State of California
AIR RESOURCES BOARD

RESEARCH PROPOSAL

Resolution 12-42

December 6, 2012

Agenda Item No.: 12-9-4

WHEREAS, the Air Resources Board (ARB or Board) has been directed to carry out an effective research program in conjunction with its efforts to combat air pollution, pursuant to Health and Safety Code sections 39700 through 39705;

WHEREAS, a research proposal, number 2748-275, entitled "Life Cycle Assessment and Co-benefits of Cool Pavements," has been submitted by the Lawrence Berkeley National Laboratory;

WHEREAS, in accordance with Health and Safety Code section 39705, the Research Screening Committee has reviewed and recommends for funding:

> Proposal Number 2748-275 entitled "Life Cycle Assessment and Co-benefits of Cool Pavements," submitted by the Lawrence Berkeley National Laboratory, for a total amount not to exceed $550,000.

WHEREAS, the Research Division staff has reviewed Proposal Number 2748-275 and finds that in accordance with Health and Safety Code section 39701, cool communities strategies, such as cool roofs and cool pavements, can reduce greenhouse gas emissions; reduce temperatures and related heat stress; reduce air pollutants; and decrease building cooling energy use. This project seeks to advance the appropriate adoption of cool pavement technologies by providing local decision makers with data on the potential impacts and benefits, including life cycle impacts, of adopting cool pavement technologies in their jurisdiction. The Research Division staff recommends this proposal for approval; and

WHEREAS, the Air Resources Board will fund Phase 1 of this proposal for a total amount $450,000, with $100,000 co-funding from Caltrans for Phase 1; and an additional $100,000 co-funding to be identified to cover Phase 2.

NOW, THEREFORE, BE IT RESOLVED that the Air Resources Board, pursuant to the authority granted by Health and Safety Code section 39703, hereby accepts the recommendations of the Research Screening Committee and Research Division staff and approves the following:

Proposal Number 2748-275 entitled "Life Cycle Assessment and Co-benefits of Cool Pavements," submitted by the Lawrence Berkeley National Laboratory, for a total amount not to exceed $550,000.

BE IT FURTHER RESOLVED that the Executive Officer is hereby authorized to initiate administrative procedures and execute all necessary documents and contracts for the research effort proposed herein, and as described in Attachment A, in an amount not to exceed $550,000.

I hereby certify that the above is a true and correct copy of Resolution 12-42, as adopted by the Air Resources Board.

Tracy Jensen

Tracy Jensen, Clerk of the Board

ATTACHMENT A

"Life Cycle Assessment and Co-Benefits of Cool Pavements"

Background

Cool pavements with high solar reflectance can reduce ambient temperatures, slow the temperature-dependent formation of smog, decrease air conditioning and peak electricity demand, and induce negative radiative forcing that cools the atmosphere (Rosenfeld et al. 1998; Akbari et al. 2009). As California cities begin to consider cool pavements as a strategy to reduce greenhouse gases (GHG), improve air quality, and reduce urban heat islands, decision-makers require a strong understanding of the lifecycle impacts of these strategies.

Life cycle assessment (LCA) offers a comprehensive approach to evaluate and improve the environmental impacts of pavements. While pavement life cycle assessment is an expanding research field, previous analyses remain largely project specific, are limited in their inclusion of use-phase impacts (including heat island effects), and have not included cool pavement technologies (Santero et al. 2010).

The proposed research project seeks to advance the adoption of strategies to reduce the greenhouse gas and air pollutant emissions and urban heat island effects of pavement systems within California.

Objective

The objective of this project is to build upon existing LCA work to evaluate traditional and cool pavements across a variety of environment outcomes, including greenhouse gas emissions, and local climate and air quality impacts due to changing albedo.

Methods

Researchers will conduct a literature review on pavement LCA and cool pavements to assess the full range and boundaries of the impacts of cool pavements, and to identify LCA data sources that quantify consumption, emissions, and impacts from pavement system processes and can be used in this analysis. Using this information, the research team, in consultation with ARB, will convene a committee composed of city planners, pavers, and other experts to inform the selection of pavements to evaluate, and the scope and boundaries of the LCA. Once this is determined, the team will begin constructing the life-cycle inventories (LCIs) for various pavement systems of interest. The project will also improve upon existing pavement LCA models by evaluating the use-phase effects of changes in pavement albedo, using climate, air quality, and building energy models. These data will be combined to create a modeling tool that will be used to evaluate the environmental impacts of adopting cool pavements for a variety of different climatic and city condition scenarios in California. In addition, sensitivity analyses will be performed to evaluate which city characteristics have the most influence on the local effects of cool pavements. Guidelines will be created to facilitate the maintenance of the modeling and guidance tools.

Expected Results

The project will result in a pavement strategy guidance tool that will help local and regional decision-makers as they consider adopting more sustainable pavement design practices. In addition, this first ever California-specific network level life-cycle analysis

will result in valuable California region-specific data on the various impacts of pavement lifecycle phases for both traditional and cool pavements.

Significance to the Board
Strategies that can simultaneously reduce greenhouse gas emissions and reduce the temperature and air quality impacts from climate change offer tremendous potential to ensure the health of our communities. Cool communities strategies, such as cool roofs and cool pavements, can reduce greenhouse gas emissions; reduce temperatures and related heat stress; reduce air pollutants; and decrease building cooling energy use. This project seeks to advance the appropriate adoption of cool pavement technologies by providing local decision makers with data on the potential impacts and benefits, including life cycle impacts, of adopting cool pavement technologies in their jurisdiction.

Contractor:
Lawrence Berkeley National Laboratory

Contract Period:
36 months

Principal Investigator (PI):
Dr. Ronnen Levinson, Ph.D.

Contract Amount:
$450,000, $100,000 from Caltrans and $100,000 co-funding to be identified if Phase 2 is pursued.

Cofunding:
Caltrans is contributing $100,000 to this project through a separate contract with the University of California Pavement Research Center. In addition, $100,000 for Phase 2 is currently being pursued. If additional funds are not secured for Phase 2, this project will still produce a life cycle assessment and fully functioning draft decision support tool.

Basis for Indirect Cost Rate:
Rates are those approved by the U.S. Department of Energy and are included in Lawrence Berkeley National Laboratory's FY 2012 Forward Pricing Rates.

Past Experience with this Principal Investigator:
Dr. Ronnen Levinson is also the Principal Investigator of an active research contract supported by the California Energy Commission and ARB entitled, "Cool Communities," which seeks to advance the science of cool communities strategies and provide technical assistance to assist in their adoption. Dr. Levinson and his research team at LBNL's Heat Island Group are one of the few, if only research groups working on quantifying the potential climate benefits of changes in surface albedo from large-scale adoption of more reflective roofs and pavements. The research team has the air quality and local climate modeling expertise necessary for this project, and they also have experience working with local governments and pavement technology manufacturers which will aid in the outreach portion of this project.

ARB has not worked directly with Dr. John Harvey, a subcontractor on the project. Dr. Harvey is a professor of Civil and Environmental Engineering at UC Davis; the Department Chair of the Transportation Technology and Policy graduate studies program; and director of the University of California Pavement Research Center

(UCPRC) at the University of California, Berkeley and Davis. He is the Principal Investigator for the Caltrans-sponsored effort on developing LCA models for California pavements, and also works closely with both the concrete, asphalt and other pavement industries on environmental issues related to pavement. Dr. Harvey is an expert on the design, materials, rehabilitation, life cycle, maintenance and reconstruction of asphalt and concrete pavements, as well as pavement strategy selection.

Prior Research Division Funding to Lawrence Berkeley National Laboratory:

Year	2012	2011	2010
Funding	$ 1,980,873	$ 650,000	$ 0

Attachment B

BUDGET SUMMARY

Contractor: Lawrence Berkeley National Laboratory

Life Cycle Assessment and Co-benefits of Cool Pavements

DIRECT COSTS AND BENEFITS		PHASE 1	PHASE 2
1.	Labor and Employee Fringe Benefits	$ 184,332	$ 30,600
2.	Subcontractors	$ 60,192	$ 35,763
3.	Equipment	$ 0	$ 0
4.	Travel and Subsistence	$ 3,420	$ 1,710
5.	Electronic Data Processing	$ 0	$ 0
6.	Reproduction/Publication	$ 0	$ 0
7.	Mail and Phone	$ 0	$ 0
8.	Supplies	$ 224	$ 112
9.	Analyses	$ 0	$ 0
10.	Miscellaneous	$ 63,130[1]	$ 7,987
	Total Direct Costs	$ 311,298	$ 76,172
INDIRECT COSTS			
1.	Overhead	$ 138,702	$ 23,828
2.	General and Administrative Expenses	$ 0	$ 0
3.	Other Indirect Costs	$ 0	$ 0
4.	Fee or Profit	$ 0	$ 0
	Total Indirect Costs	$ 138,702	$ 23,828
	TOTAL PROJECT COSTS	**$ 450,000**	**$ 100,000**

Note: In addition to the $450,000 of ARB funding for Phase 1, Caltrans will contribute $100,000 to support Phase 1.

[1] Miscellaneous costs include graduate student fee remission, procurement budget, electricity, department burden and miscellaneous recharges, and organization burden, consistent with the U.S. Department of Energy's full-cost recovery policy.

Attachment C

SUBCONTRACTORS' BUDGET SUMMARY

Subcontractor: University of California, Davis

Description of subcontractor's responsibility: UCPRC will participate in the tasks involving life cycle assessment (LCA), pavement engineering and pavement management.

DIRECT COSTS AND BENEFITS		PHASE I	PHASE 2
1.	Labor and Employee Fringe Benefits	$ 26,817	$ 10,005
2.	Subcontractors	$ 0	$ 0
3.	Equipment	$ 0	$ 0
4.	Travel and Subsistence	$ 279	$ 251
5.	Electronic Data Processing	$ 0	$ 0
6.	Reproduction/Publication	$ 0	$ 0
7.	Mail and Phone	$ 0	$ 0
8.	Supplies	$ 0	$ 0
9.	Analyses	$ 0	$ 0
10.	Miscellaneous	$ 0	$ 0
	Total Direct Costs	$ 27,096	$ 10,256

INDIRECT COSTS		PHASE 1	PHASE 2
1.	Overhead	$ 2,710	$ 1,026
2.	General and Administrative Expenses	$ 0	$ 0
3.	Other Indirect Costs	$ 0	$ 0
4.	Fee or Profit	$ 0	$ 0
	Total Indirect Costs	$ 2,710	$ 1,026
	TOTAL PROJECT COSTS	**$ 29,806**	**$ 11,282**

Attachment D

SUBCONTRACTORS' BUDGET SUMMARY

Subcontractor: PE International, Inc.

Description of subcontractor's responsibility: PE International will contribute to all tasks and bring experience of applying life cycle assessment (LCA) to pavement systems.

DIRECT COSTS AND BENEFITS		PHASE I	PHASE 2
1.	Labor and Employee Fringe Benefits	$ 27,000	$ 22,500
2.	Subcontractors	$ 0	$ 0
3.	Equipment	$ 0	$ 0
4.	Travel and Subsistence	$ 0	$ 0
5.	Electronic Data Processing	$ 0	$ 0
6.	Reproduction/Publication	$ 0	$ 0
7.	Mail and Phone	$ 0	$ 0
8.	Supplies	$ 0	$ 0
9.	Analyses	$ 0	$ 0
10.	Miscellaneous	$ 0	$ 0
	Total Direct Costs	$ 27,000	$ 22,500

INDIRECT COSTS		PHASE 1	PHASE 2
1.	Overhead	$ 0	$ 0
2.	General and Administrative Expenses	$ 0	$ 0
3.	Other Indirect Costs	$ 0	$ 0
4.	Fee or Profit	$ 0	$ 0
	Total Indirect Costs	$ 0	$ 0
	TOTAL PROJECT COSTS	**$ 27,000**	**$ 22,500**