State of California
DEPARTMENT OF TRANSPORTATION

Business, Transportation and Housing Agency

Memorandum

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To: DISTRICT DIRECTORS
CHIEF, DIVISION OF CONSTRUCTION
CHIEF, DIVISION OF TRAFFIC OPERATIONS
CHIEF, DIVISION OF ENVIRONMENTAL ANAYLSIS
CHIEF, DIVISION OF ENGINEERING SERVICES
CHIEF, DIVISION OF DESIGN
CHIEF, DIVISION OF MAINTENANCE
CHIEF, DIVISION OF PROJECT MANAGEMENT

Date: October 6, 2009

From: SHAKIR SHATNAWI
State Pavement Engineer
Chief
Division of Pavement Management

Subject: Quieter Pavement Bulletin

This transmittal memorandum provides notice that Quieter Pavement Bulletin is now available on the Pavement website at http://www.dot.ca.gov/hq/esc/Translab/ope/QuieterPavements.html. This bulletin is effective October 15, 2009 for use on all pavement construction or rehabilitation projects in noise sensitive areas of frequent human use where existing noise levels approach or exceed the Federal Noise Abatement Criteria as defined in Title 23, Code of Federal Regulations, Part 772 (23 CFR 772).

BACKGROUND:

Minimizing traffic noise impacts from State highways, while maintaining safe, smooth, and long lasting pavements, is a key goal for all pavement design, construction and maintenance strategies throughout the state. Research done to date has shown that traffic noise can be minimized by incorporating quieter pavement strategies in pavement mix designs and construction practices at little to no added cost. Quieter pavements help reduce the noise generated from the interaction between vehicle tires and pavement (i.e., at the source where the tire meets the road, thereby helping to reduce overall traffic noise impacts to the communities adjacent to the highways. This bulletin is provided as a part of the Department's Quieter Pavement Research (QPR) Program implementation plan to develop design guidance and specifications for quieter pavements in an ongoing effort to address traffic noise issues throughout the state.

GOAL:

The goal of this bulletin and the overall QPR Program is not just to be able to build quieter pavements, but to build quieter pavements that will maintain noise reduction benefits over time without compromising on safety, ride quality, and sustainability of pavement surfaces. This quieter pavement policy bulletin is needed to facilitate this effort statewide and to provide the Districts with the latest information and direction for when and how to design, build, and maintain quieter pavements.

PURPOSE:

This bulletin establishes quieter pavements policy direction for when and how to design, build, and maintain quieter pavements in noise sensitive areas of frequent human use; and provides the latest in technical information.

SUMMARY OF SIGNIFICANT DESIGN GUIDANCE:

This bulletin provides a list of recommended pavement design and construction elements that should be considered on all projects in noise sensitive areas of frequent human use where there is a desire to minimize noise for surrounding areas whether or not other noise abatement measures are taken.

APPLICATION:

This bulletin applies only to pavements, not bridges or structure approach slabs which are under the purview of Structures in the Division of Engineering Services. The bulletin establishes a new mandatory standard for applying quieter pavement treatment strategies in noise sensitive areas that meet all of the following conditions:

- urban locations
- roadways with speed limit of 40 mph or greater
- traditional noise abatement measures, such as sound walls or buffer zones, are either not existing or feasible.

When designing for quieter pavements in the above locations or other noise sensitive areas, the project must meet the design requirements outlined in this bulletin; or obtain approval from HQ Pavement Management for deviations from the required standards or to place a temporary treatment until a permanent quieter pavement treatment can be funded and constructed.

IMPLEMENTATION:

This bulletin is effective October 15, 2009. It is applicable to current projects in the PAED phase and all future projects where there is a desire to minimize traffic noise impacts for neighborhoods adjacent to major highways whether or not conventional noise abatement measures such as sound walls are used. The guidance found in this bulletin should be considered and applied to current projects in the PS&E phase where implementing can be accommodated within existing project budget.

DISTRIBUTION:

It is recommended that copies of this bulletin be distributed down to the Project Engineer, District Maintenance Engineer, Environmental Analyst, and the District Materials Engineer levels. Although this bulletin focuses on the work of the Project Engineer, District Maintenance Engineer, and the District Materials Engineer, there are significant cross-functional considerations that must be coordinated especially with the Divisions of Environmental Analysis and Pavement Management for successful implementation.

Attachment

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Pavement Policy Bulletin

PPB 09-02 Quieter Pavement Strategies for Noise Sensitive Areas

References:

Approved:

SHAKIR SHATNAWI
State Pavement Engineer
Chief, Division of Pavement Management

Effective Date: **October 15, 2009**

1.0 - Policy

1.1 Goal

The goal of the Department is to build and maintain quieter pavements that will sustain traffic noise reduction benefits over time while not compromising on the safety, ride quality, and durability of pavement surfaces. Quieter pavement strategies help reduce the noise generated from the interaction between vehicle tires and pavement (i.e., at the source where the tire meets the road); thus reducing overall traffic noise to the communities adjacent to the highways.

1.2 Definitions

- *Noise Sensitive Areas*

  Noise sensitive areas are defined as areas of frequent human use where lowered noise levels would be of benefit, and existing noise levels approach or exceed the Federal Noise Abatement Criteria as defined in Title 23, Code of Federal Regulations, Part 772 (23 CFR 772).

- *Frequent Human Use*

  Frequent human use is defined as any activity that results in human exposure to traffic noise on a regular basis over the course of a year at a given location. Examples of land uses that could be considered as areas of frequent human use are:

  - residential areas
  - hospitals, school, and churches
  - parks, picnic/recreational areas, and playgrounds
  - hotels and motels

  Examples of land uses that would not be considered as areas of frequent human use are:

  - commercial/industrial areas
  - trails and pathways
  - undeveloped land
  - farms and ranches

- *Noise Receiver*

  Noise receivers are residential properties or other properties of frequent human use that would be impacted or benefit from the noise abatement measure being considered.

1.3 – Purpose of Bulletin

This bulletin establishes quieter pavements policy direction for when and how to design, build, and maintain quieter pavements in noise sensitive areas of frequent human use, and provides the latest in technical information.

2.0 - Application

This bulletin applies only to pavements, not bridges or structure approach slabs which are under the purview of Structures in the Division of Engineering Services. Per 23 CFR 772, quieter pavement systems are not an approved noise abatement measure on federally funded projects pending the outcome of the ongoing nationwide research on the noise reduction benefits and

longevity of quieter pavement surface treatment strategies. In view of this federal regulation, the following reflects the Department's policy for the application of pavement surface treatments needed to reduce noise (see Section 3.0) on ongoing new construction or pavement preservation/rehabilitation projects.

- *Mandatory Application in Noise Sensitive Areas of Frequent Human Use.*

  Quieter pavement strategies shall be used in noise sensitive areas of frequent human use that meet all of the following criteria:

  - **In urban locations**
  - **In roadways with speed limit of 40 mph or greater**
  - **When traditional noise abatement measures, such as sound walls or buffer zones, are either not existing or feasible.**

  This policy constitutes a mandatory design standard as defined in the Highway Design Manual, Topic 82.

- *Optional Application in Other Noise Sensitive Areas.*

  Quieter pavement strategies may be considered in other noise sensitive locations to supplement but not as a substitute or alternative for sound walls or other approved noise abatement measures when said measures are justified per 23 CFR 772.

- *Performance Requirements.*

  - Pavement design life requirements, safety requirements, and other pavement performance standards found in the Highway Design Manual, Traffic Noise Analysis Protocol, and other Department manuals must still be met.
  - Selected quieter pavement strategy should be the one with the lowest life cycle cost of the available quieter pavement strategies as determined by this bulletin and the Life Cycle Cost Analysis Procedures Manual.
  - Design and material standards/requirements found in this bulletin are met.

3.0 - Approved Quieter Pavement Surfaces

The following surfaces have been approved as quieter pavement strategies based on research data collected throughout the state and nationally.

1. Flexible/Composite Pavement

   a. Rubberized Hot Mix Asphalt, Type O (RHMA-O) overlay or surface treatment: Use ½ inch maximum aggregate size or smaller.

   b. Open Graded Friction Course (OGFC) overlay or surface treatment: Use ½ inch maximum aggregate size or smaller and polymer modified binder.

   Note: Where RHMA-O and OGFC are not allowed for other reasons, a gap graded rubberized hot mix (RHMA-G) or dense graded hot mix asphalt (HMA) using 1/2" maximum aggregate size or smaller is acceptable.

2. Rigid Pavement

   a. Diamond grind new and existing pavement surface: Consult with Division of Pavement Management on most current specifications to use.

   b. Rubberized Hot Mix Asphalt, Type O High Binder (RHMA-O-HB) overlay or surface treatment: Use ½ inch maximum aggregate size or smaller.

Note: Noise reducing thin asphalt overlays should not be used in locations where snow tires and chains are allowed during the winter season.

Other Strategies are being investigated and may be included in future updates of this bulletin. For further information on possible use of these and other strategies for quieter pavement surface treatments, contact the HQ Quieter Pavement Coordinator in the Office of Pavement Policy and Planning, Division of Pavement Management.

4.0 - Additional Design Requirements

The following design requirements are necessary to assure a quieter pavement will meet performance goals and requirements:

1. Apply quieter pavement surface treatments across all traffic lanes, in both directions, including HOV lanes, auxiliary lanes, and ramps where posted speed limit is 40 miles/hour or greater.

2. To reduce traffic noise in the area of concern, the limits of the pavement treatment in each direction should extend for at least three times the offset distance from the end noise receiver(s) to the center of the nearest traffic lane but not to exceed 500 feet beyond the end noise receiver(s) as shown in Figure 1. This will be the required begin and end limits for the quieter pavement surface treatment.

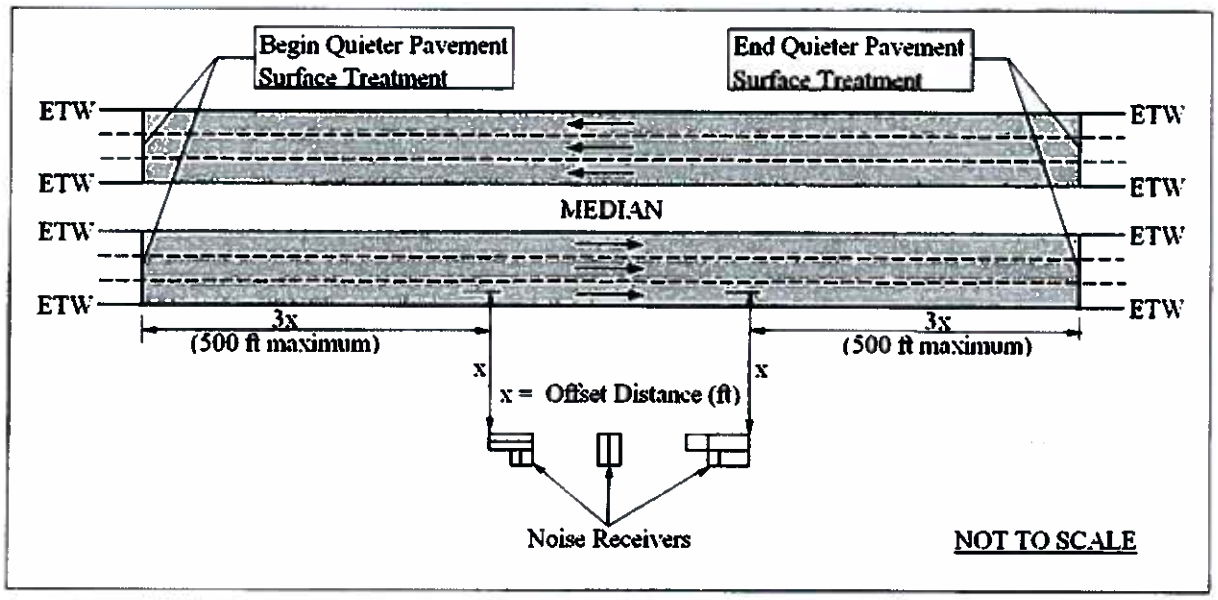

FIGURE 1
Begin and End Limits for Quieter Pavement Surface Treatment

3. When widening an existing facility, the existing lanes should be repaired and approved surface treatment applied as part of the project in accordance with the identified pavement need (preventive maintenance, CAPM, or rehabilitation) identified in the pavement condition survey.

4. Prior to or in conjunction with placing approved quieter pavement overlays over existing pavements, failed areas shall be replaced, cracks sealed (specify recessed fills only), spalls repaired, and rough ride corrected. In addition, for rigid pavements, the following corrective measures shall be undertaken prior to applying the quieter pavement surface treatment:

    a. Diamond grind existing surface as needed to remove any faulting or slab curling. The grinding specifications should specify achieving the profile index values specified in the Section 40-1.10 Final Finishing of the Standard Specifications and not limit the maximum depth of grind to achieve that result.

    b. Existing transverse joints should be tested for Load Transfer Efficiency (LTE). If the results indicate a deficiency, perform one or several of the following mitigations: dowel bar retrofit; slab or lane replacement; or crack, seat and overlay. Each of these rehabilitation strategies should be evaluated using a LCCA to determine the most cost-effective solution. Dowel bar retrofit and slab replacement guidelines should be used if these alternatives are chosen. Dowel bar retrofit guidelines can be found in the *Jointed Plain Concrete Pavement Preservation and Rehabilitation Guide* at the Department's pavement website.

5.0 - Material Elements

The materials selected have been shown through research to have an impact on the noise characteristics and longevity of pavements. Research has shown that the Department already utilizes a number of elements which minimize noise levels or extend the noise reduction benefits from pavements. Such elements include the following:

- Open graded friction course overlays
- RHMA using ½ inch maximum aggregate size or smaller
- Longitudinal tining of concrete pavements
- Grinding concrete pavements
- Doweled or continuously reinforced concrete pavement

The following table provides additional material and specification requirements to use for designing or maintaining quieter pavement strategies in noise sensitive areas. These additional requirements can also be considered on other pavements where there is a desire to minimize noise.

Pavement Surface Type	Element	Description
ALL PAVEMENTS	Smoothness	Wherever applicable, use nSSP for incentive-based smoothness specification (see smoothness web page on the Pavement website) to ensure a high standard of smoothness for the finished surface. Smoother pavements are quieter.
	Crack sealing	Avoid excess crack sealant protruding above pavement surface (i.e. do not overfill.) Use flush or recessed fills. (See Maintenance Manual, Volume 1, A19 for flexible pavement joint and crack sealing, and B09 for rigid pavement joint and crack sealing. Additional information can also be found in the Maintenance Technical Advisory Guide (MTAG) Volume I (Flexible Pavement) and Volume II (Rigid Pavement)). Both the Maintenance Manual and the MTAG can be found on the Division of Maintenance website.
FLEXIBLE & COMPOSITE PAVEMENT (NEW & PRESERVATION/ REHABILITATION)	Aggregate Size	Use ½" maximum aggregate size or smaller for the surface course of the pavement.
	Binder	Use polymer modified or rubberized asphalt binders to extend the life of the surface course of the asphalt.
NEW RIGID PAVEMENT	Transverse Joints	Where a new jointed plain concrete pavement (JPCP) is placed, the transverse joints should be designed and constructed as follows to minimize joint slap noise, which increases overall traffic noise. • Use $^1/_8$ inch single cut instead of ¼ inch double cut joint width . • Avoid excess joint sealant protruding above pavement surface.
	Alternate Surface Textures to Longitudinal Tining or Diamond Grinding	Other textures which can be applied to new rigid pavement surface in lieu of longitudinal tining or diamond grinding with prior approval of Division of Pavement Management are: • Burlap drag finish • Broom finish • Astroturf drag finish Test data indicate that these surface textures may be quieter than longitudinal tining, but care should be taken to make sure that the pavement surface meets friction requirements.

6.0 - Funding

Federal Highway Trust Funds may be used for new pavement surfacing, including quieter pavement strategies, as long as the justification for the surfacing is for reasons other than noise abatement, such as pavement preservation or rehabilitation. The following are the main alternatives for funding quieter pavement surface treatments where needed to reduce traffic noise impacts with or without being a part of pavement preservation or rehabilitation project.

6.1 - State Funding

The Department will assume the cost of placing the quieter pavement surface treatment if the project meets any of the following conditions:

1. A state funded widening or new construction project is planned or programmed for the location requested.
2. A preservation/rehabilitation project is currently programmed, in the 10-year SHOPP, or the 5-year Maintenance Plan for the location requested.
3. There is a current construction project at the location requested and the construction project has sufficient funds to do the additional work.

6.2 - Local Agency Funding

The requesting Local Agency will be required to pay for the cost of placing the quieter pavement surface treatment under the following conditions:

1 If the local agency would like quieter pavement surface treatment done where no work is planned/programmed by the Department or sooner than when the Department can fund the work.

2 If the requesting local agency wants to apply a more expensive quieter pavement surface treatment than what exists or is recommended by the Department. Note that more expensive can also apply to life cycle costs, meaning if the cost to maintain the pavement is higher than what exists or is recommended by the Department, the local agency can be required to pay for the additional future maintenance cost as well.

Any work done and/or funded by the local agency should be established through a Cooperative Agreement and agreed to by the State Pavement Engineer. Costs borne by the local agencies should include payment for wayside traffic noise measurements conducted to assess or monitor noise both before and after construction. Costs to evaluate existing pavement structural conditions and OBSI tire/pavement noise source measurements will be borne by the Department.

7.0 - Coordination

The longevity and durability of the acoustic benefits under different environmental and traffic conditions is not entirely understood at this time. To facilitate statewide coordination of projects involving quieter pavement strategies, it is important that the District or project sponsor notify the HQ Quieter Pavement Coordinator at least 3 months prior to placing the quieter pavement surface treatment. HQ may require noise measurements of the site before and after construction and periodic measurements for several years. The data obtained will help guide future research work on long-term acoustic characteristics of quieter pavement strategies.

Additional information on quieter pavements can be found on the Department Pavement website or the Division of Environmental Analysis website.

For questions or to submit requests for nonstandard application of quieter pavement strategies, please contact the following:

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8.0 - Bibliography

1. American Concrete Pavement Association (ACPA), R&T Update, Quieting Concrete Pavement Through Surface Texture Design and Modification, August 2006.

2. Aybike Ongel, John T. Harvey, Erwin Kohler, Qing Lu, Bruce D. Steven and Carl L. Monismith, Investigation of Noise, Durability, Permeability, and Friction Performance Trends for Asphalt Pavement Surface Types, First- and Second-Year Results - Summary Report, Prepared for California Department of Transportation, Report No. UCPRC-SR-2008-01, August 2008.

3. Bruce Rymer, Turn Down the Volume - Quiet Pavement and Traffic Noise Research in California, California Transportation Journal, Volume 2, Issue 1, 2006.

4. California Department of Transportation, Quieter Pavement Research Summary For Federal Highway Administration Information, November 2006.

5. California Department of Transportation, Traffic Noise Analysis Protocol, Prepared by Division of Environmental Analysis, August 2006.

6. Douglas I. Hanson, Robert S. James, Christopher NeSmith, Tire/Pavement Noise Study, NCAT Report 04-02, August 2004.

7. Douglas I. Hanson, Robert S. James, Colorado DOT Tire/Pavement Noise Study, Report No. CDOT-DTD-R-2004-5, April 2004.

8. Dravitzki, V., Kvatch, I., Road Surface Effects on Traffic Noise, Stage 3 – Selected Bituminous Mixes. Land Transport New Zealand Research Report 326, 2007.

9. Federal Highway Administration (FHWA), The Roadmap to Quiet Highways, Results of the FHWA Workshop, September 14-16, 2004.

10. Hans Bendtsen, Jørgen Kragh and Erik Nielsen, Use of noise reducing pavements - European experience, Danish Road Institute Technical Note 69, Prepared for California Department of Transportation, June 2008.

11. Illingworth & Rockin, Inc., I-80 Davis OGAC Pavement Noise Study - Traffic Noise Levels Associated With Aging Open Grade Asphalt Concrete Overlay, 7th Year Summary Report, Prepared for California Department of Transportation, December 2005.

12. Kandhal, P.S., Asphalt Pavements Mitigate Tire/Pavement Noise, Published in Hot Mix Asphalt Technology, MARCH/APRIL 2004, pp 22-31.

13. Keith W. Anderson, Linda M. Pierce, Jeff S. Uhlmeyer, and Jim Weston, Evaluation of Long-Term Pavement Performance and Noise Characteristics of Open-Graded Friction Courses – Project 2, Report No. WA-RD 691.1, March 2008.

14. Manuel Trevino and Terry Dossey, A Research Plan for Measuring Noise Levels in Highway Pavements in Texas, Report No. FHWA/TX-07/0-5185-1, July 2006; Revised November 2006.

15. Michael E. Ayers, Surface Texture Issues Related to Concrete Pavements, American Concrete Pavement Association.

16. Michael Fickes, "Asphalt Phenomenon - When asphalt rubber silenced road noise on an Arizona freeway, the public demanded more." Hot Mix Asphalt Technology, July/August 2003

17. National Center for Asphalt Technology (NCAT), Noise Level of Asphalt pavements in the United States, Presented at Quiet Asphalt 2005 Symposium, Lafayette, Indiana, November 1-3, 2005.

18. Paul Donavan, "Quieting of Portland Cement Concrete Highway Surfaces with Texture Modifications", Proceedings of Noise-Con 2005, Minneapolis, MN, October 2005.

19. Paul Donavan, Comparative Measurements of Tire/Pavement Noise in Europe and the United States, A Summary of the NITE Study, Prepared by Illingworth & Rodkin, Inc. for the California Department of Transportation, 2004.

20. Paul R Donavan and Dana M Lodico, Measuring Tire-Pavement Noise at the Source, NCHRP Report 630, Transportation Research Board, Washington DC, 2009.

21. Paul Wiegand, Concrete Solutions for Quieter Pavements on Existing Roadways, Tech Brief, National Center for Asphalt Technology, October 2006.

22. Robert Bernhard, Roger L Wayson, et.al., An Introduction to Tire/Pavement Noise of Asphalt Pavement

23. Robert Otto Rasmussen, Robert J. Bernhard, Ulf Sandberg, and Eric P. Mun, The Little Book of Quieter Pavements, Report No. FHWA-IF-08-004, July 2007.

24. Robert Otto Rasmussen, Sabrina I. Garber, Gary J. Fick, Theodore R. Ferragut, and Paul D. Wiegand, How to Reduce Tire-Pavement Noise, Interim Better Practices for Constructing and Texturing Concrete Pavement Surfaces. PCC Surface Characteristics, Tire-Pavement Noise Program Part 3 – Innovative Solutions/Current Practices, Pooled Fund TPF-5(139), July 2008.

25. Robert Otto Rasmussen, Tire/Pavement and Environmental Traffic Noise Research Study, Prepared for Colorado Department of Transportation, Report No. CDOT-2008-2, July 2008.

26. Steven M. Karamihas and James K. Cable, Developing Smooth, Quiet, Safe Portland Cement Concrete Pavements, Center for Portland Cement Concrete Pavement Technology, Iowa State University, FHWA Project DTFH61-01-X-0002, March 2004.

27. Ulf Sandberg and J. Ejsmont, Tyre/Road Noise Reference Book, Informex, Handelsbolag, Sweden, 2002.

28. Vi Brown, Survey of Traffic Noise Reduction Products, Materials, and Technologies, Prepared for Arizona Department of Transportation, Report No. FHWA-AZ-08-584, February 2008.

29. Wayne Jones, Quiet Pavement – Coming to a Highway Near You. Published in Asphalt, Summer 2005.

Acronyms and Abbreviations

CAPM	Capital Preventive Maintenance
CFR	Code of Federal Regulations
HMA	Dense-graded Hot Mix Asphalt
JPCP	Jointed Plain Concrete Pavement
MTAG	Maintenance Technical Advisory Guide
OGFC	Open Graded Friction Course
PPB	Pavement Policy Bulletin
QPC	Quieter Pavement Committee
QPR	Quieter Pavement Research
RHMA-G	Gap-graded Rubberized Hot Mix Asphalt
RHMA-O	Open-graded Rubberized Hot Mix Asphalt
RHMA-O-HB	Open-graded Rubberized Hot Mix Asphalt - High Binder
UCPRC	University of California Pavement Research Center