Research Road Map

Research Area	1. Pavement Management System	2. Smoothness	3. Preservation	4. Quiet Pavements	5. Construction Practices	6. Mechanistic-Empirical Design	7. Long Life Pavements	8. Recycling and Sustainability
Current Problem Statement	Information and data on the pavement infrastructure and highway network within California are not readily accessible or available to all possible end users.	Perception by the public that pavements as currently constructed and maintained within California provides unacceptable poor ride quality.	Pavement preservation techniques are not well understood within the transportation industry and state-of-the-art standards are nonexistent.	Perception by the public and FHWA that pavements as currently constructed and maintained within California result in unacceptable levels of noise.	Highway networks have reached near capacity and construction activities have increasingly negative impacts on the traveling public. Ways to increase construction efficiency and decrease time of lane closures need to be investigated.	With the advent of computers and algorithms it is possible to develop a more scientific approach to the design and analysis of pavement performance and to accurately predict the life of pavements and to determine as well the associated life cycle cost.	Congestion, increased travel times, and accidents associated with frequent construction and maintenance activities have become more prevalent with increases in population.	High quality sources of materials for constructing pavements are becoming more and more scarce relative to the location of construction projects. The scarcity of materials has created a need to find ways of reusing or recycling sound, in-place materials. Policy changes are also requiring that the overall environmental sustainability of highway system needs to be improved.

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Current Objectives	Develop the ability to track pavement structural sections, related pavement performance, and pavement innovations over time by creating an Enterprise Pavement Management System.	• Smoother pavements and higher ride quality.	Pavement preservation techniques, guides, and decision trees and the development of a center of excellence for training and research.	New and better maintained pavements that produce decreased levels of noise.	Faster construction capabilities through prefabrication, new techniques, new materials, composite pavements, and software.	Mechanistic-Empirical (ME) software applications that can be integrated within an enterprisewide Pavement Management System.	Proven structural designs and construction practices that result in significantly increased service life of pavements.	Proven techniques of recycling in-place materials and a well trained and equipped industry workforce.
PPRC Projects	• *SPE 3.3: Support for Implementation of Caltrans PMS* *SPE 3.9: Asset Inventory QA and Network Segmentation* • SPE 4.28: *Version 2 Caltrans Life Cycle Cost Analysis Manual* • SPE 3.10: *Implementation Version 2 LCCA*	• SPE 4.27: *Fourth-year Monitoring of Noise Test Sections* • No work order yet. To be started and work plan developed in 2009/2010: *Support for Certification of Inertial Profilometers*	• SPE 4.21: *Laboratory Evaluation of Mix Design for Thin Overlays* • SPE 4.23: *HVS Evaluation of Thin and Modified Asphalt Overlay Mix Design Procedures* • SPE 3.5: *Performance Related Specifications (PRS) for Pavement*	• SPE 4.27: *Fourth-year Monitoring of Noise Test Sections (noise, texture)* • SPE 4.20: *Laboratory Evaluation of Durability and Noise Properties of Asphalt Surface Mixes* • SPE 4.29: *Field*	• SPE 4.18: *Performance of Warm Asphalt and Low-Energy Mixes (HVS)* • SPE 3.11: *Extended Applications of Rehabilitation Construction Productivity Analysis Products (CA4PRS)* • SPE 3.15: *Performance Based Pay*	• SPE 3.4: *Implementation of Mechanistic-Empirical Pavement Design*	• SPE 3.1.4: *Continued Monitoring of LA710 Phase I Rehab* • SPE 3.2.11: *Continued Support and Monitoring of LA710 Phase II Rehab* • SPE 3.13: *Implementation Support for Long-Life Rehabilitation Projects*	• SPE 3.8: *Support for Field Projects Involving Recycling* • SPE 4.25: *Additional Studies to Support Recycling* • SPE 4.26: *Studies to Support Global Climate Change Initiative* • No work order yet. To be started

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	Manual • SPE 4.15: *Prepare LCCA Integration Analysis Procedure* • No work order yet. To be started and work plan developed in 2009/2010: *LCCA case studies and implementation support LCCA Manual version 3* • •No work order yet. To be started and work plan developed in 2009/2010: *Preliminary Performance Modeling*		*Preservation Treatments* • SPE 3.6: *Acceptance Criteria for Surface Treatments* • SPE 3.7: *Integrating Pavement Preservation into the ME Design Process* • SPE 4.24: *Field and HVS Evaluation of Extended Life Benefits of Pavement Preservation Treatments*	*Evaluation of Noise Benefits of Open-Graded Mixes* • SPE 4.22: *Quiet Concrete Pavement Research*	*Factors* • SPE 3.12: *Innovative Contracting Methods Implementation Studies*			and work plan developed in 2009/2010: *Laboratory and Analysis of Alternative Pavement Materials* • No work order yet. To be started and work plan developed in 2010/2011: *HVS Testing of Alternative Pavement Materials*

1. PAVEMENT MANAGEMENT SYSTEM (PMS)

Critical information and data on the Department's pavement infrastructure and highway network are not readily accessible or available to internal and external end users, and are inadequate to support analysis of optimal maintenance and rehabilitation treatment selection and timing, or to optimize the Department's pavement rehabilitation, maintenance, and preservation (SHOPP) budget. Work performed by the Partnered Pavement Research Center (PPRC) in this area will support the Department first to develop the ability to track over time changes made to pavement structural sections, related pavement performance, and performance changes due to pavement innovations over time by assisting with the implementation of a Pavement Management System. Once an adequate inventory of existing pavement structures has been made and performance data have been collected, preliminary performance models will be developed and used to help identify optimal treatment selection and timing, and optimal budget allocation. This work includes continued improvement of the Department's *Life-Cycle Cost Analysis Manual*—recently developed with the assistance of the PPRC—and support for implementation.

PPRC Projects in this research area:

- SPE 3.3: *Support for Implementation of Caltrans PMS*
- SPE 3.9: *Asset Inventory QA and Network Segmentation*
- SPE 4.28: *Version 2 Caltrans Life Cycle Cost Analysis Manual*
- SPE 3.10: *Implementation Version 2 LCCA Manual*
- SPE 4.15: *Prepare LCCA Integration Analysis Procedure*
- No work order yet. To be started and work plan developed in 2009/2010: *LCCA case studies and implementation support LCCA Manual version 3*
- No work order yet. To be started and work plan developed in 2009/2010: *Preliminary Performance Modeling*

2. SMOOTHNESS

There is a perception by the public that pavements as currently constructed and maintained within California provide unacceptably poor ride quality. The PPRC work in this area will focus on methods of designing and constructing smoother pavements and maintaining smoothness over longer periods of time. This work also includes identification of better methods of measuring and characterizing smoothness, and relating smoothness to pavement design, construction, maintenance, and rehabilitation practices. This work may also include study of the effects of smoothness on the overall transportation system, including interactions of smoothness with highway noise, vehicle fuel economy, pavement deterioration rates due to vehicle interaction, and air pollution.

PPRC Projects in this research area:

- SPE 4.27: *Fourth-year Monitoring of Noise Test Sections*
- No work order yet. To be started and work plan developed in 2009/2010: *Support for Certification of Inertial Profilometers*

3. PRESERVATION

Pavement preservation techniques are not well understood within the transportation industry, and state-of-the-art standards based on quantitative analysis of the effects of pavement preservation treatments and timing on pavement performance are scarce. The objective of this work is to provide information needed for guides and decision support systems for the selection and timing of pavement preservation treatments. The work will include evaluation of new kinds of treatments and development of improvements for existing treatments. Determination of long-term performance data will also be part of this work, and is necessary for life-cycle cost comparisons of pavement preservation alternatives and timing.

PPRC Projects in this research area:

- SPE 4.21: *Laboratory Evaluation of Mix Design for Thin Overlays*
- SPE 4.23: *HVS Evaluation of Thin and Modified Asphalt Overlay Mix Design Procedures*
- SPE 3.5: *Performance Related Specifications (PRS) for Pavement Preservation Treatments*
- SPE 3.6: *Acceptance Criteria for Surface Treatments*
- SPE 3.7: *Integrating Pavement Preservation into the ME Design Process*
- SPE 4.24: *Field and HVS Evaluation of Extended Life Benefits of Pavement Preservation Treatment*

4. QUIET PAVEMENTS

There is a perception by the public and FHWA that pavements as currently constructed and maintained within California produce unacceptable levels of noise. The PPRC work will evaluate new and better maintained pavements that reduce noise generated by traffic. It will also include development of new pavement surfacing materials and textures, and investigation of the interaction of noise with other variables. Determination of long-term performance data is also part of this work, and is necessary for life-cycle cost comparisons of alternatives. The PPRC work will also include helping the Department implement the results of PPRC research and research by partners in its design, policy, and planning processes.

PPRC Projects in this research area:

- SPE 4.27: *Fourth-year Monitoring of Noise Test Sections (noise, texture)*
- SPE 4.20: *Laboratory Evaluation of Durability and Noise Properties of Asphalt Surface Mixes*
- SPE 4.29: *Field Evaluation of Noise Benefits of Open-Graded Mixes*
- SPE 4.22: *Quiet Concrete Pavement Research*

5. BEST CONSTRUCTION PRACTICES

Regional highway networks have reached capacity, or are near capacity at peak hours, and construction activities have increasingly negative impacts on the traveling public. There is a continuing need to increase construction efficiency and quality, and to decrease time of lane closures. Methods for remediation of these needs can come from construction process analysis and contracting methods. The Department recently won a prestigious reward from the International Road Federation based on its support for and implementation of research on construction productivity and the interaction of construction and traffic, primarily based on the construction and traffic analysis tool *CA4PRS*, developed by the PPRC through previous PPRC contracts and pooled fund studies. Proposed PPRC work will include continued development of *CA4PRS* and extension to additional areas of construction, implementation studies, development of productivity field data to better populate the *CA4PRS* database, and training. Additional areas for expansion of *CA4PRS* include widening, bridges, ramps, new strategies, integration with LCCA, and traffic models. *CA4PRS* and other analyses can also be used to assess energy use and emissions associated with pavement construction. Work in this area will include the evaluation of new materials and practices that increase construction efficiency. Evaluation of Warm Mix Asphalt through Heavy Vehicle Simulator (HVS) and laboratory testing began in the last year of the current PPRC contract.

PPRC Projects in this research area:

- SPE 4.18: *Performance of Warm Asphalt and Low-Energy Mixes (HVS)*
- SPE 3.11: *Extended Applications of Rehabilitation Construction Productivity Analysis Products (CA4PRS)*
- SPE 3.15*: Performance Based Pay Factors*
- SPE 3.12: *Innovative Contracting Methods Implementation Studies*

6. MECHANISTIC-EMPIRICAL (M-E) DESIGN

The long-term monitoring of pavements together with the collection of precise performance data from laboratory and HVS testing is providing quality data that are being used in computer models and simulation packages to develop a more scientific approach to the design and analysis of pavement performance, to accurately predict the life of pavements, and to determine associated life-cycle costs. The Department is moving towards M-E design for all of its practice based on a Deputy Directive. The PPRC has developed M-E design methods and software tools for the Department, and evaluated M-E design methods and software produced for AASHTO. The work in this proposed PPRC Research Technical Agreement (RTA) will continue development, evaluation, and calibration of M-E design procedures, collection of laboratory and field testing data to support design, support for implementation by the Department, and use of M-E analysis procedures to create simplified design tools for routine use. Work on M-E design performed by the PPRC will be performed with the additional objective of compatibility with the Pavement Management System (PMS).

PPRC Projects in this research area:

- SPE 3.4: *Implementation of Mechanistic-Empirical Pavement Design*

7. LONG-LIFE PAVEMENTS

Congestion, increased travel times, and accidents associated with frequent construction and maintenance activities have become more prevalent with increases in population. At the same time, the implementation of a new *Life-Cycle Cost Analysis Manual* by the Department (previous PPRC results) has shown that pavements with longer design lives for high traffic locations offer it significant cost savings. Previous PPRC work has included case study design of long-life pavement structures for District 7, and evaluation of structures for District 8 as implementation projects using M-E design and long-term monitoring and documentation of their performance. This work focuses on design and construction practices that will reduce the frequency of such activities and therefore reduce the impact on the traveling public.

PPRC Projects in this research area:

- SPE 3.1.4: *Continued Monitoring of LA710 Phase I Rehab*
- SPE 3.2.11: *Continued Support and Monitoring of LA710 Phase II Rehab*
- SPE 3.13: *Implementation Support for Long-Life Rehabilitation Projects*

8. RECYCLING AND SUSTAINABILITY

Improving the sustainability of pavement operations requires that steps be developed to reduce the resources needed to maintain a high level of service to road users, and to reduce the impacts associated with use of the network. Sustainability is analyzed through Life-Cycle Analysis (of which Life-Cycle Cost Analysis is a subset), and includes consideration of the results of the other seven pavement research program areas to determine energy use, emissions, safety, materials consumption, and repeated reuse. One of the most promising areas for research and development to improve sustainability is recycling of materials for use in pavement layers. One example is the recycling of used tires into asphalt binders, an area of considerable PPRC research and development work in the current and previous contracts. As another example, high-quality sources of materials for constructing pavements are becoming scarcer near the locations where they are needed, resulting in increased cost to the Department and greater environmental impact because of the need to transport large quantities of aggregate over long distances. This scarcity of materials has created a need for finding ways to reuse or recycle sound, in-place materials. Work needed in this area will include evaluation and development of new materials, structural designs, and construction practices that increase the use of recycled pavement materials processed in-place and off-site. Evaluation of unstabilized and foam asphalt-stabilized deep *in-situ* recycled (DISR) pavement layers was completed during the previous PPRC contract. Assessment of other recycled materials is required, and additional implementation work will likely be needed for DISR with foamed asphalt and other stabilizers.

PPRC Projects in this research area:

- SPE 3.8: *Support for Field Projects Involving Recycling*
- SPE 4.25: *Additional Studies to Support Recycling*
- SPE 4.26: *Studies to Support Global Climate Change Initiative*
- No work order yet. To be started and work plan developed in 2009/2010: *Laboratory and Analysis of Alternative Pavement Materials*
- No work order yet. To be started and work plan developed in 2010/2011: *HVS Testing of Alternative Pavement Materials*