CONGRÈS
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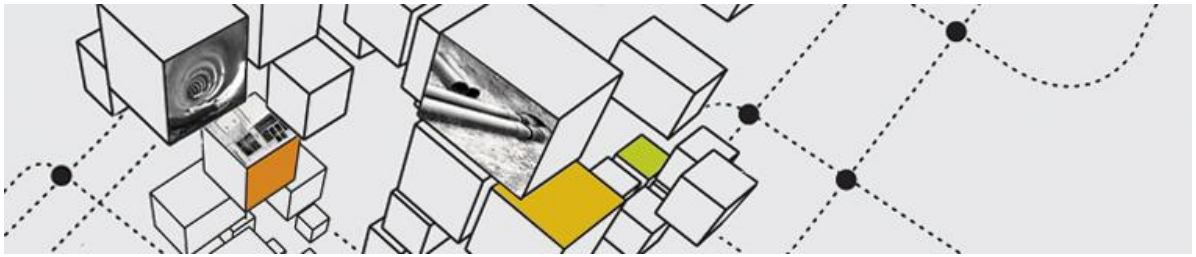

Bringing Sustainability into Road Widening and Rehabilitation Decision-Making

Michael Maher, Toronto, Ontario
Jeanette Southwood, Ottawa, Ontario
Vaughn Grey, Montréal, Québec

7-9 November 2011

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Overview

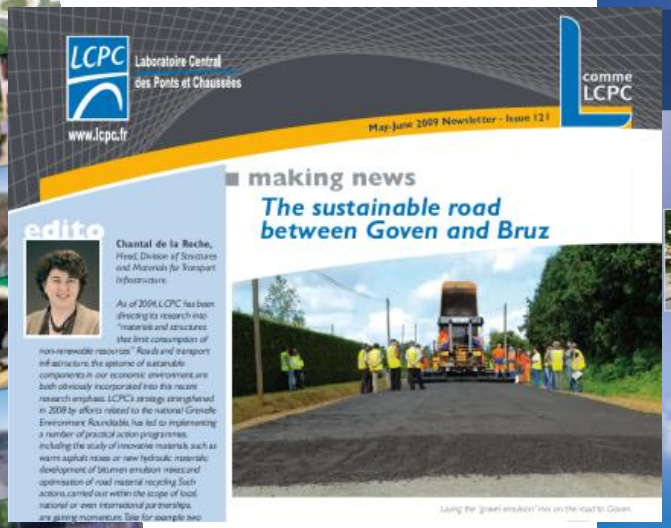
- Recognition of the Problem
- LEED-type Approaches
- Overview of Quantitative Sustainability Tool
- Example of Application to Road Rehabilitation Decision-making

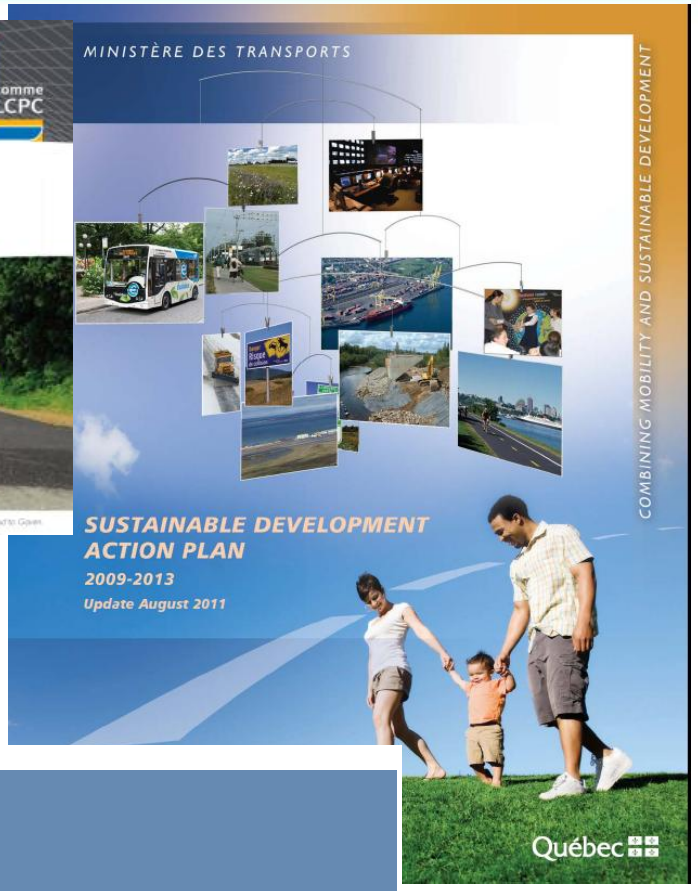
Strategies for Sustainable Development

1. Climate change and clean energy
2. Sustainable transport
3. Sustainable consumption and production
4. Conservation and management of natural resources
5. Public health
6. Social inclusion, demography and migration
7. Global poverty and global sustainable development challenges

Sustainability on the Roads Agenda

Agencies Responding





Focus area I

Ensure the sustainability of transportation systems for future generations

1st intervention item: Road infrastructures

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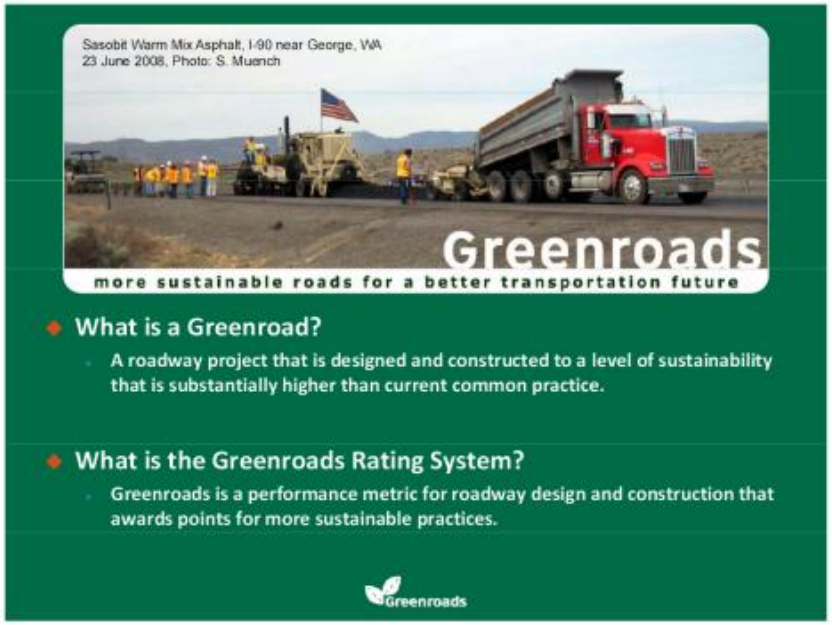
In the U.S.

GOAL

To provide an assessment of the sustainability of pavement designs and construction for the purpose of promoting greener pavements



In U.S. for road infrastructure

- 35 Million T of Asphalt/year
- 48 Million T of concrete/year
- Cost: $65 Billion
- Roadway conditions significant factor in 1/3 of accident fatalities
- Poor roads cost motorists $67 Billion/year in vehicle repairs ($333/motorist) (ASCE, 2009)

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Objectives

- Defines basic roadway sustainability attributes
- Greater participation in roadway sustainability
- Better evaluation of sustainability tradeoffs
- Provide a means for sustainability assessment
- Confer market recognition for sustainability efforts

Greenroads' Scorecard

Point Totals
A = Achieved by this project
P = Potientially achievable with low additional effort
M = Maximum achievable regardless of cost

Certification Levels
C = Certified (All PR's Met + At Least 32 Points)
S = Silver (All PR's Met + At Least 43 Points)
G = Gold (All PR's Met + At Least 54 Points)
E = Evergreen (All PR's Met + At Least 64 Points)

Credit Scorecard

Project Requirements (PR)		Possible	A	P	M
PR-1	Environmental Review Process	Req	X	X	X
PR-2	Lifecycle Cost Analysis	Req	X	X	X
PR-3	Lifecycle Inventory	Req		X	X
PR-4	Quality Control Plan	Req	X	X	X
PR-5	Noise Mitigation Plan	Req		X	X
PR-6	Waste Management Plan	Req		X	X
PR-7	Pollution Prevention Plan	Req	X	X	X
PR-8	Low-Impact Development	Req	X	X	X
PR-9	Pavement Management System	Req	X	X	X
PR-10	Site Maintenance Plan	Req	X	X	X
PR-11	Educational Outreach	Req	X	X	X
	Total	11	8	11	11

Environment & Water (EW)		Possible	A	P	M
EW-1	Environmental Management System	2			2
EW-2	Runoff Flow Control	1 - 3			3
EW-3	Runoff Quality	1 - 3			3
EW-4	Stormwater Cost Analysis	1		1	1
EW-5	Site Vegetation	1 - 3	3	3	3
EW-6	Habitat Restoration	3			
EW-7	Ecological Connectivity	1 - 3	3	3	3
EW-8	Light Pollution	3			3
	Total	21	6	7	18

Access & Equity (AE)		Possible	A	P	M
AE-1	Safety Audit	1 - 2			2
AE-2	Intelligent Transportation Systems	2 - 5	3	3	5
AE-3	Context Sensitive Solutions	5	5	5	5
AE-4	Traffic Emissions Reduction	5	5	5	5
AE-5	Pedestrian Access	1 - 2	1	1	2
AE-6	Bicycle Access	1 - 2	1	1	2
AE-7	Transit & HOV Access	1 - 5			
AE-8	Scenic Views	2	2	2	2
AE-9	Cultural Outreach	1 - 2		1	2
	Total	30	17	18	25

Construction Activities (CA)		Possible	A	P	M
CA-1	Quality Management System	2			2
CA-2	Environmental Training	1		1	1
CA-3	Site Recycling Plan	1		1	1
CA-4	Fossil Fuel Reduction	1 - 2			2
CA-5	Equipment Emission Reduction	1 - 2			2
CA-6	Paving Emission Reduction	1	1	1	1
CA-7	Water Use Tracking	2		2	2
CA-8	Contractor Warranty	3			3
	Total	14	1	5	14

Materials & Resources (MR)		Possible	A	P	M
MR-1	Lifecycle Assessment	2			2
MR-2	Pavement Reuse	4- 5	4	4	5
MR-3	Earthwork Balance	1			
MR-4	Recycled Materials	1 - 5	2	5	5
MR-5	Regional Materials	1 - 5	4	5	5
MR-6	Energy Efficiency	5			
	Total	23	10	14	17

Pavement Technologies (PT)		Possible	A	P	M
PT-1	Long-Life Pavement	5	5	5	5
PT-2	Permeable Pavement	3			
PT-3	Warm Mix Asphalt	3		3	3
PT-4	Cool Pavement	5			5
PT-5	Quiet Pavement	2 - 3			
PT-6	Pavement Performance Tracking	1			1
	Total	20	5	8	14

Custom Credit (CC)		Possible	A	P	M
CC-1/2	Custom Credit Title	1 - 5	5	5	5
CC-3/4	Custom Credit Title	1 - 5	2	2	5
	Total	10	7	7	10

All 11 PR Met?		No	Yes	Yes
Greenroads Total	108	46	59	98
Certification Level			G	E

Semi-quantitative Approach

Pavement Technologies (PT)		Possible	A	P	M
PT-1	Long-Life Pavement	5	5	5	5
PT-2	Permeable Pavement	3			
PT-3	Warm Mix Asphalt	3		3	3
PT-4	Cool Pavement	5			5
PT-5	Quiet Pavement	2 - 3			
PT-6	Pavement Performance Tracking	1			1
	Total	20	5	8	14

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Ontario GreenPave

Ontario Ministry of Transportation

GreenPave

Pavement Sustainability Rating System

GREENPAVE

GREEN PAVEMENT DESIGN RATING SYSTEM

REFERENCE GUIDE

For New Construction and Rehabilitation of Ontario Pavement Structures

Version ___

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GreenPave Rating Summary Sheet

Maximum Point	GreenPave Category		Assigned Point							
			Option 1	Option 2	Option 3	Option 4	Option 5	Option 6	Option 7	Option 8
9	**Pavement Technologies**		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	**Credit PT - 1**	Long-Life Pavement	0.0	0.0	0.0	0.0				
2	**Credit PT - 2**	Permeable Pavements	0.0	0.0	0.0	0.0				
2	**Credit PT - 3**	Noise Mitigation	0.0	0.0	0.0	0.0				
2	**Credit PT - 4**	Cool Pavements	0.0	0.0	0.0	0.0				
11	**Materials & Resources**		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	**Credit MR - 1**	Recycled Content								
2	**Credit MR - 2**	Undisturbed Pavement Structure								
2	**Credit MR - 3**	Local Materials								
2	**Credit MR - 4**	Construction Quaility								
8	**Energy & Atmosphere**		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	**Credit EA - 1**	Reduce Energy Consumption								
3	**Credit EA - 2**	GHG Emission Reduction								
1	**Credit EA - 3**	Pavement Smoothness								
1	**Credit EA - 4**	Pollution Reduction								
4	**Innovation & Design Process**		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	**Credit I - 1**	Innovation in Design								
2	**Credit I - 2**	Exemplary Process								
32	**Total GreenPave Points:**		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Green Pave Rating:		NOT CERTIFIED	NOT CERTIFIED	NOT CERTIFIED	NOT CERTIFIED				

Bronze X-XX points **Silver** XX-XX points **Gold** XX-XX points **Trillium** XX-XX points

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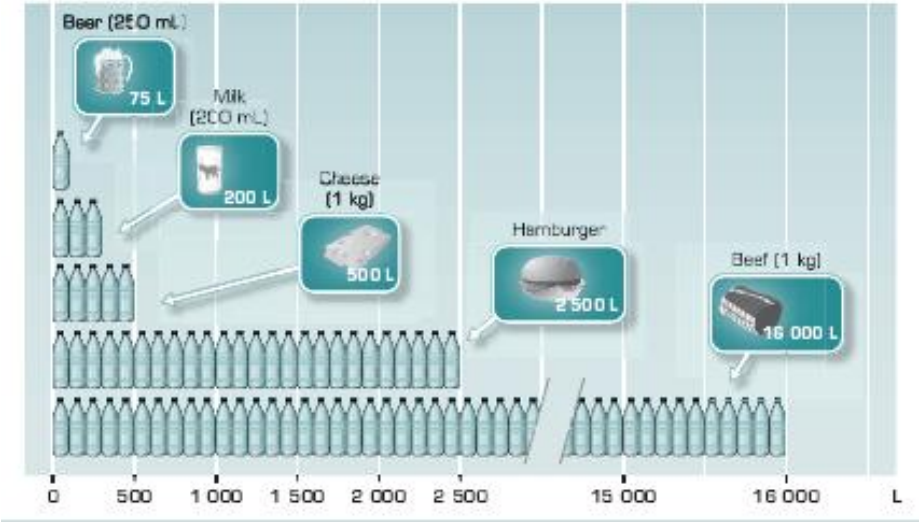
GHG Emissions Reduction

	Surface/Binder Layers	Granular Layers
1 point	• Use of Warm Mix Asphalt Technology • Asphalt Layer with at 5-15% RAP, by mass • Concrete layer with 16-25% SCM, by mass of the total cementing material in concrete	• Granular with 10%-49% RM, by mass
2 points	• Asphalt Layer with 16-40% RAP, by mass • HIR	• Granular with at least 50% RM, by mass • In-Place Processing (e.g. FDR, Rubblizing, Crack and Seat)
3 points	• CIR • CIREAM	• FDR-EAS

Why is a new approach needed?

Use of Sustainability Metrics

What gets measured gets done!

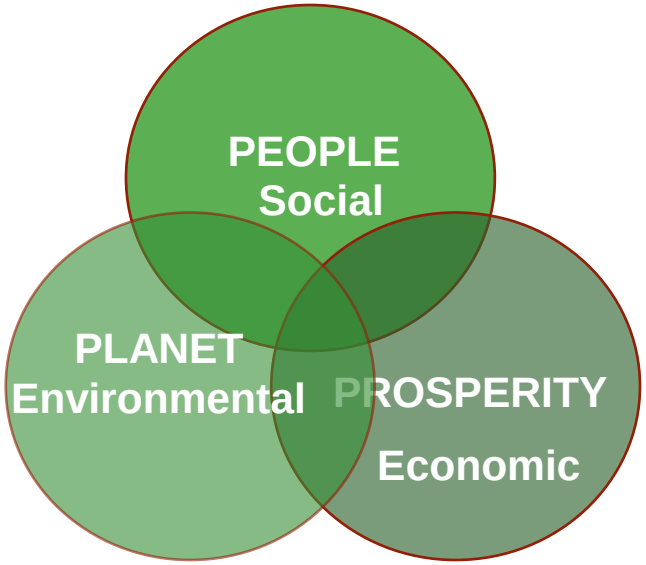


- Learning
  - Benchmark internally
  - Evaluate alternatives
- Decision-making
  - Identify improvement options
- Accountability
  - Track performance
- Demonstration
  - Build the business case
  - Promote ‘sustainable’ initiatives
- Support change
- Report to Stakeholders

Simple Tool for Sustainability

- Need for analytical framework to evaluate sustainability options
- Impartial, balanced and comprehensive
- Enhance the understanding of SD issues
- Support proactive stakeholder engagement
- Assist in managing risks
- Lead to better operational practices
- Improve “Triple Bottom Line”

Achieving sustainable financial performance while promoting environmental integrity and social equity



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GoldSET : Sustainability Evaluation Tool

Project Definition

- **Current condition**
- **Design criteria**
- **Minimum performance objectives**

Technology Identification and Evaluation

- **Fatal flaw analysis:**
  - Objectives
  - Cost
  - Duration
  - Technical
  - Performance

Indicators

Includes:

- Standards & Best Practices
- Agency policies
- Legal Requirements

Environmental

- Natural Resources
- Ecological Integrity
- Energy use
- Waste generation

Social

- Health & Safety
- Quality of life
- Aesthetics

Economic

- Capital cost
- Life cycle cost
- Impacts on local economy

Select Acceptable Options

Meet all technical design criteria

Scoring

Quantification of indicators:

- Specific to client requirements

Evaluation of Options based on "Triple Bottom Line"

Structured system for ranking options

Interpretation & Reporting

Rank Options

- OPTION A
- OPTION B
- OPTION C
- OPTION D

Recommendations to support decision making:

- Sustainable
- Consistent
- Objective
- Transparent
- Optimized

Automated reporting (web version)

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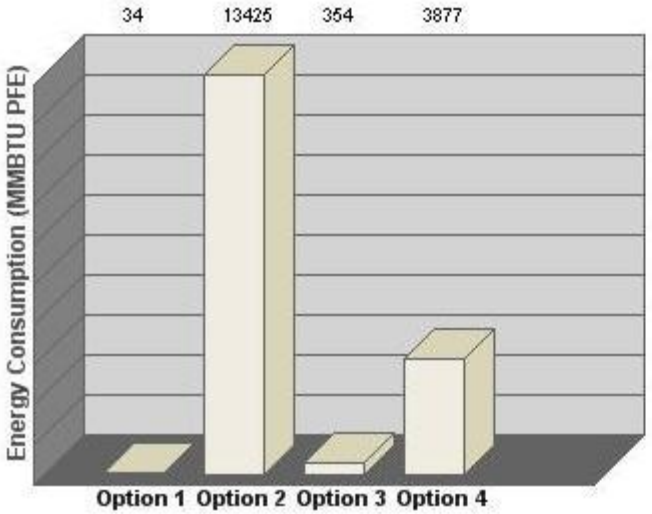
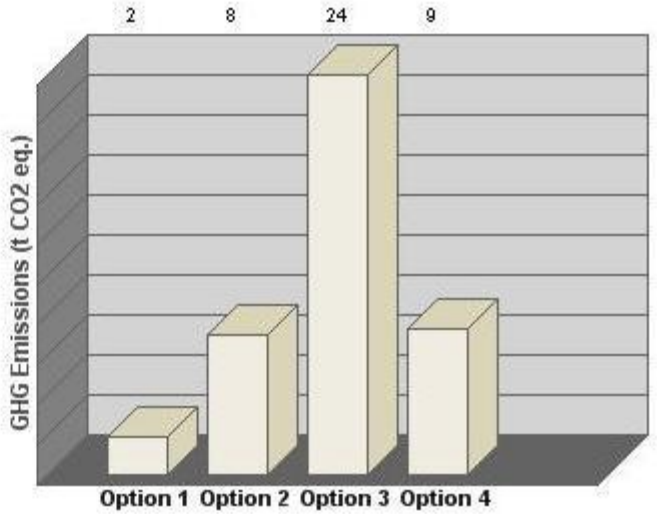
Quantitative Indicators

- Need robust and appropriate quantitative indicators
- Quantitative indicators, such as $, t CO_2, KWh, water usage, etc. can be compared to derive relative scores
- Analysis can be customized to fit desired level of uncertainty

Energy Consumption



Greenhouse Gases



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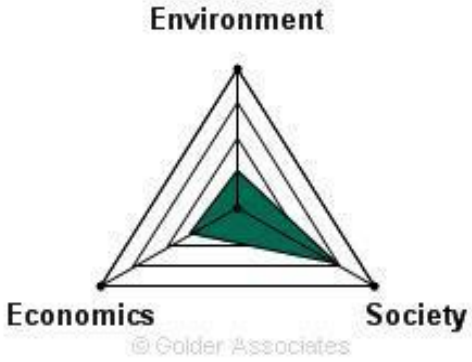
Analysis Output in Graphical Form

- The best approach from a sustainability standpoint is based on:
  - The bigger, most balanced triangle
  - Highest performance in each dimension
  - Balanced performance between all dimensions

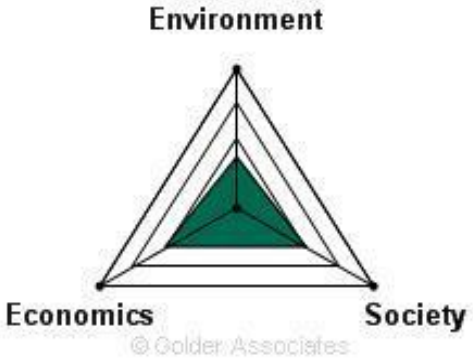
Option 1

ENVIRONMENT	27%
SOCIETY	71%
ECONOMICS	34%



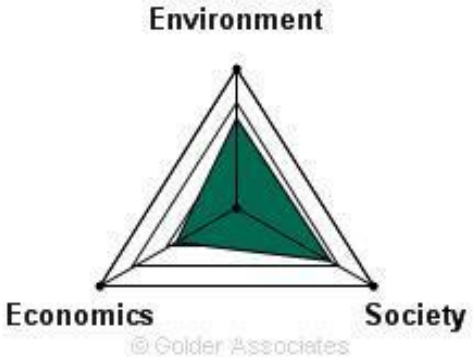
Option 2

ENVIRONMENT	36%
SOCIETY	50%
ECONOMICS	51%



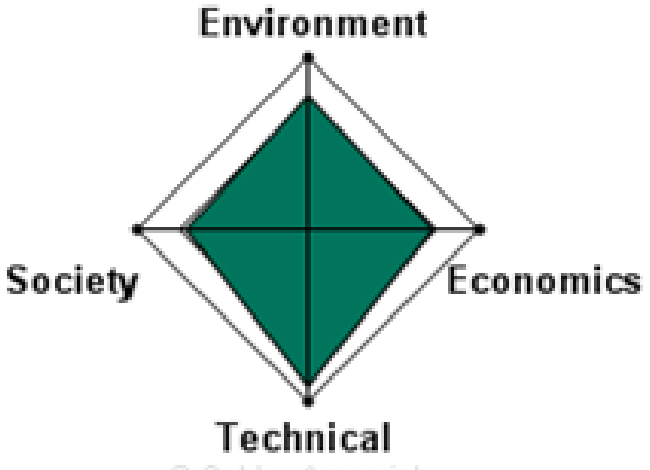
Option 3

ENVIRONMENT	63%
SOCIETY	67%
ECONOMICS	44%



Technical Dimension Output

ENVIRONMENT	78%
SOCIETY	70%
ECONOMICS	72%
TECHNICAL	91%



- A sustainability assessment does NOT replace technical feasibility
- Only technically acceptable options should be considered
- A fourth dimension can be added to address technological aspects

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A Tiered Approach with GoldSET©

Data requirements

Uncertainty

Tier 1

- Preliminary evaluation
- Qualitative criteria
- Indirect stakeholder involvement

Tier 2

- Semi-quantitative evaluation
- First order of magnitude estimations
- Stakeholder consultations

Tier 3

- Detailed evaluation
- Quantification of key criteria based on modeling, life-cycle / cost-benefits analyses
- Extensive stakeholder consultations

Sensitivity analyses

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Current Drivers

- **Reduce** use of natural resources and **non-renewables**
- Greater **re-use** of materials
- Greater **recycling** using enhancing agents and re-processing where necessary
- Enhance **safety**
- **Reduce** generation of **waste**

- Improved landscape and **urban amenity**
- Protected **biodiversity** within road allowance and in neighbouring vicinity and waterways
- **Reduced impacts** on **watercourses** and aquatic system
- Improved local **air quality**
- **Reduced** road-related **noise**
- **Protection** of cultural **heritage**
- **Reduced** GHG **emissions**

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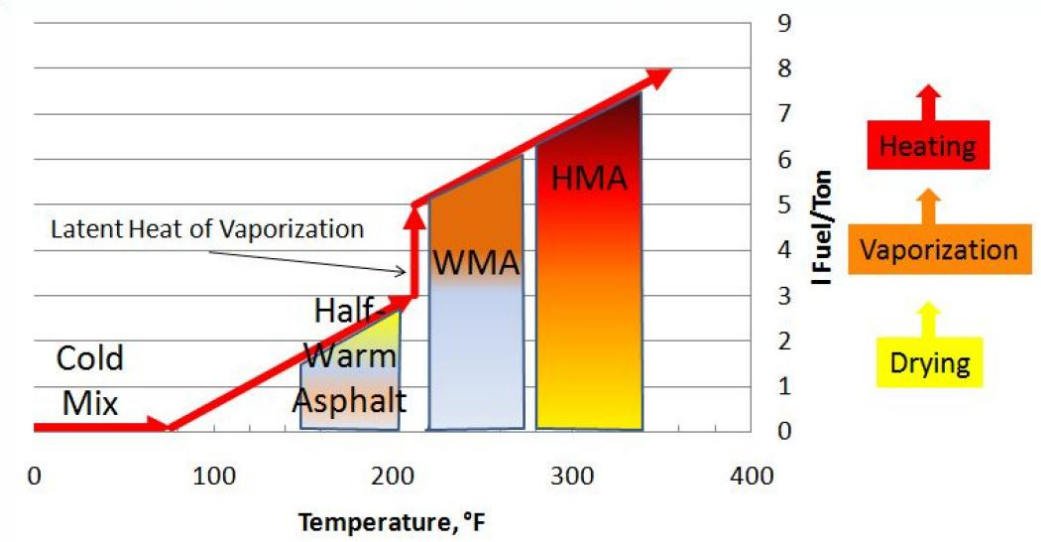
Encouraging New Technologies

Warm Asphalt Vs Conventional Hot Asphalt

- Savings in energy
- Decreased plant emissions
- Reduced exposure to fumes
- Higher incorporation of recycled asphalt
- Low/No odour
- Improved compaction
- Extended paving season
- Safety
- Longer binder life



Typical Road Rehabilitation Project

- Typical distresses that need to be addressed during road rehabilitation

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Road Rehabilitation Treatments

- **Surface Treatments**
  - Fog seal
  - Slurry seal
  - Microsurfacing
  - Chip seal (single & double)
  - Scrub seal
  - Ultrathin friction course
- **Shallow Rehabilitation Treatments**
  - Asphalt overlay
  - Cold planing
  - Cold in-place recycling (CIR)
  - Hot in-place recycling (HIR)
  - White topping
- **Partial and Full Depth Treatments**
  - Total reconstruction
  - ***Full depth reclamation (FDR)***
  - Expanded asphalt
  - Granular grade raise
  - Full depth asphalt removal
- **Other Rehabilitation Treatments**
  - Premium asphalt mixes
  - Central plant cold mix paving
  - Full depth crack repair and overlay
  - Warm mix asphalt

Range of Inputs for FDR

Stabilising Types

- Mechanical
  - Virgin aggregate, Reclaimed asphalt pavement, Crushed concrete
- Chemical
  - Lime, Portland cement, Flyash, Kiln dust, Mg/Ca chloride, Proprietary chemicals
- Bituminous
  - Liquid asphalt, Emulsion, Foamed asphalt
- Blends
  - Various combinations of items above

- Equipment
  - Self propelled reclaimer
  - Motor graders
  - Compactors
  - Dump haul trucks
  - Calibrated aggregate spreader
  - Water truck with spray bar
  - Calibrated bulk spreader
  - Mixer and tanker for slurries
  - Asphalt emulsion tanker
  - Liquid or foamed asphalt system
  - Front end loader

Typical Options

OPTION 1

- Cold mill
- Place milled material on shoulder
- In-place Process
- Add Virgin granular where required
- Resurface with two-lifts asphalt
- Estimated Life: 18 years
- Estimated initial cost of construction $170,000/2 lane km

OPTION 2

- Cold In-Place Recycle
- Tack-coat and resurface with one lift of asphalt
- Estimated Life : 10 to 12 years
- Estimated initial cost of construction $120,000/2 lane km

OPTION 3

- Mill and pave selected patches
- Overlay with one lift of asphalt
- Estimated Life: 5 to 7 years
- Estimated initial cost of construction $60,000/2 lane km

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Sustainability Assessment Criteria

- **Environmental**
  - Use of natural resources
  - Energy consumption
  - GHG emissions
  - Construction air emissions/dust
  - Waste generation
  - Noise in service
  - Runoff quantity/quality
  - Smoothness
  - Heat island effects
- **Social**
  - Health & safety during construction
  - Construction impact on community
  - Equity-local jobs, training
  - Noise in service
  - Rider comfort and safety
  - User delay

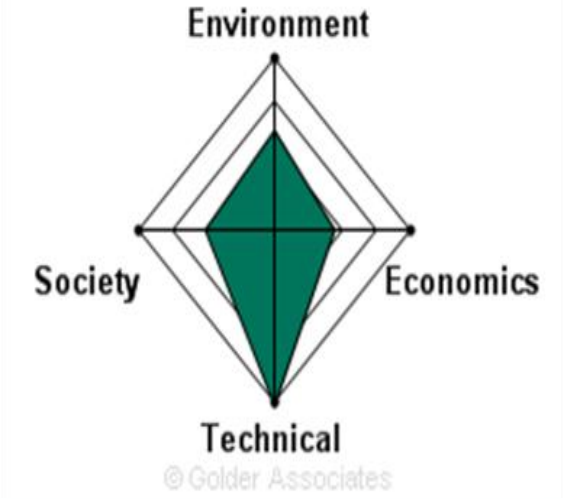
Sustainability Assessment Criteria

- **Economic**
  - Construction cost
  - Life cycle cost
  - Impact on local business/commerce
  - Future maintenance interventions
- **Technical**
  - Performance risk
  - Quality risks

Graphical Output from GoldSET Analysis

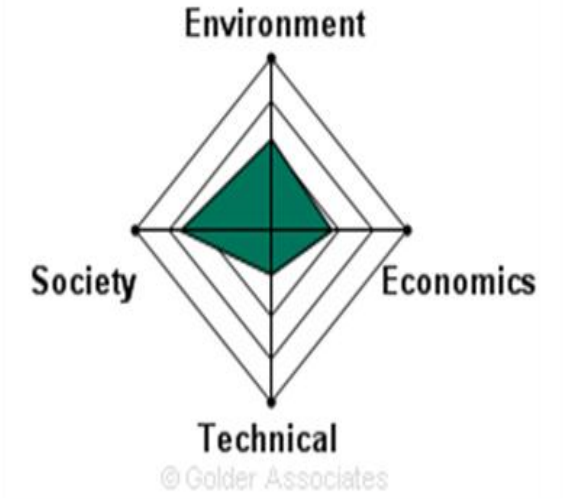
Mill, FDR and 2-lift overlay

ENVIRONMENT	57%
SOCIETY	50%
ECONOMICS	44%
TECHNICAL	100%



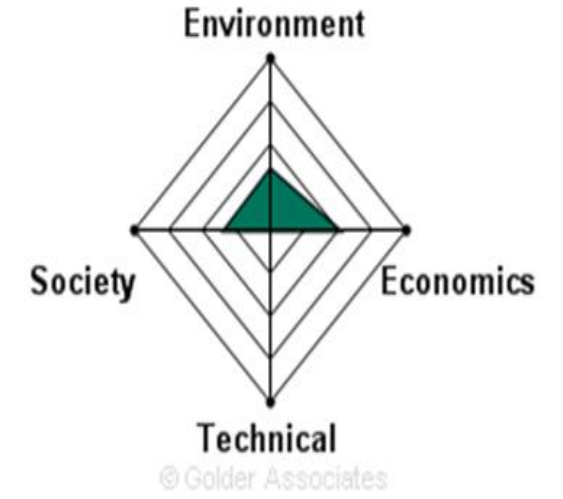
CIR & 1-lift overlay

ENVIRONMENT	52%
SOCIETY	65%
ECONOMICS	44%
TECHNICAL	25%



Mill, hot mix patch & 1-lift overlay

ENVIRONMENT	35%
SOCIETY	34%
ECONOMICS	50%
TECHNICAL	0%



Conclusions

- Supporting proactive stakeholder engagement
- Leads to greater user satisfaction
- Fosters optimised expenditures and better outcomes
- Measures and rewards more sustainable construction technologies
- Encourages more innovation from equipment manufacturers and contractors
- Provides a framework for estimating the ‘greeness’ of new technologies
- Helps meet overall objectives of a more sustainable road network

Thank you!

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