ISSUE MEMORANDUM

TO: AMARJEET S. BENIPAL
State Pavement Engineer
Pavement Program
Division of Maintenance

PHILIP J. STOLARSKI
State Materials Engineer
Deputy Division Chief
Materials Engineering and Testing Services and
Geotechnical Services
Division of Engineering Services

SCOTT JARVIS
Assistant Division Chief
Division of Construction

FROM: PETER VACURA
Chief, Office of Flexible Pavements
Pavement Program
Division of Maintenance
Tel.: 916-274-6194; e-mail: Peter_Vacura@dot.ca.gov

PREPARED BY: PETER VACURA

CONTACT: PETER VACURA

DATE: February 8, 2012

SUBJECT: **California Department of Transportation Transition to Mechanistic-Empirical (ME) Flexible Pavement Design**

ISSUE:

Currently, the California Department of Transportation (Caltrans) uses the R-value method for the design of new flexible pavements and the deflection reduction method for the rehabilitation of existing flexible pavements. Both empirical methods are extremely limited in their ability to account for design parameters such as longer design lives, increased axle loads and tire inflation pressure, new axle configurations, extreme levels of truck traffic repetitions on major freight corridors, climate regions, new materials (rubberized, polymer-modified and warm-mix asphalts, PG graded asphalts, different aggregate sources), and recycled materials (in-place and plant-recycled asphalt, concrete, and granular materials).

Mechanistic-Empirical (M-E) design method provides for the ability to capture the effects of all of the above parameters. Other benefits of the M-E method is its ability to: predict pavement performance at any time during service life, perform forensic pavement failure investigation,

incorporate construction compaction and mix design, consider pavement preservation activities in the design, and integrate with and benefit from the pavement management system (PMS).

The transition to M-E design method parallels the Department's move from the Hveem mix design to the AASHTO Superpave mix design. These two efforts together will better facilitate the transition from existing empirical methods to M-E method for enhanced design of new and reconstructed flexible pavements and rehabilitation of existing flexible and concrete pavements.

BACKGROUND:

California currently uses the R-value empirical design method, originally developed by Francis Hveem, for design of new and reconstructed asphalt pavement, and the empirical deflection-reduction method for design of asphalt overlays. Both of these design methods utilize limited empirical data collected in the 1940s-50s for the R-value method and in the 60s and 70's for the overlay method. The data is limited in types of traffic, climate, and standard materials tested, and can result in conservative designs of new and rehabilitation of existing flexible pavement sections.

Caltrans recognizes the limitations of these two empirical design methods and sees the M-E method as a powerful alternative capable of addressing those limitations. Therefore, Caltrans approved an issue memorandum in 2005 titled "*Adoption of Mechanistic-Empirical (ME) Pavement Design Method*", which calls for ME pavement design methodology to replace existing empirical methods. The issue memorandum has lead to local calibration and adoption of the AASHTO MEPDG for rigid pavement design, and support for completion, calibration and implementation of a California-sponsored research effort to develop M-E design system for flexible pavements. Caltrans completed the development of the new flexible pavement M-E design system early in 2011, and the system now consists of two design and analysis computer programs (including guidelines and users manuals):

- CalME which will replace the current empirical methods of design, and
- CalBack for in-situ material characterization using falling weight deflectometer (FWD) data as input to CalME for rehabilitation design.

DISCUSSION:

The Division of Maintenance, Pavement Program, has developed an implementation plan that leads to statewide full implementation of the M-E design and rehabilitation of flexible pavements. The implementation plan consists of a schedule of various topics shown in Attachment A. The Pavement Program developed a strategic organization structure to assist in the implementation of the M-E method and efficient deployment of the tools needed to perform M-E designs. The organization structure and roles and responsibilities of the various units are provided in Attachment B.

SUBJECT: California Department of Transportation's Transition to Mechanistic-Empirical (M-E) Flexible Pavement Design

RECOMMENDATION:

To implement M-E design across the state.

EFFECT ON EXISTING LAW:

None.

ESTIMATED COST:

The cost to fully implement M-E design procedure is broken down into the following areas:

1. Development of training materials (including web based training) and instruction. The estimated cost to develop the materials is ~$40,000.
2. Laboratory material testing:
    a. Utilize University of California Pavement Research Center (UCPRC) contract for all laboratory testing to be performed at UC Berkeley or University of Nevada, Reno for FY 2012/13 and 2013/14. The cost of conducting the testing will be charged to individual projects.
    b. Assess the ability, validity, and repeatability of the Asphalt Mixture Performance Tester (AMPT) versus AASHTO T-320 and ASSHTO T-321 material characterization in FY 2011/12 and 2012/13. UCPRC research study will cost an estimated $300,000 (funding available). This research will help the Department decide whether to use AMPT for pavement design and specifications development in lieu of AASHTO tests.
    c. Procure AMPT equipment for support of Superpave mix design. $80,000 (funding available).
3. METS will upgrade, in FY 2012/13, the existing beam fatigue machine for conducting AASHTO T-321 test for $100,000. METS will be responsible for supporting districts for testing beginning in FY 2013/14. Testing will be on approximately 6 projects per year for T321 and 2-3 per year for FWD.

TIME FACTOR:

The goal is to have M-E design fully implemented in the districts by June 30, 2012.

SUBJECT: California Department of Transportation's Transition to Mechanistic-Empirical (M-E) Flexible Pavement Design

APPROVED:

Margaret S. Benipal — 2/7/2012

AMARJEET S.BENIPAL — Date
State Pavement Engineer
Pavement Program
Division of Maintenance

Philip J Stolarski — 2/7/12

PHILIP J. STOLARSKI — Date
State Materials Engineer
Deputy Division Chief
Materials Engineering and Testing Services and
Geotechnical Services
Division of Engineering Services

Scott C Jarvis — 2-7-12

SCOTT JARVIS — Date
Assistant Division Chief
Division of Construction

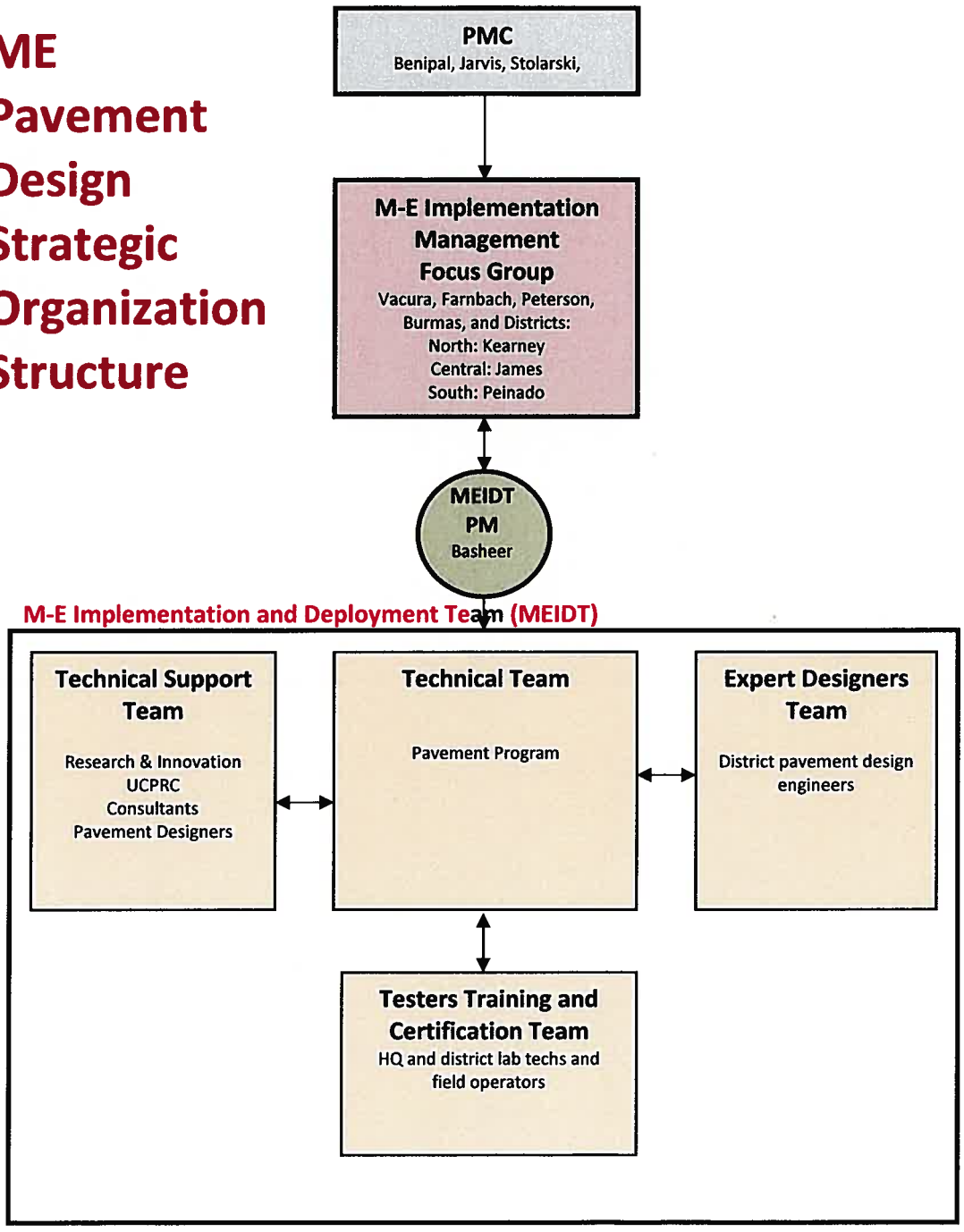
Attachment/s

ATTACHMENT A

	Implementation Topic	Description	Target completion date
1.	**ME Design Awareness**	Develop awareness among Caltrans management boards, district management, district materials engineers and pavement designers regarding the transition to ME design.	2/1/12
2.	**Project Selection Criteria**	Develop criteria to assist engineers in the design and testing levels (amount of input data and design considerations) depending on pavement life, traffic conditions, and project scope.	COMPLETED
3.	**Criteria for Field Testing**	Develop criteria to assist engineers in identifying the minimum field tests that need to be performed depending on project selection criteria. Testing focuses on Falling Weight Deflectometer (FWD) and coring.	COMPLETED
4.	**Criteria for Laboratory Testing**	Develop criteria to assist engineers in identifying the minimum laboratory tests that need to be performed on the materials depending on project selection criteria. Testing focuses on AASHTO T-320 and T-321.	3/31/12
5.	**Development of Performance Threshold Criteria and Reliability Level Selection Criteria**	1. Document criteria for performance thresholds using PaveM. 2. Develop reliability levels for use in project design. 3. This will ensure consistency in design throughout the state.	COMPLETED
1.	**Designer Resources**	Develop all tools to ensure pavement engineers designing with the ME methods are capable of producing the most effective designs. These tools include: • User-friendly software (CalBack, CalME), • Software user's manuals, • User's guidelines, • Revised HDM, • Standard design report.	3/31/12
2.	**Development of Performance Related Specifications (PRS)**	Develop first generation PRS for materials used in constructing pavements designed with ME methods.	2/1/12
3.	**Develop training materials and deliver training**	Identifying training needs and developing the necessary materials and tools needed for training (i) engineers on the use of ME design suite, (ii) laboratory technicians on materials testing, and (iii) field operators on field testing.	6/1/12

ATTACHMENT B

ME Pavement Design Strategic Organization Structure



Roles and Responsibilities

M-E Implementation Management Focus Group

- Provides Department wide representation and management of the deployment of M-E design.
- Oversees the implementation and deployment of M-E design
- Establishes policies and procedures on the use of M-E design.
- Establishes priorities for the successful implementation of M-E design
- Assists the districts in procuring, maintaining, and upgrading field and laboratory testing equipment and devices used in M-E design activities.
- Ensures proper and timely training and certification for field and laboratory technicians.

ME Implementation and Deployment Team (MEIDT)

This team embodies four smaller teams:

Technical Team

- Identifies and evaluate technical (engineering) enhancement aspects of the various ME design tools and resources (guidelines, manuals, and software) and design supplementary inputs such as threshold criteria, project selection, reliability factors, lab and field testing intensity, etc. The Team also prioritizes enhancement issues and makes recommendations to MEIDT manager regarding future work on those issues.
- Provides technical support to district engineers during implementation of the M-E design methods.
- Evaluates and oversees the development of training materials for engineers and technicians.
- Serves as co-instructors and co-trainers for district engineers in M-E pavement design.

Technical Support Team

- Provides support and expertise to Technical Team in aspects of M-E design requiring external review and analysis.
- Facilitates and secures necessary resources and funding to support the Technical Team in implementing M-E design
- Provides input in the implementation steps of M-E design.

Expert Designers Team

In Phase I, members are trainees (from districts) who will be trained to become users and trainer in Phase II. The Team members will:

- Conduct and/or oversee M-E design in their districts.
- Identify non-engineering related challenges in the implementation of the M-E design methods in their districts and communicate those challenges to the districts representatives in the M-E Implementation Management Focus Group.

- Identify and communicate technical (engineering) challenges and issues related to the use of the M-E design resources and tools (manuals, guidelines, software, etc.) to MEIDT manager.
- As trainers, train new engineers in their districts and engineers in other districts on the use of the M-E design methods.
- Assist the Technical Support Team in providing technical assistance to other districts while implementing M-E design.

Testers Training and Certification Team

Team members are FWD and coring field operators and lab technicians from various districts and/or regional labs. Team members will receive necessary training, initial or follow-up, on the use of equipment (field and laboratory) in obtaining data needed for M-E design. For District and Regional laboratories that receive equipment, the Team members' responsibilities will be to:

- Oversee the district's efforts for maintaining and upgrading, laboratory testing equipment and devices used in M-E design activities.
- Oversee and participate in conducting the training for district lab technicians on the new test methods necessary for M-E design.
- Assist district laboratories in obtaining the certification for their labs and technicians through the M-E Implementation Management Focus Group.
- Communicate with the MEIDT manager and the M-E Implementation Management Focus Group on the progress, challenges, and resource needs to effectively respond to testing needs as M-E implementation moves forward.