Sustainable Pavements Case Study

Sustainable Transportation Program

INVEST Operations & Maintenance

Operations and Maintenance (OM) is the third step in the lifecycle of a transportation project. This is where infrastructure planned, designed and constructed in prior steps is operated and maintained, resulting in needs for data collection and new project identification. This information is then passed back to the SP step, to complete the lifecycle of projects. This module focuses on performing system-level operations and maintenance activities in a manner that contributes to the overall sustainability of the highway network. The OM criteria are primarily written for the scoring of an agency's internal, system operations as well as, asset management and maintenance activities performed on the network infrastructure. The OM module contains 14 criteria and will constitutes the bulk of ADOT's 2015 sustainability efforts.

Goal

OM-07: Pavement Management System

Leverage a pavement management system to balance activities that extend the life and function of pavements with impacts to the human and natural environment.

Sustainability Linkage

Maintaining and using a pavement management system supports the environmental and economic principles by optimizing the management of pavements, including preservation, restoration, and replacement, to maximize their lifetime. This reduces costs, the environmental impacts of construction, and raw material usage.

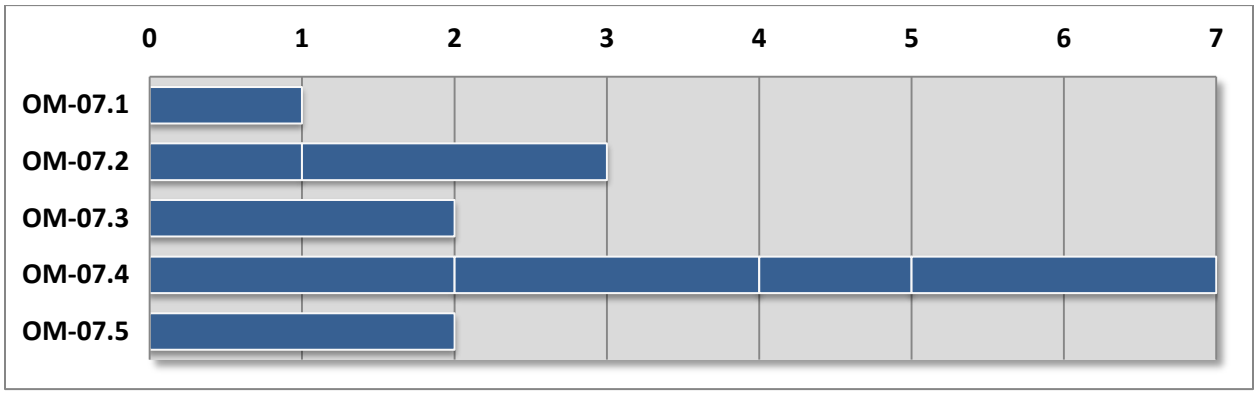
This criterion includes the following elements:

- Develop a Pavement Management System and Collect Data
- Track Pavement Network Performance
- Set Goals and Monitor Progress
- Leverage Data to Demonstrate Sustainable Outcomes
- Sustainable Specifications

Overall, ADOT views the INVEST OM Pavement Management System as contributing to sustainability by optimizing pavement life cycles to reduce costs, the environmental impacts of construction, and raw material usage.

ADOT OM-07 Performance

ADOT received all 15 points available for OM-07, and goes above and beyond INVEST goals.



-Requirement OM-07.1: Develop a Pavement Management System and Collect Data
1/1 point

ADOT has a system-wide Pavement Management System (PMS) which incorporates all required elements.

-Requirement OM-07.2: Track Pavement Network Performance
3/3 points

- *Requirement OM-07.2a: Use Common Metrics (1/1 point)*

  ADOT tracks pavement using common metrics, including IRI.

- *Requirement OM-07.2b: Measure Project Timelines (2/2 points)*

  The PMS identifies future projects and activities as well as project histories.

-Requirement OM-07.3: Set Goals and Monitor Progress
2/2 points

ADOT sets quantifiable goals for pavement condition and has monitored progress toward these goals for several years.

-Requirement OM-07.4: Leverage Data to Demonstrate Sustainable Outcomes
7/7 points

- *Requirement OM-07.4a: Leverage PMS Data to Prioritize Projects (2/2 points)*

  ADOT leverages PMS data and traffic counts to prioritize projects.

- *Requirement OM-07.4b: Leverage Life Cycle Cost Analysis (LCCA) to Predict Costs (2/2 points)*

  ADOT performs LCCA to predict short- and long-term costs every year.

- *Requirement OM-07.4c: Include Pavement Preservation in Annual Plan (1/1 point)*

  ADOT's STIP includes lump sum pavement preservation needs.

- *Requirement OM-07.4b: Link Pavement Repair, Preservation and Maintenance to Projects (2/2 points)*

  Pavement preservation and maintenance activities are linked to capital projects.

-Requirement OM-07.5: Sustainable Specifications
2/2 points

ADOT's pavement team always considers sustainable pavements for its projects. The sustainable pavements are used when they are the best option available.

ADOT Transportation Defined: Pavement Design Life

Pavement design life is a term that engineers use when they're planning to build a new road or maintain an existing roadway. They'll also use a number of years to go along with it, for example: 10-year pavement design life, 20-year pavement design life, etc.

The phrase should not be taken to imply that a road is only being built to survive for a set number of years. What it does represent is the road's age at which some preventative maintenance or reconstruction will be considered so the road can continue to be durable and useful for the traffic it's serving.

For a typical highway, ADOT generally will design asphalt pavement for 20 years. A lot is taken into consideration, soil condition, location, expected traffic levels and the area's climate. All those conditions play a role in how the pavement is designed. Say, for example, the road's being built in an area that gets very cold weather. If that's the case, engineers will adjust the asphalt pavement mix to account for the temperature extremes.

ADOT Quiet Pavement Program

One the real standout programs at ADOT is the Quiet Pavement Program. Back in the early 2000s ADOT started to hear from drivers who said certain stretches of Valley freeways seemed quieter than others. ADOT and the Maricopa Association of Governments (MAG) noticed a difference, too. It seemed that areas paved with an asphalt rubber friction course (rubberized asphalt), which MAG funded through the Regional Transportation Plan, were less noisy than freeway surfaces with cement concrete pavement. ADOT set out to determine whether the rubberized asphalt really did make any difference when it comes to noise abatement. ADOT officials also wanted to know whether the perceived noise-reducing properties of the rubberized asphalt would last as the pavement aged.

After some initial studies showed promise, ADOT, in connection with the Federal Highway Administration, developed the Quiet Pavement Pilot Program in 2003.

A three-year, $34 million project to surface about 115 miles of Phoenix-area freeways with rubberized asphalt is working toward a smoother ride for motorists and quieter neighborhoods for those who live adjacent to the roads.

The first areas to receive the “quiet pavement” were on the Loop 101 Agua Fria Freeway from Union Hills Drive to 31st Avenue, and on the Loop 101 Pima Freeway from 21st Avenue to Tatum Boulevard and from Frank Lloyd Wright Boulevard to Mountain View Road. State Route 51 was resurfaced from Shea Boulevard to Bell Road. The entire Loop 101 and SR 51 freeways plus sections of Interstate 10, Interstate 17 and the Loop 202 Red Mountain and Santan freeways will also receive new rubberized asphalt surfaces.

What Is Rubberized Asphalt?

Rubberized asphalt has been used for more than 20 years to resurface highways and city streets in Arizona when pavement surfaces reach their normal life expectancy. While it helped reduce the disposal of used tires, it recently has been recognized for its reduction of traffic noise.

Description of Rubberized Asphalt

Rubberized asphalt consists of regular asphalt paving mixed with “crumb rubber" which is ground, used tires that would otherwise be discarded or take up space in landfills. Used tires are processed by separating the casings, fabric and steel. The extracted rubber then is pulverized to the consistency similar to that of ground coffee. Rubberized asphalt has the benefit of being smoother and quieter. Noise readings have shown the rubberized asphalt generally reduces tire noise by an average of 4 decibels.

Approximately 1,500 tires are used for every lane-mile of rubberized paving, which can put a major dent in the 2 million used tires that are generated annually in Maricopa County.

Rubberized Asphalt Is Temperature Sensitive

Rubberized asphalt cannot be applied during cold weather or very hot weather. The concrete pavement surface needs to be between 85 and 145 degrees Fahrenheit for the material to adhere properly. So rubberized asphalt can only be applied in the spring and fall in the Phoenix area, from March 15 to May 31 and from September 1 to November 15. Prior to application, contractors must repair pavement cracks, chips and joints and prepare the concrete surface for the rubberized asphalt overlay.

Financing

The Quiet Pavement Program was developed by ADOT in cooperation with MAG and area cities. The completion was over a three-year period and funded using $34 million from other regional projects.

Latest Use

I-17 project in Phoenix is adding new layer of smooth pavement

https://www.azdot.gov/media/News/news-release/2017/05/11/adot-s-use-of-rubberized-asphalt-gives-new-life-to-recycled-tires

ADOT sustainable application types

Treatment	Description	Economic	Social	Environmental
Crack Filling	Placement of adhesive material	Life : Low Cost: Low	Aesthetics/Roughness	Low
Crack Sealing	Placement of adhesive material	Life : Low Cost: Low	Aesthetics/Roughness	Low
Asphalt Patching	Localized structural distress	Life : Medium/Low Cost: Medium/Low	Aesthetics/Roughness	Low Variable
Fog/Seal Rejuvenators	Very light asphalt emulsion application	Life: Low Cost: Low	Improved Aesthetics	Medium Variable
Chip Seal	Sprayed application/subsequent chips	Life : Medium/Low Cost: Medium/Low	Improved Friction/Roughness	Medium High
Slurry Seal	Mix of well-graded aggregate/emulsion	Life : Medium/Low Cost: Medium/Low	Aesthetics/Improved Friction	Medium
Microsurfacing	Crushed, well graded aggregate/emulsion/multiple course	Life: Medium/High Cost: Medium	Aesthetics/Improved Friction	Medium Variable
Hot In-Place Recycling	Heat or mechanically loosening within top 2"	Life: Medium/High Cost: Medium/High	Aesthetics/Ride Quality/Friction	Medium High
Cold In-Place Recycling	Milling and sizing reclaimed asphalt pavement (RAP)	Life: Medium/High Cost: Medium	Aesthetics/Ride Quality/Friction	Medium Variable

End of life sustainable pavement applications decision making (replacing recycled applications)

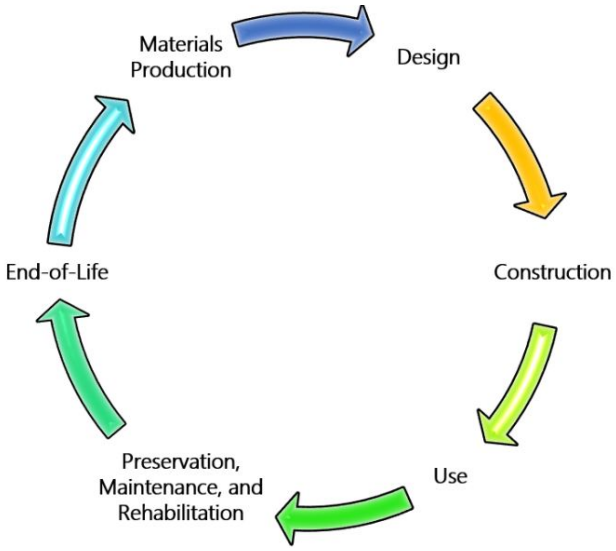
- If the pavement is extremely deteriorated and the residual asphalt content is too low then it is not a candidate for a second round of recycling with a rejuvenation agent. The only option is to Remove and Replace with newly produced AC pavement.

- If the pavement is deteriorated and the residual asphalt content is determined to be sufficient then it is a candidate for a second round of recycling with a rejuvenation agent.

FHWA Sustainable Pavements Tech Brief

In October 2014, FHWA issued a TechBrief on Pavement Sustainability (HIF-14-012)[1]. FHWA defines a sustainable pavements as one which "achieves its specific engineering goal" (i.e., meeting accepted performance standards) while meeting "basic human needs," using "resources effectively," and preserving/restoring ecosystems. FHWA notes that this is an aspirational goal to evolve toward, but is "not yet fully achievable".

Figure 1. Pavement Life-Cycle Phases (Source: FHWA)



Pavement sustainability, as defined by FHWA, is meant to involve every phase of the pavement life cycle, including 1) materials production, 2) pavement design, 3) construction, 4) use, 5) preservation, maintenance, and rehabilitation (the main emphasis of INVEST OM-07), and 6) end-of life.

FHWA notes that measuring pavement sustainability is often critical to the improvement of practices and achievement of objectives, and cites four main methods of measurement: 1) performance assessment (e.g., condition ratings, structural capacity, ride quality, etc.), 2) life-cycle cost analysis (evaluation of the "total cost of an investment over its entire life"), 3) life-cycle assessment (quantification of the environmental impacts of pavements over their life spans), and 4) rating systems, such as INVEST and Greenroads[2].

FHWA recognizes that most sustainable pavement investments will entail consideration of tradeoffs and suggests a decision-making framework that includes: 1) priorities and values of the organization or project, 2) performance ("the ability to serve an intended use"), 3) cost and benefit (focused on economic considerations), 4) impact magnitude and duration (of both positive and negative impacts), 5) risk (the degree to which the costs and/or impacts are uncertain), and 6) broad impacts in time and space (the extent to which decisions have impacts "beyond their immediate purpose").

Sustainability best practices suggested by FHWA involve "activities that result in life-cycle reductions in 1) the quantities of non-renewable resources consumed either as fuel or as direct materials, 2) the amount of greenhouse gas (GHG) emissions generated and 3) … ecological impacts." Suggested practices are organized into the following categories:

- **Materials.** Practices that aim to reduce energy and emissions while maintaining or enhancing performance. Generally, these practices a) reduce the use of virgin materials through the use of

[1] http://www.fhwa.dot.gov/pavement/sustainability/hif14012.pdf

[2] https://www.greenroads.org/

recycled, co-product, and waste materials, b) improve mix design to enhance longevity, and/or c) improve the efficiency of materials production to reduce impacts, including emissions.

- **Pavement Structural Design.** Practices include a) considering life cycle implications in decision-making, b) applying innovative pavement types and materials, and/or 3) improving structural design (leading to improvements in performance and longevity) through the application of new tools and techniques.
- **Construction Considerations to Improve Pavement Sustainability.** Practices generally focus on pavement quality, which impacts the performance and longevity across the pavement life cycle. Suggested best practices include a) allowing the use of sustainability best practices, as appropriate, b) reducing fuel consumption, energy use, and GHGs involved in construction, and/or c) improving construction quality.
- **Maintenance and Preservation Practices.** Includes practices that result in a) keeping pavements smoother for longer durations, which enables better fuel efficiency for roadway users, and b) extending the service life of pavements, resulting in material reductions over time.
- **End-of Life Considerations.** Practices that a) delay the need to repave or reconstruct (extending the usable life of pavements) and/or b) involve pavement recycling or reuse.

Next Steps for Arizona DOT

FHWA's reference document, entitled *Toward Sustainable Pavement Systems* (January 2015), elaborates and expands on these concepts and practices[3]. Although ADOT received all points available in the INVEST OM-07 scoring process, the agency recognizes that further sustainability gains can be achieved, particularly by leveraging recent FHWA research and resources. ADOT hopes to partner with FHWA to pilot a selection of suggested sustainable practices and to further recognize sustainable pavement innovations and applications by ADOT staff. The ADOT Pavement Group would like to try an Ultra-Thin Bonded Overlay (UTBO) (1/2" to 5/8") as an alternative to a ½" Friction Course in areas that have high turning movements. A Friction Course has a tendency to scrub off quickly in urban conditions. A few UTBO projects were done 10± years ago and it's time to try again.

The 2017 goal also includes the launching of a sustainable pavement systems program

Relevant Videos

Pavement Optimization Using TriAx Geogrid on ADOT Project
http://www.roadsbridges.com/pavement-optimization-using-triax-geogrid-adot-project

ADOT Boot Truck Innovation
https://www.youtube.com/watch?v=8YrpL8uw31o

Rubberized Asphalt (April 2014)
https://www.youtube.com/watch?v=RknBLFv41p0

Building a Freeway: Rubberized Asphalt
https://www.youtube.com/watch?v=8wHQ5TXheA0

[3] http://www.fhwa.dot.gov/pavement/sustainability/hif15002/hif15002.pdf