The What, Why and How of Sustainability for the Asphalt Industry

Heather Dylla
Director of Sustainable Engineering

42nd Annual Rocky Mountain Asphalt Conference and Equipment Show
Outline

• Why: The Benefits of Adopting More Sustainable Practices
• What: The Three Pillars of Sustainability
• How: The Economic, Social and Environmental Best Practices for Asphalt Plants and Mixes
Why: The Benefits of Adopting More Sustainable Practices
Motivation

- Public Demand for Sustainability
- Policies & Regulations
- Business Opportunities
- Future Trends
- Economic, Environmental, Social Benefits

It is just the right thing to do!
Growing Public Demand

81% Executive Corporate Leaders believe they need to adopt sustainability principals

McGraw-Hill Construction 2012

>50% of State DOT’s have adopted sustainability principles

NCHRP 20-83 2012
Growing Policy


- Pavement Vehicle Interaction
- Pavement Albedo Mandates

EPA 2011

NAPA
NATIONAL ASPHALT PAVEMENT ASSOCIATION

Lemmen, D.S. & F.J. Warren 2004
Increasing Business Opportunities

Public Demands

44% Green nonresidential construction

$66 Billion

McGraw-Hill Construction
January 2014
Grad students look into the future of impact issues...

93% of students say social/environmental issues are important to a business’ long-term success.

Students predict the most important issues for business to get right in the next ten years:

1. Climate & Energy [34%]
2. Sustainable Product Development & Marketing [23%]
3. Resource Conservation [17%]
4. Supply Chain Management [14%]
5. Human Rights/Fair Labor [13%]
Economic, Environmental, Social Benefits

• Improved Processes or Leaner Processes
  • Economic – Recycling, Less virgin material use
  • Environmental – Reduced Waste and Emissions

• Lower Impacts
  • Environmental – Clean air, clean water
  • Social – Be good neighbors
  • Economic – Regulatory compliance

• Generating more value
  • Social – Customer relationships, Community Outreach
  • Environmental – Corporate Responsibility
  • Economic - Profit
What: The Three Pillars of Sustainability
Definition of Sustainable

Sustainable

“Meets the needs of the present without compromising the ability of future generations to meet their own”¹

Sustainable Pavements?

No universal definition

“Three Pillars of Sustainability”

¹ UN World Commission on Environment and Development
Sustainable Pavements Program

- FHWA created in 2010
- Sustainable Pavements Technical Working Group (SP TWG)
- Advance Knowledge of Sustainable Pavements

Technical Working Group
- Meetings with Stakeholders
- Technical Input

Reference Center
- Reference Manual
- Technical Articles

Technology Transfer
- Technical Briefs
- Webinars
Sustainable Asphalt Pavements

Societal
- Safe
- Quiet
- Smooth Ride Quality
- Minimizes User Delay
- Natural Resource Conservation

Economic
- Virgin Material Reuse/Replacement
- Reduced Fuel
- Improved Durability
- Long Life

Environmental
- Storm Water Runoff
- Water Treatment
- Reduce Emissions
- Reduce Landfill
Sustainable Asphalt Technologies

- Porous Asphalt
- Warm Mix Asphalt (WMA)
- Reclaimed Asphalt Pavement (RAP)
- Ground Tire Rubber (GTR)
- Recycled Asphalt Shingles (RAS)
- Perpetual Asphalt Pavement
How: The Economic, Social and Environmental Best Practices for Asphalt Plants and Mixes
Tools to Evaluate Sustainability

How Do We Measure Our Progress?

• Green Rating Metrics
• Life Cycle Assessments
Sustainability Rating Metrics
Sustainability Rating Metrics

Standards
- Voluntary
- Sets stakeholder metrics
- Defines Industry Best Practices
- No enforcement
- No Review

Codes
- Law
- Permits
- Little Flexibility
- Code Official Review

Rating Systems
- Voluntary
- Aspirational & Elective
- Ratings define achievement
- 3rd Party Review
Infrastructure Green Rating Systems

- National, State, Local
- Rating Tool
  - Best practices
  - Earn Credits
  - Indicator of sustainability

I-LAST™
Leadership in Energy & Environmental Design

US Green Building Council (USGBC)

**Scope:** Buildings and Neighborhoods

**Pavement Related - 10%**
- Urban Heat Island nonroof (1 pt)
- Stormwater design (2 pts)
- Construction waste management (2 pts)
- Materials reuse (2 pts)
- Recycled content (2 pts)
- Regional materials (2 pts)

**v.2009 New Construction**

- Sustainable Sites
- Water Efficiency
- Energy & Atmosphere
- Indoor Environmental Quality
- Materials & Resources
- Innovation and Design
- Regional Priority
Envision

Scope: Civil Infrastructure
Pavement Related - 25%

<table>
<thead>
<tr>
<th>Leadership</th>
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<tr>
<td>By-Product Synergy Opportunities</td>
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<td>Extend Useful Life</td>
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<table>
<thead>
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<th>Natural World</th>
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<tr>
<td>Develop Local Skills and Capabilities</td>
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<td>Enhance Public Health and Safety</td>
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<td>Reduce Air Pollutant Emissions</td>
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<td>Prepare for Long-Term Climate Adaptability</td>
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<td>Reduce Net Embodied Energy</td>
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<td>Support Sustainable Procurement</td>
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<td>Use Recycled Materials</td>
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<td>Use Regional Materials</td>
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<tr>
<td>Divert Waste from Landfills</td>
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<tr>
<td>Provide for Deconstruction and Recycling</td>
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INVEST

Scope (3 Modules)

• System Planning – Transportation system & project planning
• Project Development – Design & Construction
• Operations & Maintenance

Pavement Related - 39%

<table>
<thead>
<tr>
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<tr>
<td>Stormwater</td>
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<td>Reduce and Reuse</td>
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<td>Recycle Materials</td>
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<tr>
<td>Long-Life Pavement</td>
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<td>Reduce Energy Emissions in Pavement Materials</td>
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<tr>
<td>Contractor Warranty</td>
<td>1 or 3</td>
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<tr>
<td>Construction Environmental Training</td>
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<tr>
<td>Construction Equipment Emission Reduction</td>
<td>2</td>
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<tr>
<td>Construction Noise Mitigation</td>
<td>2</td>
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<tr>
<td>Construction Quality Control Plan</td>
<td>5</td>
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<tr>
<td>Construction Waste Management Plan</td>
<td>3</td>
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**Scope:** Roadway Design & Construction  
**Pavement Related - 45%**

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<th>Category</th>
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<td>Access &amp; Equity</td>
<td>30</td>
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<tr>
<td>Construction Activities</td>
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<td>Quality Management System</td>
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<td>Environmental Training</td>
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<tr>
<td>Site Recycling Plan</td>
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<tr>
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<td>1-2</td>
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<tr>
<td>Equipment Emission Reduction</td>
<td>1-2</td>
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<td>Paving Emissions Reduction</td>
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<tr>
<td>Contractor Warranty</td>
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<td><strong>Materials &amp; Resources</strong></td>
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<td>Life Cycle Assessment</td>
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<td>Pavement Reuse</td>
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<td>Recycled Materials</td>
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<td>Regional Materials</td>
<td>1-5</td>
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<td><strong>Pavement Technologies</strong></td>
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<td>Warm Mix Pavement</td>
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<td>Cool Pavement</td>
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<tr>
<td>Quiet Pavement</td>
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<tr>
<td>Pavement Performance Tracking</td>
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</table>
Diamond Sustainability Commendation

**Scope:** Asphalt Plant Mix Producers

**Societal**
- Public Corporate Sustainability Report
- Noise Mitigation
- Odor Mitigation
- Dark-sky friendly lighting
- Community Outreach

**Economic**
- Energy Consumption Tracking
- Energy Consumption Reduction
- Helping Customers Achieve LEED Credits

**Environmental**
- WMA
- Variable Frequency Drive Motors
- Recycled materials
- No idling policy
- Tracking greenhouse gases
Summary Green Rating Metrics

Similarities
• Stormwater Management
• Recycling or Reusing Materials
• Local Materials (except for INVEST)
• For Designers (except for Diamond Program)

Green Rating System Benefits
• LEED
  • Most Well Known
• INVEST
  • No Urban Heat Island credit
• ENVISION
  • Not Prescriptive
• Greenroads
  • Most Pavement Specific Credits
• Diamond Sustainability
  • For asphalt plant mix producers
Green Rating Metrics - Future Trends

- Measuring Potential Impacts
  - Life Cycle Assessments
  - Environmental Product Declaration
  - Health Product Declarations
Life Cycle Assessment (LCA)

– methodology to measure and understand the potential environmental impacts associated with a product
LCA Framework

Defined in ISO 14040 Series

Goal and Scope

Life Cycle Inventory

Impact Assessment

Review and Refine

Interpretation

Source: ISO 14040
1. Goal and Scope Definition

**Goal** defines:

- What is the aim of the study?
- Who is the audience of the study?

**Scope** defines:

- Unit
- System Boundary
System Boundaries

Cradle to Gate

Asphalt binder manufacture
- Transportation to plant

Aggregate production
- Transportation to plant

Fuels
- Transportation to plant

Plant Operations

Transportation to site

Construction
2. Life Cycle Inventory

Inputs – Materials, Energy, Water

- Raw Material
  - Aggregates
  - Admixtures
  - Asphalt Binder
  - Transport

- Production
  - Fuel
  - Water
  - Equipment

- Construction
  - Transport
  - Paving

- Use
  - Vehicle Operation – (PVI)
  - UHI
  - Stormwater Runoff
  - Maintenance/Workzone congestion

- End of Life
  - Landfill
  - Recycle

Outputs – Solid Wastes, Emissions to Air, Emissions to Water
3. Impact Assessment

- **Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts (TRACI)**
- Impact Assessment Tool for US
- Developed by EPA

### Emissions to Air (g/ton)

<table>
<thead>
<tr>
<th>Per ton of HMA</th>
<th>Asphalt</th>
<th>Aggregates</th>
<th>Plant Oper.</th>
<th>Transport</th>
<th>Const.</th>
<th>Total</th>
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<td>SO₂</td>
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<td>1.7E+00</td>
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<td>NOₓ</td>
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<td>1.3E+00</td>
<td>1.3E+01</td>
<td>4.4E+02</td>
<td>1.5E+02</td>
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<tr>
<td>CO₂</td>
<td>1.5E+04</td>
<td>1.2E+03</td>
<td>1.7E+04</td>
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<td>---</td>
<td>3.2E+04</td>
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<tr>
<td>CO</td>
<td>7.3E+00</td>
<td>---</td>
<td>6.5E+01</td>
<td>1.9E+03</td>
<td>6.0E+02</td>
<td>2.6E+03</td>
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<tr>
<td>HC</td>
<td>6.8E+01</td>
<td>---</td>
<td>---</td>
<td>1.5E+02</td>
<td>5.0E+01</td>
<td>2.7E+02</td>
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<td>HCl</td>
<td>5.7E-02</td>
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<td>PM2.5</td>
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<td>5.6E-03</td>
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<td>4.7E+01</td>
<td>3.2E+01</td>
<td>---</td>
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<tr>
<td>Total PM</td>
<td>1.1E+01</td>
<td>8.1E+01</td>
<td>1.6E+02</td>
<td>1.4E+02</td>
<td>4.4E+01</td>
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<td>CH₄</td>
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<td>6.0E+02</td>
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<td>VOC</td>
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<td>1.6E+02</td>
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### Potential Environmental Impact

- Global Warming Potential
- Acidification
- Eutrophication
- Fossil Fuel Depletion
- Water Use
- Criteria Air Pollutants
- Human Health- Noncancerous
- Human Health- Cancerous
- Photochemical Smog
- Ozone Depletion
- Terrestrial Toxicity
- Resource Depletion
- Land Use
- Aquatic Toxicity

Source: Hassan 2009
4. Interpretation

- Results are **Potential Impacts** not Actual
- Must consider the assumptions made & data limitations
- **Does not** account for technical performance, costs, & many social impacts

Interpretation of LCA results and comparisons are not easy!
Environmental Product Declarations

**Product Category Rules (PCRs)**
Rules a product must follow to publish an EPD

- Defines Goal and Scope
- Sets LCA boundaries
- Delineates Acceptable Inventory Data
- Identifies Impact Categories
- ISO 14025

**Environmental Product Declarations (EPDs)**
Standardized LCA Report defined by Product Category Rules (PCRs)

- Fair
- Comparable
- Third Party Reviewed
- Credible
- ISO 14025
Example EPD

Nutrition Facts
Serving Size 1/2 cup (115g)
Servings Per Container About 4

Amount Per Serving
Calories 250  Calories from Fat 130
% Daily Value*
Total Fat 14g  22%
  Saturated Fat 9g  45%
Cholesterol 55mg  18%
Sodium 75mg  3%
Total Carbohydrate 26g  9%
  Dietary Fiber 0g  0%
  Sugars 26g
Protein 4g

Vitamin A 10%  Vitamin C 0%
Calcium 10%  Iron 0%

* Percent Daily Values are based on a 2,000 calorie diet.

Environmental Facts
Functional unit: 1 metric ton of asphalt concrete

<table>
<thead>
<tr>
<th>Environmental Impact</th>
<th>Value</th>
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<tbody>
<tr>
<td>Primary Energy Demand [MJ]</td>
<td>3.9x10³</td>
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<tr>
<td>Renewable [MJ]</td>
<td>3.9x10³</td>
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<tr>
<td>Non-Renewable [MJ]</td>
<td>3.5x10²</td>
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<tr>
<td>Global Warming Potential [kg CO₂-eq]</td>
<td>79</td>
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<tr>
<td>Acidification Potential [kg SO₂-eq]</td>
<td>0.23</td>
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<tr>
<td>Eutrophication Potential [kg N-eq]</td>
<td>0.012</td>
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<tr>
<td>Ozone Depletion Potential [kg CFC-11-eq]</td>
<td>7.3x10⁻⁹</td>
</tr>
<tr>
<td>Smog Potential [kg O₃-eq]</td>
<td>4.4</td>
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</tbody>
</table>

Boundaries: Cradle-to-Gate
Company: XYZ Asphalt
RAP: 10%

Source: PE International, Values are for illustration purposes only.
EPD Development Process

1. Identify Program Operator
2. Identify or Develop a PCR - Program Operator and Industry Stakeholders
3. Conduct LCA study - LCA Consultant
4. Development of EPD - LCA Consultant
5. Verification of EPD and LCA study - Third Party Reviewers
Who are Program Operators?

- LCA/EPD Consultants
  - NSF
  - UL
  - FPInnovations

- Standard Developers
  - CSA Group
  - ASTM INTERNATIONAL

- Non-Profit Associations
  - earthsure
  - NRMCA CERTIFIED EPD
  - NAPA CERTIFIED PRODUCT DECLARATION
Role of Program Operator

www.asphaltapavement.org/epd
Industry Average EPD

Environmental Sustainability

- 2014-2015 Project
- Funded by SAPAs and NAPA
- EPD Tool – Amlan Mukherjee and *Life Cycle Solutions*
  - Aid Contractors to Create EPD
  - Benchmark Against Industry Averages
Conclusions

• Growing Demand for Sustainability
• Many Sustainable Asphalt Technologies
  • RAP, RAS, WMA, GTR
  • Porous
• Tools Available to Measure Sustainability
  • Green Rating Systems – LEED, Greenroads, Envision, INVEST, NAPA Diamond Achievement Commendation
  • LCAs
  • EPDs