WSDOT
Engineering and Regional Operations
Construction Division
State Materials Laboratory

2012

Annual Report

April 2013

Table of Contents

Introduction

State Materials Laboratory Mission Statement

"Together we support our customers and enhance construction quality by providing specialized technical expertise, materials testing, and engineering services."

Welcome to our 2012 Annual Report. Our annual report was conceived as a method to convey three messages:

1. How we are measuring our performance, using internal customer performance measures
2. Informing our customers of what we do and what services we offer
3. Provide a road map to where we are headed in the future, especially with the Strategic Directions

The State Materials Lab is made up of three Offices. The State Geotechnical Office, the State Pavement Office, and the General Materials Office. We have expanded the Strategic Directions to provide greater detail on this important roadmap to the future. And check out the performance measures: We have driven up performance and driven down costs, especially in field exploration in the Geotechnical Office.

We continue to implement innovation while cutting costs. Critical questions about the present and the future include:

1. Who tests WSDOT materials?

   Answer: Private industry mostly.

   Over 81% of materials used by WSDOT are tested by private industry; only 19% are tested by WSDOT.

   To achieve this we have made heavy use of the Materials Risk Analysis, in evaluating which materials to test in-house and which to out-source. (http://www.wsdot.wa.gov/Research/Reports/700/745.1.htm) We have twice reviewed the Materials Risk Analysis to decrease testing and increase acceptance by certification of compliance or by visual inspection throughout the program.

   We have greatly expanded the use of NTPEP (the AASHTO National Transportation Product Evaluation Program). NTPEP provides $2M in testing and evaluation of materials for a pooled fund fee of only $7500 (rising to $10,000 in 2012). NTPEP audits HDPE pipe manufacturers, reinforcing steel and welded wire manufacturers and geotextile and geo-reinforcement manufacturers. NTPEP evaluation allows WSDOT to cut

testing costs, while increasing confidence in the quality of the materials provided by manufacturers.

2. How much money has been saved (costs avoided) by implementing materials research?
   Answer: Over a billion dollars ($1B) in the last 14 years (1999 – 2012). Major savings have come in the Pavement Preservation Program (over $732 million), Geotechnical Design (walls, engineered slopes, unstable slope management and foundation designs, to the tune of more than $150M in savings) and in Construction Materials (Superpave, PG binder and PG Plus implementation), statistical acceptance of materials, implementing quality systems plans for fabricators and Design-Builders, Materials Risk Analysis changes system-wide use of NTPEP and expanded use of visual inspection and the implementation of SAM and CATS (which have saved over $22M on design-build projects to date). The benefits WSDOT has already realized based upon targeted research can be expected to continue into the future.

3. What is happening with staffing at the State Materials Lab?
   Answer: The Materials Lab is committed to supporting the Highway Construction Program effectively with an appropriate number of staff. As a result of the WSDOT Methods of Delivery efforts, we are actively working to downsize our overall FTE footprint while continuing much of what we have been doing. We are well underway to reach that goal, reducing from 126 permanent FTEs in June 2011 to our current level of 112 permanent FTEs. In comparison, in 1999 we had 116 permanent FTEs. We have achieved this reduction by cutting out work as we have cut FTEs, we no longer rate the condition of BST pavements and we have abandoned the testing of many lower risk materials.

4. What future innovation is in the works?
   Answer: The innovation, and the savings (some call it "cost avoidance") continue. Some hot subjects:
   a. MOBA Pave-IRs. We are conducting an in-house study on the Pave-IR system, measuring continuous pavement temperatures and GPS positioning. We are looking for opportunities to eliminate pavement damage due to thermal differentials / density differentials.
   b. RCA: Recycled Concrete Aggregate. Can we re-use our old concrete pavement as aggregate for new pavement? That is the question and researchers at WSU are working to help us find the answer. We have a wealth of aggregate locked up in our concrete pavements and reusing those aggregates could save money and increase sustainability.
   c. Geo-reinforced Bridge Abutments: Tony Allen, the State Geotechnical Engineer, was invited to join an FHWA team to examine the effects of the large earthquake in Chile. One of the key findings of that investigation was that geo-reinforced bridge abutments had good survivability after the

quake. We will be looking for trial installations around the state, with more testing and evaluation for what should be a markedly less expensive bridge foundation.

We appreciate any and all feedback.

On behalf of the great crew at the State Materials Laboratory, I want to thank every customer for using our services and products in 2012; we look forward to serving you again in 2013.

Thanks,
Jeff

Jeff Carpenter, PE

Director, Construction Division

WSDOT
State Materials Laboratory

Mailing address:
310 Maple Park Ave, SE
PO Box 47354
Olympia WA 98504-7354

Phone: 360-705-7821
Phone: 360-951-4806

Delivery (Street) Address:
1655 S. 2nd Ave.
Tumwater, WA 98512

e-mail: carpenj@wsdot.wa.gov
Website: <http://www.wsdot.wa.gov/biz/mats

Strategic Directions 2011-2013

Construction Materials

Joe DeVol, Bituminous/Chemical/Electrical Materials Engineer

Examination of N-design: Nationwide research is underway to validate the Superpave HMA design levels (compaction tables) for volumetric mix designs. The question is: are current standards giving us the best possible pavement performance?
This study to include: Review of WSDOT Equivalent Single Axel Loads (ESAL) and HMA design levels; Collect production data for comparison to mix design data; Identify candidate projects to evaluate pavement performance; Provide recommendations for future Superpave HMA design levels.
Status: Since implementation of the Superpave volumetric mix design process in 2004 the Bituminous Materials Section has been collecting test data using both the Hveem stability and Superpave HMA mix design processes on every project paved in the state. This review started in January 2005 and will continue until national standards are changed and/or WSDOT identifies an alternative. The recommendation from National Cooperative Highway Research Program (NCHRP) project 9-9(1) was a reduction in gyratory compaction levels based on studies of densification in the field. Although this study was quite extensive, the relationship between gyratory compaction levels and densification in the field was not strong. As a result the Federal Highway Administration's (FHWA) Asphalt Mixture & Construction Expert Task Group (Mix ETG) concluded after extensive evaluations that no general recommendation could be established for reductions of the gyratory levels. Based on the research and recommendation from the FHWA and the solid performance of Superpave HMA in Washington State this task is terminated.

Multiple Stress Creep Recovery (MSCR) Asphalt Binder Specification. Collect informational test data from production samples of performance graded (PG) asphalt binders in 2010 using the provisional MSCR protocol, use this data and previously gathered information to develop and implement a new WSDOT specification for acceptance of PG binders.
Status: Results from a national inter-laboratory study (ILS) provided precision and bias statements for the MSCR test protocol that show additional developments in this technology are needed before it could be considered for implementation on Washington State. The Construction Materials Division has implemented an Elastic Recovery (ER) asphalt binder test requirement in the 2012 Standard Specifications until the MSCR test can be refined to improve precision and bias. This task is completed.

HMA Rutting and Moisture Susceptibility Research Study. What can the Hamburg Wheel Tracking Device (HWTD) tell us about the HMA mixes used in Washington State? Can this device predict premature failure of HMA from rutting and/or moisture induced damage? Can the HWTD be used for acceptance of Paving Contractor's HMA mix designs and production material?
This study to include: Test mix design verification samples with and without antistripping additive, test production mix design conformation samples and roadway cores from select projects; write specifications and provide recommendations for implementation if warranted.
Status: Currently analyzing 2010, 2011 data and testing 2012 mix design and production samples. Test data will be used to evaluate material quality and develop specification. Roadway core sample testing will only be conducted if needed for investigative purposes. Project on schedule.

HMA Density Study. WSDOT is one of only two states in the nation that are using the direct transmission method for testing in-place density of HMA when using the nuclear density gauge. There are actually three different methods that can be used to test in-place density with the nuclear gauge; however, it is unclear which method would provide the most accurate and consistent results.
This study to include: Perform testing using all three methods on select projects, compare results with roadway cores, and analyze data to determine accuracy and reproducibility provide recommendations for changes to current methods if warranted.
Status: Testing on nine paving projects completed, data has been compiled and analyzed, report pending. Based on the findings of the study, the Construction Materials Division has updated the testing procedures to allow in-place density testing to be conducted using both direct transmission and thin layer mode. As each nuclear density gauge is scheduled for replacement through the Transportation Replacement Fund (TEF) they will be replaced with the multi-mode gauge. Once all gauges have been replaced, direct transmission testing will be discontinued.

Roadway Core Density Study. Due to recent concerns regarding accuracy of the bulk specific gravity determination of roadway cores used to correlate the nuclear density gauge for measuring in-place density of asphalt concrete pavements a roadway core density study is to be conducted.
This study to include: Perform comparative testing on roadway cores using AASHTO T 331 Bulk Specific Gravity (Gmb) and Density of Compacted Hot Mix Asphalt (HMA) Using Automatic Vacuum Sealing Method and AASHTO T 166 Bulk Specific Gravity (Gmb) of Compacted Hot Mix Asphalt (HMA) Using Saturated Surface-Dry Specimens. Provide recommendations for changes to current methods if warranted.
Status: (New Project, Sept. 2012) Currently conducting literature review of previously conducted research for insight and guidance on this study. Proposed study to be conducted with two Regional Laboratories and the State Materials Laboratory.

Elastic Recovery Specification for Emulsified Asphalt. Researchers have recognized AASHTO T 301 Standard Method of Test for Elastic Recovery of Asphalt Materials by Means of a Ductilometer as a more reliable method of identifying the presence of active polymer in Polymer Modified Cationic Emulsion (CRS-2P) than the Torsional Recovery Test (CA 332) or the Benson Toughness/Tenacity test. A comparison testing study will be conducted by the Bituminous Materials Section during the 2013 construction season using both methods. On completion of the study, recommendations will be provided to continue using CA 332 or to implement a change to use T 301.
Status: (New Project, January 2013), Comparison testing will be conducted during the 2013 construction season and the test data will be analyzed. Project 5% complete.

Marilyn Olson, Chemical Materials Manager

Review and modify Standard Specifications, Section 9-08 started in January 2008. Additional review to consider modifications to Pigmented Sealer specifications to incorporate gloss requirement, Section 9-08.3.
Status: 9-08 specifications updated in 2010 printing of standard specifications. Specification 9-08.3 has been reviewed and no changes recommended to include gloss number system, semi opaque is adequate. Task is 100% complete.

Consider replacing the Inductively Coupling Plasma (ICP) with X-ray fluorescence (XRF).
Status: The XRF instrument has been purchased and received. The XRF support equipment i.e. chiller, M4 Fluxer, and ventilation system are currently being installed by materials lab maintenance section. The XRF unit is scheduled for installation, set-up and training by the manufacturer in March 2013. Once the XRF is operational, comparative testing will be conducted during 2013 construction season. At conclusion of comparative testing, final plans for full implementation of XRF will be completed. Task is 90% complete.

The technique of Infrared Spectroscopy (IR) is being employed to analyze the uniformity of a specific company's epoxy coating system formula over time. Our objective is to test and evaluate the uniformity of these epoxy systems and determine whether we can correlate spectrum differences (chemical formula variations) of samples with failing physical testing and whether there was a change to the formulation of the same product.
Status: Epoxy samples are being analyzed resulting in no correlation between failing samples and formulation changes. Samples are continuing to be scanned as they come in creating an epoxy library. The new IR is installed; a new library is being established for pigmented sealer vehicle comparisons. Task is 85% complete.

The new instrument Ion Chromatograph (IC) is being set up to test Chlorides and Sulfate in liquids as well as concrete and soil slurries. This will replace the outdated titration methods.
Status: Comparison studies titration/IC are being conducted. The methods for extraction are being worked through and samples are being tested. Additional comparison samples are needed. Task is 95% complete.

Develop a new standard specification for joint sealant used to span joint openings in road and bridge construction that will supplement Section 9-04.2(2) Poured Rubber Joint Sealer.
Status: Test methods established and need to be formatted for inclusion to Section 9-04.2(2) Task is 90% complete.

Establish Fly Ash Metals allowances and write QC Plan
Status: The QC plan and modifications to the Construction and Materials Manuals have been completed. Task is 100% complete.

Review all current test procedures for compliance with AASHTO/ASTM/WSDOT methods and write procedures as needed. Starting date August 2010.
Status: We are up to date for methods being used in the chemical laboratory at this time. Task is 100% complete.

Re-write Specification 9-21 for Raised Pavement Markers incorporating NTPEP performance testing
Status: We are up to date for methods being used in the chemical laboratory at this time. Task is 100% complete.

Re-write Bridge Paint Specification 9-08 including performance testing requirements as defined in ASTM and SSPC standards.
Status: Specification is written and under review. Working with Bridge Office to define field performance testing specification. Task is 95% complete.

Dwight Carlson, Electrical and Signing Engineer

This task includes looking at the NTPEP testing for traffic devices such as flexible guide posts and raised pavement markers (RPM) and a re-write of Specification 9-21. Where possible, consider modifying WSDOT specifications and allow for ASTM specification and use of NTPEP acceptance testing if benefit is realized.
Status: Specifications identified and drafted for majority of items, wording for NTPEP performance testing drafted as well. NTPEP testing available for Type II and Type III RPM's, but not for Type I RPM's (will need to draft alternate requirements for acceptance). Task is 85% complete. No change since last reporting.

Update Standard Specifications Section 9-29 Illumination, Signal, Electrical. This section in the Standard Specifications has not been updated in a number of years and needs to be updated to remove outdated requirements and updated to include the latest standards. Need to identify and assemble Expert Task Group to review specifications (ETG Members identified). 17 of 25 sections completed at the end of this reporting period.
Status: Specification is written and submitted for amendment, task is 95% complete.

Investigate how WSDOT can contribute to the use of renewable energy in the daily operation of the highway system. The investigation will include research into how the use of solar energy can reduce the amount of and/or the cost of commercial electrical energy WSDOT consumes, through the use of existing resources or developing resources, in partnership with industry, which would have a predictable pay back. The title of this item was changed to Energy Project and includes other forms of energy production such as wind generation, as well as other efficiencies that can be achieved.
Status: Task in beginning stages, will continue to monitor national research and developments that would contribute to advances in this technology, task is 3% complete.

Prepare a performance specification for a non-slip cover for Junction Boxes
Status: Research into available test instruments is continuing for this task. There are several approaches to testing for non-slip surfaces NFPA 1901 has a specification for fire truck running boards which may apply, in addition Regan Scientific has a test instrument that may apply. Research into this issue has shown that there are no instruments commercially available to test for the COF. Currently there is a GSP requiring non-slip j-box covers accompanied by a Special Provision listing two proprietary products. Task is 90% complete no change since last reporting.

Prepare a performance specification for Uninterruptable Power Supplies to be used for battery back-up systems for traffic signalized intersections, changeable traffic lane gates and miscellaneous ITS equipment.
Status: The standard cabinet requirements have been defined need to complete the performance specification for the batteries and charger system. Task is 40% complete no change since last reporting.

Bob Briggs, Assistant Construction Materials Engineer – Materials Quality

Develop requirements for a HMA mix design submittal program.
Status: As part of the Materials Testing System (MATS) program, we will have a way for the HMA mix designs to be electronically filled out and requested by the contractor. These mix designs will be sent through the project office to the State Materials Laboratory for verification. This strategic direction will be to develop the requirements for programming the HMA mix design submittal process. The initial layout is complete. We discussed this with industry as to the requirements that they would like. We will be developing the requirements based on this discussion. No work on this strategic direction this quarter. This is on hold for the MATS program at this time.

Development requirements for a concrete mix design submittal program.
Status: As part of the Materials Testing System (MATS) program, we will have a way for the concrete mix designs to be electronically filled out and requested by the contractor. These mix designs will be sent to the project office for approval. This strategic direction will be to develop the requirements for programming the concrete mix design submittal process. When we get the HMA submittal program, it will be easy to make it work for concrete mix designs. No work on this strategic direction this quarter. This is on hold for the MATS program at this time.

Development requirements for Materials Tracking Program (MTP) to allow for document storage.
Status: As part of the ongoing improvements to the MTP, and with the completion of MATS, we need to have an electronic way to store approval documents, acceptance documents, test reports, and other materials documentation in a logical, meaningful location with easy access. This strategic direction will be to develop the requirements for programming the document storage process in MTP. Materials test reports from MATS are now automatically filed in MTP. Still working on miscellaneous document storage in MTP. This quarter we have put the process into testing. It needs a few more things and it will be put into production next quarter. January 2012, this has been finished and is in the QA MTP program for training and testing. This has not been deployed at this time.

Finish the Materials Testing Program (MATS)
Status: The materials testing program, MATS, is about 95% programmed. Working with the chem lab for the last few tests to be programmed. The remaining work, 10 chemical tests will be finished under maintenance. We are working on maintenance of the existing parts of MATS, and finishing the electrical tests.

Review and incorporate into the standard specification the BTPEP HDPE Plastic pipe audit program as a requirement.
Status: Currently preparing specification update and contacting NTPEP and pipe manufacturers to determine how long it will take to get through NTPEP testing process. Specification requirements for NTPEP compliance have been written and will go into effect in the Aug 2012 amendments. The manufacturers have been notified of the new specifications and change. These revisions will be put in the January 2013 amendments. This item is complete.

Rob Molohon, Materials Quality Assurance Engineer

Quality Control Plans for Aggregate Materials Producers & Suppliers, to include recycled materials (glass, rap, pcc rubble, blast furnace slag, foundry slag, foundry sand, and so on.)
Status: The development of this standard will be to establish and set protocols for evaluating all aggregate materials to determine their approval status. It will capture all aggregate types of materials and develop methodologies and processes to allow expanded use of recycled materials that are not identified in our specifications such as: foundry sand and roofing tiles. This strategic direction is currently on hold due to current work load.

Revision to Division 3 of the Standard Specs.
Status: Division 3 of the Standard Specification currently deals with production aggregate sites and does not reflect today and tomorrow's way of mining and producing aggregate materials. This section will be revised to include current technology, statistical acceptance of aggregates, and requirements for getting on the Aggregate Source Approval (ASA) database. There will be requirements for recycled materials, and blending facilities included in this section. The statistical specifications have been written. Have started pencil drafting the specification. Will address approval of aggregate materials (recycled included) and inclusion of the statistical specification. The statistical acceptance of aggregate was published in the 2012 spec book. Other revisions were also made to chapter 3. 100% complete and no more revisions are planned.

Development of the requirements for a materials approval (RAM) process program.
Status: The development of a materials approval computer program will be another step to achieving the fully electronic Project Engineer's Office. The goal is to develop requirements to have the RAM process fully electronic (no paper) and tie into MTP. This strategic direction is one of the lean suggestions. It is currently on hold due to current work load.

Develop and implement a plan for the re-evaluation of Qualified Products List (QPL) products.
Status: One of the recommendations from the FHWA national audit of other State Highway Agencies was to implement re-evaluation of materials, systems, and processes listed on the Qualified Products Lists. In an effort to address this recommendation the Materials Documentation section will develop a plan and process for re-evaluating materials, systems, and processes identified in WSDOT's QPL. Have drafted the process for re-evaluation of Bituminous Materials (PG, Cationic Emulsions), and Cement. Currently classifying the process for geosysnthetics (NTPEP, Temporary, and other). Have developed the phone application process and the QPL submittal process (internal). These processes are currently being utilized. QPL Engineer has developed some revisions, will review this fall. Soliciting other state DOT's for their re-evaluation process.

Americans with Disability Act (ADA) Warning systems
Status: The ADA warning systems have the following challenges; #1 No material specifications, this has led to bias evaluations of these materials. This issue had been brought to Paula Hammond's attention from a ADA warning system supplier. #2 An environmental group has determined that the WSDOT is wasting 1/2 billion dollars in ten years by the use of plastic ADA warning systems. This issue had gotten the attention of the House of Representatives and the WSDOT has been directed to address it. #3 WSDOT has documented plastic ADA warning systems losing color contrast in two years. Completed field investigation of catalyst-hardened panel used in the City of Tacoma. Have drafted field investigation into the material specification.

Linda Hughes, Quality Systems Manager

Develop a basic statistical class that teaches our specification and calculations.
Status: This course is intended to be a brief synopsis of the specifications and calculations used to determine pay factors for statistical acceptance of materials. This course will aid in reducing phone calls to the Materials Laboratory concerning why pay factors are low. All updates have been made and the course is in review.

Develop and implement a plan for New Products process.
Status: Met with Bob Briggs and Kurt Williams to discuss flow of New Products Process. Flowchart is being revised. Application forms are complete.

Randy Mawdsley, Design Build Quality Verification Oversight Engineer

Write a materials documentation guide for design build offices.
Status: This guide is being developed to aid the Design-Builder's QA personnel and the DOT's Quality Verification personnel in Materials approval, acceptance and verification. The shift of these Materials approval, acceptance and verification responsibilities from WSDOT to the Design-Builder has had word of mouth guidance up to this time. The guide goal is to clarify roles and responsibilities to both owner and design-builder. Product is nearly ready for initial review by Bob Briggs.

Develop Materials section for the Design Build Manual.
Status: In a Design Build project, Sections 1-06, 2.25 and 2.28 of the RFP's deal with the quality assessment, methods of acceptance and the quality process. The goal of the materials section of the WSDOT Design-Build manual is to give the DOT Quality Verification organization a path for startup to project closure within the RFP time frames. Lessons learned are being used to facilitate this guidance. The most recent Design-Build projects have moved section 1-06 in to section 2.25. The materials portion of the manual will facilitate that transition. A tactical/logistics' conversation with Derek Case has lead me to revise my percentage complete due to several aspects we discussed that weren't part of the scope I originally started with. This process is ongoing but, five public disclosure requests on the pontoon project have taken up quite a bit of time.

Write a Desk Manual for CATS Software.
Status: This software needs a desk reference for when the incumbent Design Build QV Oversight Engineer retires and a successor has to update the checklists. Continuing to note the idiosyncrasies in the software that are worked around now but, should be modified in a newer version of the software. I'm continuing to capture my lessons learned facilitating this software in field use and for more widespread field use. I'm also formulating a priority list for functional revision. This process is ongoing.

Mike Polodna, Structural Materials Testing Engineer

WSU study on the use of low degradation aggregates in concrete.
Status: Report has been finalized. Based on the report, no changes will be made to the WSDOT Standard Specifications.

The WSDOT Construction Manual needs to be updated with specific information on what needs to be checked on concrete mix designs so WSDOT Project Offices can independently check concrete mix designs.
Status: 95% complete. Will have WACA review and comment before finalizing.

Kyle Caufman, Fabrication and Coatings Engineer

Develop Quality Systems Manual Standard Practice Procedures for approval of fabrication plants. Standard Practice Procedures will be separated into standard plant approvals and annual plant approvals. Development will include incorporating Standard Practice Procedures into the WSDOT Standard Specifications.
Status: Materials Manual Standard Practice QC 6, QC 7, and QC 8 have been written and sent to the Construction Materials Engineer for review. QC 6 is Annual Plant Approval process for Prestress Plants, QC 7 is Annual Plant Approval process for Precast Plants, and QC 8 is the process for approval of manufacturing plant fabrication and coatings facilities. Proposed revisions to Standard Specification Section 6-02.3(25), and 6-02.3(28) to incorporate QC 6, and QC 7 have been written and sent to the Construction Materials Engineer for review. Proposed new Standard Specification 1-06.1(5) to incorporate QC 8 has been written and sent to the Construction Materials Engineer for review. The Materials Quality Assurance Engineer has reviewed and revised Kyle's proposed Standard Specification 1-06.1(5) and QC 8. That version was sent to the Construction Materials Engineer who has returned the documents to Kyle with revisions and questions. Kyle Caufman discussed QC 7 with precast fabricators during the annual plant approval trip in June. Feedback was positive. Sent QC 6 out to key prestress plants for review and comment. 86% Complete.

Geotechnical

Tom Badger, Chief Engineering Geologist

Complete draft plan to develop Geographic Information System (GIS) database of new and existing geotechnical borings statewide, and begin implementation, which includes populating the database with borings. Assigned to: Tom Badger/Marc Fish
Status: Estimate 60% complete. A prototype database has been developed that can access historic boring logs in pdf format from the database and has been placed on the GIS Workbench referencing State Route/Mile Post (SRMP). This database does not contain the data/information associated with the test boring logs. Full implementation of a GIS/SQL server database for all existing and future test boring data/information is waiting on the development of gINT rules for gINT Professional Plus (our test boring/SQL server database). In conjunction with the manufacturer of gINT and Office of Information Technology (OIT), we are looking into either having the manufacturer, OIT, or both develop these rules and to provide routine maintenance on the database so we can finish and implement this strategic objective.

Improve horizontal drain effectiveness through development of improved design procedures. a. Complete pooled fund research study, which includes assessment of several fully instrumented field horizontal drain installations to validate the methods developed. b. Develop research implementation plan to incorporate results into WSDOT design and construction practice. Assigned to: Tom Badger

Status: Pooled fund study is essentially complete; waiting on copyright permissions for some figures; should be finalized in mid-February. Will be proposing TRB-hosted webinars for T2 activities scheduled for April-May 2013. Need to employ design procedure for WSDOT project to evaluate how we're going to implement it into our design. This will be an ongoing activity as projects arise to implement research.

Develop an Unstable Slopes Management System (USMS) utilizing Geographical Information System (GIS) technology.

a. The system needs to contain viewing, querying, and analysis applications. b. The system needs to be accessible to all WSDOT users. c. A user's manual needs to be developed. d. A training program needs to be implemented to train users on how to use the GIS. Assigned to: Tom Badger/Marc Fish

Status: Estimate 75% complete. An in-house GIS application has been created. The system is slower on less robust computers and needs to be improved upon. This improvement will require additional storage space on network computers. We have constructed a new Internet-based mapping application of our USMS, which is available through our USMS website. This is a very basic application. We recently received training and access to a DOT GIS mapping license and we will be using our new knowledge and available license to improve upon this application and to create new ones. We are also approximately 75% complete in bringing our new USMS website into a current programming language (to ".Net" from "Cold Fusion"). It is currently in quality control status as checks are being made and bugs fixed. As part of the new USMS website programming, we have made some modifications/additions to the USMS SQL server database that stores our USMS information. These modifications/additions will help us track risk reduction scaling slopes (RRS) and partially mitigated slopes in addition to our normal unstable slope within the USMSs. We will be offering training once the USMS website and GIS are finalized and help manuals have been written.

Develop residual strength database to improve design parameter selection for landslide analyses. a. Develop detailed test procedures and obtain a baseline of experience with the test to get off the learning curve. b. Develop database of ring shear (residual strength) test results and correlate with other soil properties such as PI or LL, gradation, residual strength from back analysis of landslide, and also correlate with geologic unit.
Assigned to: Tom Badger/Doug Anderson
Status: Test method has finally been developed after much difficulty replicating Dr. Stark's test results. Currently doing one final set of tests in which split samples were obtained for a WSDOT project so that a direct comparison between WSDOT and Dr. Stark's test results can be made. Assuming the comparison is favorable, procedure is ready to use in production work. Need to start building database of test results as projects become available.

Jim Cuthbertson, Chief Foundation Engineer

1. Qualify testers on the operation of the SSH-100 equipment for the following test procedures.
1.1. D7181 - Triaxial Compression CD Soil
1.2. T297/D4767 - Triaxial Compression CU Soil
1.3. T296/D2850 - Triaxial Compression UU
1.4. D5084 - Hydraulic Conductivity (Flexible Wall)
1.5. D3999 - Cyclic Triaxial (Modulus & Damping)
1.6. D5311 - Cyclic Triaxial (Liquefaction Potential)
1.7. D6528 - Direct Simple Shear CU
1.8. Cyclic Simple Shear (with PP)
2. Develop a WSDOT test procedures for Cyclic Simple Shear Testing (1.8 above) as AASHTO and ASTM do not have test procedures for this test. Note that the primary focus of this testing is for liquefaction evaluation, though other types of cyclic properties can also be determined.
3. Train Staff in the selection of test parameters and interpretation of the test results for all cyclic tests performed on the machine.
4. Incorporate test results into a database
5. Develop WA specific soil correlations for use on all WSDOT projects
Assigned to: Jim Cuthbertson/Pete Palmerson
Status: 78% Complete Overall
Item 5-1, 100% Complete. Items 1.1. through 1.6 are infrequent tests. In accordance with our AMRL certification, we do not need to be qualified for infrequent tests. Accordingly, we are currently compliant with tester qualification for these infrequent tests. Items 1.7 and 1.8 are more frequent tests and we have qualified two testers for these tests.
Item 5-2, 90% Complete. Item 5-2 is essentially complete. We have a test procedure developed and just need to write it up as a final paper procedure.
Item 5-3, 90% Complete. The Geotechnical Office has contacted several individuals familiar with this type of testing and negotiated with them to develop training for our engineering staff, but we have not been able to get final approval for funds to hold the training. Training of the engineering staff is on hold until funds become available. We did successfully develop and hold training for the Technicians performing the testing. There was a fair amount of time invested in setting up training for the testing.

Item 5-4, 30% Complete. We have hired a project person to begin developing data tables in gINT for us to store laboratory test results. He is working on that and making progress. We expect to have most of the data tables required constructed by the end of the Biennium.
Item 5-5, 0% Complete. This Strategic direction needs to be deferred to the next Biennium. We need to get the database in Item 5-4 constructed and populated with data before we can begin to develop correlations. We have been doing database testing to get soil properties and have been storing that data until we can populate the database and do data analysis.

---

1. Train core staff to more fully develop their expertise in this area, including attendance at conferences as they become available and are determined to be beneficial to achieving this strategic direction.
2. Obtain or update the necessary computer software to conduct the seismic analyses needed – especially important is obtaining/augmenting non-linear effective stress analysis software.
3. Have core seismic staff consult with other staff that are faced with doing this type of design on their projects, and as they do so, train these other staff on how to do the analysis.
4. Continue development/revision of the Geotechnical Design Manual (GDM), especially chapter 6 on seismic design to document the design procedures needed, how to obtain the design parameters needed, etc.

Assigned to: Jim Cuthbertson/Jim Struthers
Status: 85% Complete Overall
Item 6-1, 80% Complete. Item 6-1 is still hampered by budgetary issues and travel restrictions. There are insufficient funds for training, and travel restrictions prevent us from sending staff outside State to attend FHWA, NHI, and other training opportunities. We have had a couple of informal training sessions developed by our own staff, but our work load is high and devoting the necessary time to developing the training has been virtually impossible.
Item 6-2, 100% Complete. Basic training regarding the use of DMOD has been completed for some core staff. WsLiq a liquefaction analysis tool developed by the University of WA is complete and fully implemented. In addition, the University of WA has developed a ground motion modeling and analysis tool through funded research. The tool is currently available for use by the core seismic team.
Item 6-3, 100% Complete. Two projects North River and Smith Creek were identified to implement this training, and have been completed.
Item 6-4, 60% Complete. Tony Allen has been working on updates to the GDM including the seismic chapter. Edits are currently in progress on the chapter. It is hoped that the edits will be complete and FHWA will be finalized so revised manual can be published before the end of the biennium.

---

gINT Professional Plus offers centralized data storage for boring log information and laboratory test results. It is a SQL Server based product which will enable the Geotechnical Division to store and query geotechnical data. Data can be made available to other WSDOT programs like Microstation or GIS platforms such as ARC-GIS. Tasks to be accomplished for this strategic direction are as follows:
1. Set up GIS accessible database so that as test results are obtained, they can be recorded/stored

in an easily retrievable system.
2. Develop soil/rock property database and correlate those properties to geologic units commonly encountered in WA.
3. Search the Geotechnical Office records for lab data to help populate the database.
4. As time allows (during less busy times in lab), conduct tests for key properties (shear strength, compressibility, etc.) on existing stored undisturbed samples.
5. Summarize results in Chapter 5 of the GDM to provide design parameter selection guidance based on these results.
Assigned to: Jim Cuthbertson/Pete Palmerson
Status: 20% Complete Overall
Item 7-1, 90% Complete. Item 7-1 was advanced from 75% to 85% complete this last quarter. gINT professional plus has been purchased. We have completed the data template for the boring logs as well as the new DIRT program. We are continuing to add data tables and create reports for the lab data we generate. Before we are able to really implement the new system however, we need to get some issues resolved. We are currently working with the MATSLAB IT group as well as gINT technical support.
Item 7-2, 30% Complete. We have hired a project person to begin developing data tables in gINT for us to store laboratory test results. He is working on that and making progress. We expect to have most of the data tables required constructed by the end of the Biennium 2011-2013.
Item 7-3, 0% Complete. This Strategic direction needs to be deferred to the next Biennium. Our current work load has prevented us from having the staff available to accomplish this direction.
Item 7-4, 100% Complete. Database testing has been occurring during periods of low lab work. We have met the intent of this element, even though we are continuing to perform the work.
Item 7-5, 50% Complete. We have reviewed the current information in the GDM and revised the chapter accordingly. Next we need to develop soil specific correlations and then re-review the GDM to ensure that the material properties are consistent with our Database data. Like all tasks database related, we must finish the database prior to being able to complete this task.

Develop investigation and implementation plan for use of geogrids in pavement base coarse reinforcement and as subgrade reinforcement for pavements. a. Summarize results from nationwide survey. b. Review research results obtained to date by others, and in consideration of nationwide survey results, and work with the Materials Lab Pavements Division to help develop design and use policies for geogrids for this application.
c. Identify potential test sites where this trial design policy could be tested.
Assigned to: Jim Cuthbertson
Status: This effort is on hold until research efforts by others (NCHRP) is completed that will develop the analysis tools needed by pavement designers to accommodate geosynthetic base reinforcement.

Tony Allen, State Geotechnical Engineer

Continue development of the GDM, especially focusing on updates to Chapter 15 to reflect new AASHTO seismic design specifications for walls, Chapter 6 on seismic design (see also Strategic Direction No. 6), especially with regard to lateral spreading and flow failure impacts to foundation design, updated drilled shaft design specifications (Chapter 8), and filling any gaps in the recommended design practice to insure clarity for design-build contracts.
a. Complete updates by the end of 2012 or sooner.
b. Assigned to: Tony Allen/Jim Cuthbertson
Status: Several updates to GDM chapters have just been completed, including Chapters 15 (walls) and 22 (Geotechnical Design-Build). Work is partially complete on developing updates to Chapters 6 (esp. regarding lateral spreading and flow failure design), Chapter 15 (esp. regarding implementation of the new AASHTO wall seismic design provisions, and clean-up of the shoring/temporary cut and fill design sections), Chapter 5 (soil and rock property determination), Appendices to Chapter 15 to update/add proprietary wall system preapproved procedures and details, Chapter 9 (temporary fill design requirements), Chapter 1, and Chapter 23. Note that work on the GDM is an on-going process, so this strategic direction is anticipated to be on-going.

Continue to develop geotechnical design procedures in LRFD format for aspects of foundation and wall design that are not currently in LRFD format (soil nail walls, micropiles, noise walls, reinforced slopes, etc.), primarily through continued participation in the AASHTO Bridge Subcommittee and various NCHRP panels, and possibly other research. Develop updated procedures to submit to AASHTO regarding drilled shaft foundation design procedures, spread footing design, and MSE wall design.
Assigned to: Tony Allen
Status: New drilled shaft design specifications have been completed and are now in full subcommittee review - a subcommittee vote is anticipated in June. Changes to Section 11 to update/improve the MSE wall design specifications are being developed.

Develop long range plan to fully implement MSE wall research (K-Stiffness Method).
a. Complete research reports and publish updated design method in well respected journals. This includes development of load and resistance factors using reliability theory, application of method to seismic design and to establish link between working stress design (K-Stiffness method) and limit equilibrium design (compound stability analysis)
b. Work with other states/agencies to identify potential instrumented test walls, including those with lower quality backfill materials to establish accuracy of method and improve user confidence
c. Complete RMC research - scheduled completion date is July 2012.
d. Work with the FHWA and AASHTO T-15 so that they have what they need to consider how improved MSE design methods such as the K-Stiffness Method should be addressed in the AASHTO LRFD specifications and FHWA manuals.
Assigned to: Tony Allen

Status: The K-Stiffness Method has been well established in the literature. The database of walls was expanded significantly prior to 2008 by including a number of walls from Japan, the methodology was updated and published in 2008, and LRFD calibration of this and other available methods for internal stability design of MSE walls (including resistance statistics and analysis using data from AASHTO NTPEP and other sources) has been partially accomplished. The work has won several international awards. However, there are some within the profession who have raised concerns as to how the proposed methodology assures equilibrium of the system is maintained (i.e., working stress vs. limit equilibrium design). Therefore, efforts are underway, including journal papers that are completed or in the journal review process, using available results from testing of full scale walls to near failure at RMC to assess the relationship between working stress and limit equilibrium design, especially considering how to address compound stability of MSE walls designed using working stress methods. Other key implementation issues in the method development that are actively being researched include how to incorporate seismic design with the K-Stiffness Method, prediction of wall lateral and vertical deformation, procedures to handle surcharge loads in working stress conditions using the K-Stiffness Method, and refinements to better handle the effect of wall height, improve the facing stiffness model, and the steel reinforcement stiffness model. A paper series to address these issues is well underway. Discussions with the FHWA and T-15 regarding potential future design specification revisions to address current short-comings in the MSE wall design procedures for internal stability have begun. Getting through the journal review process takes time, but we anticipate acceptance late this year (2013).

Pavements

Jeff Uhlmeyer, State Pavement Engineer

WSDOT Pavement Preservation Folio - Develop folio for internal and external customers to fully communicate preservation needs.
Status: Plan is being developed.

Quieter Pavement Web Page - Update and maintain quieter pavements web page
Status: Update webpage on a quarterly basis or as new information becomes available.

Pavement Preservation Proviso - Develop Proviso based on 2011 Legislature request, detail WSDOT preservation needs.
Status: Begin work December 2011. Due to WSDOT July 2012.

Permeable Pavement Revisions to HRM - Update content and design procedures of permeable pavements
Status: Revisions are under development.

Quieter Pavement Award on Web Page
Status: Complete.

Overlay Pavement Policy Strategy
Status: Complete.

CA4PRS Implementation - Work with WSDOT Design to Implement CA4PRS
Status: Evaluation is beginning.

Integration of Pavement Maintenance with Asset Management - Continue to expand use of BST's, crack sealing and pavement repair to rehab pavements as one asset.
Status: Evaluation is underway.

Construction Data Collection - Pavement Life: Investigate ways to collect contract construction information and incorporate into WSPMS for historical pavement needs. Obtaining this data will be used for forensic and performance evaluations.
Status: Evaluation is ongoing.

Mark Russell, Pavement Design Engineer

Monitoring of Quieter Pavement Test Sections
Status: Noise and pavement data updated through August.

Experimental Features.
Status: Being worked on as time is available.

Pavement Forensics.
Status: Currently up to date.

PCCP Smoothness Specification
Status: Evaluation of new PCC section will begin after new equipment is purchased.

Update Pavement Web Page
Status: Complete.

Pave-IR Evaluation
Status: First two demonstration projects constructed summer 2011. Four additional projects to be constructed in 2012. Analyzing data.

Safety Edge Evaluation
Status: Draft evaluation (report) is complete.

Warm Mix Evaluation
Status: 2008 and 2009 projects are being tracked. Working with Construction Materials to get data on 2010 and 2011 WMA projects.

David Luhr, Pavement Management Engineer

WSPMS Documentation - The WSPMS has been successfully functioning for over 40 years. A comprehensive User's Guide has been implemented; however, no overall documentation of the new webWSPMS exists. This documentation will describe PMS concepts incorporated into the webWSPMS, and the user functions.
Status: WSPMS file processes have been documented, and Profilometer calibration has been documented. An outline for the summary documentation will be developed, followed by the creation of the summary document.

Evaluation of Pavement Life - The life of each pavement resurfacing is stored in the WSPMS database. This data needs to be studied in order to evaluate what factors are causing either long-length or short-length resurfacing life. Different statistics related to Remaining Service Life performance also need to be analyzed.
Status: Initial calculations have been performed, but an analysis plan needs to be developed.

Economic Performance Measures - The initial version of economic performance measures (i.e., $/lane-mile/year or $/lane-mile/ESAL) has been implemented in WSPMS. This work needs to be continued to evaluate Economic Performance trends and the development of performance targets.
Status: Economic Performance measures are available on WSPMS. Further data clean-up (data spikes at intersections, etc.) needs to be completed. A plan for evaluating results needs to be developed.

WSPMS Data Base Audit - Some fields in the database are blank, for certain years. Other data is not consistent. An audit needs to be done to identify problems with the data base and develop remedies.
Status: Work has begun on evaluation of data issues, but no recent progress has been made.

Evaluation of texture and Skid Data - A new macro-texture laser has been deployed on the 2009 Pathway condition survey van. This data needs to be analyzed and understood in how it can be used, especially in relationship to skid data and BST performance.
Status: The data collection of the macro-texture data has begun. Initial study of the texture data is under way.

Develop WSPMS Notebook - Similar concept to the "Grey Notebook", the WSPMS Notebook can be a standard repository of statistics, graphs, and other performance indicators that anyone can retrieve off of the internal web site. Items to include: WSPMS lane miles by type, fair or better condition plots, IRI data, construction lane miles by season, project costs, chip seal annual costs and more.
Status: An initial set of data has been processed, and is available on the Alpha/Beta versions of WSPMS. Requirements document was completed some time ago, but needs to be updated in light of new functions in WSPMS. This Pavement Notebook capability can probably be incorporated into WSPMS, so a development plan needs to be created to complete the work.

Interfacing WSPMS with Maintenance -An initial capability has been implemented in WSPMS to receive data from the Highway Activity Tracking System (HATS). This needs to be interfaced with the tracking of P1 Maintenance plans. Olympic Region is a key development partner in this effort.
Status: Initial capabilities are in WSPMS, but a development plan needs to be created for new features and continued integration with Maintenance data.

Administration

Colleen Reynolds, Information Technology Systems Application Specialist

Internal/External Software Audit
Status: Adobe compliance review is complete, we will continue with other software manufacturers until all software has been identified and purchasing records are attached. This task is complete, but will be ongoing for new technology.

Ed Bellinger, Information Technology Systems Specialist

Disaster Recovery
Status: OIT and DOT Server administrators group have made a decision on an enterprise backup/DR solution. FalconStor software backed by XioTech hardware. The Materials Laboratory has integrated its disaster recovery plan with OIT.

Disaster Recovery / Business Continuity Implementation
Status: Data center consolidation to OIT is complete. DR/BC is directed and managed from OIT. The DOT COOP plan has been submitted to the governor's office.

Development Self help Web for users
Status: Currently interviewing users for specific scenarios for help site. We continue to add content as specific topics are encountered.

Kathy Brascher, Information Technology System Specialist

Move Group data onto SharePoint document server, create standards, procedures and searchable structure for project data.
Status: A committee has been formed to develop the standards, procedures and searchable structure. Testing continues at a very slow pace due to current workload of testers. We are currently using the sharepoint site in a semi production mode for a few projects.

Replace Smartware with MATS and continue to develop the remainder of MATS.
Status: Remaining replacement includes Chem Lab, Liquid Asphalt Lab and Electrical Lab.

Replace Regional Technical System, Work Order Grabbers and Report Generator with MATS
Status: Currently working on replacement modules.

Business Functions

New or Ongoing Construction Materials/Pavements Research Projects

Evaluation of Warm Mix Asphalt Field Performance

Warm mix asphalt (WMA) refers to a technology that reduces the mixing and compaction temperatures to lower energy consumption and emission of greenhouse or other toxic gases. When compared to hot mix asphalt (HMA), WMA could offer some benefits to help achieve densities and can contribute to sustainability. However, before its widespread use, WMA should be studied carefully in terms of field performance, because a long-lasting pavement itself is the most economic and sustainable. The objective of this proposed research is to evaluate the engineering performance of WMA, in terms of fatigue, rutting, thermal cracking, and moisture susceptibility.

Extended Discharge Time/Revolution Count for Cast In Place Concrete

Existing specifications typically require concrete be discharged within 90 minutes of batching cement and water and within 300 revolutions of the concrete mixing truck. These specifications were established prior to the introduction of set retarding chemical admixtures which delay hydration or setting of fresh concrete. Use of 90 minutes and 300 revs, although typical, affects delivery schedules and frequently leads to rejection of concrete that, in all other ways, meets owner requirements. The objective is to assess concrete quality from extended discharge times and determine performance.

Expected Life and Best Practices for Pavement Maintenance Treatments

The state typically spends approximately $200-$250 million per biennium on capital projects to preserve the pavement system. The appropriate use of maintenance could extend pavement life, but which techniques to use, and how effective they are, are not well known. Research needs to be performed to understand the best maintenance practices and determine how effective each one is at extending pavement life. The effect of maintenance on pavement life needs to be quantified, and best practices for maintenance treatments need to be developed as well as guidelines for how each maintenance treatment affects the pavement life.

Structural Design Parameters of Current WSDOT Concrete Mixes

The variability of structural design parameters of concrete mix designs has been a major concern among bridge designers. Parameters such as compressive strength, density, modulus of elasticity, modulus of rupture, creep, shrinkage, and permeability could be significantly different if concrete mix ingredients change. The structural properties of some concretes being recently used for WSDOT bridge projects are questionable and may not be consistent with specifications, therefore the scope is to determine the structural properties and develop performance based specifications.

Optimal Timing of BST's on HMA and BST Pavements

Previous research determined the Average Annual Daily Traffic (AADT) threshold that we are currently using and modified the standard specifications for BST's. The next step is to determine the optimal time to place a BST on an existing BST or HMA pavement. BST's are seen as an effective and relatively inexpensive method of pavement surfacing, however, there is no reliable method to determine when the most cost effective time to apply a BST. The benefit will be the improved cost effectiveness of BST pavements and will result in better pavement performance and more efficient investments.

Determination of Optimum HMA Density Based on Pavement Performance

With the implementation of the Superpave mix design procedure and the asphalt binder specifications, there is concern that there may be issues related to HMA permeability, which can be offset by ensuring adequate density, with or without the initial secondary consolidation. Through the data in WSPMS and QA Spec/SAM, this research should determine how HMA density impacts pavement performance, and what level of HMA density is necessary to provide long-lived HMA pavements for construction throughout the year. In addition, determine how the QA specification has impacted pavement performance over time – the current HMA density specification has not been modified with the implementation of Superpave.

Determining Changes in Greenhouse Gas Emissions from Circa 1990 to Present Due to Changes in Pavement Technology

Climate change will impact every facet of asset management at WSDOT. Outside forces may drive inappropriate changes due to lack of information or lack of understanding. Understanding of the effects from pavement management, design, and construction can aid in developing accurate measures for climate change and greenhouse gas emissions (GGE). Therefore, the objective is to determine the contributions to GGE reductions due to improved pavement design, management, materials, and construction.

Concrete Performance Using Low Degradation Aggregate

Generally, as low degradation materials are removed from a quarry, they are typically very hard with low LA wear values, therefore typical material testing cannot determine or predict long-term deterioration. As the low degradation materials are removed from the source and subjected to water, this type of material becomes altered to clay and will not perform as expected. This research will evaluate the long-term performance of concrete when using such aggregates, identify the potential long-term problems with the use of low degradation aggregates in concrete, and recommend test procedures and specifications for future use.

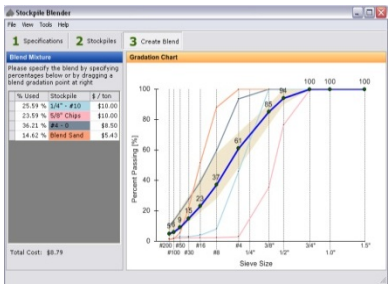
Cost Benefit Analysis of Concrete Pavement Reconstruction and Rehabilitation Options

The goal of this research is to set up a framework, based on a cost-benefit analysis, which can assist WSDOT in making decisions on concrete pavement rehabilitation or reconstruction options. WSDOT currently uses life cycle cost analysis (LCCA), but needs an additional tool to show whether it makes more sense to rehabilitate a portion of concrete roadway or reconstruct it.

Tire/Pavement Noise Research Consortium

This consortium has been initiated to: provide a forum for states to discuss pavement noise issues, utilize the same measurement techniques to build a tire/pavement noise database, create a synthesis of global practice in regards to utilizing pavement technology for decreasing tire/pavement noise, determine the cost/benefits of using low-noise pavements, and provide guidelines for best practices in measuring and evaluating noise benefits and decreases over the wearing life of the roadway surface.

Pavement Tools Consortium



The Pavement Tools Consortium fosters the continued development and implementation of computer-based paving tools, such as: Pavement Guide, Virtual Superpave Laboratory, Media Library, HMAView, PMSView, Stockpile Blender, XPactor, and EverFE. The major focus of the pavement tools is the enhancement of pavement-related training and construction operations.

State Pavement Technology Consortium (SPTC)

WSDOT is partnering with three other states (California, Minnesota, and Texas) which allows participation in a series of project meetings focused on sharing information, identifying critical issues of mutual interest, developing plans for joint research and testing, and educating transportation professionals on the latest developments in the design, construction, reconstruction and maintenance of highway pavements. The benefits of this arrangement have exceeded millions of dollars since its inception in 1999.

Pavement Reconstruction Scheduling Software

This consortium was formed through the SPTC to develop a software simulation tool which can be used to consider pavement design options along with construction scheduling, resource constraints, traffic management, and user-delays. The CA4PRS software is a construction and scheduling analysis tool to make sound construction project management decisions at each stage of the highway rehabilitation project: planning, design, and construction. CA4PRS estimates how many miles of pavement can be rehabilitated or reconstructed under different traffic closure strategies with given project constraints of: pavement design, lane closure tactics, schedule interfaces, contractor logistics and resources.

Technology Transfer Concrete Consortium

Increasingly, state departments of transportation (DOTs) are challenged to design and build longer life concrete pavements that result in a higher level of user satisfaction for the public. One of the strategies for achieving longer life pavements is to use innovative materials and construction optimization technologies and practices. In order to foster new technologies and practices, experts from state DOTs, Federal Highway Administration (FHWA), academia and industry must collaborate to identify and examine new concrete pavement research initiatives. The purpose of this pooled fund project is to identify, support, facilitate and fund concrete research and technology transfer initiatives.

New and Ongoing Geotechnical Research Projects

3D Numeric Evaluation of Seismic Forces on Bridge Abutments

The dynamic response of bridges is strongly affected by soil-structure interaction effects, being soil-pile interaction the most familiar form. Embankment-abutment interaction is also an important effect, particularly in integral reinforced concrete bridges subjected to earthquakes. Recent studies and field evidence shows that this form of interaction during earthquakes may significantly alter the bridge response and must be taken into account during design and assessment, especially in the case of typical highway overcrossings that have abutments supported on earth embankment. Of particular interest are 3D effects on embankments subjected to lateral spreading that, when not taken into account, may result in the estimation of unrealistic forces, and therefore, the design of excessively strong and expensive bridge structures. The objective of this research is to develop and validate a design methodology to estimate earthquake-induced lateral spreading forces in embankments taking into consideration 3D effects.

Liquefaction-Induced Downdrag on Shafts/Piles

Numerous incidences of downdrag and associated failures of drilled shafts and pile foundations have been observed in the recent Magnitude 8.8 (Feb 7, 2010) Chilean earthquake. Sandy soil layers may undergo compression during liquefaction and this compression results in a downward movement of the overlying soil layers. For pile foundations, such movement influences the axial load distribution, especially the magnitude of the drag load and the location of the force equilibrium in the pile. Depending on the site conditions, the changes in axial load distribution and downdrag settlement resulting from liquefaction-induced effects can have significant bearing on deep foundation performance including failures like those observed in the Chilean earthquake.

LRFD Procedures for Geotechnical Seismic Design

Develop a framework to determine load and resistance factors that would, accounting for uncertainties in earthquake occurrence and effects, produce designs with reliabilities consistent with those achieved by LRFD procedures for high-probability loading conditions. Development of reliability-based design procedures will allow seismic aspects of design to be consistent with non-seismic aspects, and will allow the reliability of geotechnical elements to be balanced with the reliability of structural elements. They will also allow uniformity across geographic regions – structures in all of the various seismic environments of Washington would be designed for consistent reliability.

Subsurface Drainage for Landslide and Slope Stabilization

Research is needed to identify, collect and develop best practices and guidelines to raise the standards for subsurface drainage design, installation, and maintenance. This research is especially important because subsurface drainage is typically the most cost-effective stabilization measure, often being an order of magnitude less than other commonly employed slope stabilization measures. In addition, the research should explore new applications of existing materials and technologies that can be advantageously applied to subsurface drainage systems for slope stabilization.

Strength and Deformation Analysis of MSE Walls at Working Loads

This work has developed an improved method for internal stability design of MSE retaining walls, the K-Stiffness method. This method appears to produce a more cost-effective design for MSE walls as compared to the AASHTO Simplified Method. The K-Stiffness method has only been developed and validated for high quality sandy backfill soils. The next two phases will extend the K-Stiffness method to 1) marginal quality backfill materials and 2) full-scale field walls that will be monitored for validation. The validation of the K-Stiffness method for marginal quality backfill materials and monitoring full-scale walls is necessary to incorporate this method into the AASHTO LRFD design specifications.

Full-Scale Shake Table Testing to Evaluate Seismic Performance of Reinforced Soil Walls

The objective of this project, once the full scale prototype wall is constructed and tested, is to perform a unique experimental investigation of the dynamic response and performance of two full-scale (10 m) reinforced soil retaining walls constructed using realistic materials and methods. Considering that these walls will be substantially taller than for any similar previous research (by a factor of 3), a key focus of the proposed research will be on the influence of wall height on overall system response and distribution of dynamic tensile forces (i.e., seismic demand) in soil reinforcement. Other focus areas will be dynamic earth pressure on facing elements, effects of dynamic loading on soil-reinforcement load transfer mechanisms and permanent deformations after dynamic loading.

Recently Completed Construction Materials/Pavements Research Projects

Best Practices for the Design and Construction of PCCP

This research will provide the most effective and efficient methods of design and construction or use in PCCP design and rehabilitation/reconstruction. The first part of the study focused on stud wear of PCCP, which is a major obstacle in designing and maintaining PCCP over a life span of 50 plus years. The second part will focus on a life cycle assessment of varied options for reconstructing PCPP.

Development of a New Drilled Shaft Acceptance Method

Drilled shafts using the wet method are typically accepted based on successful results of the Cross Sonic Logging test. This method of Quality Assurance testing can only verify the quality of concrete inside the shaft core and does not provide for verification of adequate concrete cover over the shaft rebar cage. There is a lack of reliable test methods to verify the quality of the entire concrete drilled shaft. This research will determine test methods that may be capable of testing for core concrete quality as well as the presence of adequate concrete cover outside the shaft rebar cage and determine the reliability and cost-effectiveness of those test methods.

Deicer Longevity and Cost-Effectiveness

The objectives of the proposed research are to evaluate the longevity of corrosion inhibitors in storage and on the road as well as their cost-effectiveness, and to establish a reliable measure to quantify the performance of anti-icing and deicing products. This research will allow the transportation agency to determine whether the inclusion of inhibitors into liquid or solid deicers is cost-effective, taking into account: the acceptable deicer corrosivity, reasonable duration of protection expected of inhibitors, and other agency-specific constraints.

Recently Completed Geotechnical Research Projects

Earthquake Ground Motion Selection Tool

This research was performed to provide WSDOT with software tools that aid in the selection and scaling of earthquake ground motions for geotechnical and structural response analysis. The researchers modified an existing software program to provide a database that has similar ground motions as what we expect to have here in Washington State as well as information on the selection and scaling of the ground motions.

In-House Pavement Research

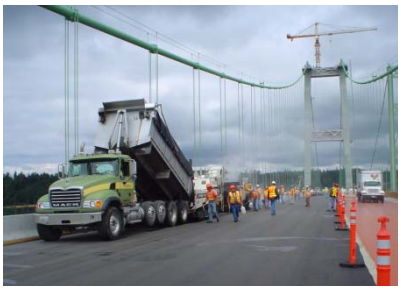
The following is a list of all completed, in-progress, and new research topics that are being investigated by the Pavements Division. Completed reports and TechNotes are available on the Materials Lab Pavements Division web site accessible by clicking here. January 2013.

Carpet Drag and Longitudinal Tining (COMPLETED)

Two adjacent projects on I-5, Pierce County Line to Tukwila I/C HOV Stage 4 and South 317th Street HOV Direct Access, were constructed with carpet drag, longitudinal tining and transverse tining. The durability of each type of texture is being evaluating along with the tire/pavement noise characteristics. Wear and noise readings at five years indicate all three texturing methods are equally durable and are producing about the same noise level. Final report WA-RD 637.2 issued May of 2012.

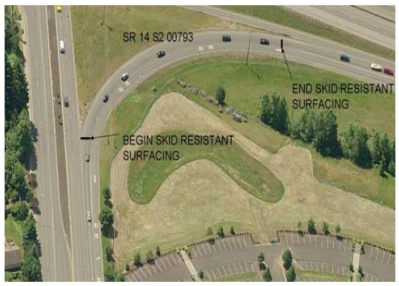
Trinidad Lake Asphalt (UNDER EVALUATION)

The steel bridge deck on the new Tacoma Narrows Bridge requires a highly crack resistant overlay. HMA pavements on steel bridge decks often use Trinidad Lake Asphalt to improve crack resistance. This experimental feature documents the construction and performance of the HMA overlay with Trinidad Lake Asphalt. Post-construction report issued in September of 2008. Final report due in 2013.



Tyregrip® (UNDER EVALUATION)

Tyregrip® is a high friction surface (HFS) used to increase the frictional properties of a pavement surface in high accident locations. It consists of an epoxy binder top dressed with a calcined bauxite aggregate. It was used on a tightly curved ramp in the Southwest Region in 2011 to reduce the occurrence of single car wet weather accidents. A post-construction report was issued in June of 2012.



Warm Mix Asphalt (UNDER EVALUATION)

This experimental feature documents the construction and performance of warm mix asphalt placed on I-90 west of the town of George. Warm mix asphalt is a bituminous mixture which can be produced and placed at lower temperatures. Lowering the production temperature means the mix requires less energy to produce leading to a corresponding reduction in greenhouse gas emissions. The lower placement temperature also reduces worker exposure to fumes. Post-construction report WA-RD 723.1 issued in April of 2009.

Quieter Pavement (UNDER EVALUATION)

As a result of the study on *Quieter Pavement: Options and Challenges for Washington State*, WSDOT has developed three Experimental Feature test sections to evaluate the construction and performance of hot mix asphalt open graded friction course (OGFC) quieter pavement. The test sections evaluate two types of OGFC, one that utilizes an asphalt-rubber binder and one that utilizes a polymer modified asphalt binder. Test sections were constructed on I-5, 52nd Avenue to SR-526 (southbound only) in 2006, SR-520 between Evergreen Point Road and I-405 in 2007 and on SR 405 between Coal Creek Parkway and SE 8th Street in 2009. The OGFC sections on all three projects were initially quieter than the conventional HMA but after less than one year there was no audible difference between the OGFC and conventional HMA. The OGFC sections on all three projects quickly developed ruts due to raveling from studded tire wear. The I-5 and SR 520 test sections have been removed after only four years of service. Final report on the I-5 project WA-RD 683.2 and SR 520 project WA-RD 691.2 were issued in June of 2012. Final report on the I-405 project is due in 2013.

I 5

S R 5 2 0

I 4 0 5

High Slag Cement (UNDER EVALUATION)

This experimental feature evaluates the ability of concrete produced using high slag cement to resist studded tire wear. Test sections containing high slag cement were constructed on SR 543 in Blaine in October 2007. The tests sections will be monitored for ride, friction and wear for a period of five years. Post-construction report WA-RD 728.1 issued in June of 2009.

MMFX Dowel Bars (IN PROGRESS)

MMFX 2 Steel is an uncoated, high corrosion resistant steel-reinforcing product that meets or exceeds the mechanical properties of ASTM A615 Grade 75 steel. MMFX 2 Steel is a high chromium and low carbon steel in comparison with conventional ASTM A 615 steel. Its chromium content (9 to 10 percent) almost approaches that of stainless steel. The purpose of this experimental feature is to use MMFX 2 Steel dowel bars at each transverse joint in the new concrete pavement.

Pavement Joint Adhesive (IN PROGRESS)

Longitudinal joints are often the first area to fail on HMA pavements. This experimental feature evaluates performance of joints constructed using a bituminous joint adhesive instead of the traditional emulsified asphalt. Preliminary results indicate excellent performance from those projects that used the adhesive.

Hot In-Place Recycling (IN PROGRESS)

Hot in-place recycling is a process by which the existing pavement is removed from the roadway, processed and repaved as new asphalt pavement in one pass. Hot in-place recycling has the advantage of reusing 100 percent of the old pavement and requires less fuel and produces lower emissions than tradition hot mix asphalt paving. This study will document the design, construction of the pavement placed on SR 542 in 2009 and monitor performance for five years. Post-construction report WA-RD 738.1 issued in June of 2010.

Double Chip Seal (IN PROGRESS)

A chip seal constructed on an existing flushed roadway has the potential to result in bleeding or flushing of the new chip seal. The excess binder, if not properly accounted for during design and construction, will migrate to the surface of the chip seal and fill the aggregate void spaces leaving a flushed surface. This study documents the design and construction of a two shot chip seal (double seal) as a method to mitigate a bleeding problem on SR 20. Post-construction report WA-RD 760.1 issued April of 2011.

Next Generation Concrete Surface Texture (IN PROGRESS)

Next Generation Concrete Surface (NGCS) is a new method of diamond grinding that has produced the quietest concrete pavement surface tested to date. This experimental feature documents the construction and performance of a section of NGCS installed on I-82 near Sunnyside, Washington. This project is part of a continuing effort by WSDOT to test new methods of decreasing the noise generated from highway facilities. Post-construction report WA-RD 767.1 issued in April of 2011.

Mateen FRP Dowel Bars (IN PROGRESS)

Mateen fiber reinforced polymer (FRP) dowel bars are non-corrodible alternatives to metallic bars. A 1,000 foot test section of these dowel bars was installed on I-82 near Granger in 2011. The performance of the bars will be monitored for a minimum of five years. Post-construction report WA-RD 795.1 issued in September of 2012.

Pavement Edge Treatment (IN PROGRESS)

The pavement edge treatment is a wedge of pavement that provides a non-vertical slope at the edge of the pavement which reduces the forces needed in steering for re-entering the roadway in comparison to a near vertical face. A device bolted to the screed on the paving machine forms the wedge. The treatment was used on two projects in 2011. Two more projects will be built in 2012 and a post-construction report will be issued in 2013.

MOBA Pave-IR (IN PROGRESS)

The MOBA PAVE-IR™ is mounted on the back of the paver where its 12 infrared sensors collect infrared images over the entire asphalt mat in real time. The infrared images, speed and location data is collected by the on-board computer where the paving crew can view the results and make process corrections to eliminate cold spots if necessary which will ultimately improve the overall pavement quality. Data collected can be downloaded onto a personal computer for analysis at a later time. The equipment was used on two projects in 2011 and four projects in 2012.

Polyester Concrete Overlay (IN-PROGRESS)

Polyester concrete (PPC) overlays have been used by WSDOT to prevent chloride intrusion and provide a new wearing surface on bridge decks. Short sections of PCC were installed on I-90 west of Spokane to fill ruts in the existing concrete pavement caused by studded tires. The PPC is being evaluated for its ability to mitigate studded tire wear. A post-construction report will be issued in 2013.

Preventive Maintenance Preservation Evaluation (IN-PROGRESS)

This project is measuring the life span of various maintenance treatments used on pavements. Pavement maintenance preservation is one strategy WSDOT is using to stretch our limited funds. Knowing how long various maintenance treatments last will help WSDOT be more cost effective. Documentation began in 2012 and additional data points will be added each year to develop the database of information.

Performance Measures

Construction Materials

Bituminious/Chemical/Electrical

Bituminous Materials Section

Hot Mix Asphalt Mix Design Anti-Strip Evaluation 2012

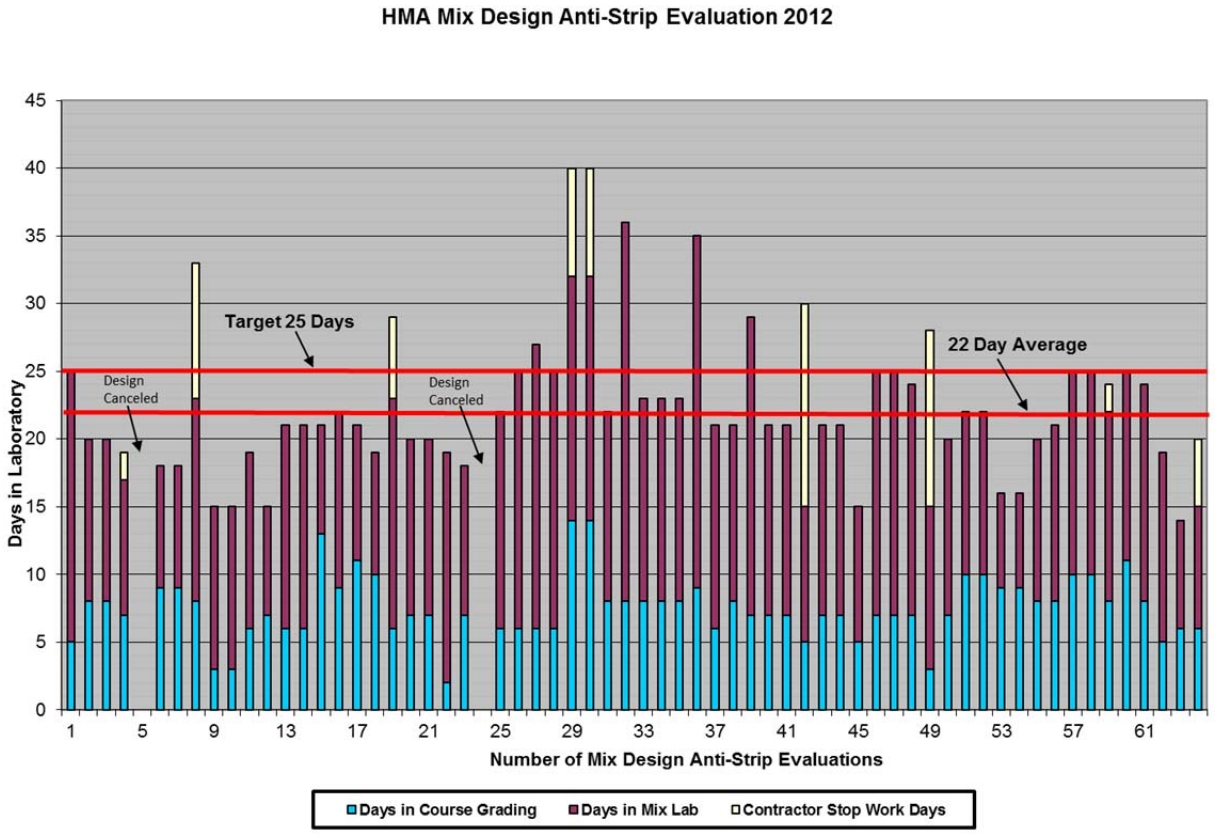
Standard Specification 5.04.3(7)A Mix Designs, states "Prior to the production of Hot Mix Asphalt (HMA), the Contractor shall determine a design aggregate structure and asphalt binder content in accordance with WSDOT Standard Operating Procedure 732. Once the design aggregate structure and asphalt binder content have been determined, the Contractor shall submit the HMA mix design on DOT form 350-042 demonstrating that the design meets the requirements of Sections 9-03.8(2) and 9-03.8(6). A mix design anti-strip evaluation report will be provided within 25 calendar days after a mix design submittal has been received at the State Materials Laboratory in Tumwater."

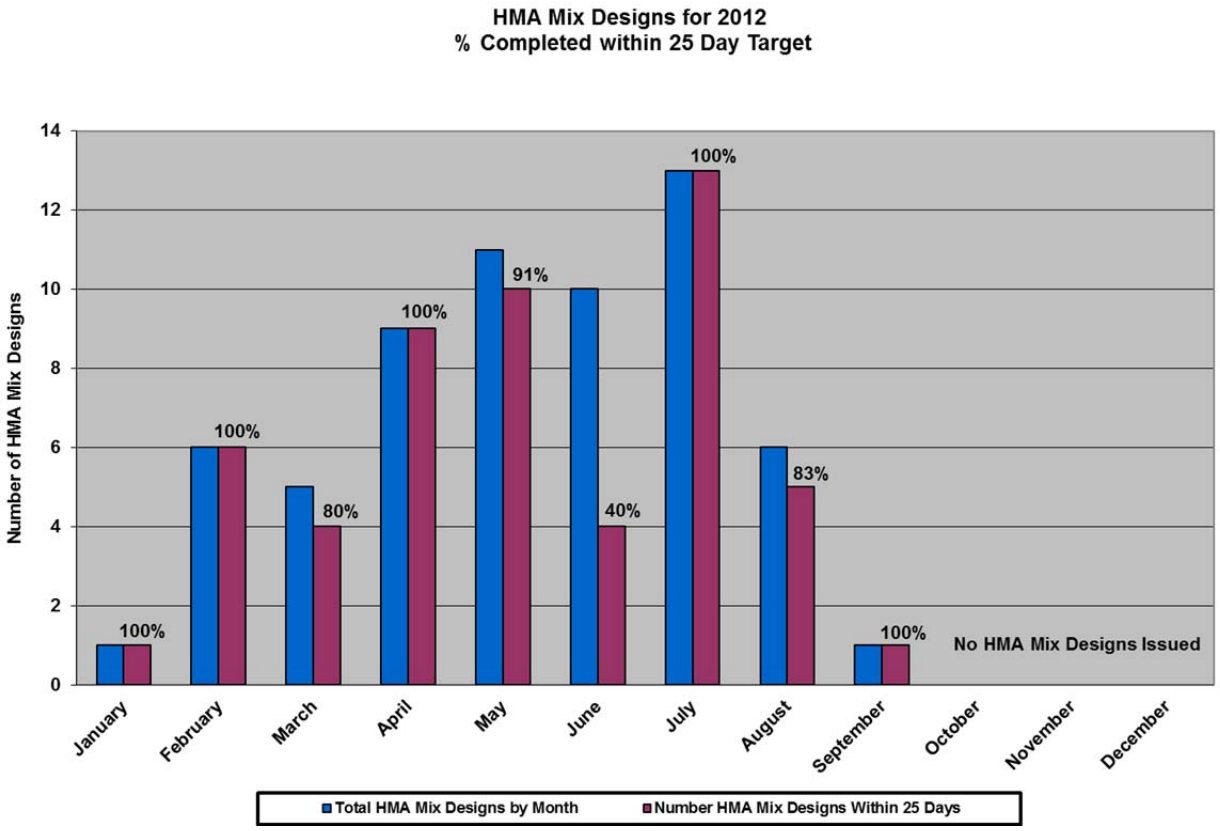
Factors that can affect the 25 day completion schedule:

- Work-load in Physical Testing Section
- Undersized or non-representative samples
- Delays in asphalt binder shipments from suppliers
- Work-load in the Bituminous Materials Section
- Special handling of designs
- FTE's
- Equipment and laboratory space
- Overtime authorization

In 2012 the Bituminous Materials Section completed 64 HMA mix design anti-strip evaluations with an average of 22 calendar days. 54 of these mix design anti-strip evaluations were either completed on or before their due date. 10 mix design anti-strip evaluations were not completed within 25 calendar days. Of these 10 mix design anti-strip evaluations: 4 design evaluation reports were delayed due to the contractor not submitting enough aggregate to the State Materials Laboratory for mix design testing, 4 designs were late due to extra Hamburg and Lottman testing needed for anti-strip determination, 1 design was late due to the contractor re-submitting a new job mix formula after WSDOT volumetric analysis revealed a potential poor performing mixture and 1 Open Graded Friction Course (OGFC) mix design evaluation was put on hold due to the

State Materials Laboratory receiving a late shipment of asphalt binder and fiber needed for this specialty asphalt pavement.





Hot Mix Asphalt Reference Mix Design Anti-Strip Evaluations: 2012

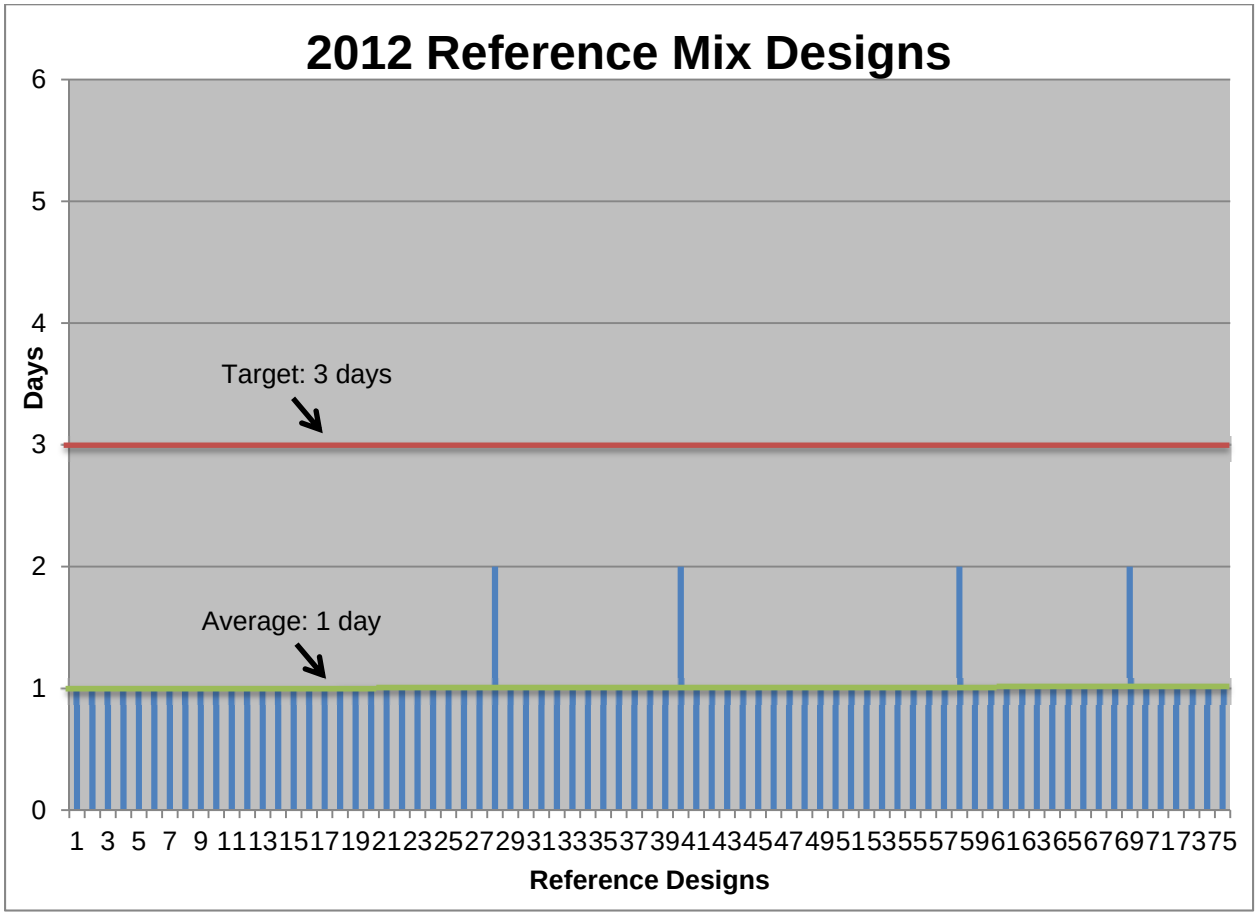
Hot Mix Asphalt (HMA) reference mix designs allow Contractors to use a valid mix design on multiple contracts with the same design criteria. If a mix design can be referenced to another contract instead of a new mix design being developed, time and money can be saved. The HMA reference mix design policy also allows WSDOT to analyze production data from previous usage of the design to ensure quality, and decide whether continued use is advisable.

The basis for this performance measure is comprised of the number of days it takes to issue the reference design once the request has been submitted. Based on past performance measures, the Bituminous Materials Section has set a goal of three business days for completion of this task.

Factors that can affect the 3 day completion schedule:

- Workload in the Bituminous Materials Section
- Incomplete requests
- Certification letters from the Contractor stating that aggregate and asphalt binder properties have not changed since the original design was issued per Standard Specification 5-04.3(7)A1

In 2012, the Bituminous Materials Section issued 75 reference mix designs. The average time of completion was one business day; this average was the same as in 2011. There were no designs that took more than two business days to issue.

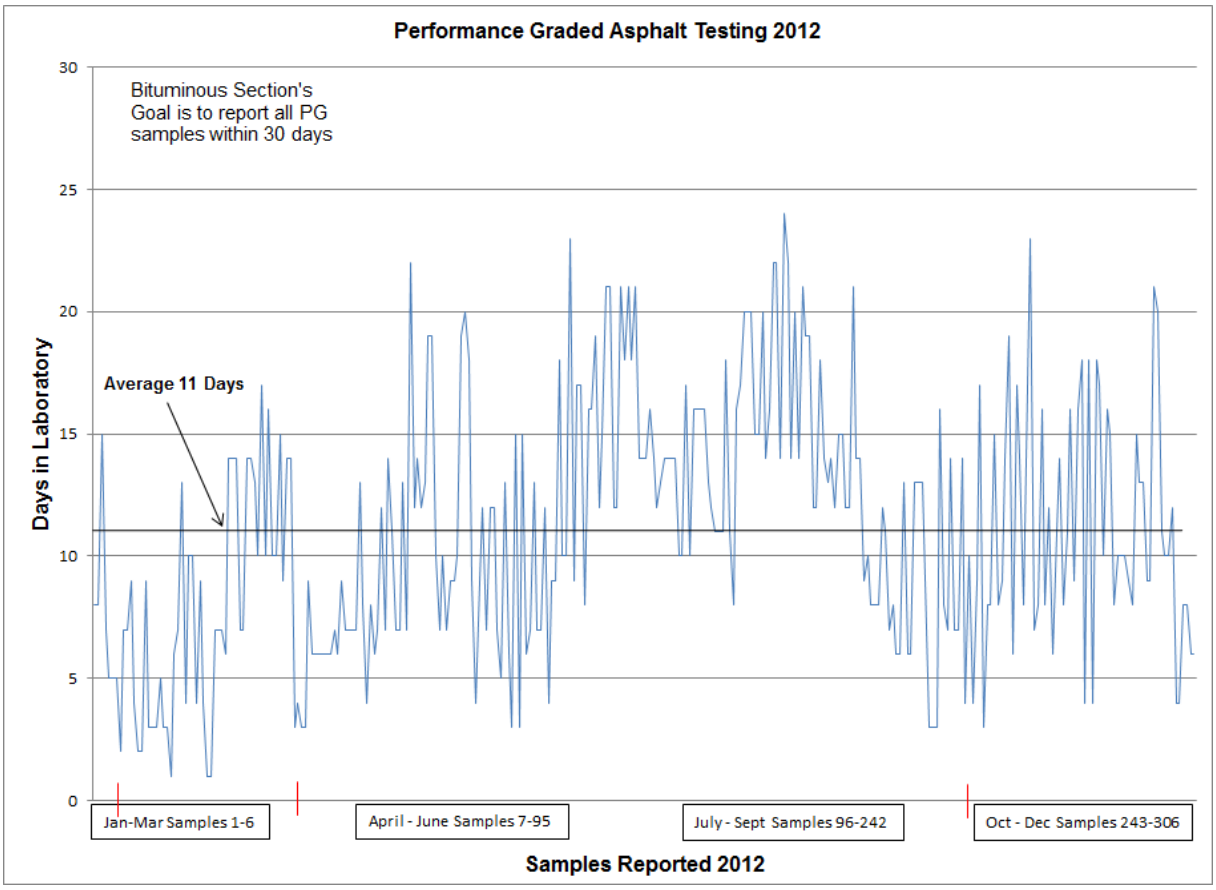


Performance Graded Asphalt Binder Testing 2012

As stated in the Construction Manual section 9-4.2, PG asphalt binder samples must be approved prior to use. Materials must be approved by the Qualified Product List or Request for Approval of Material (RAM). Samples for verification conformance will be taken based on the frequencies stated in section 9-3.7 (Acceptance Sampling and Testing Frequency Guide). PG asphalt binder samples for verification are taken with every other mix acceptance sample, every 1600 tons of Hot Mix Asphalt (HMA) produced on a construction project.

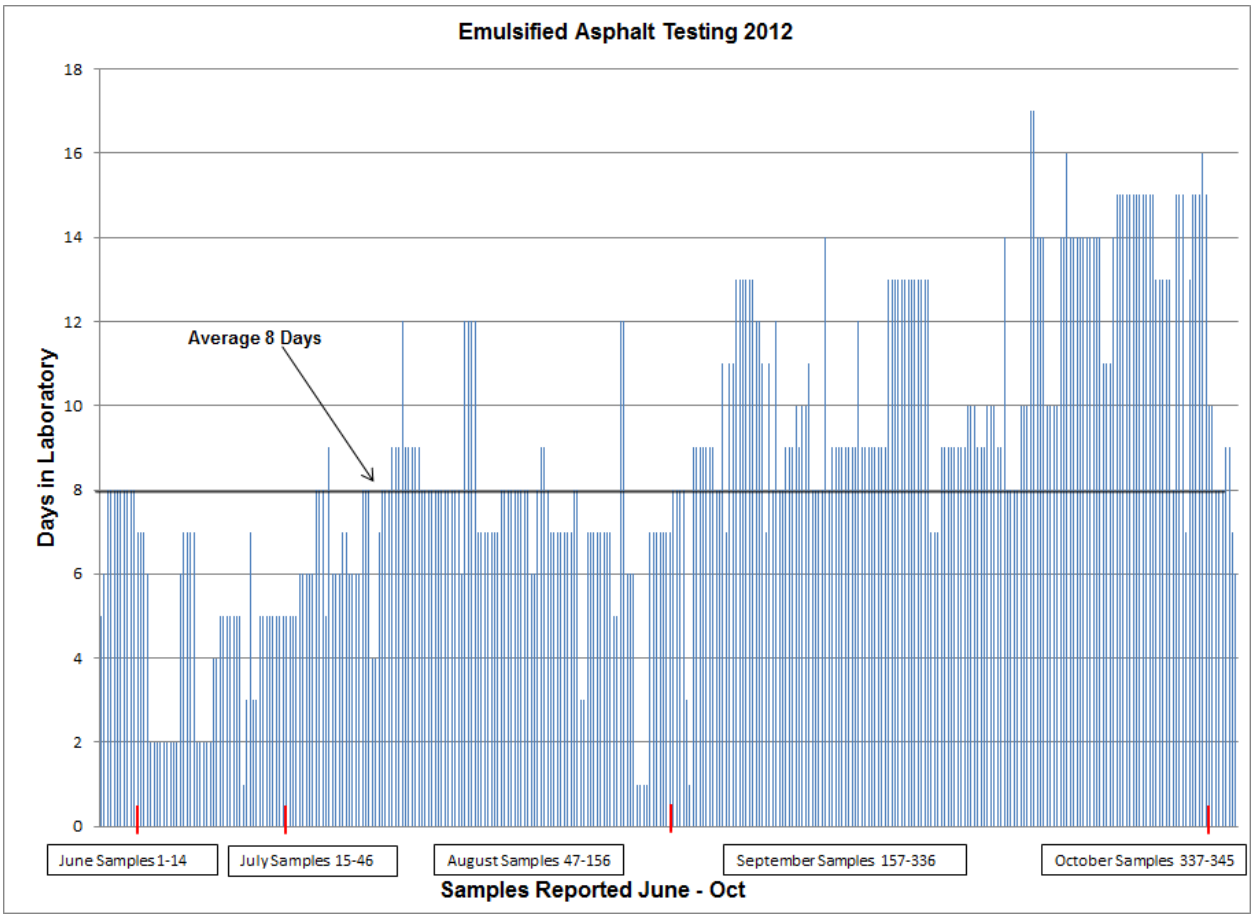
Due to the large volume of samples received during the construction season, the Liquid Asphalt Laboratory does not test all samples. For PG samples, the first, third, fifth and every fifth sample thereafter are tested per contract, per supplier. If a sample does not meet specification, previous and subsequent samples are tested until the window of failure is captured. This policy brackets any failing samples, indicating the extent of the failure.

The Bituminous Materials Section goal for Performance Graded Asphalt Binders is to have all samples tested and logged out within 30 days. Due to different testing temperatures used with different grades of PG binders, additional samples outside the normal testing protocol may need to be tested in order to achieve the 30 day goal.

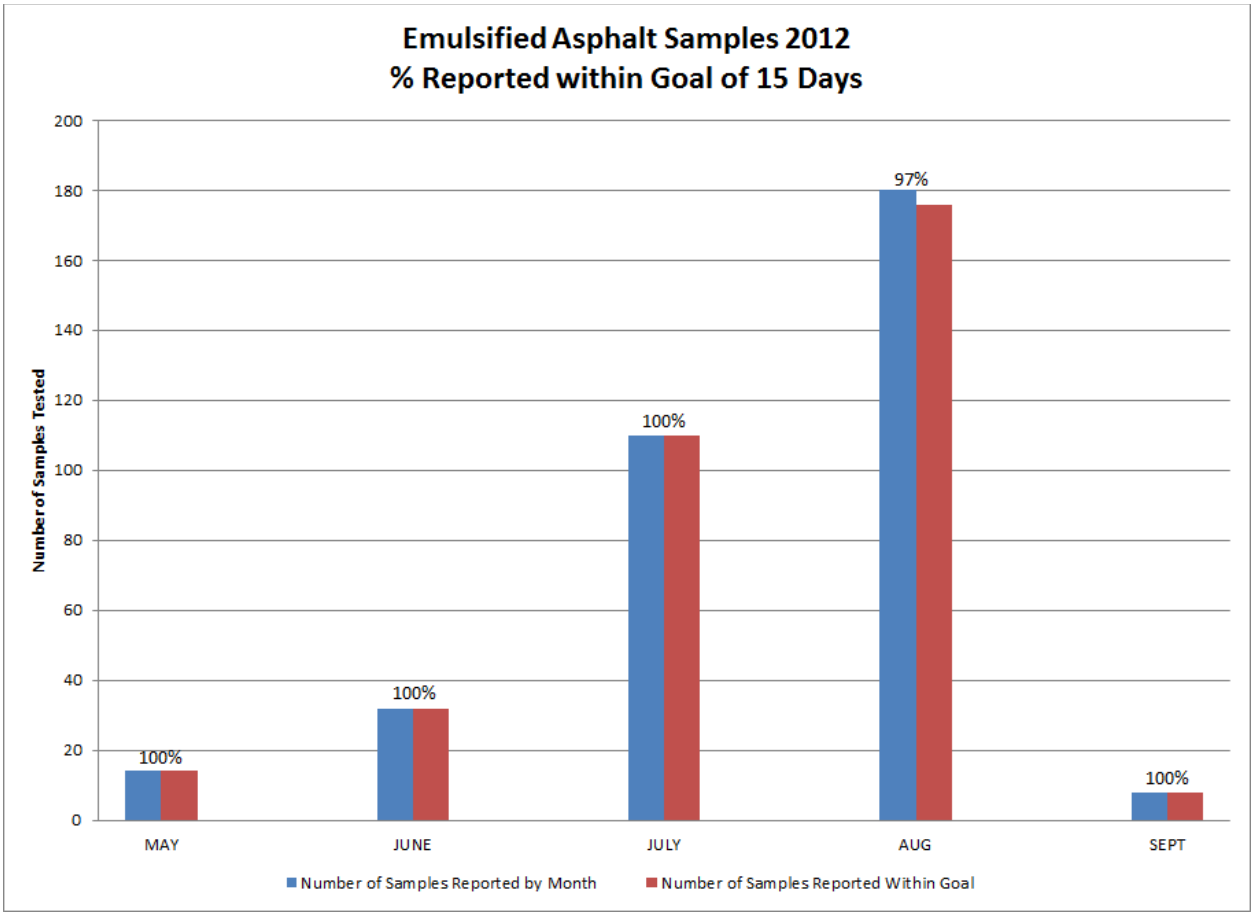


Asphalt Emulsion Testing 2012

As stated in the Construction Manual section 9-4.2, Emulsified Asphalt samples must be approved prior to use. Materials must be approved by the Qualified Product List or Request for Approval of Material (RAM). Samples for verification conformance will be taken based on the frequencies stated in section 9-3.7 (Acceptance Sampling and Testing Frequency Guide). Emulsified asphalt shall be sampled from every other shipment to the project. The first emulsified asphalt sample taken for each day of production, per contract, receives a complete battery of tests per Standard Specification 9-02.1(6) and 9-02.1(6)A. All other samples taken that day will be tested for viscosity only. The chart indicates the days in the Materials Laboratory for all emulsion samples tested in 2012.



The Bituminous Materials Section goal for Emulsified asphalt is to have all samples tested and logged out within 15 days. To achieve this goal the Liquid Asphalt Laboratory may utilize overtime to ensure that testing is completed within a timely manner.



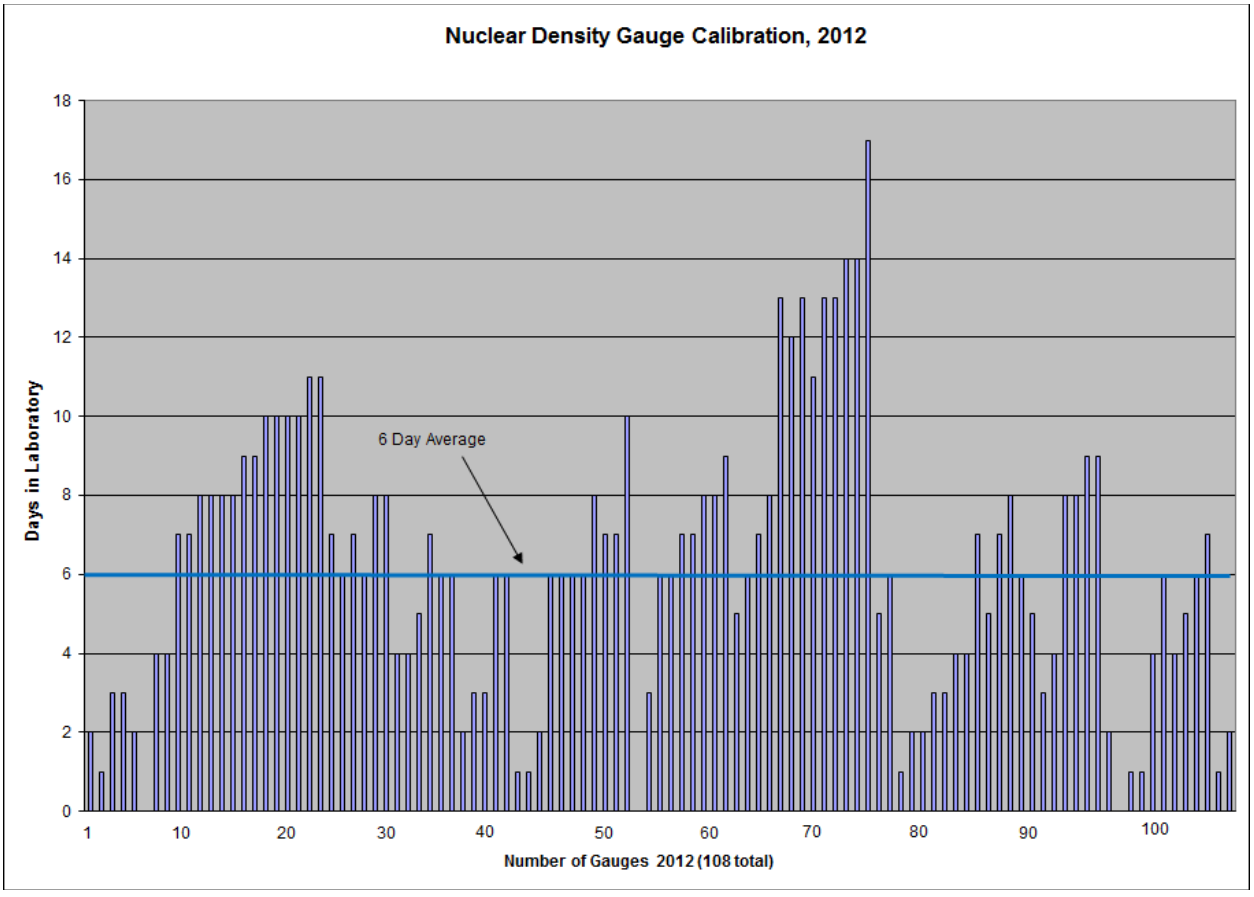
In 2012 the performance goals for Emulsified Asphalt samples were met on 98.8% of samples received. 340 out of 344 samples were reported within 15 calendar days.

Nuclear Density Gauge Maintenance and Calibration 2012

The Bituminous Materials Section, Nuclear Electronics Laboratory, performs the annual maintenance, calibration and repair of all nuclear density gauges owned by WSDOT. Technicians with specialized training in diagnostic repair and service keep the department's one hundred and eight nuclear density gauges operating efficiently for use in acceptance of base, intermediate and surface materials. This performance measure is designed to evaluate the timely completion of the annual maintenance and calibration of WSDOT's nuclear density gauges and monitor annual efficiency.

The gauge calibration process begins with the disassembly, cleaning, lubricating, and reassembly of the density gauge. Parts that are unserviceable are replaced. The source rod is inspected under a microscope to ensure there are no unsafe wear or cracks in the weld. The battery system and charging circuits are tested for proper functionality. All radiation detection systems are tested for proper electrical current and adjusted if needed. The calibration is performed by taking data at all measuring depths on standardized, NIST Traceable blocks, each of solid Magnesium, combination Magnesium/Aluminum, and solid Aluminum. A fourth standard block of combination Magnesium/Polyethylene is used to calibrate the moisture detection system in each gauge. The calibration adjusts to compensate for aging, repair and/or replacement of the electronic systems, or replacement of the detectors.

It takes approximately three months to complete the maintenance and calibration of all the gauges so this work is scheduled in the winter months when most density gauges are not in use on construction projects. The average turnaround for gauges in 2012 was 6 days. Repairs to the density gauges are performed throughout the year as needed. Performing maintenance, calibration and repair by trained WSDOT staff results in considerable time and cost savings to the department. Shipping, calibration, maintenance and repair costs would be significantly higher if this work was outsourced. The turnaround time of outsourcing this work would also impact the time sensitive testing on construction projects.



Hot Mix Asphalt Mix Design Conformation Samples 2012

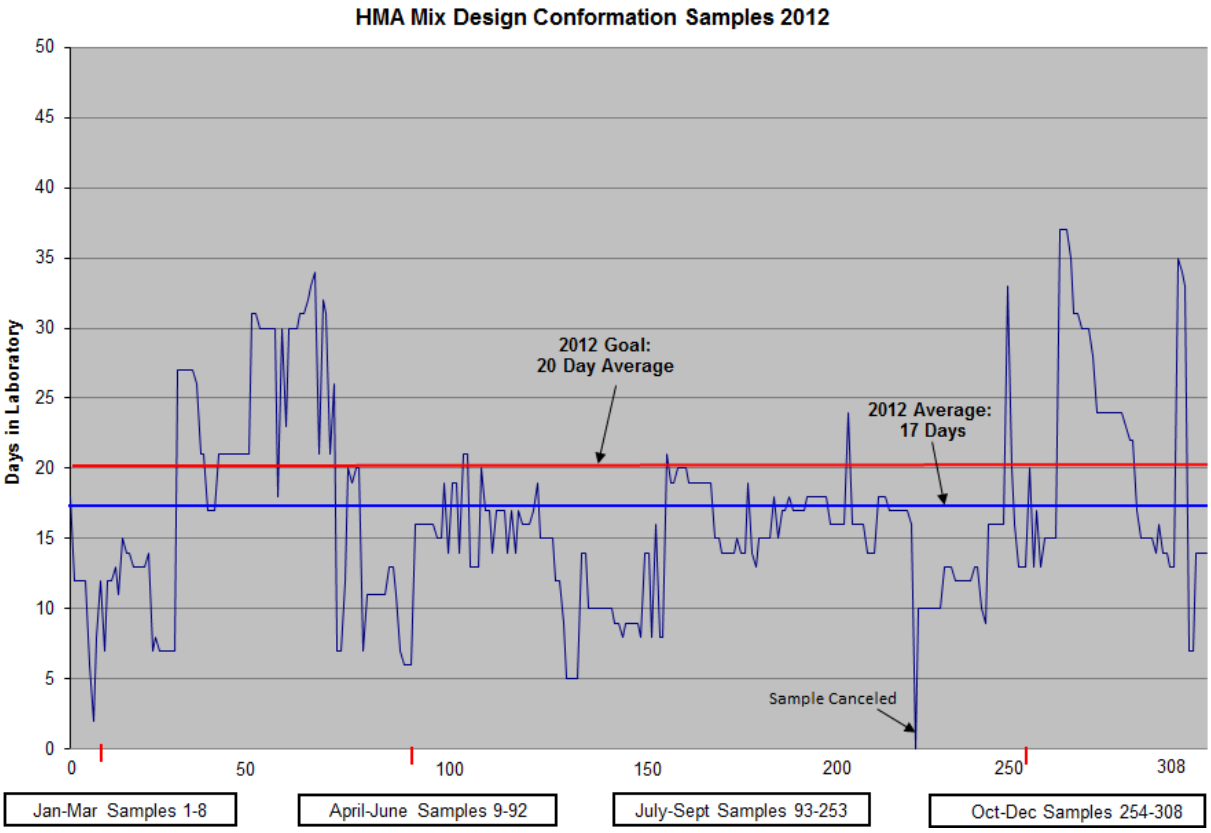
HMA mix design conformation samples are actual split samples taken during production and tested for comparison to original mix design properties including the Hamburg Wheel-Tracking test. For all projects, conformation samples are taken one per day from the first five days of production for each contract and one sample every fifth day of production thereafter. This production data can also be used to determine if a mix design is acceptable for use on additional paving projects. The Bituminous Materials Section occasionally tests challenge samples and/or assists in the troubleshooting of problematic HMA issues outside the normal conformation sample testing schedule.

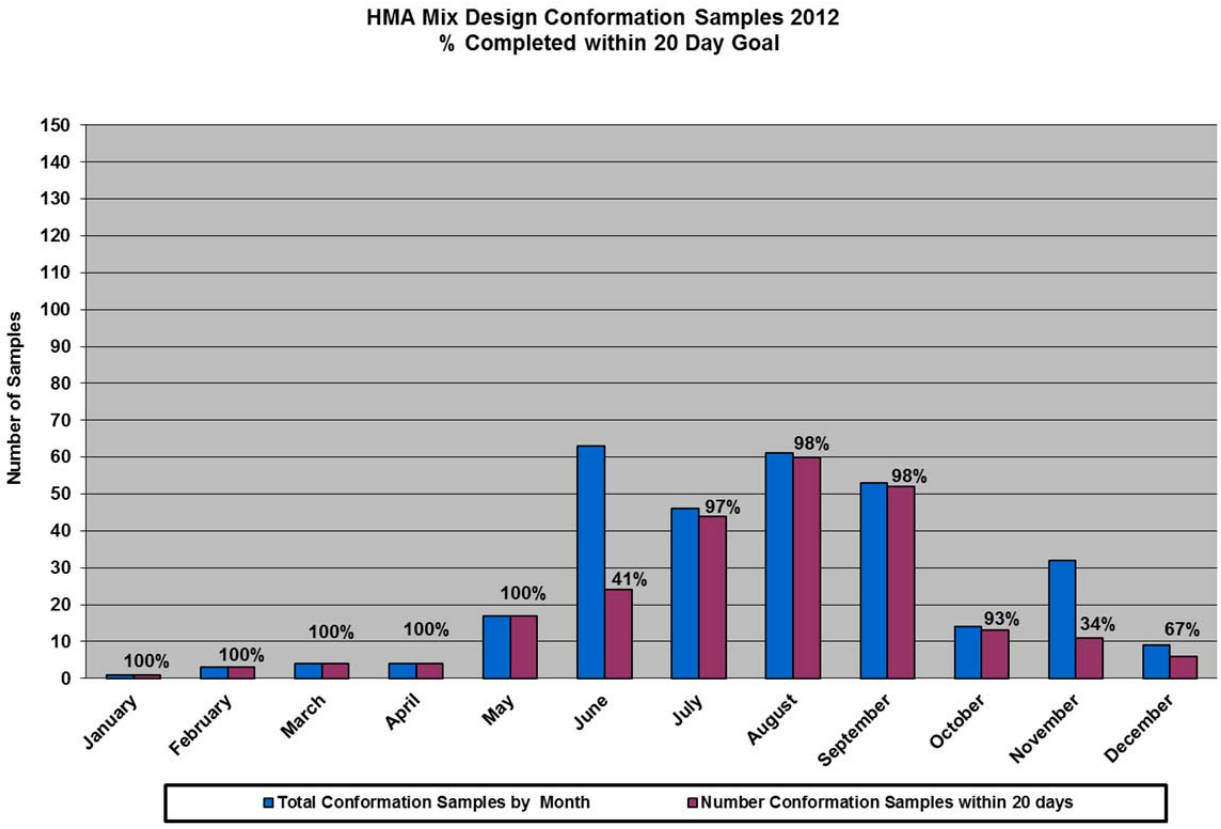
The basis for this Performance Measure is measured by the number of days from when the sample was received at the Headquarters Materials Laboratory until it is tested and logged out by the Bituminous Materials Section.
Based on past performance measures, the Bituminous Materials Section set a goal for mix design conformation samples to be completed within an average of 20 calendar days. Currently Hamburg Wheel-Tracking test results are not included in this measurement.

Factors that can affect a timely completion schedule:

- Workload in the Bituminous Materials Section
- FTE's
- Equipment and space
- Overtime authorization
- Project Engineer delays

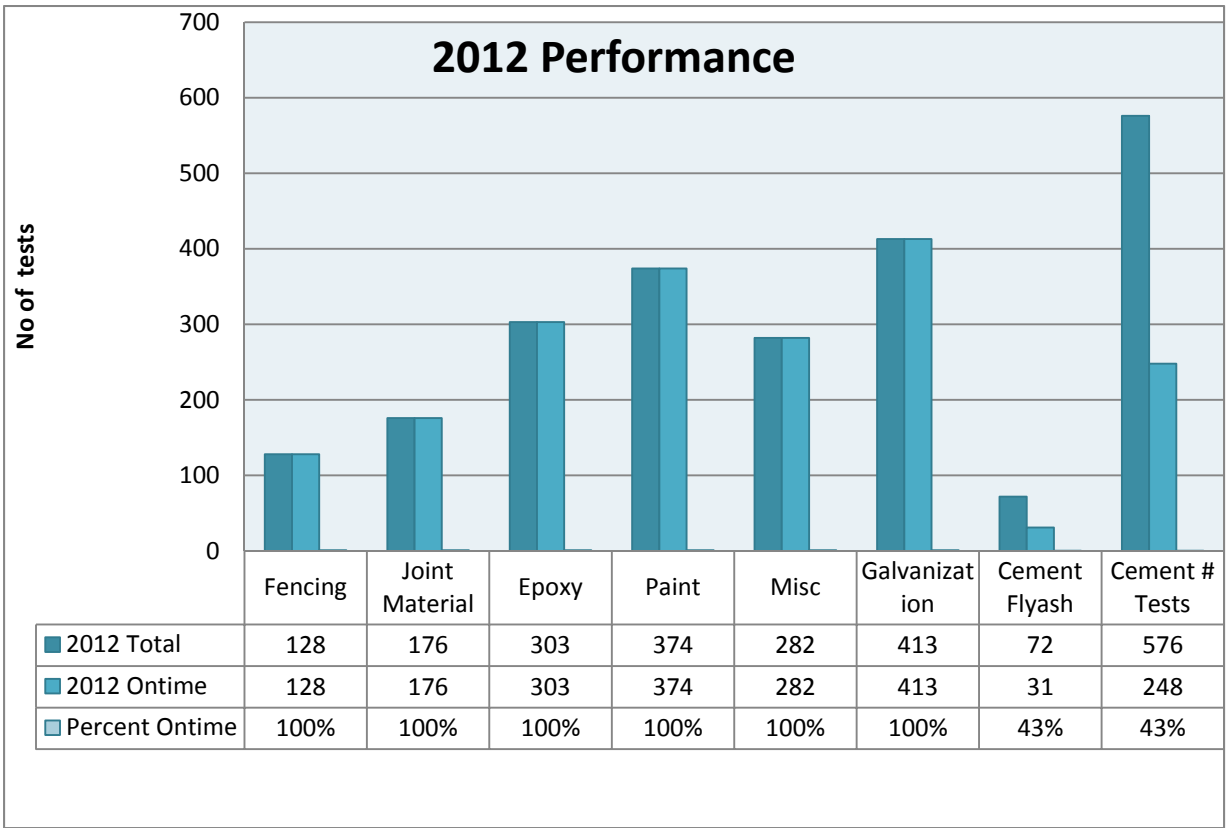
In 2012, the Bituminous Materials Section tested 308 HMA mix design conformation samples. The average time of completion for these samples was 17 calendar days. This average is higher than the 2011 average of 14 calendar days. An increase in Hamburg mix design research testing, insufficient transmittal information, Lottman compression machine repair and early 2013 mix design work are contributing factors to the rise in average calendar days.


HMA Mix Design Conformation Samples 2012
Days in Laboratory
50
45
40
35
30
25
20
15
10
5
0
2012 Goal:
20 Day Average
2012 Average:
17 Days
Sample Canceled
0
50
100
150
200
250
308
Jan-Mar Samples 1-8
April-June Samples 9-92
July-Sept Samples 93-253
Oct-Dec Samples 254-308

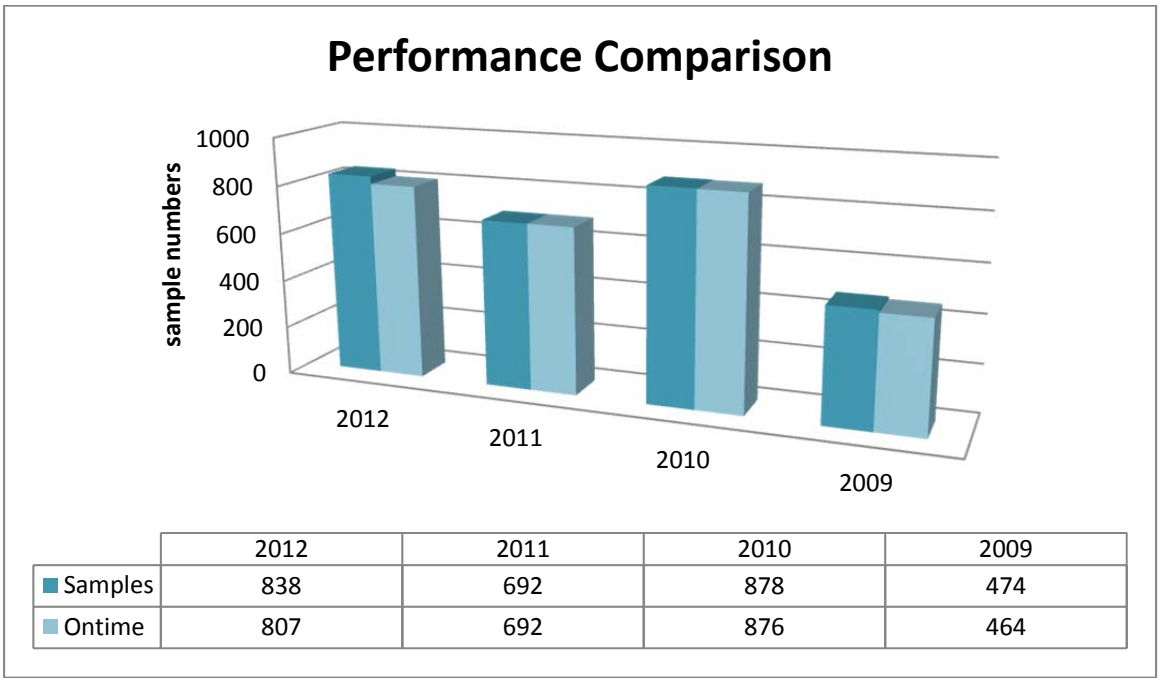

HMA Mix Design Conformation Samples 2012
% Completed within 20 Day Goal
Number of Samples
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
100%
100%
100%
100%
100%
41%
97%
98%
98%
93%
34%
67%
January
February
March
April
May
June
July
August
September
October
November
December
Total Conformation Samples by Month
Number Conformation Samples within 20 days

Chemistry Section

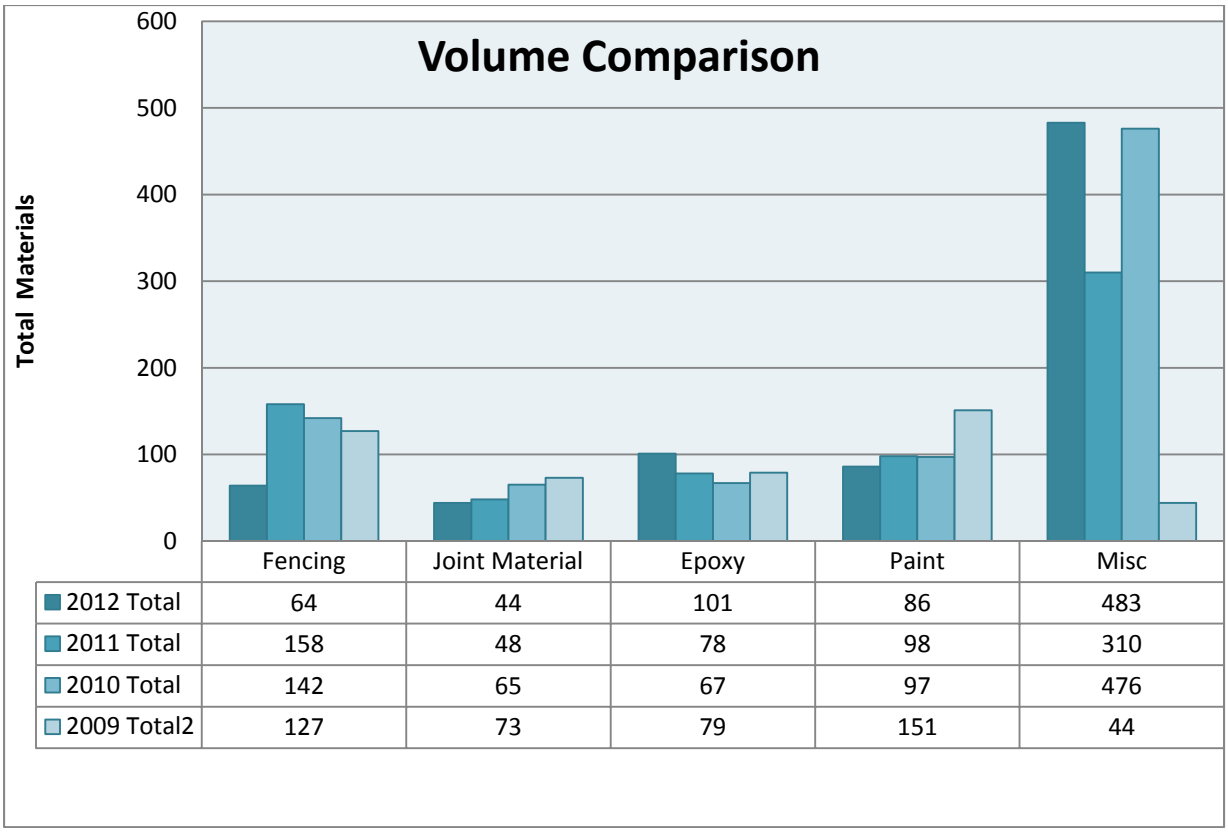
- Fencing materials met the completion time for 64 samples, 128 tests
- Joint materials met the completion time for 44 samples, 176 tests
- Epoxy Adhesives met the completion time for 101 samples, 303 tests
- Paint materials met the completion time for 86 samples, 374 tests
- Miscellaneous materials met the completion time for 58 samples, 282 tests
- Galvanization studies met the completion time for 413 samples
- Cement/Fly ash samples met 43% completion for 72 samples, 576 tests



	Fencing	Joint Material	Epoxy	Paint	Misc	Galvanization	Cement Flyash	Cement # Tests
2012 Total	128	176	303	374	282	413	72	576
2012 Ontime	128	176	303	374	282	413	31	248
Percent Ontime	100%	100%	100%	100%	100%	100%	43%	43%



	2012	2011	2010	2009
Samples	838	692	878	474
Ontime	807	692	876	464



	Fencing	Joint Material	Epoxy	Paint	Misc
2012 Total	64	44	101	86	483
2011 Total	158	48	78	98	310
2010 Total	142	65	67	97	476
2009 Total2	127	73	79	151	44

Electrical Section

The attached stack bar chart titled “Performance Measures 2012” represents the amount of time used for each of the traffic controller assemblies tested at the State Materials Lab from September 30, 2011 to October 1, 2012. The length of the bar represents the total time the controller assembly was resident at the lab for testing. The bar is divided into two sections: the upper section represents the amount of time used by the lab to complete the evaluation of the controller assembly: the bottom section represents the amount of time spent waiting for the vendor to correct problems discovered during the evaluation.

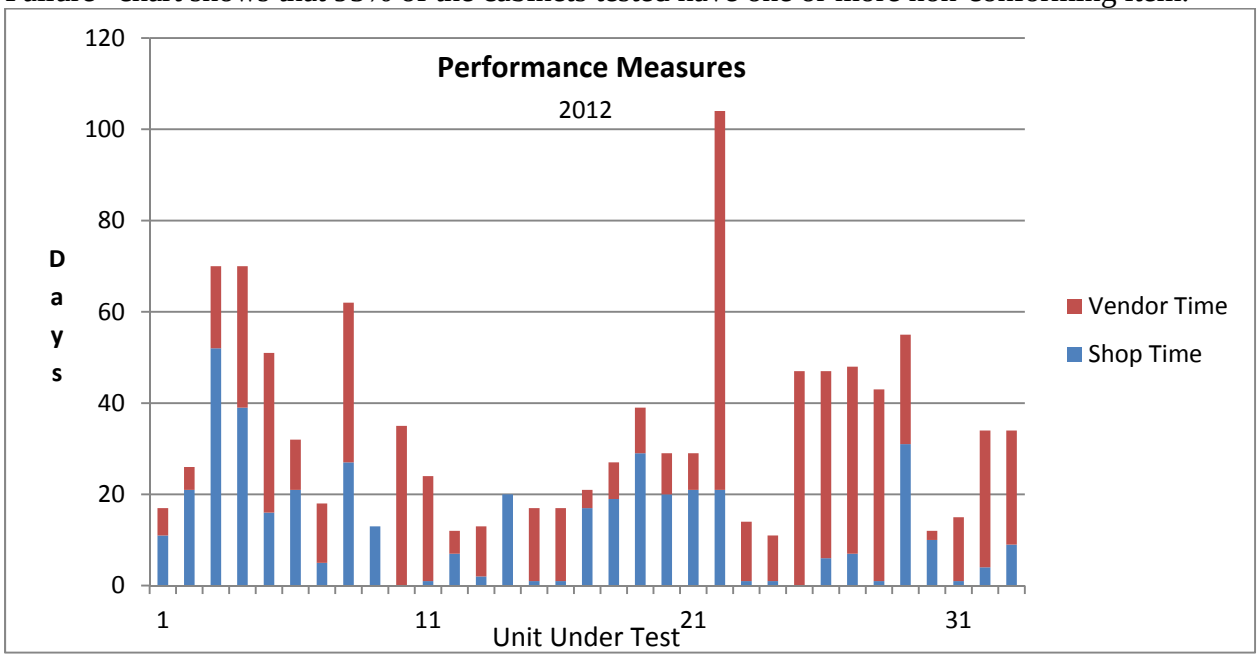
The average number of days required to complete the evaluation of a traffic controller assembly for the period of September 30, 2011 and October 1, 2012 was 34 days, compared to 41 from the previous reporting period. During the same reporting period the average Vendor Delay increased from an average of 12 days to an average of 20 days while the average Test Time was 13 days. Presented in the following table are the statistics of each of the distributions: Total Time, Vendor Delay, and Test Time, for 2010, 2011 and 2012.

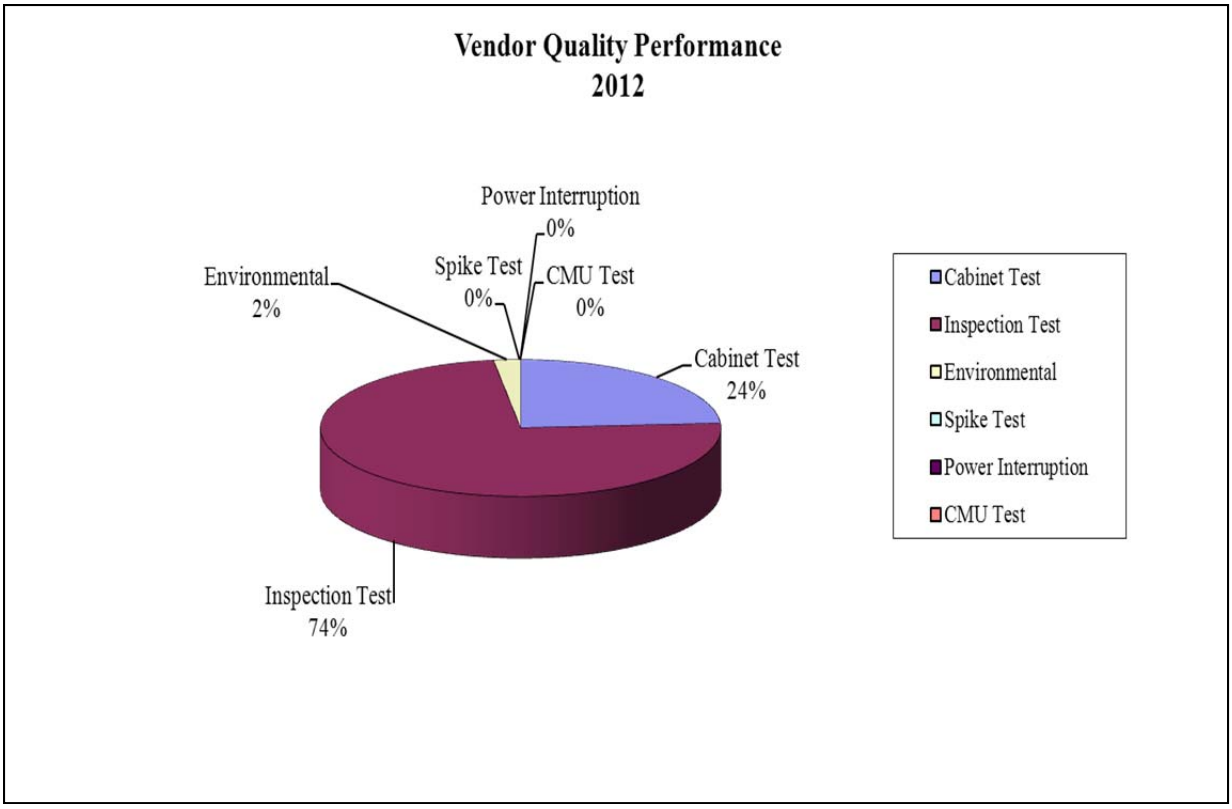
Year	2010			2011			2012		
Days	Total Time	Vendor Delay	Test Time	Total Time	Vendor Delay	Test Time	Total Time	Vendor Delay	Test Time
Average	43	37	6	41	12	30	34	20	13
Max	195	195	27	126	94	126	104	104	52
STD	36	36	8	26	22	20	21	21	12

In an analysis of the data used in the chart the average total time went from 41 days shown for year 2011 to 34 for 2012. The apparent decrease in average total time can be attributed to backlog experienced in year 2011. The apparent decreased test time is explained by the reduced volume of controller cabinets tested in 2011. The goal of not letting the total time for testing exceed 29 days was not achieved.

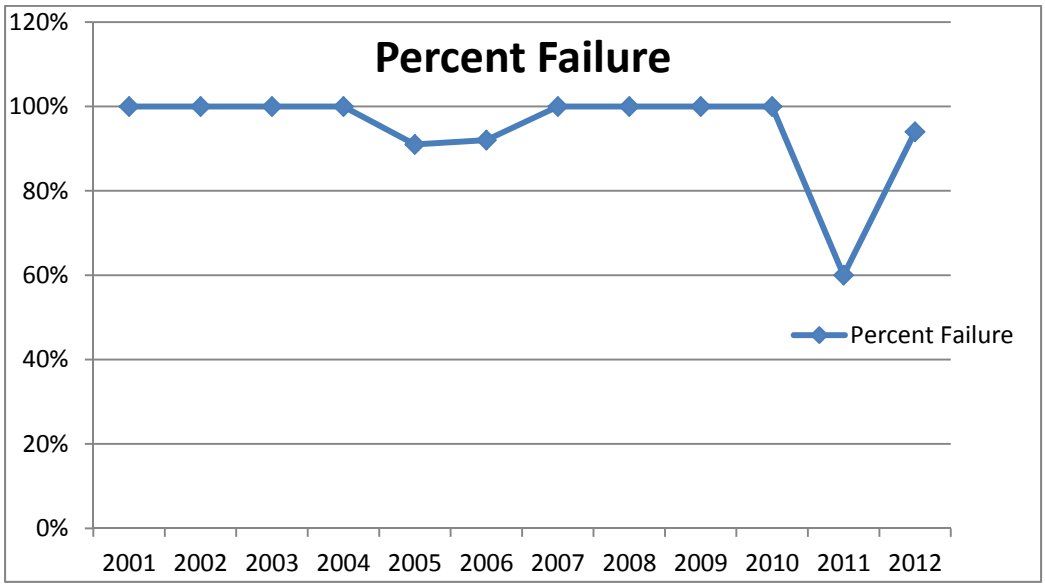
During the reporting period of September 30, 2011 to October 1, 2012 a total of 33 traffic controller cabinet assemblies were tested. There was a total of 138 nonconforming items identified while testing the 33 cabinets. 94% of the 33 cabinets tested had at least one non-conforming item. The chart titled "Vendor Quality Performance" shows the distribution of the nonconforming items with respect to the test that identified the nonconforming item. This chart is included to provide information on the continued tracking of nonconforming items seen during traffic controller assembly testing. The most interesting feature about the chart is that more than 98% of the identified nonconforming items continue to be found with a simple inspection and wiring test.

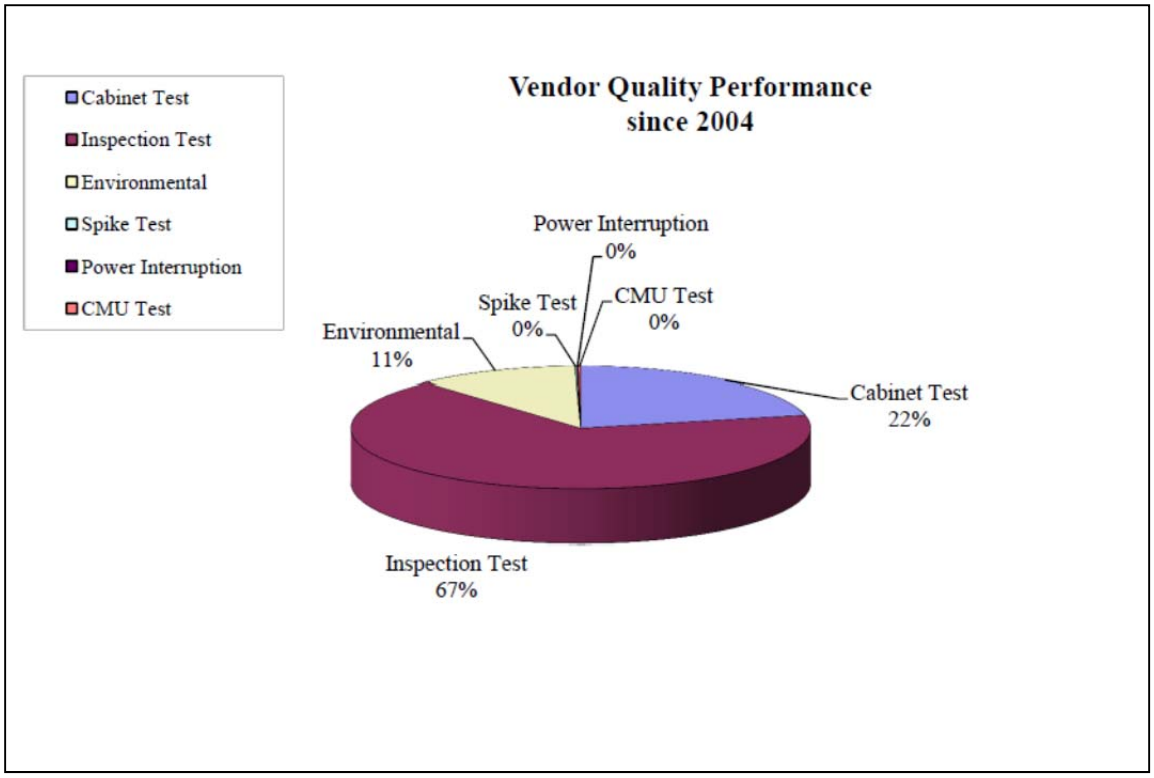
The charts labeled "Vendor Quality Performance since 2004" and "Percent Failure" represent a summary of testing data collected since year 2000. The information provided in the "Percent Failure" chart shows that 95% of the cabinets tested have one or more non-conforming item.





Year	Cabinet Test	Inspection Test	Environmental	Spike Test	Power Interruption	CMU Test
2004	22	96	16	2	1	2
2005	30	110	35	0	0	0
2006	50	116	42	0	0	0
2007	45	143	23	0	0	0
2008	81	204	21	0	0	0
2009	48	96	30	0	1	1
2010	30	127	12	0	0	0
2011	28	143	10	0	0	0
2012	33	102	3	0	0	0
	367	1137	192	2	2	3
	21.55%	66.76%	11.27%	0.12%	0.12%	0.18%


Percent Failure
120%
100%
80%
60%
40%
20%
0%
2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012
Percent Failure


Cabinet Test
Inspection Test
Environmental
Spike Test
Power Interruption
CMU Test
Vendor Quality Performance since 2004
Power Interruption 0%
Spike Test 0%
CMU Test 0%
Environmental 11%
Cabinet Test 22%
Inspection Test 67%

Year	Total Count	Total Fail	% Fail
2001	65	65	100%
2002	29	29	100%
2003	43	43	100%
2004	25	25	100%
2005	58	53	91%
2006	63	58	92%
2007	49	49	100%
2008	71	71	100%
2009	43	43	100%
2010	34	34	100%
2011	104	62	60%
2012	33	31	94%
	Grand Average		95%

Construction Materials

Materials Quality Section

Record of Materials

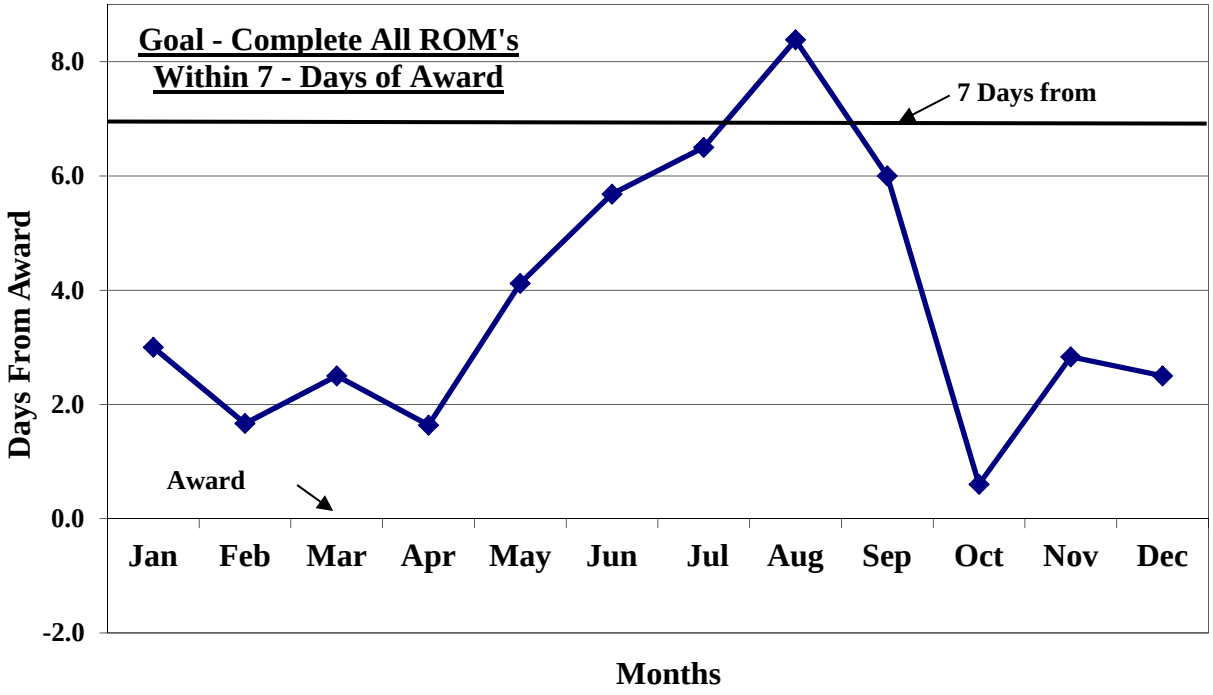
A Record of Materials (ROM) is prepared by the State Materials Laboratory Materials Quality Assurance Section for every WSDOT construction contract and many local agency construction contracts. The ROM report is a list of all major construction items intended for use on each specific contract, taking into account the contract which includes Contract Provisions, Contract Plans, Standard Specifications, Construction Manual, Standard Plans and the quantities of those materials deemed to require acceptance testing. It further identifies the minimum number of acceptance and verification samples required for acceptance of those materials, with reference to total quantities and respective specification criteria. Also listed are products requiring other actions, such as fabrication inspection, manufacturer's certificate of compliance, shop drawings or catalog cuts that may need to be performed or acquired prior to installation of each material in the field.

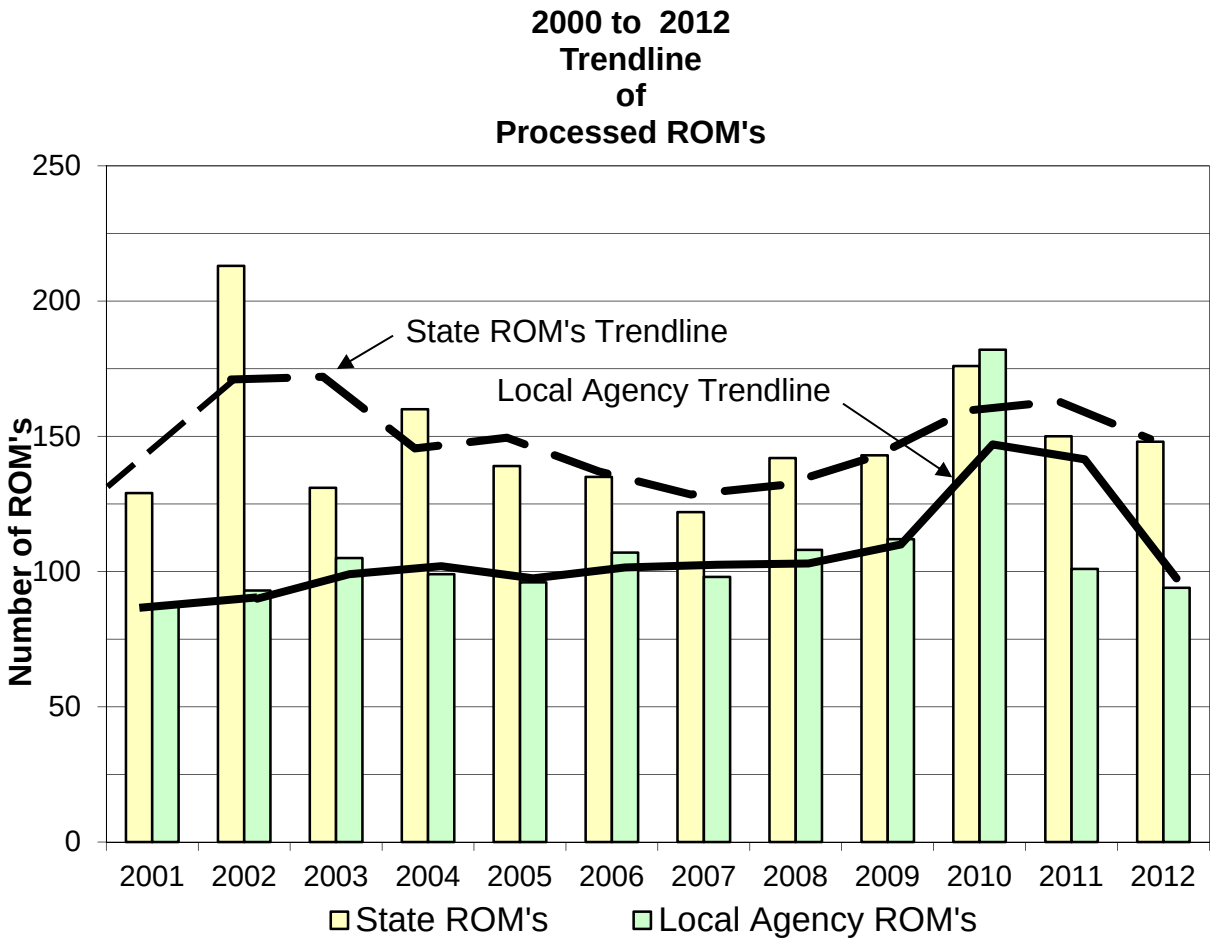
The ROM is processed by the State Materials Laboratory Materials Quality Assurance Section and forwarded electronically to every Project Office or appropriate Local Agency. The office administering the construction project can then provide this information to the Contractor and/or use it themselves to determine appropriate testing frequencies and acceptance criteria for each material or product used on the project.

The State Materials Laboratory Materials Quality Assurance Section's goal is to complete the ROM within seven days after the contract is awarded. The performance goal was developed based on feedback from regional personnel and the necessity to wait as long as possible to allow for incorporating any last minute addendum that may apply to the contract.

Record of Materials - 2012

Average Number of Days from Award for State Contacts





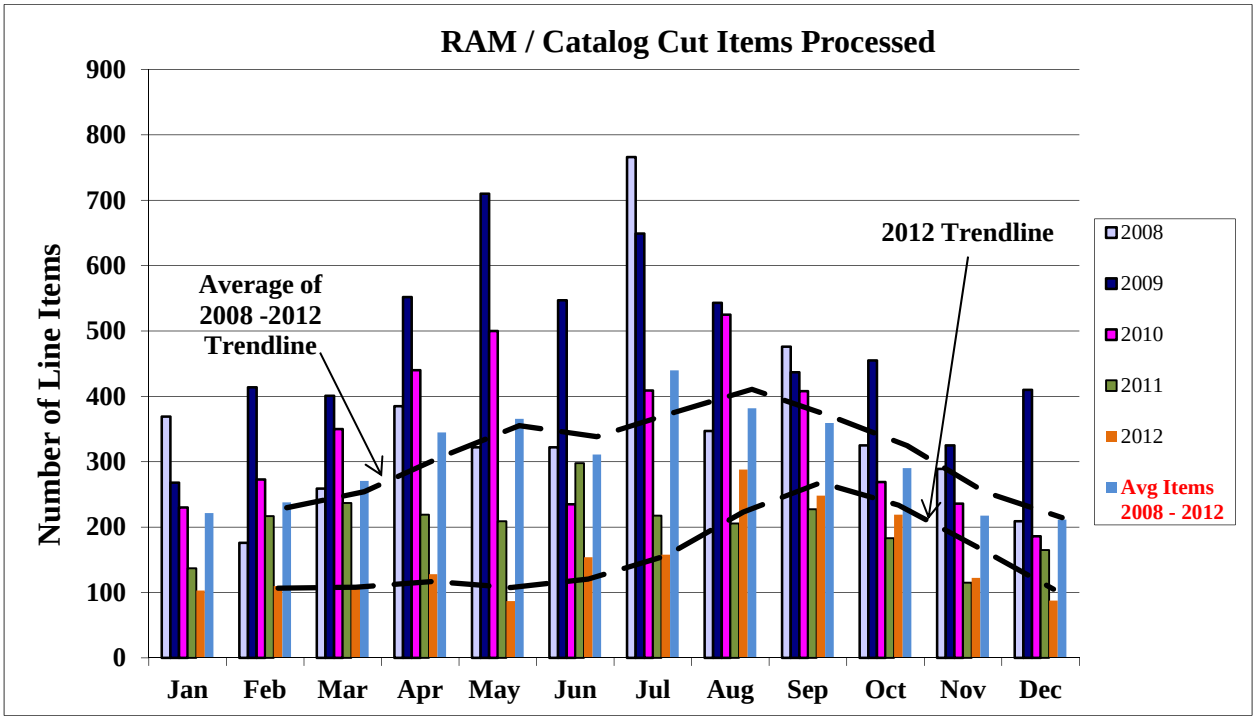
Request for Approval of Material and Catalog Cut

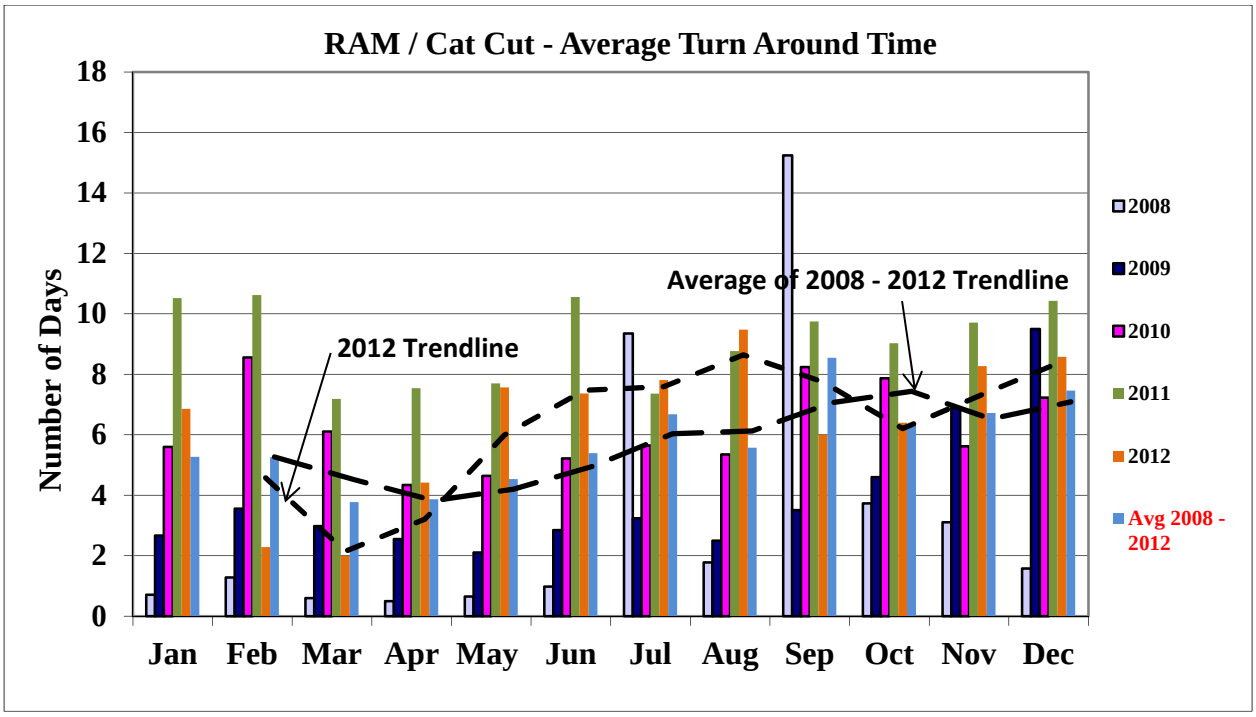
A Request for Approval of Material (RAM) is prepared by the Contractor and submitted to the PEO (Project Engineer's Office) for each product or material anticipated for use on a construction project. The purpose of a RAM is to approve a product or material prior to it being placed on a construction project. Depending on what is known about the product or material, testing may be done to determine if the product or material meets the requirements of the contract. In certain instances additional information is needed to review a product or material for approval. The review of Catalog Cuts is a method of verifying, for approval, products within the RAM process.

The RAM or Catalog Cut is processed by the PEO and forwarded to the State Materials Laboratory Materials Quality Assurance Section when the Project Office has insufficient information to approve the product or material. An alternate to submitting a RAM could be choosing a product or material already evaluated and approved via the QPL (Qualified Products List) process.

The State Materials Laboratory Materials Quality Assurance Section's Goal is to complete all RAMs and Catalog Cuts in the timeliest manner possible. Prior to approving a material or product on a RAM and Catalog Cut, the RAM Engineer will often need to consult with various Subject Matter Experts (SMEs) within WSDOT. The RAM Engineer is dependent on a multitude of SMEs to gain concurrence to approve the product or material submitted on a RAM or Catalog Cut. The most frequent engineering disciplines utilized are Hydraulics, Bridge & Structures, Environmental and the State Materials Laboratory experts such as Chemical, Physical Testing, Geotechnical, Electrical and Bituminous Materials. RAMs that must be sent to WSDOT's SMEs take longer to process.

The data has shown that the greatest impact in recent years to the RAM process was through training and in 2010 when the Construction Manual was modified to allow the Project Engineer Offices the ability to process more RAMs at the office level. Delegating approval of some RAMs has reduced the amount of RAMs submitted to the State Materials Laboratory, but has caused a longer period of time to process due to the increase in complexity of the material being submitted.

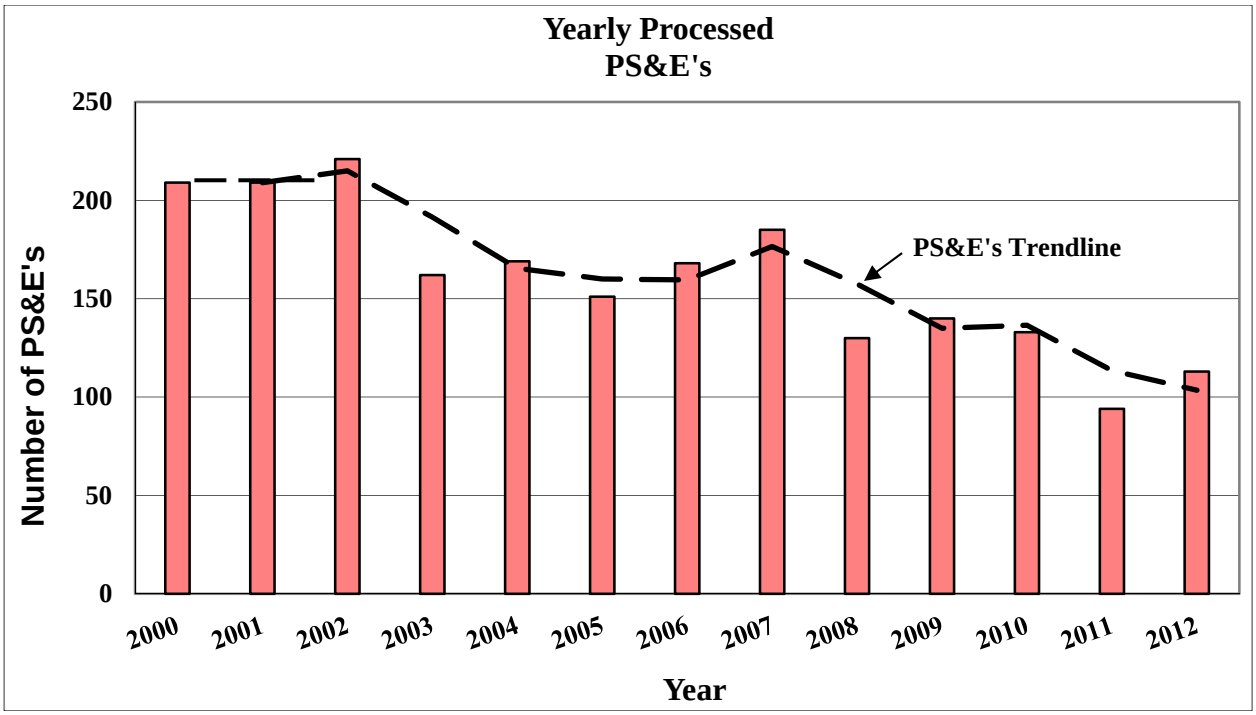




Plans, Specification & Estimate Review

Plans, Specifications & Estimates (PS&E) are the preliminary draft form of a construction Ad & Award contract. The State Materials Laboratory Materials Quality Assurance Section reviews all PS&E copies and determines what Subject Matter Expert in the Laboratory will need to perform a review. The comments from the Subject Matter Experts are gathered and returned to the designer so that the Ad & Award can be completed. There are 'Standard' PS&E and 'Bridge' PS&E that are required to be reviewed.

The State Materials Laboratory Materials Quality Assurance Section's Goal is to distribute and assist the Subject Matter Experts in the State Materials Laboratory to expedite the review in a timely manner. A thorough review and making changes at the PS&E phase will ultimately reduce the needs for changes during the construction phase of the Ad & Award and save engineering costs in the Project Engineer Office.

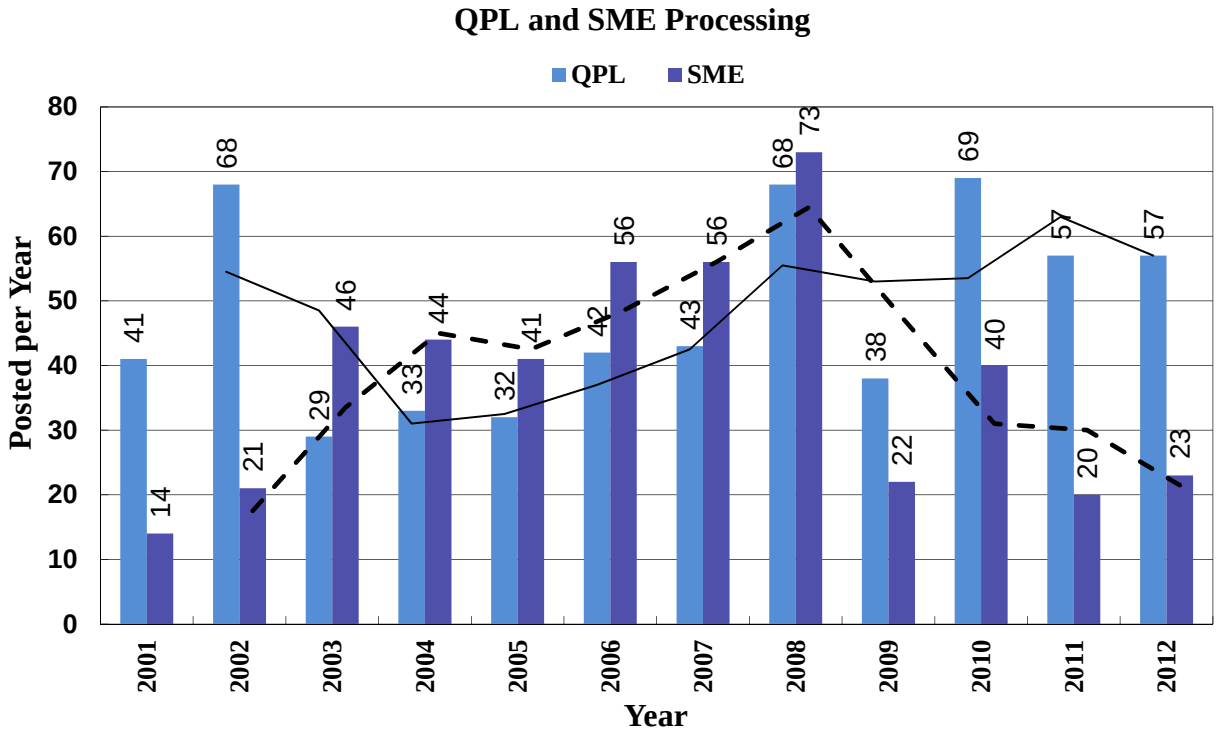


Qualified Products List

The Qualified Products List (QPL) is a list of approved products, materials and systems identified by the Washington State Department of Transportation (WSDOT) Standard Specifications, General Special Provisions, Bridge Special Provisions and Standard Plan compiled by the State Materials Laboratory Materials Quality Assurance Section.

There are two ways that products can be reviewed and approved for inclusion in the QPL. The product manufacturer can contact WSDOT and request that the product be reviewed, or the Subject Matter Expert can recommend a product be included in the QPL after seeing a history of the product conforming to WSDOT standards.
The State Materials Laboratory Materials Quality Assurance Section's Goal is to make a tool available to Contractors and PEOs to assist in the planning and execution of WSDOT, County or Municipal road and highway construction projects. This is facilitated by providing products, materials and systems that have previous approval, which in turn saves both manpower and time.

The most current QPL is accessed at the web address that has been used in the past. That website address is http://www.wsdot.wa.gov/biz/mats/QPL/QPL.cfm.



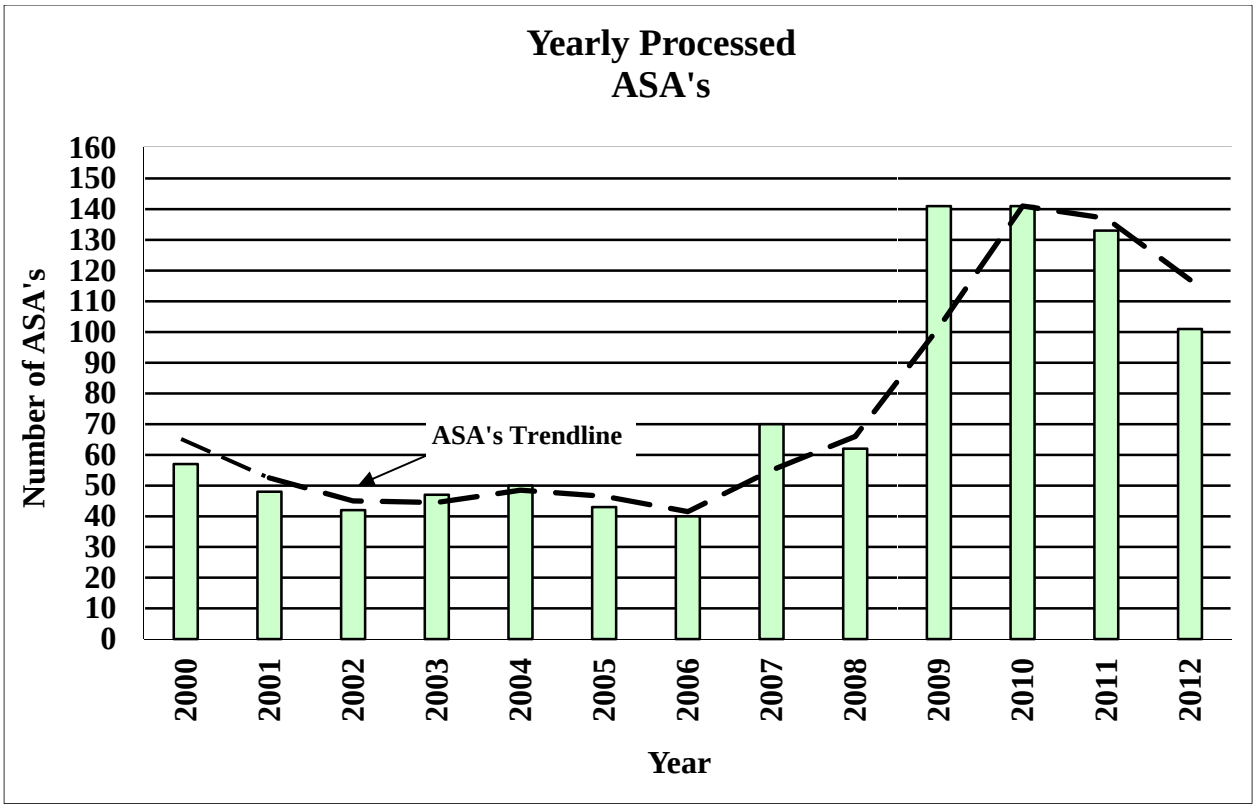
Aggregate Source Approval

The Aggregate Source Approval (ASA) Program is a computer-based program that is used statewide by Contractors, Aggregate Source Owners, Lessees, DNR, Tribes, Local Agencies, WSDOT Regional and Project Personnel. The ASA program determines the approval status of aggregate sources submitted for evaluation for potential use on transportation construction projects.

The sampling of aggregate material sources for evaluation is critically important in the direct support of the highway and local municipality construction programs.

The Aggregate Sources Approval (ASA) application stores the details of Aggregate Sources historically used by contracts in Washington State. The ASA application is designed to allow the user to query the database for only the source or sources that meet the search criteria and also allows examination of each in greater detail.

The State Materials Laboratory Materials Quality Assurance Section Goal is to be proactive and maintain a reliable database of approved aggregate sources that both governmental and private sector entities have access to for potential use on transportation construction projects.



Compliance Reviews

As part of the WSDOT's Stewardship Agreement with the FHWA, the WSDOT is required to review contract compliance in the materials documentation area, these compliance reviews are a "spot check", verifying compliance with WSDOT's materials documentation requirements. The State Materials Laboratory Materials Quality Assurance Section has been tasked with conducting Compliance Reviews and acting as unbiased auditors verifying contracts meet materials documentation requirements.

The requirements are covered in the WSDOT Construction Manual 9-1.2F(2)IV, State Materials Laboratory - Compliance Review for Materials Certification Process. A Compliance Review is performed on at least one contract for each project office once every two years. The reason Compliance Reviews are performed is to review previous materials documentation, assist Project Offices in maintaining adequate materials acceptance practices for future contracts, and to be proactive in initiating possible changes to the Construction Manual and Standard Specifications.

The Compliance Review findings are discussed with Project Office personnel during the wrap-up meeting after the review. A final letter covering the compliance review findings is then prepared and shared with WSDOT and the FHWA to document the Compliance Review findings.

Tracking and Charting Compliance Reviews

Each item reviewed during the Compliance Review is evaluated, tracked, and charted in the following areas.

Field Verification

Was the material verified in the field by the inspector for what material was approved to be used by the RAM/QPL and proper acceptance criteria?

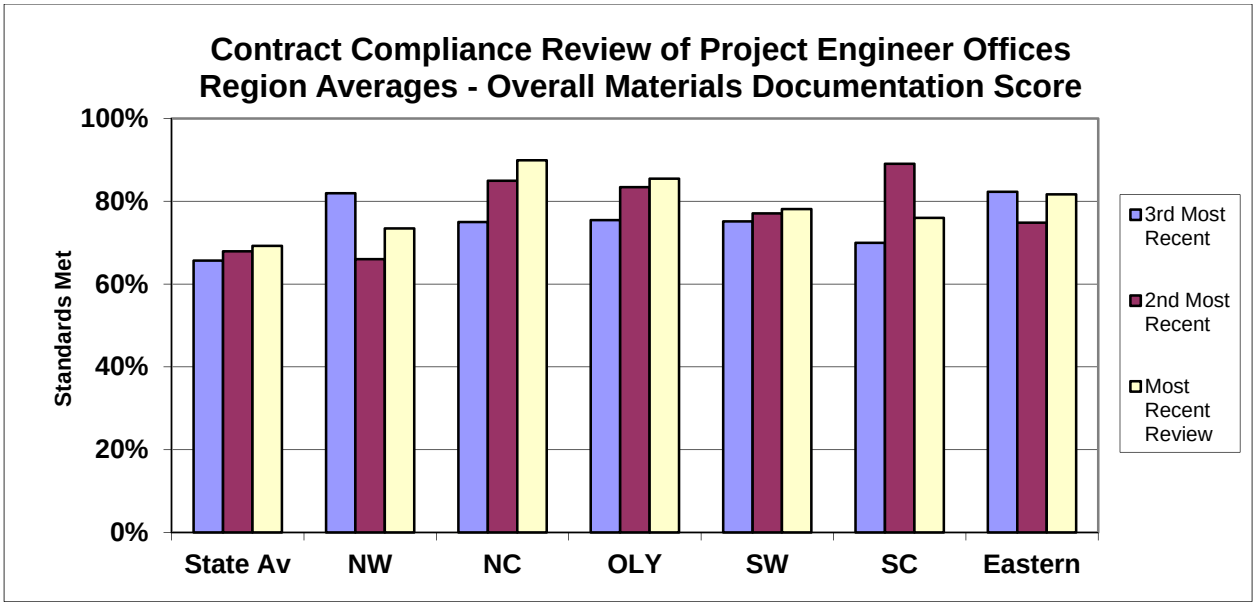
Office Materials Documentation Score

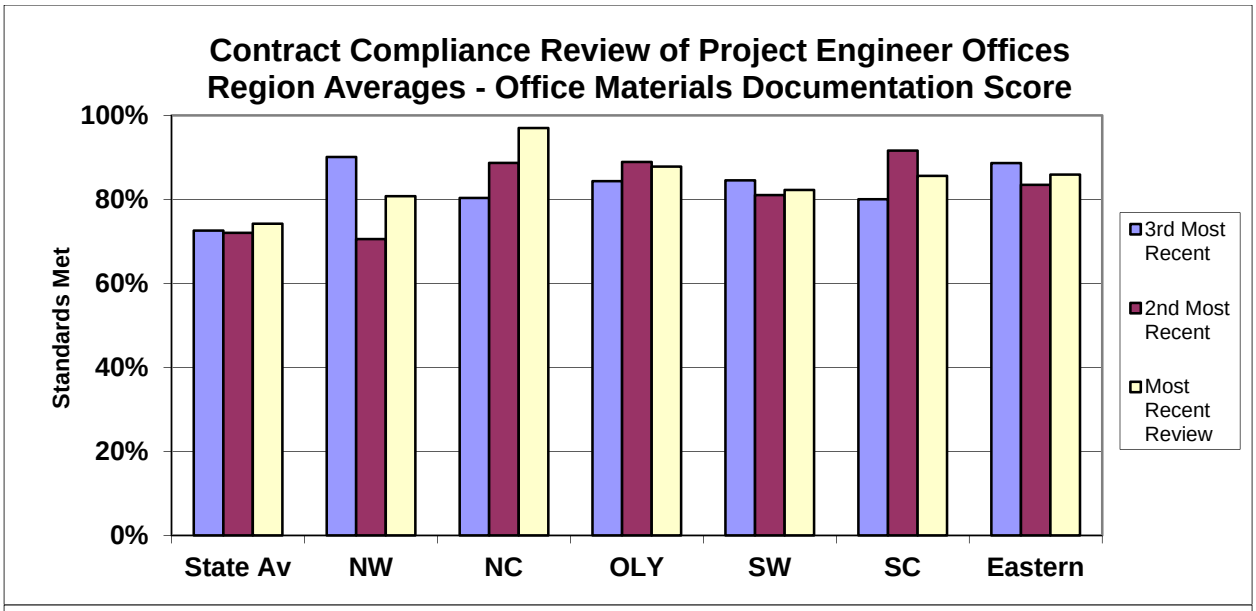
Each criterion mentioned below counts 25% of the Office Materials Documentation Score.

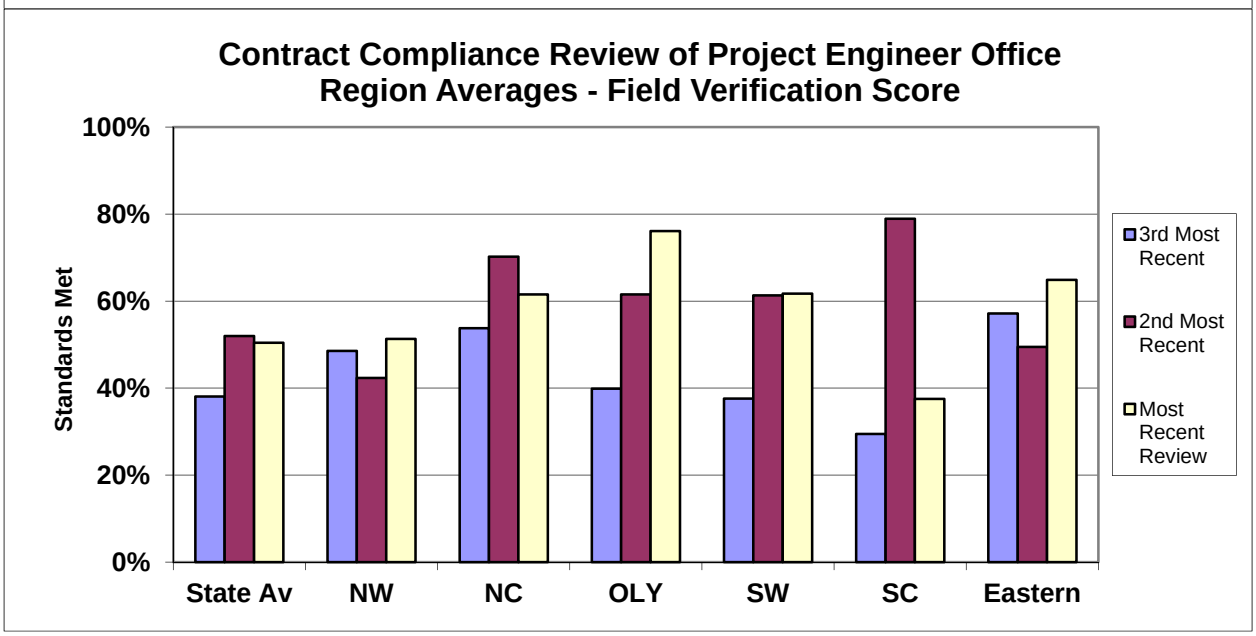
- Were the Pay Ledger and Field Note Records consistent for materials paid?
- Was the maintained ROM (tracking program) being kept up for quantity used, proper materials acceptance, and other documentation requirements as needed per 9-1.2 and 9-1.2CA of the Construction Manual?
- Was a RAM or QPL used prior to material placement and used correctly per 1-06.1 of the Standard Specifications and 9-1.3B of the Construction Manual?
- Was the proper acceptance criteria received and approved prior to placement, i.e. Acceptance Sample, Catalog Cut, Manufacture Certification of Compliance, Approved for Shipment 'Tag' or 'Stamp' or Shop Drawing per the Standard Specifications, Standard Plans, Construction Manual and the Contract Specials and Plans?

Overall Materials Documentation Score

The four parts of the Office Materials Documentation Score are added to the Field Verification Score and then divided by "5".




Contract Compliance Review of Project Engineer Offices
Region Averages - Office Materials Documentation Score
Standards Met
100%
80%
60%
40%
20%
0%
State Av
NW
NC
OLY
SW
SC
Eastern
3rd Most Recent
2nd Most Recent
Most Recent Review


Contract Compliance Review of Project Engineer Office
Region Averages - Field Verification Score
Standards Met
100%
80%
60%
40%
20%
0%
State Av
NW
NC
OLY
SW
SC
Eastern
3rd Most Recent
2nd Most Recent
Most Recent Review

Construction Materials

Fabrication Inspection Section

Crosshole Sonic Logging Testing (CSL)

The Materials Fabrication Inspection office performs all In-plant inspections for all WSDOT construction contracts for roads and bridges. 16 years ago the fabrication office started providing CSL testing to the Regional Project Engineer's office throughout the State.

The performance measure will track our response time in performing CSL testing, from the test date requested by the Project Office to the date of actual testing. The goal is to respond no later than 48 business hours from the test date requested.

This information will be used to track our efficiency in responding to the project engineer's office request for CSL testing and also maximizing the scheduling of in-plant inspection of our inspectors.

These Performance Measure charts and graphs illustrate the relationship of CSL testing date, as it relates to request dates for CSL testing. They are divided into:

- Breakdown: Shows all test locations and the date tested under the number of business days since the date requested for testing.

- Notification: Table of number of days from date request for testing until testing with corresponding graph.

- Comparison: Compares cumulative percentage of annual testing from 2005 to 2012, broken down from the request date until actual date tested.

2012 CSL Testing LOG

Job Number	CSL Machine	Shaft Location	Date Requested	Date Completed	(-1) Day	On Time	(+1) Day
8128	40L07005	Br 142N Pier 2 Shaft C	01/26/2012	01/26/2012		X	
8128	40L07005	Br 142N Pier 2 Shaft A	01/26/2012	01/26/2012		X	
8128	40L07005	Br 142N Pier 2 Shaft B	01/26/2012	01/26/2012		X	
8128	40L07005	Br 142N Pier 3 Shaft C	01/27/2012	01/27/2012		X	
8128	40L07005	Br 142N Pier 3 Shaft B	01/27/2012	01/27/2012		X	
8128	40L07005	Br 138N Pier 9 Shaft C	01/31/2012	01/31/2012		X	
8128	40L07005	Br 142N Pier 3 Shaft A	01/31/2012	01/31/2012		X	

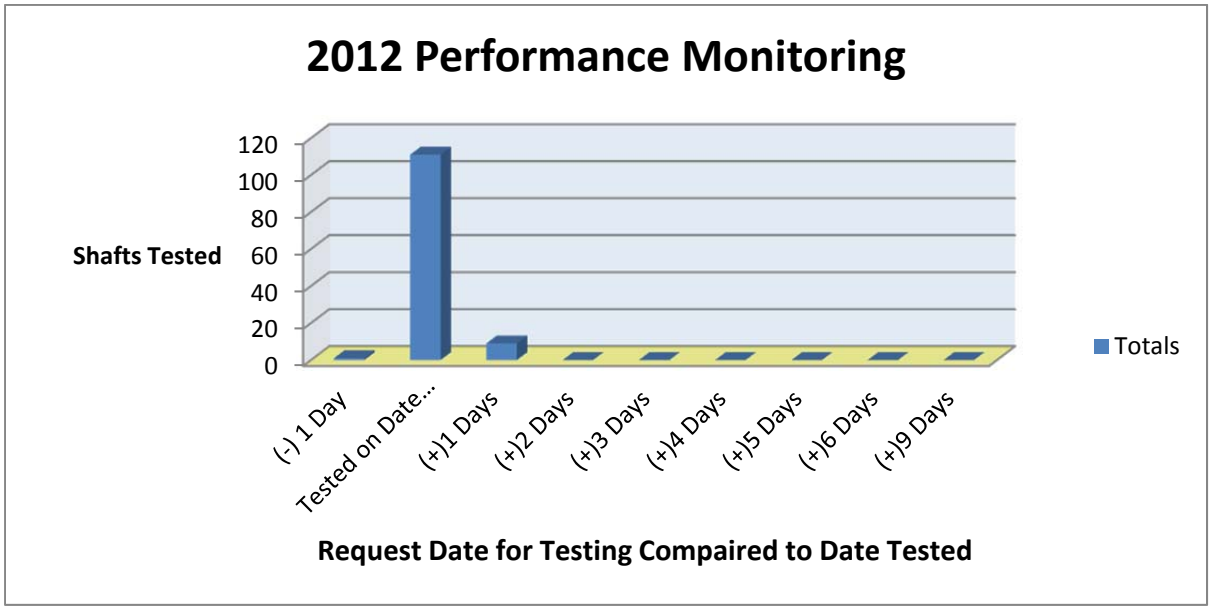
TA2376	40L07005	Abutment 6 Shaft 1	02/01/2012	02/01/2012		X	
8128	40L07004	Br522/142N Pier 1 Shaft D	01/10/2012	01/09/2012	1		
8128	40L07004	Br522/142N Pier 1 Shaft C	01/10/2012	01/10/2012		X	
8128	40L07004	Br522/142N Pier 1 Shaft B	01/26/2012	01/26/2012		X	
8128	40L07004	Br522/142N Pier 1 Shaft A	01/26/2012	01/26/2012		X	
8128	40L07004	Br522/138N Pier 9 Shaft A	01/30/2012	01/30/2012		X	
8128	40L07004	Br522/142N Pier 4 Shaft A	02/07/2012	02/07/2012		X	
8128	40L07004	Br522/142N Pier 4 Shaft D	02/07/2012	02/07/2012		X	
8128	40L07004	Br522/142N Pier 4 Shaft C	02/07/2012	02/07/2012		X	
TA2376	40L07004	Abutment 6 Shaft 3	02/08/2012	02/08/2012		X	
TA2376	40L07004	Abutment 6 Shaft 2	02/08/2012	02/08/2012		X	
TA2376	40L07004	Abutment 6 Shaft 4	02/08/2012	02/08/2012		X	
8128	40L07004	Br522/142N Pier 4 Shaft B	02/14/2012	02/14/2012		X	
7847	40L07004	Pier 5 C Shaft D	03/12/2012	03/12/2012		X	
TA2376	40L07004	Pier 5 Shaft 2	03/07/2012	03/07/2012		X	
TA2376	40L07004	Pier 5 Shaft 3	03/07/2012	03/07/2012		X	
7847	40L07004	Pier 5C Shaft C	03/08/2012	03/08/2012		X	
TA2376	40L07004	Pier 5 Shaft 2	03/07/2012	03/08/2012			1
7847	40L07004	Pier 4C Shaft D	03/20/2012	03/20/2012		X	
8189	40L07005	HOV 16 PIER 7 SHAFT A	03/13/2012	03/13/2012		X	
8189	40L07005	HOV 16 PIER 8 SHAFT B	03/13/2012	03/13/2012		X	
8189	40L07005	HOV 16 PIER 8 SHAFT A	03/16/2012	03/16/2012		X	
7847	40L07004	Pier 3C Shaft C	03/26/2012	03/26/2012		X	
7847	40L07004	Pier 3C Shaft D	03/26/2012	03/26/2012		X	
8189	40L07005	PIER 7 SHAFT B	03/16/2012	03/16/2012		X	
8189	40L07005	PIER 5 SHAFT B	04/06/2012	04/06/2012		X	
8189	40L07005	PIER 3 SHAFT A	04/06/2012	04/06/2012		X	
7847	40L07005	Pier 5N Shaft C	04/09/2012	04/09/2012		X	
7847	40L07005	Pier 6N Shaft C	04/11/2012	04/11/2012		X	
7847	40L07005	Pier 6N Shaft D	04/11/2012	04/11/2012		X	
7847	40L07005	Pier 1C Shaft C	04/16/2012	04/16/2012		X	
7847	40L07005	Pier 1C Shaft D	04/16/2012	04/16/2012		X	
7847	40L07005	Pier 4C Shaft C	03/15/2012	03/15/2012		X	
8189	40L07005	HOV 16 PIER 5 SHAFT A	04/11/2012	04/12/2012			1
8189	40L07005	HOV 16 PIER 4 SHAFT A	04/11/2012	04/12/2012			1
8189	40L07005	HOV 16 PIER 4 SHAFT B	04/11/2012	04/12/2012			1
8189	40L07005	HOV 16 PIER 3 SHAFT B	04/16/2012	04/16/2012		X	
8189	40L07005	HOV 16 PIER 6 SHAFT B	04/28/2012	04/28/2012		X	
8189	40L07005	HOV 16 PIER 6 SHAFT A	04/28/2012	04/28/2012		X	
7847	40L07005	Pier 2C Shaft C	04/23/2012	04/23/2012		X	
7847	40L07005	Pier 2C Shaft D	04/30/2012	04/30/2012		X	
8189	40L07005	ED 16 PIER 1 SHAFT D	06/07/2012	06/07/2012		X	
7852	40L07005	PIER 2 SHAFT AE	06/15/2012	06/15/2012		X	
7852	40L07005	PIER 2 SHAFT CE	06/15/2012	06/15/2012		X	
7852	40L07005	PIER 2 SHAFT DE	06/15/2012	06/15/2012		X	
7852	40L07005	PIER 1 SHAFT AW	06/15/2012	06/15/2012		X	
7852	40L07005	PIER 1 SHAFT A EAST	06/25/2012	06/26/2012			1

7852	40L07005	PIER 1 SHAFT B EAST	06/25/2012	06/26/2012			1
7852	40L07005	PIER 2 SHAFT A WEST	06/29/2012	06/29/2012		X	
7852	40L07005	PIER 2 SHAFT B EAST TEST 2	06/29/2012	06/29/2012		X	
7852	40L07005	PIER 2 SHAFT C WEST	06/29/2012	06/29/2012		X	
7852	40L07005	PIER 2 SHAFT D WEST	06/29/2012	06/29/2012		X	
7852	40L07005	PIER 2 SHAFT B WEST	06/29/2012	06/29/2012		X	
8139	40L07005	PIER 3 SHAFT A	07/31/2012	07/31/2012		X	
8139	40L07005	PIER 3 SHAFT B	07/31/2012	07/31/2012		X	
8272	40L07005	PIER 2 SHAFT B	08/08/2012	08/08/2012		X	
8128	40L07004	Pier 2 Shaft B	08/01/2012	08/01/2012		X	
8272	40L07004	PIER 2 SHAFT A	08/13/2012	08/13/2012		X	
1017.101	40L07004	Abut 1 Shaft No 4	08/18/2012	08/18/2012		X	
1017.101	40L07004	Abut 1 Shaft No 5	08/18/2012	08/18/2012		X	
1017.101	40L07004	Abut 2 Shaft No 9	08/18/2012	08/18/2012		X	
1017.101	40L07004	Abut 2 Shaft No 10	08/18/2012	08/18/2012		X	
8128	40L07004	Br138N Pier 3 Shaft No A	08/20/2012	08/20/2012		X	
8128	40L07004	Br138N Pier 3 Shaft No B	08/20/2012	08/20/2012		X	
8272	40L07005	Mellen St Pier 3 Shaft B	08/15/2012	08/15/2012		X	
8272	40L07005	Mellen St Pier 3 Shaft A	08/20/2012	08/20/2012		X	
8272	40L07005	Skookumchuck NCD Pier 2 shaft A	08/29/2012	08/29/2012		X	
8272	40L07004	NCD Pier 3 shaft A	09/27/2012	09/27/2012		X	
8272	40L07004	NCD Pier 4 shaft A	09/27/2012	09/27/2012		X	
8272	40L07004	NCD Pier 4 Shaft B	09/27/2012	09/27/2012		X	
8272	40L07004	NCD Pier 4 Shaft C	09/27/2012	09/27/2012		X	
8189	40L07005	NEW AW BRIDGE PIER 2	07/06/2012	07/06/2012		X	
8128	40L07005	PIER 2 SHAFT A	07/27/2012	07/27/2012		X	
8139	40L07005	Br2/215 Pier 2	08/31/2012	08/31/2012		X	
8272	40L07005	Pier No 1 Shaft C	09/13/2012	09/13/2012		X	
8272	40L07005	Pier No 1 Shaft B	09/13/2012	09/13/2012		X	
8272	40L07005	Pier No 1 Shaft A	09/13/2012	09/13/2012		X	
8272	40L07005	Pier No 2 Shaft B	09/13/2012	09/13/2012		X	
8127	40L07005	Pier No 2 Shaft C	10/02/2012	10/02/2012		X	
8127	40L07005	Pier No 2 Shaft B	10/02/2012	10/02/2012		X	
8127	40L07005	Pier No 2 Shaft A	10/02/2012	10/02/2012		X	
8272	40L07005	NCD Pier 3 Shaft B	10/09/2012	10/09/2012		X	
8272	40L07005	SCD Pier 3 Shaft A	10/09/2012	10/09/2012		X	
8272	40L07005	SCD Pier 3 Shaft B	10/09/2012	10/09/2012		X	
8272	40L07005	SCD Pier 4 Shaft A	10/09/2012	10/09/2012		X	
8272	40L07005	SCD Pier 4 Shaft B	10/09/2012	10/09/2012		X	
8272	40L07005	SCD Pier 4 Shaft C	10/09/2012	10/09/2012		X	
8272	40L07005	SCD pier 2 Shaft B	10/15/2012	10/15/2012		X	
8272	40L07005	SCD pier 1 shaft A	10/15/2012	10/15/2012		X	
8290	40L07005	Pier 15 Right Shaft	10/23/2012	10/23/2012		X	
8290	40L07005	Pier 14 Right Shaft	10/29/2012	10/29/2012		X	
8290	40L07005	Pier 15 Left Shaft	11/05/2012	11/05/2012		X	
8290	40L07005	Pier 14 Left Shaft	11/06/2012	11/06/2012		X	
8290	40L07005	Pier 13 Shaft	11/12/2012	11/13/2012			1

8290	40L07005	Pier 12 Shaft	11/13/2012	11/13/2012		X	
8290	40L07005	Pier 11 Right Shaft	11/26/2012	11/26/2012		X	
8290	40L07005	Pier 11 Left Shaft	11/26/2012	11/26/2012		X	
8290	40L07005	Pier 1 Left Shaft	12/10/2012	12/10/2012		X	
8290	40L07005	Pier 1 Right Shaft	12/10/2012	12/10/2012		X	
8290	40L07005	Pier 6 Shaft	12/12/2012	12/13/2012			1
8290	40L07005	Pier 5 Left Shaft	12/26/2012	12/26/2012		X	
8290	40L07005	Pier 2 Shaft	12/26/2012	12/26/2012		X	
8127	40L07005	PIER 1 SHAFT C RESORT CREEK BRIDGE	10/05/2012	10/05/2012		X	
8127	40L07005	PIER 1 SHAFT B RESORT CREEK BRIDGE	10/05/2012	10/05/2012		X	
8127	40L07005	PIER 1 SHAFT A RESORT CREEK BRIDGE	10/05/2012	10/05/2012		X	
8272	40L07005	SCD PIER 1 SHAFT A	10/22/2012	10/22/2012		X	
8272	40L07005	SCD PIER 1 SHAFT B	10/22/2012	10/22/2012		X	
8272	40L07005	SCD PIER 2 SHAFT A	10/22/2012	10/22/2012		X	
8292	40L07006	PIER 2 WEST	11/27/2012	11/27/2012		X	
8292	40L07006	PIER 2 EAST	12/13/2012	12/13/2012		X	
8333	40L07006	RIGHT SHAFT (SOUTH)	12/21/2012	12/21/2012		X	
8333	40L07006	LEFT SHAFT (NORTH)	12/21/2012	12/21/2012		X	
8292	40L07006	PIER 3 EAST	12/28/2012	12/28/2012		X	
8290	40L07005	Pier 6 Shaft	12/17/2012	12/18/2012			1

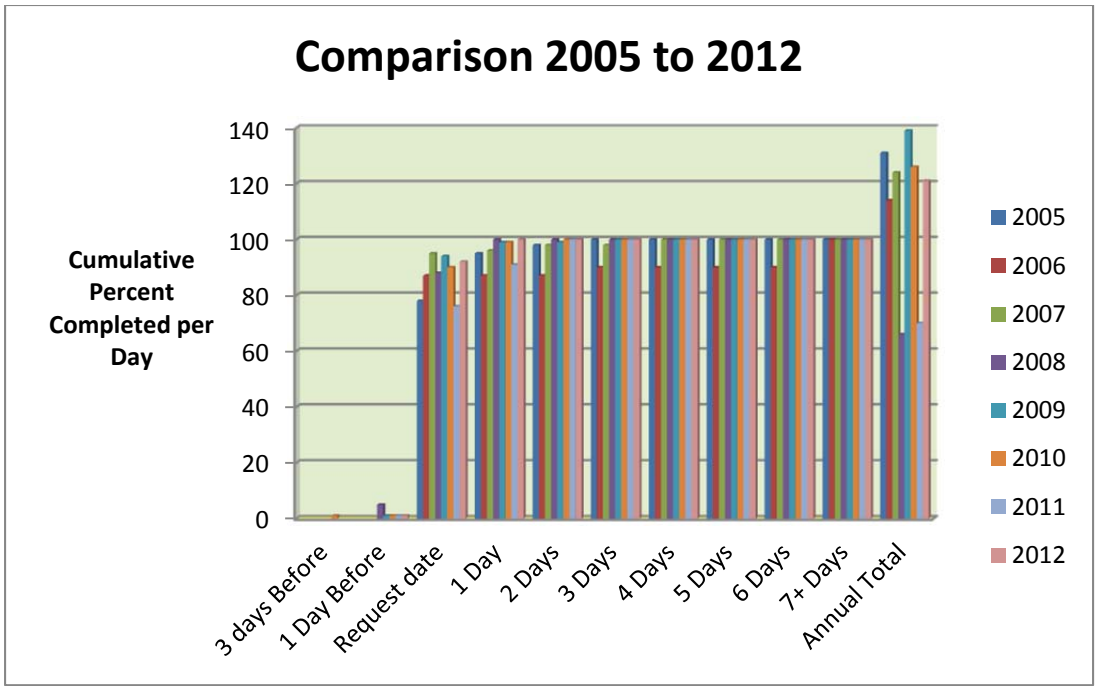
Crosshole Sonic Logging Performance Monitor 2012

A total of 121 shafts were tested in 2012. This year all shafts were tested within the two day specification.



Comparison 2005 to 2012

The cumulative percentage of the annual total testing by the number of days from the date requested until data acquisition was actually obtained. The target is for 100% of the testing to be completed no later than two days from the request date for testing.



	2005	2006	2007	2008	2009	2010	2011	2012
3 days Before						1		
1 Day Before				5	1	1	1	1
Request date	78	87	95	88	94	90	76	92
1 Day	95	87	96	100	99	99	91	100
2 Days	98	87	98	100	99	100	100	100
3 Days	100	90	98	100	100	100	100	100
4 Days	100	90	100	100	100	100	100	100
5 Days	100	90	100	100	100	100	100	100
6 Days	100	90	100	100	100	100	100	100
7+ Days	100	100	100	100	100	100	100	100
Annual Total	131	114	124	66	139	126	70	121

This year all of the shafts tested were within the 2 Day specification with the exception of 1 shaft, which was able to be rescheduled to accommodate workload and staffing between contractor and WSDOT.

Geotechnical

Productivity Measures

The Geotechnical Office provides statewide geotechnical (foundation engineering and engineering geology) design, construction, and maintenance support services for WSDOT. For performance measurement purposes, The Office's services can be subdivided into three primary functions, which include field exploration services, geotechnical design services, and P3 program unstable slopes technical management.

A measure of our service to the Region offices, the Washington State Ferries (WSF), the Bridge Office, the Office of Program Management, and other key customers statewide is how well we keep our commitments regarding costs and completion time, and our overall cost and time effectiveness. To assess these issues, performance measures are provided for actual/estimated geotechnical drilling costs, the cost/ft of drilling for various types of geotechnical drilling, and for the timeliness of completing geotechnical performance tests.

We have found that the performance measures as applied to the field exploration and laboratory testing components of the geotechnical program have been useful and effective. However, we have not included a performance measure for the geotechnical engineering component of the geotechnical program for the following reasons:

- Each geotechnical design project is unique and furthermore is subject to significant changes once the project is estimated as the subsurface conditions discovered can have a dramatic influence on the design effort required, and the complexity of the design.
- The scope of the geotechnical design effort often changes during the design process, either due to unanticipated design complexity, or due to project factors that are not within the control of the Geotechnical Office, such as not getting important site data from the region in time, problems with getting access to a site for field exploration due to permit or right of entry issues, changes in the project civil design that affects the geotechnical scope of work, etc.

Geotechnical Field Exploration

Figure 1 provides a comparison between the estimated and actual (billed) costs needed to complete the field exploration for a design project. A ratio (costs billed/estimated costs) of 1.0 means that the estimated costs and the billed costs are the same. A ratio less than 1.0 indicates the project field exploration was completed for less cost than estimated, which is desirable, provided that the estimate was not too much higher than the actual amount of time it took to get the job completed. A ratio greater than 1.0 indicates that more cost was billed than estimated, which is undesirable. Our target is to have the estimate within 20% of the actual cost.

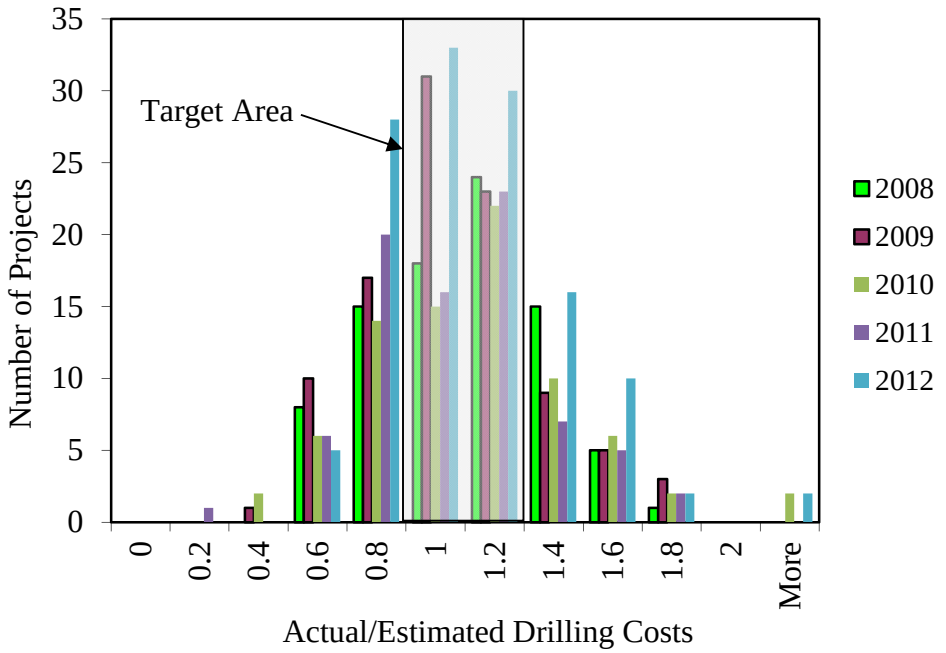


Figure 1. Ratio of billed costs to estimated costs for geotechnical field exploration services completed January 2008 through December 2012.

For the sake of readability, only the data for years 2008 through 2012 are provided. However, Table 1 (below) summarizes the key statistics that illustrate the drilling cost prediction accuracy from 2002 to 2012.

Table 1. Summary of drilling project estimate statistics.

	2002	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
Total Number of Projects	74	93	82	71	83	83	86	99	79	80	126
Projects Outside of 20% Target Range (% of total)	39%	37%	37%	32%	37%	40%	51%	45%	53%	51%	50%
Projects More Than 20% Over Budget (% of total)	25%	14%	18%	15%	22%	22%	24%	17%	25%	18%	24%

Figure 2, which shows the difference between the estimated and actual drilling costs for each project, provides a more complete picture of the nature of the overruns in the drilling costs, in that most of the significant overruns are for small projects where a $5,000 overrun makes a big difference in the ratios. Based on Figure 2, we find that 26% of the field exploration projects were significantly more than $5,000 over budget (negative numbers indicate a cost overrun) in 2008, 16% in 2009, 16% in 2010, 21% in 2011, and 6% in 2012. Just an extra day of drilling on a project can result in this type of cost increase, which can easily happen depending on the site conditions encountered or if equipment breakdown occurs. The fluctuation in the number of projects over budget reflects the many uncertainties in estimating the cost of geotechnical field exploration, as discussed in more detail below. Furthermore, this fluctuation is dependent on how aggressively the estimate is made, i.e., rather than estimating project costs conservatively, targeting greater accuracy in the estimate.

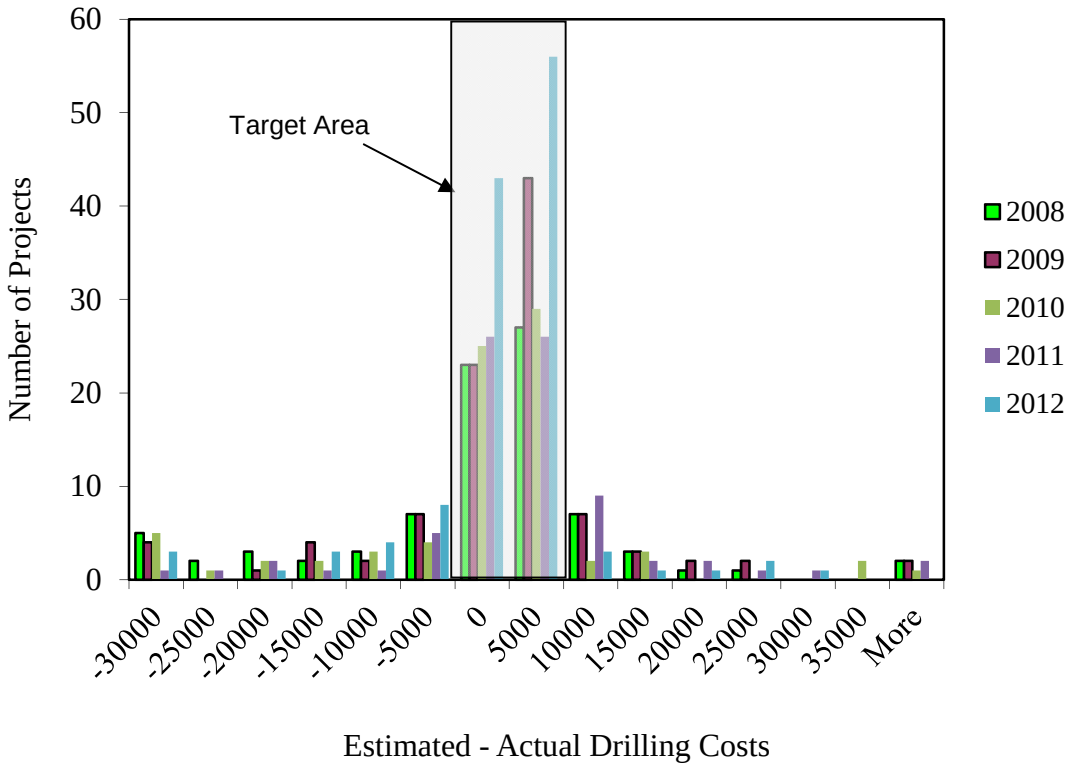


Figure 2. Estimated minus actual cost for geotechnical field exploration services completed January 2008 through December 2012.

It should be recognized that there are a lot of uncertainties in putting together estimates for geotechnical work, primarily due to the variable nature of the subsurface conditions which can affect the type and complexity of the design required, as well as the depth and number of test holes, probes, etc., needed to characterize those conditions. Scope changes during design can also affect the accuracy of the estimate. Continued improvement is needed to better track hours and cost estimates as the project progresses, and to immediately discuss the impact of any customer generated changes in scope with the customer, so that the estimate can be properly adjusted and planned for. We made some progress on this issue in recent years, but this will continue to be a goal for next year's performance.

In spite of the uncertainties in estimating geotechnical design and exploration costs, these performance measures have been useful to evaluate performance of crews and units within the Geotechnical Office. These performance measures allow us to monitor crew/unit performance and track project costs better. It has increased our focus on the key aspects of the services provided by the Geotechnical Office. It has also allowed the crew/unit members to see what is expected of them and to follow their progress to completion of all projects. These tools have also proven useful to better communicate with our customers and to help develop realistic expectations regarding the scope and cost of services needed for a given project.

In the past, when criticism has been received, it has often been the result of unrealistic expectations, or poor communication between the Geotechnical Office and the customer regarding the project scope and the cost to accomplish that scope. The performance measures reported herein will continue to be used to insure that the project scope is properly assessed and communicated, and that expectations are realistic.

A benefit of these performance measures is the improved ability of Geotechnical Office managers to evaluate performance and make course corrections before problems get big and costly. This has been especially apparent when evaluating the performance of the field exploration unit. If the performance measures and their use by management are effective, cost decreases to deliver services should occur as inefficiencies are reduced or eliminated.

For field exploration activities, another measure of productivity that can be used is the cost per foot of test hole drilling. The cost per foot is dependent on a number of factors, including:

- the type of drilling equipment used,
- the travel distance and difficulty encountered in getting the drilling rig to the test hole location,
- the nature of the soil/rock encountered during the drilling (e.g., bouldery soils are much more difficult to drill through than uniform sands and silts), and
- the productiveness of the drill crew.

Therefore, comparisons must be made for similar equipment in similar drilling and access conditions.

Tables 2, 3 and 4, which provide the unit cost per ft of test hole drilled (field exploration services), illustrate trends in the cost/ft of drilling.

Table 2. Summary of average drilling costs for 2002 through 2012.

Year	Average Cost/ft for All Rigs	Cost Decrease (-) or Increase (+) Relative to Previous Year
2002	$124.62	--
2003	$114.20	-9.1%
2004	$99.38	-14.9%
2005	$90.91	-9.3%
2006	$91.20	+0.3%
2007	$91.93	+0.8%
2008	$98.95	+7.1%
2009	$102.27	+3.3%
2010	$77.76	-24.0%
2011	$77.76	0.0%
2012	$86.59	+11%

Table 3. Summary of average drilling costs, broken out by rig type, for 2009 and 2010.

Type of Drill Rig	Average 2009 Cost/ft of Drill Hole			Average 2010 Cost/ft of Drill Hole		
	No. of Holes	Drill Footage (ft)	Cost/ft	No. of Holes	Drill Footage (ft)	Cost/ft
All Rigs and Projects	910	48,382	$102.27	844	42,933	$77.76
Track Mounted 850 Rig	77	3,612	$90.49	142	7,228	$90.21
Truck Mounted Rig	7	205	$123.06	17	1,246	$118.64
Skid Rig	95	3,236	$121.69	21	1,040	$115.48
Barge Rig	29	2,701	$205.16	39	4,015	$63.93
Multiple Rig Type Project	642	36,499	$109.35	447	23,377	$98.17
Hand tools	60	2,129	$17.12	168	5,453	$13.10

Table 4. Summary of average drilling costs, broken out by rig type, for 2011 and 2012.

Type of Drill Rig	Average 2011 Cost/ft of Drill Hole			Average 2012 Cost/ft of Drill Hole		
	No. of Holes	Drill Footage (ft)	Cost/ft	No. of Holes	Drill Footage (ft)	Cost/ft
All Rigs and Projects	1,032	73,959	$77.76	734	34,844	$86.59
Track Mounted 850 Rig	94	4,567	$90.94	138	6,082	$99.31
Truck Mounted Rig	5	415	$121.42	18	972	$103.02
Skid Rig	52	2,110	$104.26	36	2,215	$185.32
Barge Rig	2	121	$202.67	7	820	$131.35
Multiple Rig Type Project	686	59,836	$98.28	332	18,032	$104.88
Hand tools	193	6,910	$8.89	203	6,723	$18.14

While such comparisons on drilling costs must be made cautiously, as drilling cost for even the same rig type will be affected by the difficulty of the site subsurface conditions, traffic control restrictions, environmental permit restrictions, and variability in the difficulty and distance to mobilize the rig to the site, the general trend is that from 2002 to 2005, a significant decrease in drilling costs occurred each year. These cost decreases occurred in spite of increases during that time period in the cost recovery hourly rates that the Geotechnical Office must charge. These reduced per foot drilling costs have resulted in a total savings of over $1,000,000 from 2002 through 2005.

A major increase in the cost recovery rates occurred in 2007, primarily due to a significant increase in the base salary for technicians and engineers to catch them up to 25% below their peers in the private sector and other organizations outside of Washington state service. This resulted in an increase of 18% in the cost recovery rates by July 2007. Yet, in spite of this increase in the hourly rates, the overall cost/ft of drilling only increased $0.73 (0.8%) relative to 2006 costs, illustrating that a significant improvement in the cost effectiveness and efficiency of the WSDOT provided drilling services occurred in 2007. These continued cost decreases relative to the cost recovery rates are an exceptional accomplishment, worthy of recognition.

In 2008, the drilling cost per foot did not continue to decrease, but increased slightly, as continued year by year decreases in the drilling cost per foot are difficult to maintain. In addition, a significant number of non-permanent employees were used to fill out some of the drill crews in 2008 and 2009, possibly resulting in minor reductions in the productivity of some of the crews due to the limited experience of the non-permanent employees. The crews are also having to go to more extremes to comply with permit regulations to protect against site runoff issues and protection of adjacent environmental resources, and also to accommodate archeological needs to make sure that nothing of archeological significance is encountered that could hinder the project.

However, in 2010, major decreases in the drilling cost/ft occurred again (a 24% drop relative to the previous year). In some cases, this is the result of being able to drill some rather large projects, which minimized the cost of mobilization to each test hole (i.e., economies of scale). The Field Exploration Manager also got much more aggressive at reducing the cost estimates for each project (see Table 1, which indicates that the percentage of projects under estimated was a bit higher than in past years). The crews know the cost estimate before they mobilize to the site and its effect on the rate of drilling required (ft/day of drilling) to achieve it, and in effect, these aggressive cost estimates become a goal for the crew to achieve. Finally, the temporary members of the crews have been with the field exploration for several years, and they have gained the experience they needed to drill more efficiently. The drill crews were amazingly able to repeat this feat in 2011. In fact, even when considering the costs for specific drill rig types, costs/ft of drilling for 2010 and 2011 are quite consistent. This demonstrates that the reduced cost/ft of drilling they achieved in 2010 was not an anomaly, but something that they have been able to maintain.

In 2012, the average cost went up approximately 11%. However, there was a significant increase in the number of projects, many of which were fish passage projects. With smaller projects comes a greater percentage of costs due to mobilization, which may explain the increase. In any case, the increase was not very large, and overall costs are much lower than when we first started doing this performance measure. Further, with such a long history of nearly continuous price drops, it is likely that the drilling operation is as efficient as it will get, so some ups and downs in cost per ft should be expected at this point.

Geotechnical Laboratory Testing

Geotechnical laboratory testing is one component of the overall effort required to complete a geotechnical design. Once the test holes are drilled and the samples selected for testing by the geotechnical project manager/designer, the geotechnical testers can complete the testing work. The delivery date for the test results to the designer is negotiated with the designer so that it is delivered in time for the designer to complete the project design and report within the delivery date negotiated with the Region Project Office, the Bridge Office, or other office requesting geotechnical services. Therefore, the due date for the testing is internal to the Geotechnical Office.

Figure 3 summarizes how well the geotechnical laboratory delivered geotechnical performance test results to the geotechnical project managers by the required due date so that the design project can be completed in a timely manner. Geotechnical performance tests are test results that are used directly in geotechnical design. They include, for example, triaxial or direct shear tests to measure shear strength of soils, consolidation tests to measure compressibility of soils, cyclic simple shear tests to evaluate liquefaction susceptibility and parameters for soil, and rock shear strength tests.

Figure 3 shows that the vast majority of the testing conducted is completed on time or early, with only 6 tests out of the total 172 soil performance tests that were more than 2 weeks late late in 2011 and no tests that were more than 2 weeks late in 2012. Of those tests that were late, most were late due to equipment breakdown problems. Soil index tests such as gradation analysis and plasticity indices were 100% on time or early, and comprised 2,575 tests in 2011 and 3,133 tests in 2012. Overall, 2012 showed modest improvements in timeliness of the testing over 2011.

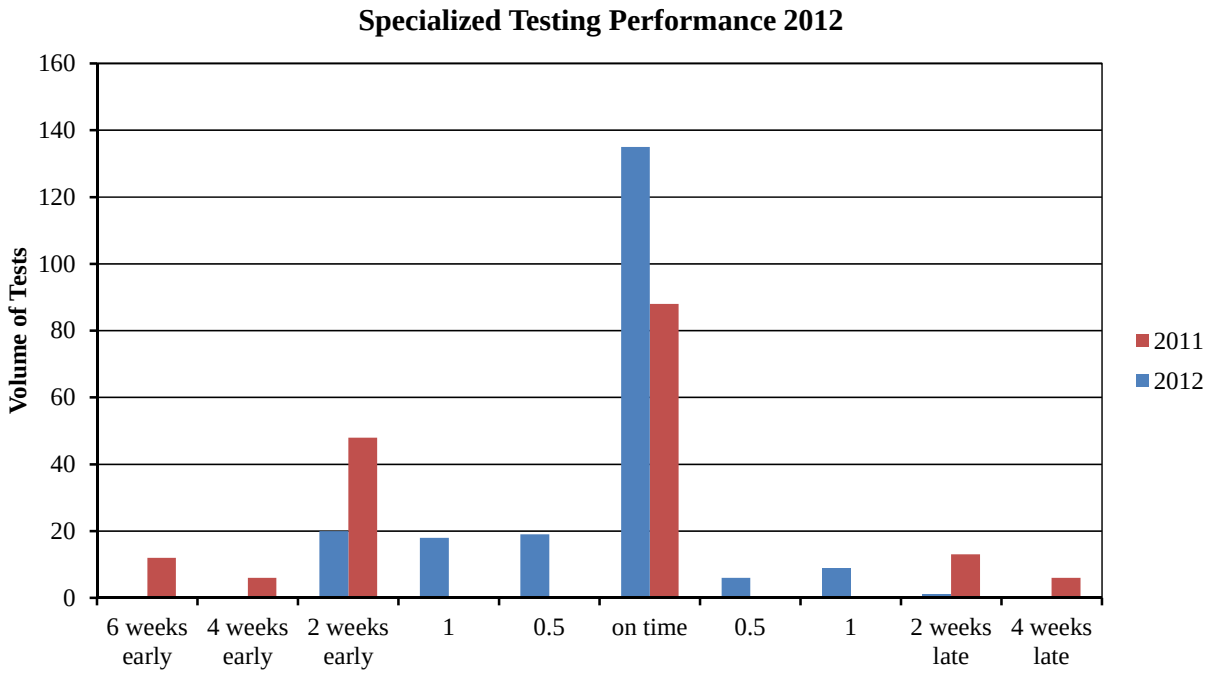


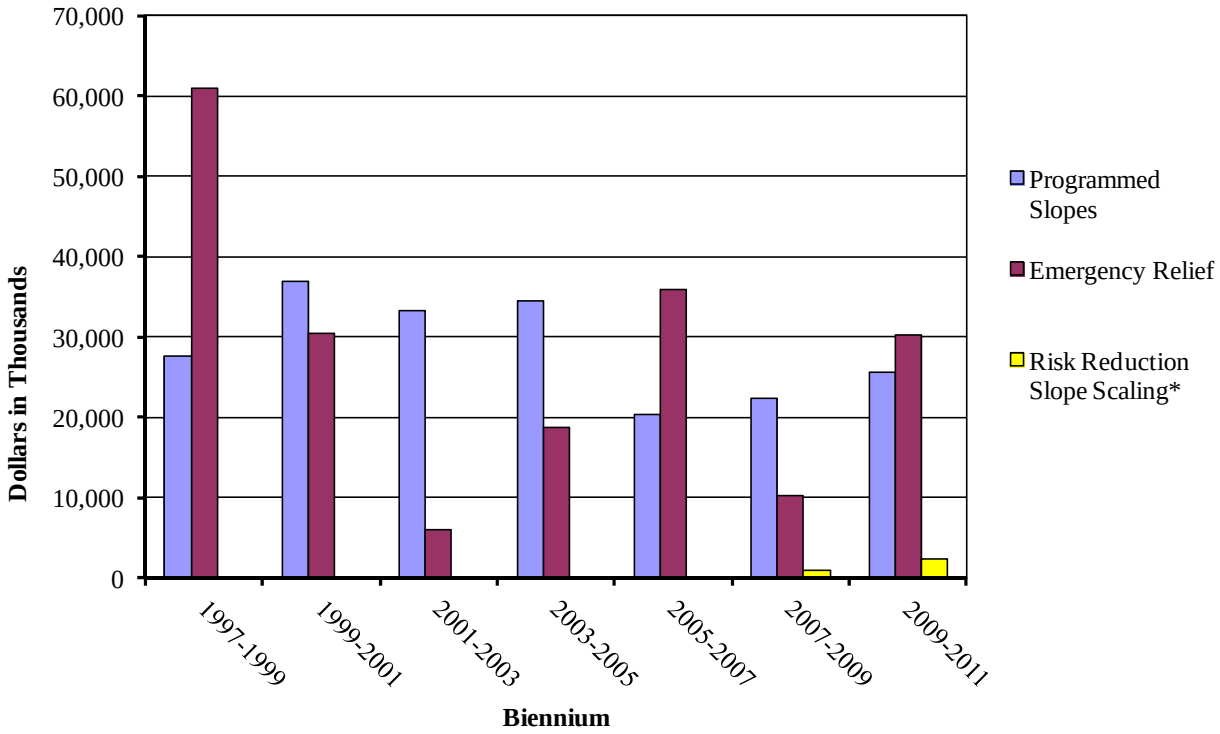
Figure 3. Timeliness of delivery of geotechnical performance tests.

Unstable Slopes Program (P-3)

The effectiveness of the unstable slopes program can be partially assessed from a global perspective by considering whether or not the proactive mitigation of unstable slopes is reducing the number and severity of slopes that must be mitigated under an emergency scenario. Figure 4 illustrates the long-term trends with regard to this issue, considering the cost to mitigate those unstable slopes. As can be seen in the figure, in the first biennium of the program, emergency relief expenditures were quite high in general and significantly higher than the amount spent through the P-3 program to mitigate unstable slopes proactively. In the second biennium, emergency relief expenditures were greatly reduced, but still about the same as the amount spent through the P-3 program. After the first two biennia, emergency relief expenditures were significantly reduced, with the exception of a couple of biennia where expenditures for emergency situations were unusually high. For example, in the 2005-2007 biennium, one of the winters had extreme weather conditions. In the 2009-2011 biennium, most of the emergency relief expenditures were for one unusual and very expensive slide (i.e., the Nile Valley Slide on SR-410). In any case, this figure shows that the P-3 program is helping to reduce emergency unstable slope situations.

Note that since the 2011-2013 biennium is not completed yet, this plot is unchanged from the plot provided in last year's annual report. This plot will be updated next year.

For additional information on the P-3 Unstable slopes program and its effectiveness, see the Unstable Slopes Folio (2010).



*New program implemented in 2007-2009.

Note: 2005-2007 Emergency Relief includes landslide mitigation as a result of severe rain and 500 year flooding events in November of 2006 and December of 2007. 2009-2011 Emergency Relief includes $18,860,000 for the SR 410 Nile Valley Landslide investigation and temporary SR 410 detour.

Figure 4. P-3 Unstable Slopes Program Expenditures Compared with Emergency Relief expenditures.

Pavement Management Section

Pavement Condition Trend

This performance measure documents the statewide pavement condition as represented by the pavement structural condition (cracking, faulting, patching, etc.), rutting, and ride (smoothness) measurements on the state highway network. This measure includes all pavement types: chip seal, asphalt, and concrete. These condition measures are used to characterize each pavement section into one of five categories: very good, good, fair, poor, and very poor. A pavement section is determined to be "due" for rehabilitation when it has reached the "Fair" category based on one or more condition measures. The chart illustrates the number of lane miles of pavement in each of the five categories from 2000 to 2011 for the approximately 12,000 lanes miles of the state route system that were evaluated in 2011. WSDOT's goal is to limit to approximately 10% the lane miles of pavement in the "Poor" or "Very Poor" category[1]. Since last reporting in January 2012, the 2011 condition data (rated and analyzed during 2011-2012) has been added and shows that the poor pavement ("Poor" and "Very Poor" categories) has increased by about 78 lane miles (increasing from 7.0% to 7.3% of the state system).

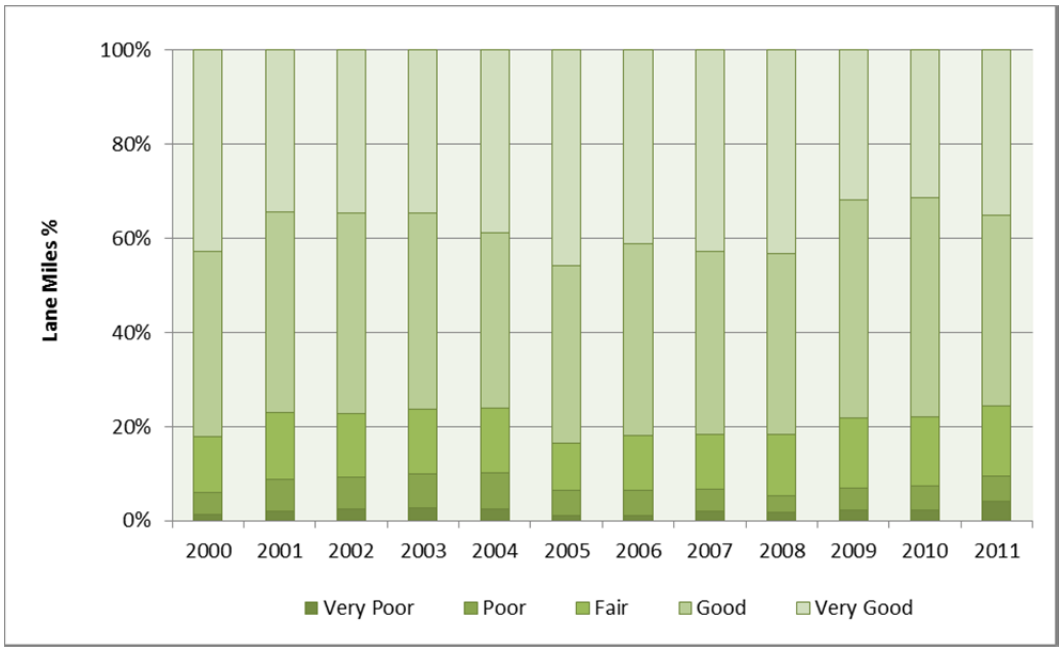


Figure 1: Pavement Condition

[1] Except for those sections of pavements that are intentionally delayed due to upcoming reconstruction or other major construction work.

The following table represents the above figure and illustrates the number of good (pavements in very good, good and fair condition) and poor (pavements in poor and very poor condition) lane miles for all pavement types.

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011[2]
Good (lane miles)	16516	16186	16197	15916	15965	16617	16743	16160	16403	15784	15918	10963
Poor (lane miles)	1068	1578	1659	1787	1797	1162	1153	1162	922	1181	1260	1147

QA/QC in Pavement Rating

This performance measure attempts to quantify the accuracy of annual pavement condition surveys using statistical methods. One of the concerns WSPMS users have raised in the past has been that, in some cases, the survey results do not accurately reflect the condition of the pavement section. After the rating crew has finished rating a "set" (approximately 100 miles of roadway), about five random sample sections, each approximately 1 mile long, are selected within this set and are rated again ("sample" rating) by a different rater than the one who performed the "production" rating. The Pavement Structural Condition (PSC), a combined index of the various distresses on the pavement surface, is then computed using both the "production" rating and the "sample" rating and are then compared for any statistical differences. For the 2011-2012 pavement rating, 421 sample sections (each approximately 1 mile long) out of a total of approximately 6,000 miles of rated roadway were considered. The "production" and "sample" ratings were tested for differences using paired t-test and Wilcoxon signed rank test and both tests indicated that there are no significant differences between the two ratings.

The following two figures show graphically the differences between the "production" and "sample" rating. Out of the 421 sample sections considered, 345 sections (81.9%) had a PSC difference of less than 10 points and 76 sections (19.1%) had a PSC difference of more 10 than points. In Figure 2, the solid line represents the line of equality (R-squared = 88.2%) and the dashed lines represent ±10 PSC points difference.

[2] Due to budget restrictions, Chip Seal pavements were not rated and were excluded from this tabulation

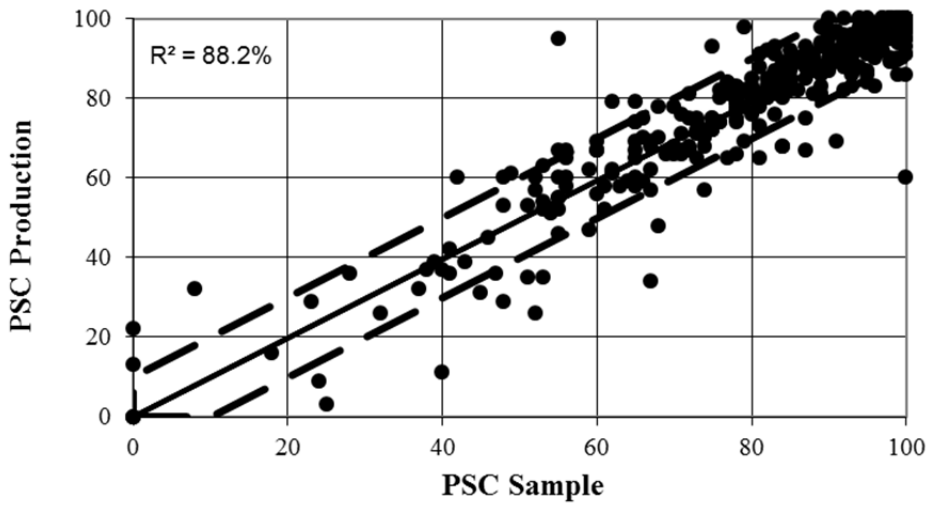


Figure 2: PSC Comparison

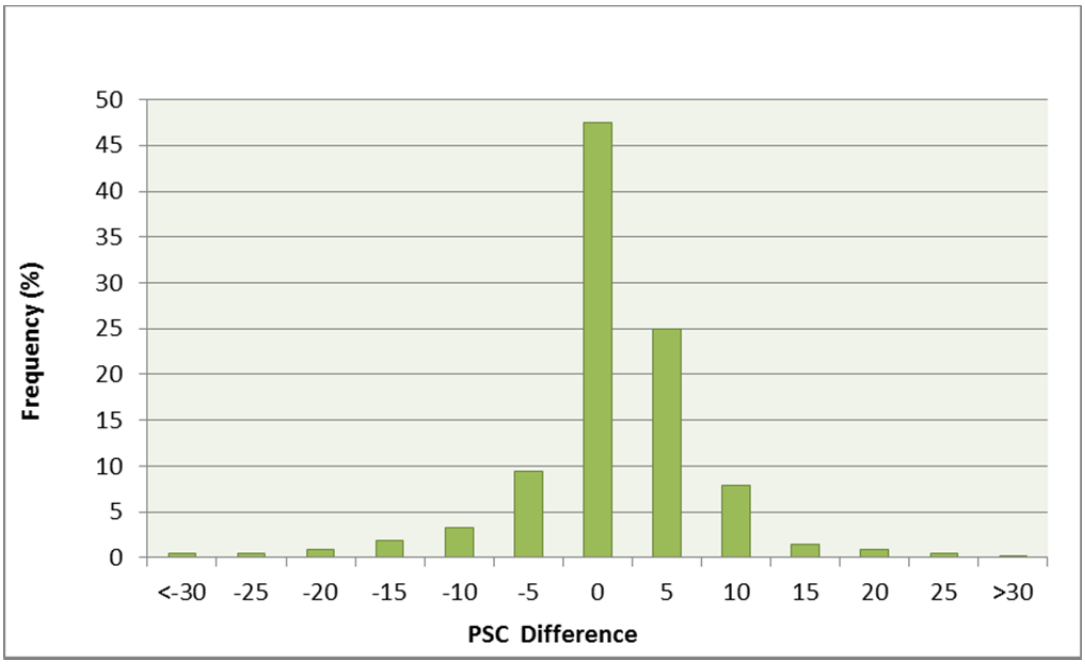


Figure 3: Histogram of Differences in PSC between Production and Sample Rating

Pavements –Review of Region Pavement Rehabilitation Reports

This performance measure documents the number of days to review, analyze, and concur with Region Rehabilitation Reports. The target for rehabilitation report concurrence is 20 days. Twenty days was set as a target for 2011 and again in 2012. The average time required to review rehabilitation reports for 2011 was 3 days. The average time required to review rehabilitation reports for 2012 was less than 3 days (2.5). The target of 20 days was not exceeded during 2012.

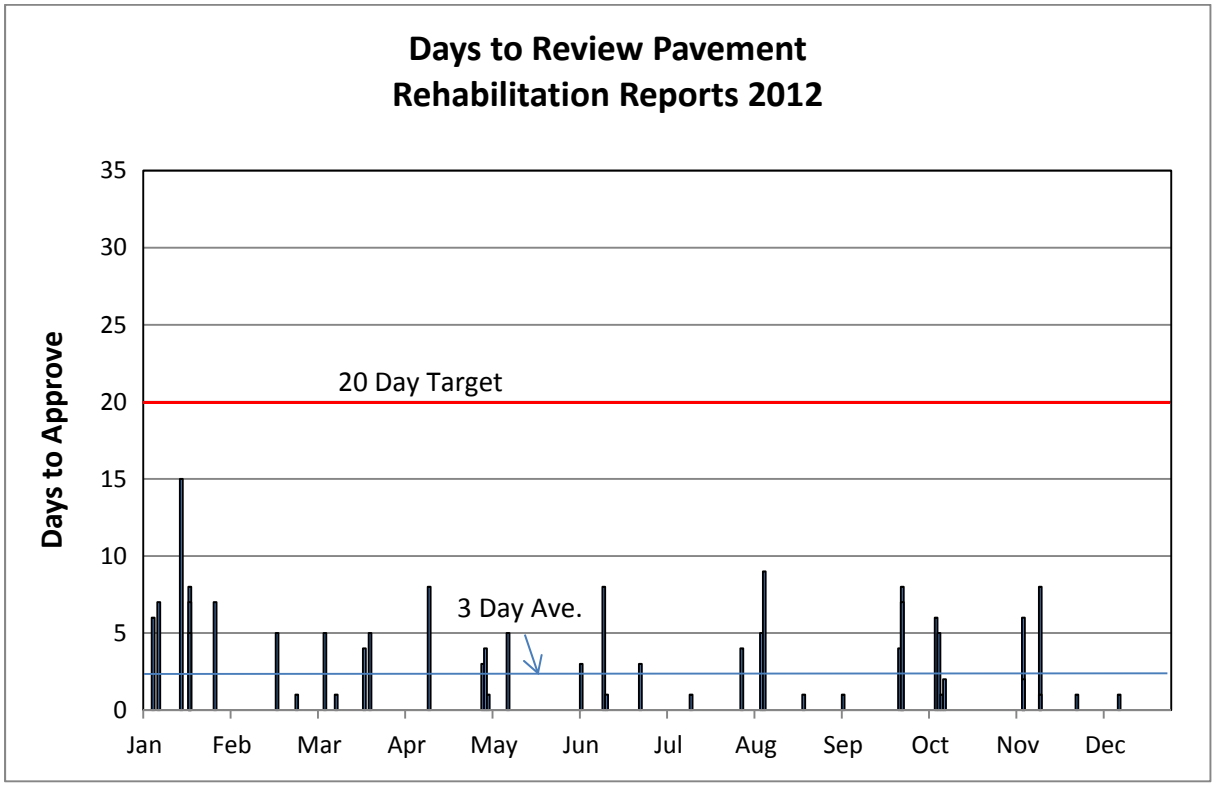


Figure 1. Days Required to Review Pavement Rehabilitation Reports for 2012.

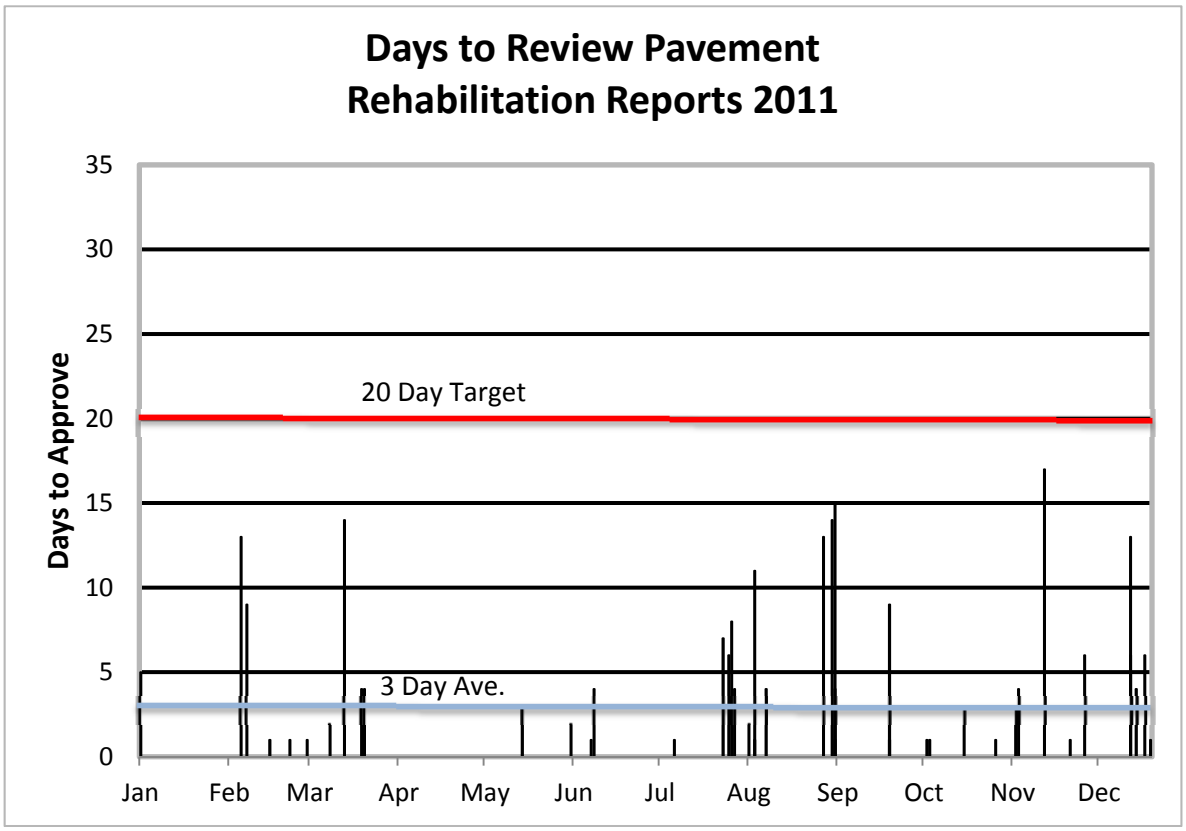


Figure 2. Days Required to Review Pavement Rehabilitation Reports for 2011.

Administrative

IT Support

Help Desk Response Time

IT Support – Help Desk Response Time

The Materials Laboratory IT Support categorize requests according to the following five major areas: Workstation (hardware, software, etc); Printing (copier, printer, etc.); Network (hardware, wireless, security, etc.); Services (data management, facilities, Meeting/Conference, research and development, etc.); Operational Services (domain, e-mail, backup, internet/ intranet,, etc.).

The following graph illustrates the average completion time for all IT help requests in the five mentioned categories. Categories, such as development and purchasing, are not included in this performance measure since the Materials Laboratory IT Support does not have direct control over this function.

Total Requests in 2012 – 3785