15}{\text{(Average)}}$$

$$\text{(Sample \#1)} - \text{(Average)} = \frac{-2}{\text{(Sample \#1)}} \quad x^2 = \frac{4}{\text{(Sample \#1)}} \quad \text{(A)}$$

$$\text{(Sample \#2)} - \text{(Average)} = \frac{6}{\text{(Sample \#2)}} \quad x^2 = \frac{36}{\text{(Sample \#2)}} \quad \text{(B)}$$

$$\text{(Sample \#3)} - \text{(Average)} = \frac{-5}{\text{(Sample \#3)}} \quad x^2 = \frac{25}{\text{(Sample \#3)}} \quad \text{(C)}$$

$$\frac{4}{\text{(A)}} + \frac{36}{\text{(B)}} + \frac{25}{\text{(C)}} \div \frac{2}{\text{(n-1)}} = \frac{33}{\text{(D)}}$$

$$\sqrt{\text{(D)}} = \frac{6}{\text{(Standard Deviation)}}$$

Standard Deviation Sample Problem 4

$$\frac{100}{\text{(Sample \#1)}} + \frac{113}{\text{(Sample \#2)}} + \frac{98}{\text{(Sample \#3)}} + \frac{103}{\text{(Sample \#4)}} + \frac{95}{\text{(Sample \#5)}} \div \frac{5}{\text{(Average)}} = \frac{102}{\text{(Average)}}$$

$$\text{(Sample \#1)} - \text{(Average)} = \frac{-2}{\text{(Sample \#1)}} \quad x^2 = \frac{4}{\text{(Sample \#1)}} \quad \text{(A)}$$

$$\text{(Sample \#2)} - \text{(Average)} = \frac{11}{\text{(Sample \#2)}} \quad x^2 = \frac{121}{\text{(Sample \#2)}} \quad \text{(B)}$$

$$\text{(Sample \#3)} - \text{(Average)} = \frac{-4}{\text{(Sample \#3)}} \quad x^2 = \frac{16}{\text{(Sample \#3)}} \quad \text{(C)}$$

$$\text{(Sample \#4)} - \text{(Average)} = \frac{1}{\text{(Sample \#4)}} \quad x^2 = \frac{1}{\text{(Sample \#4)}} \quad \text{(D)}$$

$$\text{(Sample \#5)} - \text{(Average)} = \frac{-7}{\text{(Sample \#5)}} \quad x^2 = \frac{49}{\text{(Sample \#5)}} \quad \text{(E)}$$

$$\frac{4}{\text{(A)}} + \frac{121}{\text{(B)}} + \frac{16}{\text{(C)}} + \frac{1}{\text{(D)}} + \frac{49}{\text{(E)}} \div \frac{4}{\text{(n-1)}} = \frac{48}{\text{(F)}}$$

$$\sqrt{\text{(F)}} = \frac{7}{\text{(Standard Deviation)}}$$

Standard Deviation Sample Problem 5

$$\frac{3}{\text{(Sample \#1)}} + \frac{7}{\text{(Sample \#2)}} + \frac{5}{\text{(Sample \#3)}} \div \frac{3}{\text{(Sample \#3)}} = \underline{5} \text{ (Average)}$$

$$\text{(Sample \#1)} - \text{(Average)} = \underline{-2} \quad x^2 = \underline{4} \quad \text{(A)}$$

$$\text{(Sample \#2)} - \text{(Average)} = \underline{2} \quad x^2 = \underline{4} \quad \text{(B)}$$

$$\text{(Sample \#3)} - \text{(Average)} = \underline{0} \quad x^2 = \underline{0} \quad \text{(C)}$$

$$\frac{4}{\text{(A)}} + \frac{4}{\text{(B)}} + \frac{0}{\text{(C)}} \div \frac{2}{\text{(n-1)}} = \underline{4} \quad \text{(D)}$$

$$\sqrt{(D)} = \underline{2} \text{ (Standard Deviation)}$$

Standard Deviation Sample Problem 6

$$\frac{1.26}{\text{(Sample \#1)}} + \frac{1.57}{\text{(Sample \#2)}} + \frac{1.98}{\text{(Sample \#3)}} + \frac{0.96}{\text{(Sample \#4)}} \div \frac{4}{\text{(Sample \#4)}} = \underline{1.44} \text{ (Average)}$$

$$\text{(Sample \#1)} - \text{(Average)} = \underline{-0.18} \quad x^2 = \underline{0.03} \quad \text{(A)}$$

$$\text{(Sample \#2)} - \text{(Average)} = \underline{0.13} \quad x^2 = \underline{0.02} \quad \text{(B)}$$

$$\text{(Sample \#3)} - \text{(Average)} = \underline{0.54} \quad x^2 = \underline{0.29} \quad \text{(C)}$$

$$\text{(Sample \#4)} - \text{(Average)} = \underline{-0.48} \quad x^2 = \underline{0.23} \quad \text{(D)}$$

$$\frac{0.03}{\text{(A)}} + \frac{0.02}{\text{(B)}} + \frac{0.29}{\text{(C)}} + \frac{0.23}{\text{(D)}} \div \frac{3}{\text{(n-1)}} = \underline{0.19} \quad \text{(E)}$$

$$\sqrt{(E)} = \underline{0.44} \text{ (Standard Deviation)}$$

Standard Deviation Sample Problem 7

$$\frac{0.50}{\text{(Sample \#1)}} + \frac{0.90}{\text{(Sample \#2)}} + \frac{0.40}{\text{(Sample \#3)}} \div \frac{3}{\text{}} = \underline{0.60} \text{ (Average)}$$

$$\text{(Sample \#1)} - \text{(Average)} = \underline{-0.10} \quad x^2 = \underline{0.01} \quad \text{(A)}$$

$$\text{(Sample \#2)} - \text{(Average)} = \underline{0.30} \quad x^2 = \underline{0.09} \quad \text{(B)}$$

$$\text{(Sample \#3)} - \text{(Average)} = \underline{-0.20} \quad x^2 = \underline{0.04} \quad \text{(C)}$$

$$\frac{0.01}{\text{(A)}} + \frac{0.09}{\text{(B)}} + \frac{0.04}{\text{(C)}} \div \frac{2}{\text{(n-1)}} = \underline{0.07} \quad \text{(D)}$$

$$\sqrt{\text{(D)}} = \underline{0.26} \text{ (Standard Deviation)}$$

Standard Deviation Sample Problem 8

$$\frac{5.5}{\text{(Sample \#1)}} + \frac{3.6}{\text{(Sample \#2)}} + \frac{7.4}{\text{(Sample \#3)}} + \frac{8.1}{\text{(Sample \#4)}} + \frac{4.9}{\text{(Sample \#5)}} \div \frac{5}{\text{}} = \underline{5.9} \text{ (Average)}$$

$$\text{(Sample \#1)} - \text{(Average)} = \underline{-0.4} \quad x^2 = \underline{0.2} \quad \text{(A)}$$

$$\text{(Sample \#2)} - \text{(Average)} = \underline{-2.3} \quad x^2 = \underline{5.3} \quad \text{(B)}$$

$$\text{(Sample \#3)} - \text{(Average)} = \underline{1.5} \quad x^2 = \underline{2.3} \quad \text{(C)}$$

$$\text{(Sample \#4)} - \text{(Average)} = \underline{2.2} \quad x^2 = \underline{4.8} \quad \text{(D)}$$

$$\text{(Sample \#5)} - \text{(Average)} = \underline{-1.0} \quad x^2 = \underline{1.0} \quad \text{(E)}$$

$$\frac{0.2}{\text{(A)}} + \frac{5.3}{\text{(B)}} + \frac{2.3}{\text{(C)}} + \frac{4.8}{\text{(D)}} + \frac{1.0}{\text{(E)}} \div \frac{4}{\text{(n-1)}} = \underline{3.4} \quad \text{(F)}$$

$$\sqrt{\text{(F)}} = \underline{1.8} \text{ (Standard Deviation)}$$

PWL Sample Problem 1

						Limits				
Screen	Inc #1	Inc #2	Inc #3	Avg	Std. Dev.	L	U	Q _U	Q _L	PWT
1 1/2"	100	100	100	100	0	100	100			100
1"	95	97	97	96	1.2	95	100			100
1/2"	25	23	24			25	60			
#4	9	7	8	8	1	0	10			100
#8	4	3	3	3	0.6	0	5			100
#200	1.2	1.1	1.2	1.17	0.06	0	1.49			100
Total Sample PWL Based on Construction Specifications										

$$Q_L = \frac{(\text{Avg} - L)}{\text{Std. Dev}}$$

$$Q_L = \frac{(? - 25)}{?}$$

$$Q_L =$$

PWL Sample Problem 2

						Limits				
Screen	Inc #1	Inc #2	Inc #3	Avg	Std. Dev.	L	U	Q _U	Q _L	PWT
1 1/2"	100	100	100	100	0	100	100			100
1"	96	96	96	96	0	95	100			100
1/2"	63	61	59			25	60			
#4	1	2	2	2	0.6	0	10			100
#8	1	1	1	1	0	0	5			100
#200	1.2	1.1	1.2	1.17	0.06	0	1.49			100
Total Sample PWL Based on Construction Specifications										

$$Q_U = \frac{(U - \text{Avg})}{\text{Std. Dev}}$$

$$Q_U = \frac{(60 - ?)}{?}$$

$$Q_U =$$

PWL Sample Problem 3

Screen	Limits					PWT
	Inc #1	Inc #2	Inc #3	Avg	Std. Dev.	
1 1/2"	100	100	100	100	0	100
1"	95	97	97	96	1.2	100
1/2"	26	27	28	27	1	60
#4	12	12	8			10
#8	4	3	3	3	0.6	5
#200	1.2	1.1	1.2	1.17	0.06	1.49

Total Sample PWL Based on Construction Specifications

$$Q_U = \frac{(U - Avg)}{Std. Dev} = \frac{(10 - ?)}{?} \quad Q_U =$$

PWL Sample Problem 4

Screen	Limits					PWT
	Inc #1	Inc #2	Inc #3	Avg	Std. Dev.	
1 1/2"	100	100	100	100	0	100
1"	94	96	93	95		100
1/2"	55	54	54	54	0.6	60
#4	1	2	2	2	0.6	10
#8	1	1	1	1	0	5
#200	1.2	1.1	1.2	1.17	0.06	1.49

Total Sample PWL Based on Construction Specifications

$$Q_L = \frac{(Avg - L)}{Std. Dev} = \frac{(? - 95)}{?} \quad Q_L =$$

PWL Sample Problem 5

Screen	Inc #1	Inc #2	Inc #3	Avg	Std. Dev.	Limits			PWT
						L	U	Q _U	
1 1/2"	100	100	100	100	0	100	100	100	100
1"	95	97	97	96	1.2	95	100	100	100
1/2"	26	27	25	26	1	25	60	60	100
#4	10	10	9	10	0.6	0	10	10	100
#8	6	7	7			0	5	5	
#200	1.2	1.1	1.2	1.17	0.06	0	1.49	1.49	100

Total Sample PWL Based on Construction Specifications

$$Q_U = \frac{(U - \text{Avg})}{\text{Std. Dev}} = \frac{5 - ?}{?} \quad Q_U =$$

PWL Sample Problem 6

Screen	Inc #1	Inc #2	Inc #3	Avg	Std. Dev.	Limits			PWT
						L	U	Q _U	
1 1/2"	100	100	100	100	0	100	100	100	100
1"	96	96	96	96	0	95	100	100	100
1/2"	23	19	33			25	60	60	
#4	1	2	2	2	0.6	0	10	10	100
#8	1	1	1	1	0	0	5	5	100
#200	1.2	1.1	1.2	1.17	0.06	0	1.49	1.49	100

Total Sample PWL Based on Construction Specifications

$$Q_L = \frac{(\text{Avg} - L)}{\text{Std. Dev}} = \frac{? - 25}{?} \quad Q_L =$$

PWL Sample Problem 7

Year Sodium Sulfate % Loss

2015	11.6
2015-1	9.6
2015-2	9.7
2015-3	9.4
2016-1	10.2
2016-2	10.3
2016-3	10.4

Limits = 0 - 10.49
 Average = 10.17
 STDEV = 0.74
 N = 7

$$Q_U = \frac{(U - Avg)}{Std. Dev}$$

$$Q_U = \frac{(10.49 - 10.17)}{0.74}$$

$$Q_U = ?$$

PWL = ?

Year Sodium Sulfate % Loss

2015	12.6
2015-1	5.6
2015-2	5.4
2015-3	4.9
2016-1	6.5
2016-2	6.6
2016-3	6.2

Limits = 0 - 10.49
 Average = 6.83
 STDEV = 2.62
 N = 7

$$Q_U = \frac{(U - Avg)}{Std. Dev}$$

$$Q_U = \frac{(10.49 - 6.83)}{2.62}$$

$$Q_U = ?$$

PWL = ?

PWL Sample Problem 1

						Limits				
Screen	Inc #1	Inc #2	Inc #3	Avg	Std. Dev.	L	U	Q _U	Q _L	PWT
1 1/2"	100	100	100	100	0	100	100			100
1"	95	97	97	96	1.2	95	100			100
1/2"	25	23	24	24	1	25	60		-1.0000	17
#4	9	7	8	8	1	0	10			100
#8	4	3	3	3	0.6	0	5			100
#200	1.2	1.1	1.2	1.17	0.06	0	1.49			100
Total Sample PWL Based on Construction Specifications										86

$$Q_L = \frac{(\text{Avg} - L)}{\text{Std. Dev}}$$

$$Q_L = \frac{(24 - 25)}{1}$$

$$Q_L = -1.0000$$

PWL Sample Problem 2

						Limits				
Screen	Inc #1	Inc #2	Inc #3	Avg	Std. Dev.	L	U	Q _U	Q _L	PWT
1 1/2"	100	100	100	100	0	100	100			100
1"	96	96	96	96	0	95	100			100
1/2"	63	61	59	61	2	25	60	-0.5000		36
#4	1	2	2	2	0.6	0	10			100
#8	1	1	1	1	0	0	5			100
#200	1.2	1.1	1.2	1.17	0.06	0	1.49			100
Total Sample PWL Based on Construction Specifications										89

$$Q_U = \frac{(U - \text{Avg})}{\text{Std. Dev}}$$

$$Q_U = \frac{(60 - 61)}{2}$$

$$Q_U = -0.5000$$

PWL Sample Problem 3

Screen	Inc #1	Inc #2	Inc #3	Avg	Std. Dev.	Limits			PWT
						L	U	Q _U	
1 1/2"	100	100	100	100	0	100	100		100
1"	95	97	97	96	1.2	95	100		100
1/2"	26	27	28	27	1	25	60		100
#4	12	12	8	11	2.3	0	10	-0.4348	38
#8	4	3	3	3	0.6	0	5		100
#200	1.2	1.1	1.2	1.17	0.06	0	1.49		100
Total Sample PWL Based on Construction Specifications									
$Q_U = \frac{(U - Avg)}{Std. Dev} = \frac{(10 - 11)}{2.3} = -0.4348$									

PWL Sample Problem 4

Screen	Inc #1	Inc #2	Inc #3	Avg	Std. Dev.	Limits			PWT
						L	U	Q _L	
1 1/2"	100	100	100	100	0	100	100		100
1"	94	96	93	94	1.5	95	100	-0.6667	31
1/2"	55	54	54	54	0.6	25	60		100
#4	1	2	2	2	0.6	0	10		100
#8	1	1	1	1	0	0	5		100
#200	1.2	1.1	1.2	1.17	0.06	0	1.49		100
Total Sample PWL Based on Construction Specifications									
$Q_L = \frac{(Avg - L)}{Std. Dev} = \frac{(94 - 95)}{1.5} = -0.6667$									

PWL Sample Problem 5

Screen	Inc #1	Inc #2	Inc #3	Avg	Std. Dev.	Limits			PWT
						L	U	Q _U	
1 1/2"	100	100	100	100	0	100	100		100
1"	95	97	97	96	1.2	95	100		100
1/2"	26	27	25	26	1	25	60		100
#4	10	10	9	10	0.6	0	10		100
#8	6	7	7	7	0.6	0	5	-3.3333	0
#200	1.2	1.1	1.2	1.17	0.06	0	1.49		100
Total Sample PWL Based on Construction Specifications									
									83

$$Q_U = \frac{(U - \text{Avg})}{\text{Std. Dev}} = \frac{(5 - 7)}{0.6} = -3.3333$$

PWL Sample Problem 6

Screen	Inc #1	Inc #2	Inc #3	Avg	Std. Dev.	Limits			PWT
						L	U	Q _U	
1 1/2"	100	100	100	100	0	100	100		100
1"	96	96	96	96	0	95	100		100
1/2"	23	19	33	25	7.2	25	60	0.0000	50
#4	1	2	2	2	0.6	0	10		100
#8	1	1	1	1	0	0	5		100
#200	1.2	1.1	1.2	1.17	0.06	0	1.49		100
Total Sample PWL Based on Construction Specifications									
									92

$$Q_L = \frac{(\text{Avg} - L)}{\text{Std. Dev}} = \frac{(25 - 25)}{7.2} = 0.0000$$