In-Place Pavement Recycling - Moving Towards a Sustainable Future

Southeastern States
In-Place Recycling Conference
August 20 – Sept 1, 2011.

Tom Kazmierowski, P.Eng
Ministry of Transportation

Ontario

Outline

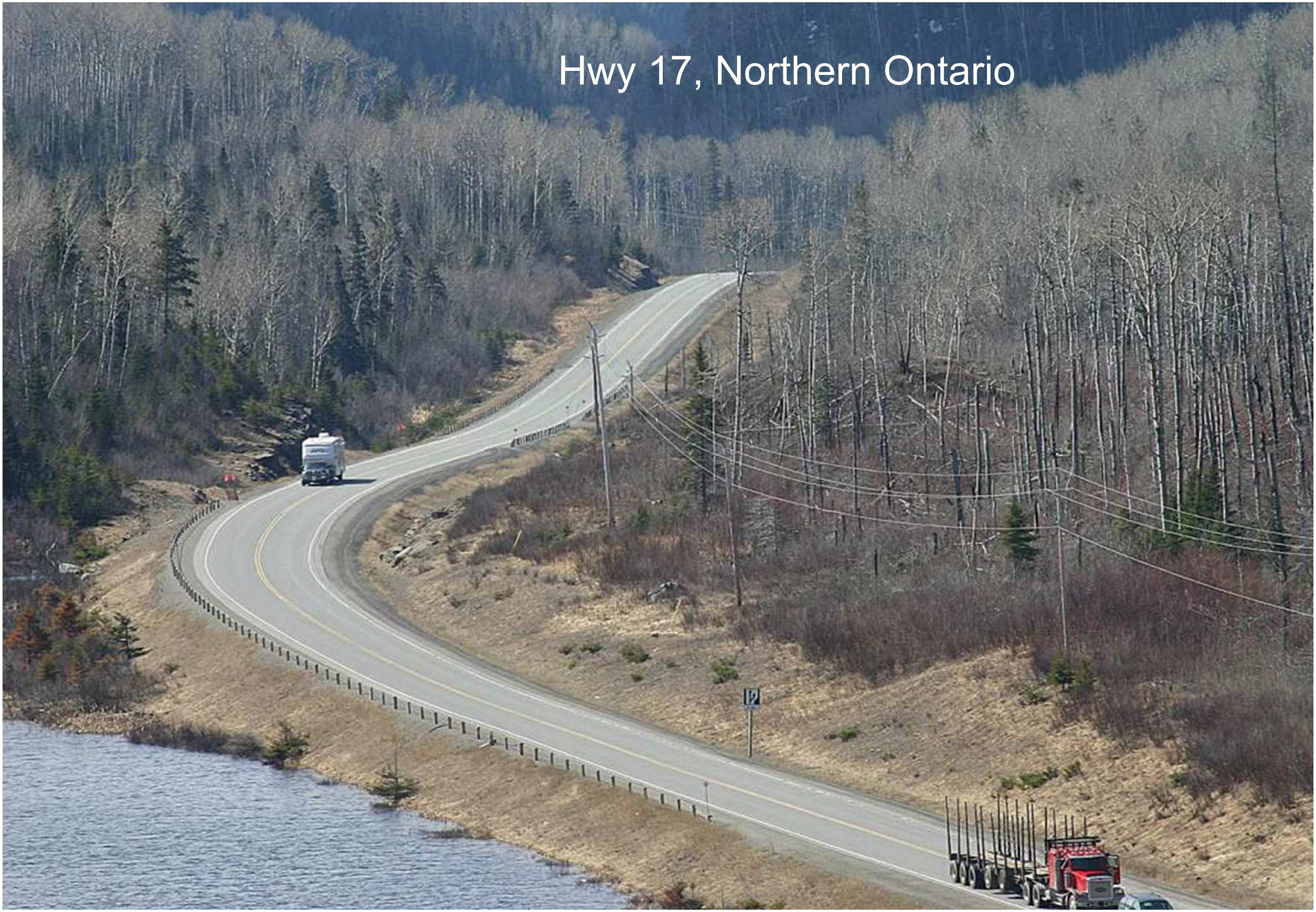
- Ontario road system overview
- Past - What have we learned
- Present - Current practices and improvements
- Case Studies
- Sustainable Future - Challenges

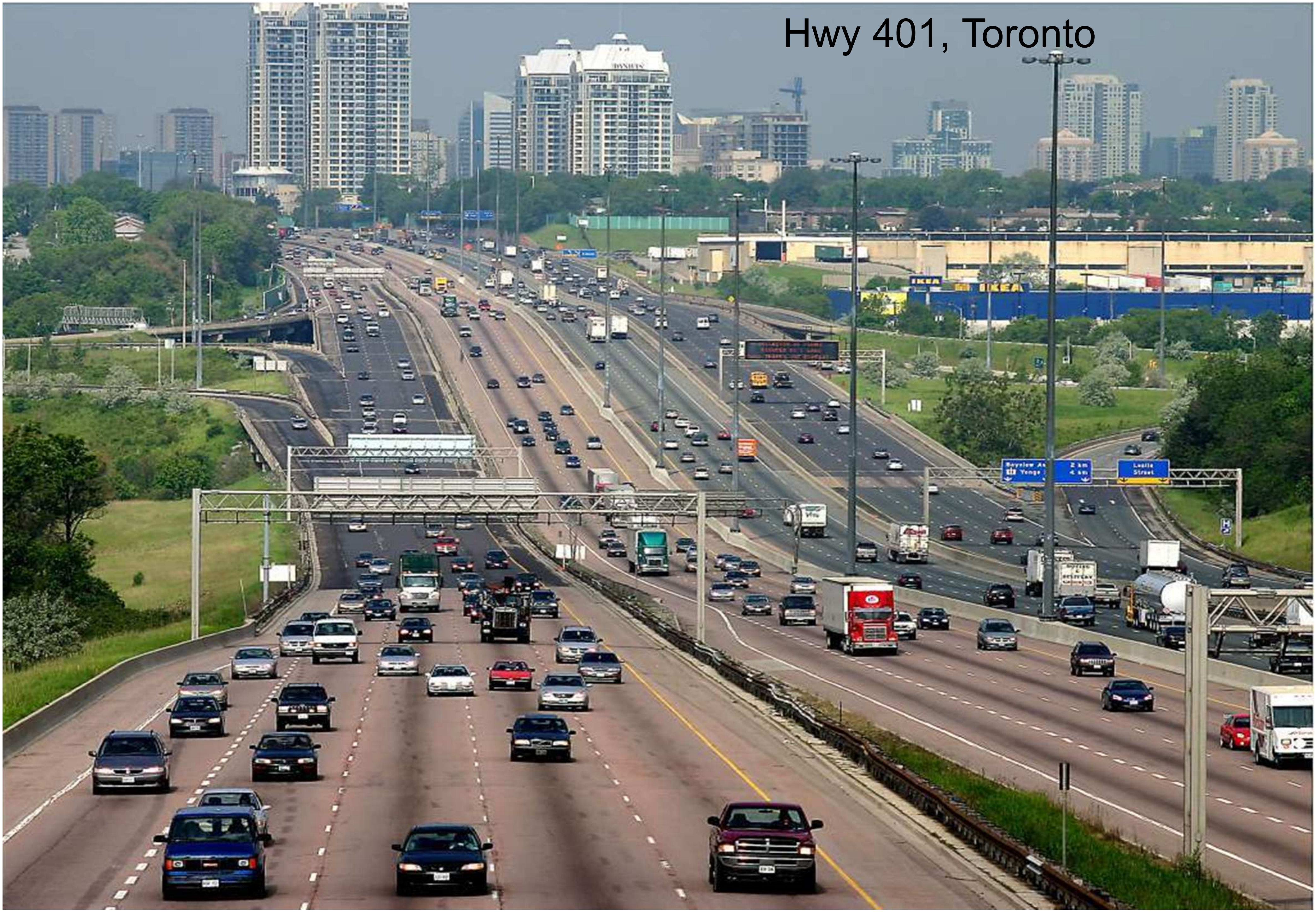
Ontario Road System

- **Provincial System**
  - Funded through provincial taxes
  - 16,520 centre-line km, 3000 bridges
  - $ 2.4 B Capital Constr.
- **Municipal System:**
  - 152,000 centre-line km 132,000 bridges

MTO Pavement Network

- Provincial Road Network
  - freeway 8,900 lane-km
  - arterial 13,000 lane-km
  - collector 9,800 lane-km
  - local 7,500 lane-km
- 95% ==> Bituminous pavements
- 5% ==> Concrete and other types of pavements
- 70% of Canada's exports and $1.2 trillion in goods are carried on Ontario's provincial highways


Hwy 17, Northern Ontario


Hwy 401, Toronto
IKEA

Greening Pavement Initiatives

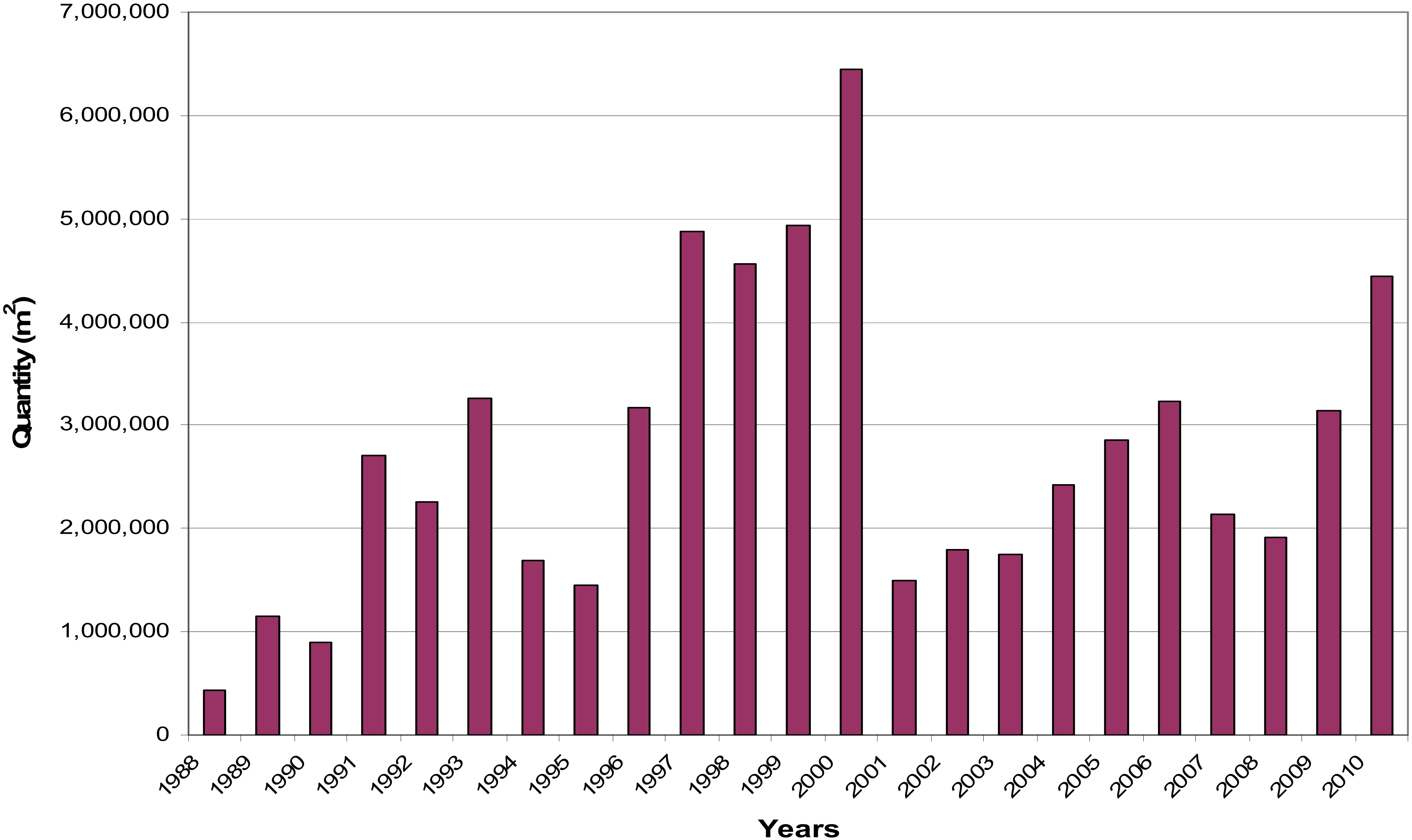
Environmentally friendly pavement design, preservation and rehabilitation strategies include:

- Reuse and recycling of materials
  - Pavement recycling
  - Roof shingles, rubber tires, glass and ceramics
  - Blast furnace slag, fly ash and silica fume
- Warm mix asphalt concrete
- Drainable/permeable pavements
- Reduced noise and perpetual pavements

Implementation of Pavement Recycling in Ontario

- Central plant recycling - late 70's
- Milling, partial depth - early 80's
- Full depth reclamation - mid 80's
- Cold in-place recycling - 1989
- Hot in-place recycling - 1990
- FDR with EA (FA) - 2000
- CIR with EA (FA) - 2003

MTO In-situ Asphalt Recycling Quantities



Ministry of Transportation

Full Depth Reclamation - FDR

Hot In-Place Recycling - HIR

Cold In-Place Recycling -CIR

FDR with Expanded Asphalt Stabilization

CIR with Expanded Asphalt

10 Years Summary of Quantities

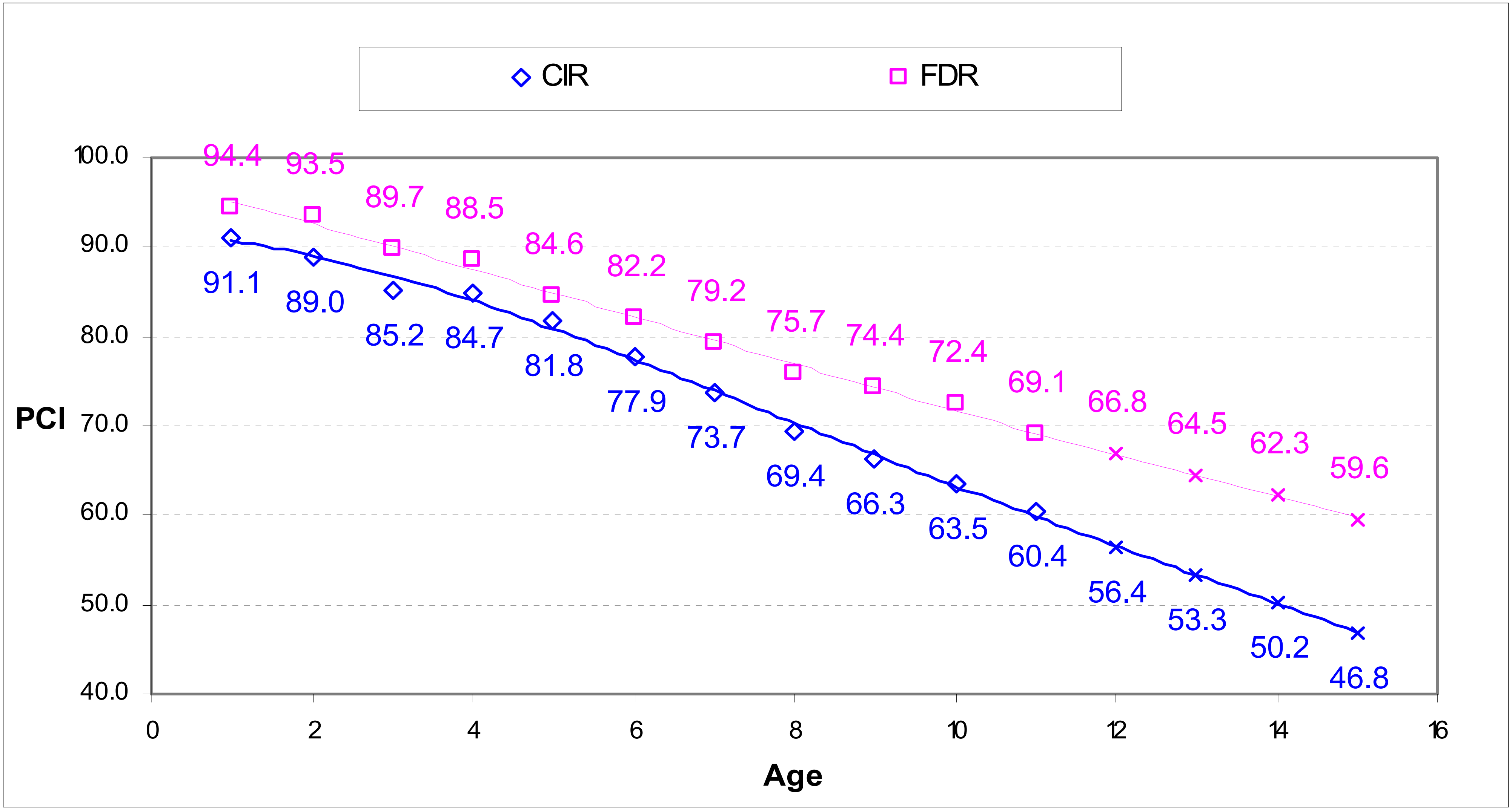
Full Depth Reclamation (FDR)	15,579,412 m^2
Hot In-place Recycling (HIR)	324,124 m^2
Cold In-place Recycling (CIR)	4,150,428 m^2
FDR with Expanded Asphalt	2,664,245 m^2
CIR with Expanded Asphalt	2,486,485 m^2

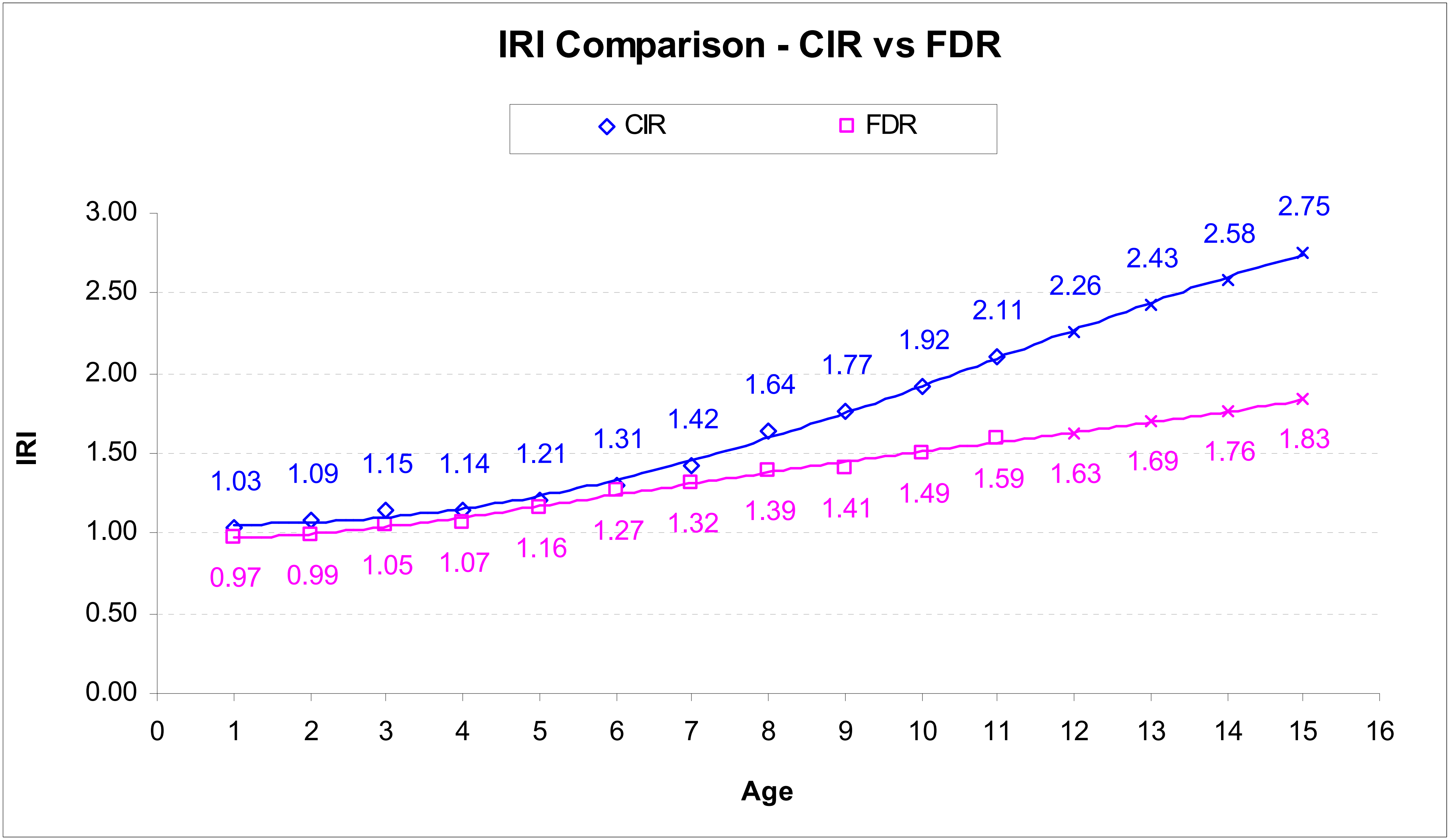
- **Total from 2001 to 2010:** **25,204,694 m^2**

Past Performance

- In-situ recycled pavements have performed well, often carrying significantly more traffic over their service life than anticipated.
- Designs built in the past have evolved from theory, road tests, and trial and error.
- Lessons have been learned from design problems/flaws, materials, and construction practices that have caused problems.

PCI Comparison – CIR vs. FDR





IRI Comparison - CIR vs FDR
CIR
FDR
IRI
Age
3.00
2.50
2.00
1.50
1.00
0.50
0.00
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
1.03
1.09
1.15
1.14
1.21
1.31
1.42
1.64
1.77
1.92
2.11
2.26
2.43
2.58
2.75
0.97
0.99
1.05
1.07
1.16
1.27
1.32
1.39
1.41
1.49
1.59
1.63
1.69
1.76
1.83

Current Practice

Recent improvements in **design**, **materials** and **construction** processes have significantly increased the benefits of in-situ recycling techniques.

Improvements in technology have provided cost effective designs and optimization of rehabilitation strategies.

Design Improvements

Comprehensive Construction and Material Specifications

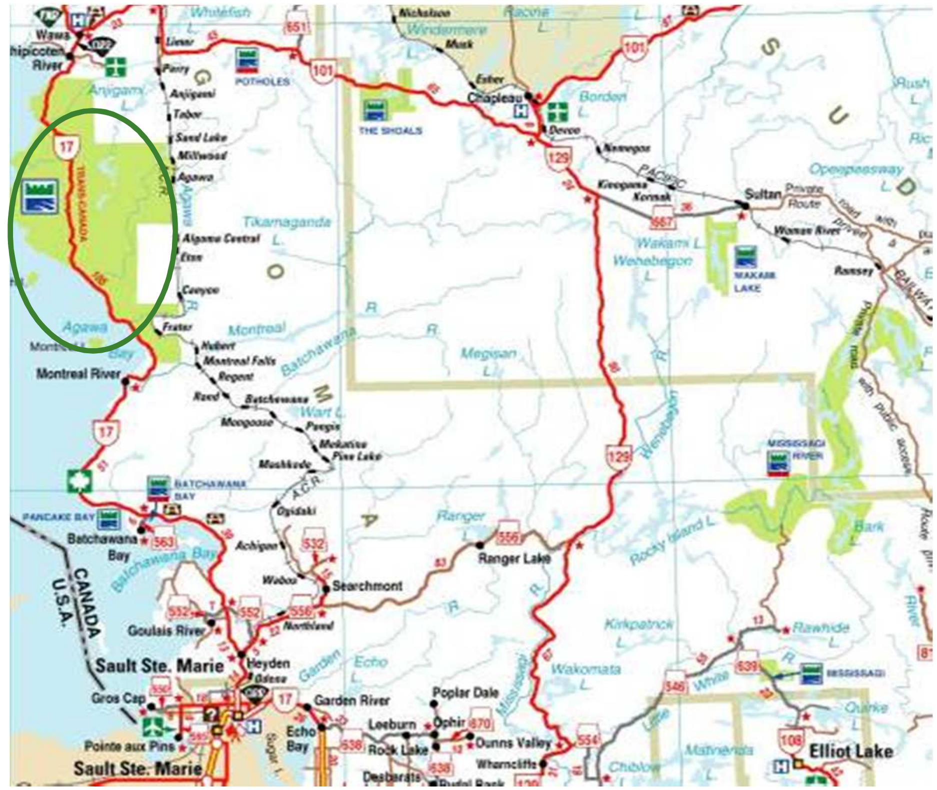
- OPSS 330, Full depth reclamation
- OPSS 334, Cold recycled mix
- OPSS 333, Cold in-place recycling
- OPSS 332, Hot in-place recycling
- OPSS 331, FDR with Expanded Asphalt
- OPSS 335, CIR with Expanded Asphalt

Available online:

http://www.mto.gov.on.ca/english/transrd

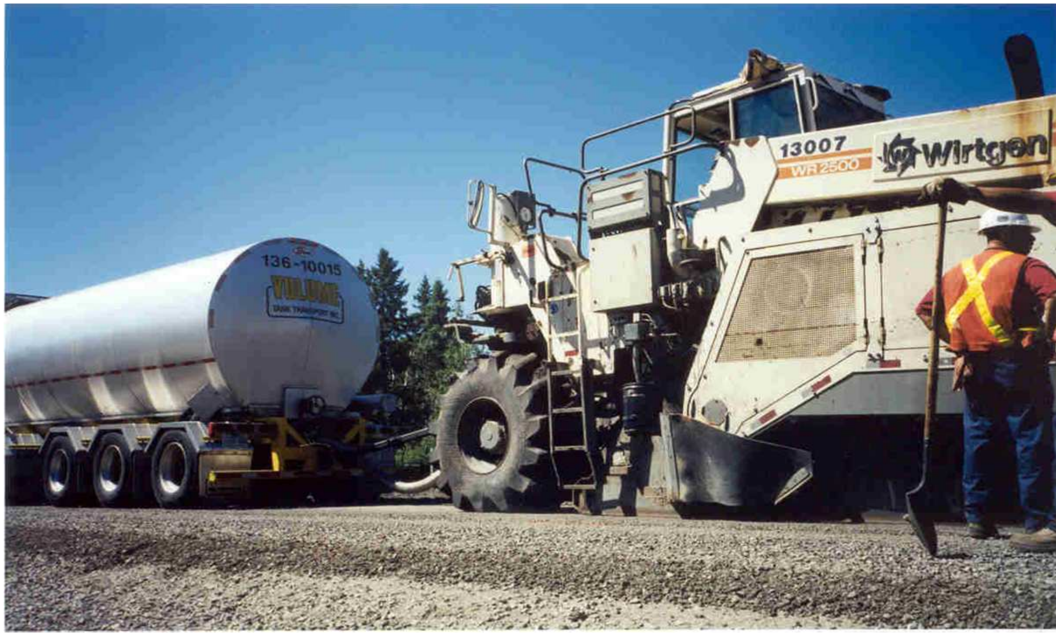
FDR with EA, Hwy 17, Wawa

- Highway 17
- 37.5 km south of Wawa.
- Within Lake Superior Provincial Park.
- 22.5 km in length.
- Grader placed



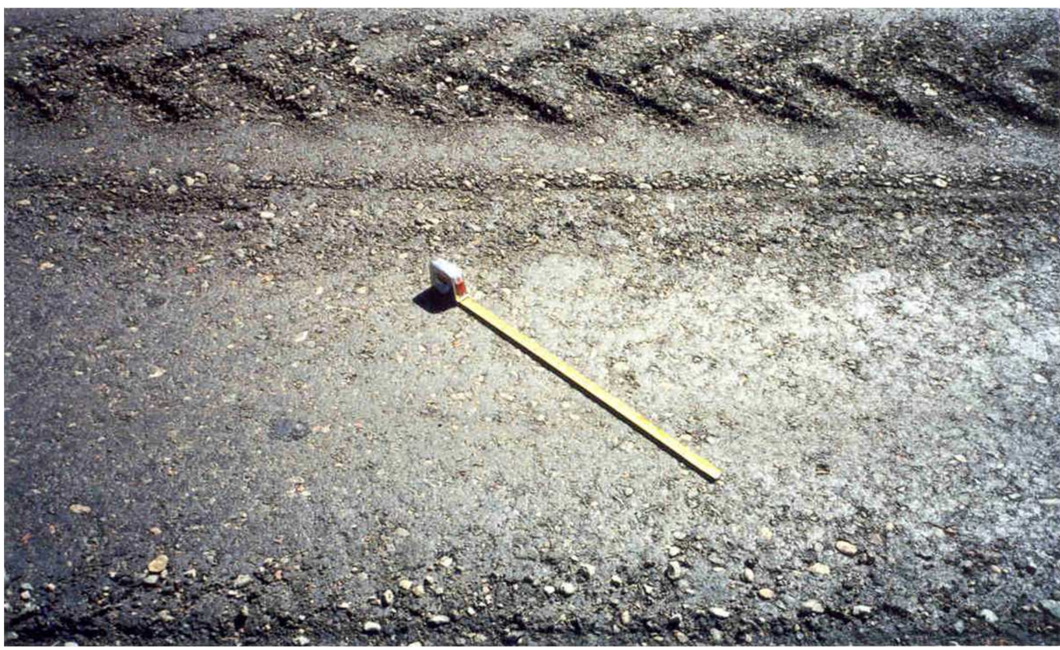
Design Considerations – Hwy 17 Project

- Existing pavement consisted of 80 mm of HMA, 100 mm of crushed granular base and 530 mm of granular subbase
- PCI was 49 out of 100 indicative of extensive, moderate transverse cracking and extensive, moderate pavement edge break-up.
- 2010 AADT was 2500 with 28% trucks, mostly logging trucks
- Rehab options considered included:
  - CIR with a 50 mm HMA overlay
  - FDR with a 120 mm HMA overlay
  - FDR with EAS and an 80 mm HMA overlay

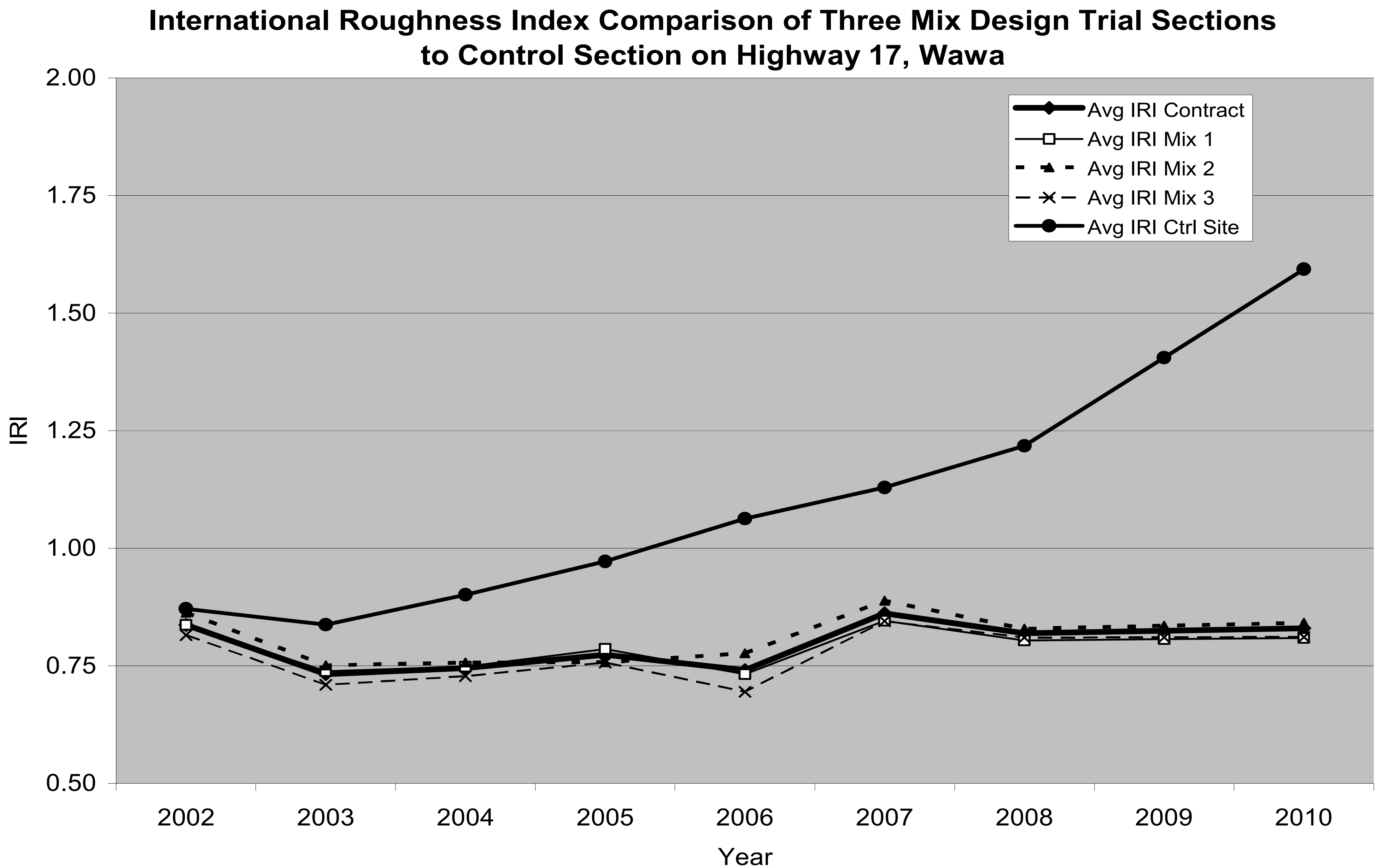


The reclaimer/stabilizer attached to a tanker of hot asphalt cement

The grading and compacting operation following behind the EAS



The expanded asphalt mat following initial pass of the breakdown roller

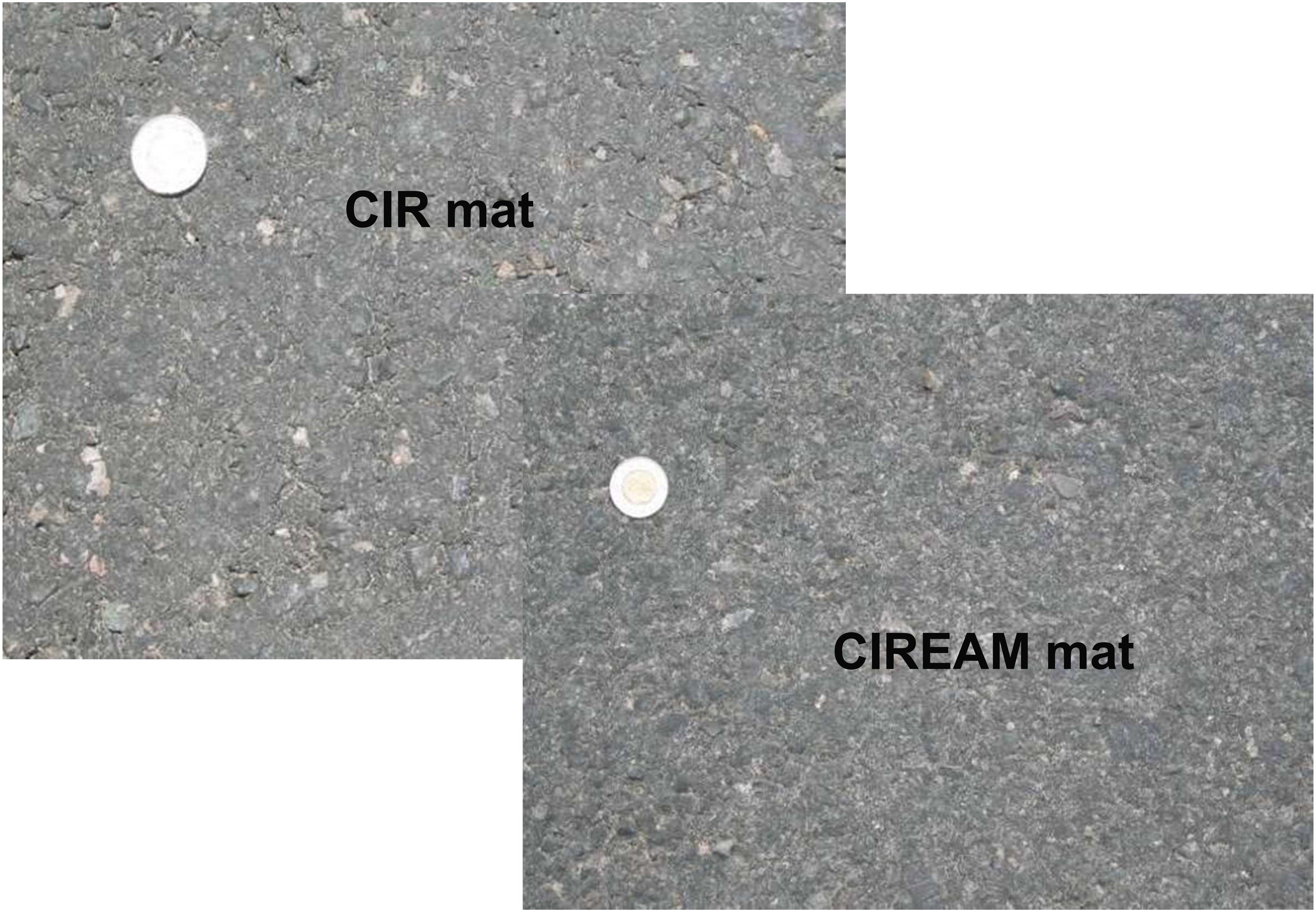

International Roughness Index Comparison of Three Mix Design Trial Sections
to Control Section on Highway 17, Wawa
2.00
1.75
1.50
1.25
1.00
0.75
0.50
IRI
2002
2003
2004
2005
2006
2007
2008
2009
2010
Year
Avg IRI Contract
Avg IRI Mix 1
Avg IRI Mix 2
Avg IRI Mix 3
Avg IRI Ctrl Site

CIR with EA Trial, Hwy 7, Perth

- MTO's first use of CIR with EA was in 2003 on Highway 7, southwest of Ottawa.



Pavement Condition Prior to CIR and CIREAM

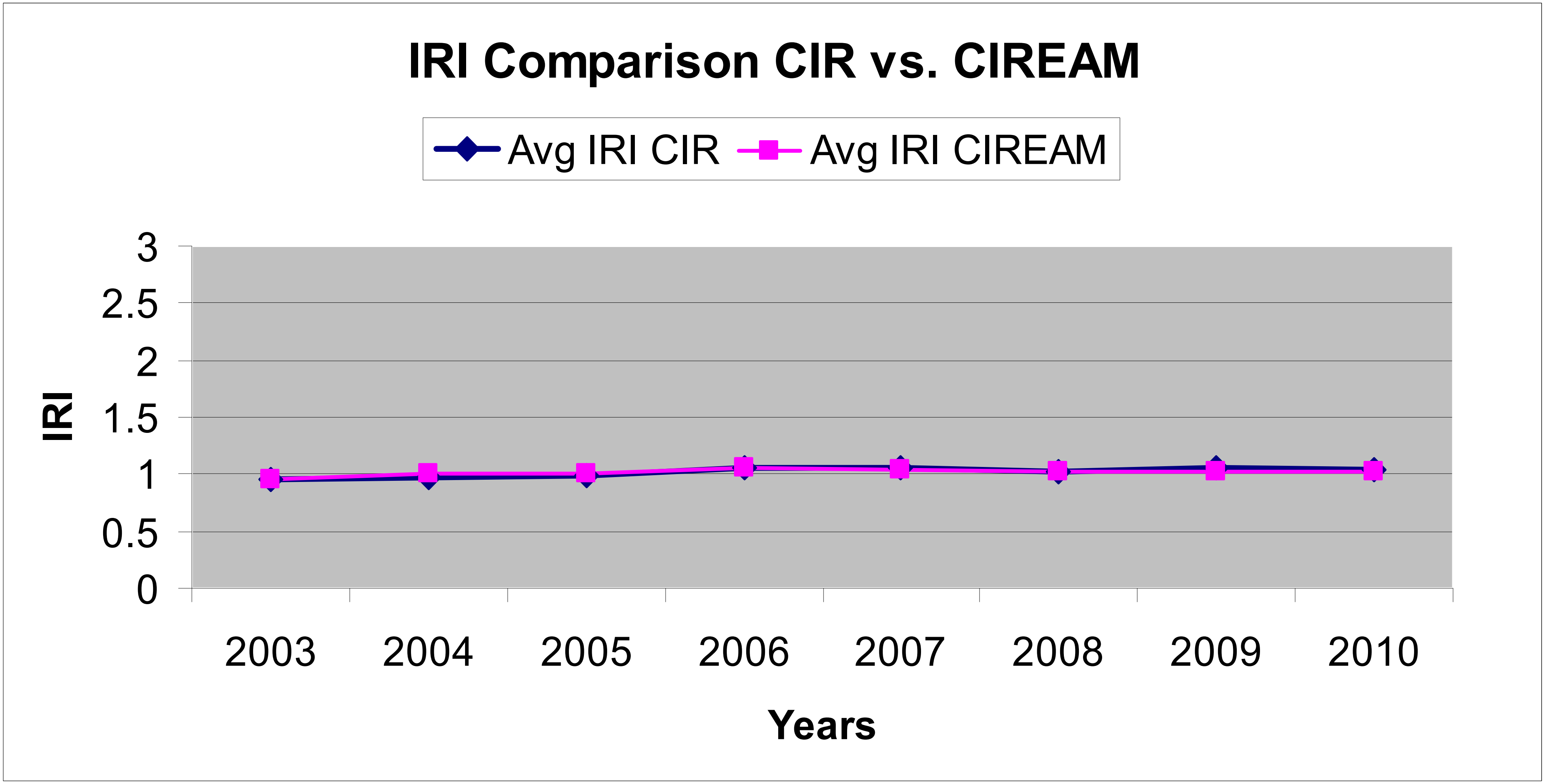

CIR mat
CIREAM mat

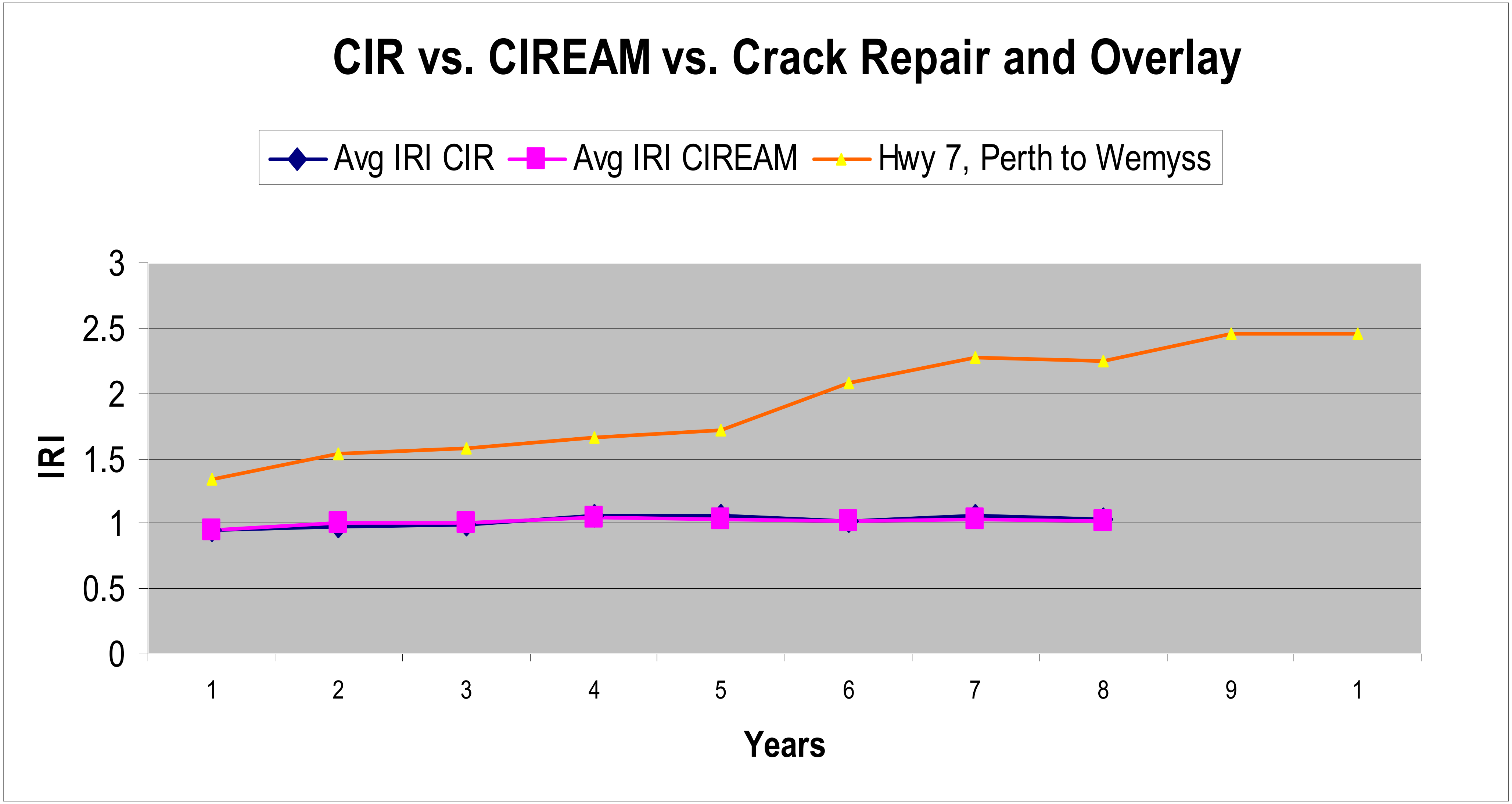
Resilient Modulus of CIREAM and CIR Field Cored Samples

	Instantaneous Resilient Modulus of Elasticity (E_{RI})				Total Resilient Modulus of Elasticity (E_{RT})			
	14+930	15+680	21+360	21+610	14+930	15+680	21+360	21+610
Section	**CIREAM**		**CIR**		**CIREAM**		**CIR**	
E_{RI} / E_{RT}	5516	5144	5414	4960	5363	5006	5249	4795
Average:	**5330**		**5187**		**5185**		**5022**	
Std. Dev.:	263		321		252		321	

Indirect Tensile Strength of CIREAM and CIR Field Cored Samples

Station	14+930	15+680	21+360	21+610
Section	**CIREAM**		**CIR**	
ITS	907.6	826.7	937.5	761.1
Average:	**867**		**849**	
Std. Dev.:	57		125	


IRI Comparison CIR vs. CIREAM
Avg IRI CIR
Avg IRI CIREAM
3
2.5
2
1.5
1
0.5
0
IRI
2003
2004
2005
2006
2007
2008
2009
2010
Years



CIR vs. CIREAM vs. Crack Repair and Overlay
Avg IRI CIR
Avg IRI CIREAM
Hwy 7, Perth to Wemyss
IRI
3
2.5
2
1.5
1
0.5
0
1
2
3
4
5
6
7
8
9
1
Years

Towards a Sustainable Future

What is Sustainable Development?

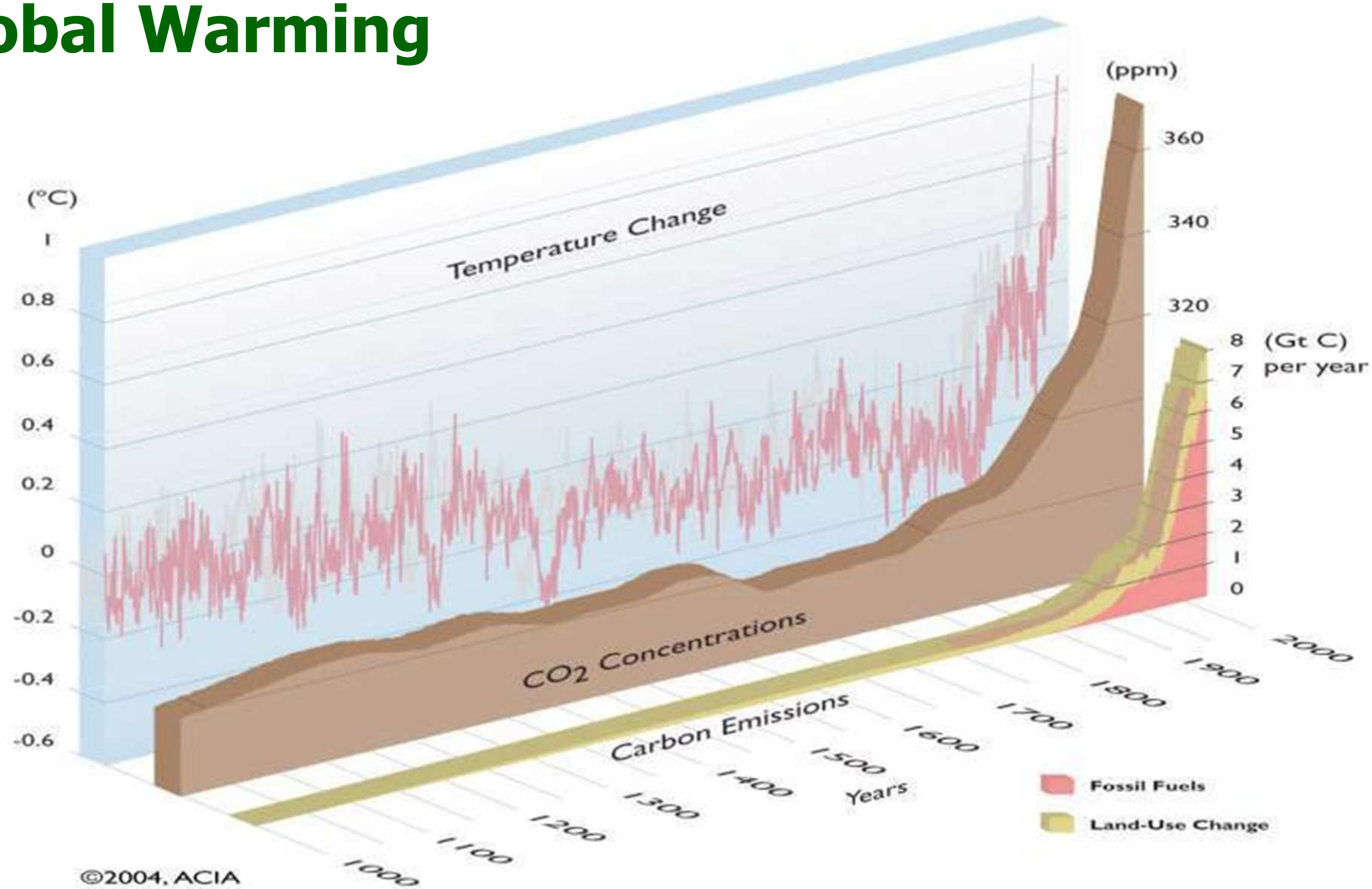
"…. Development that meets the needs of the present without compromising the ability of future generations to meet their own needs."

Towards a Sustainable Future

To achieve sustainability, every corporate decision should consider the impact of the triple-bottom-line.

“What are the Social, Economic, and Environmental (SEE) Impacts of the decision”

GHG Emissions and Global Warming



Variation in Mean Surface Temp and CO_2 Concentration

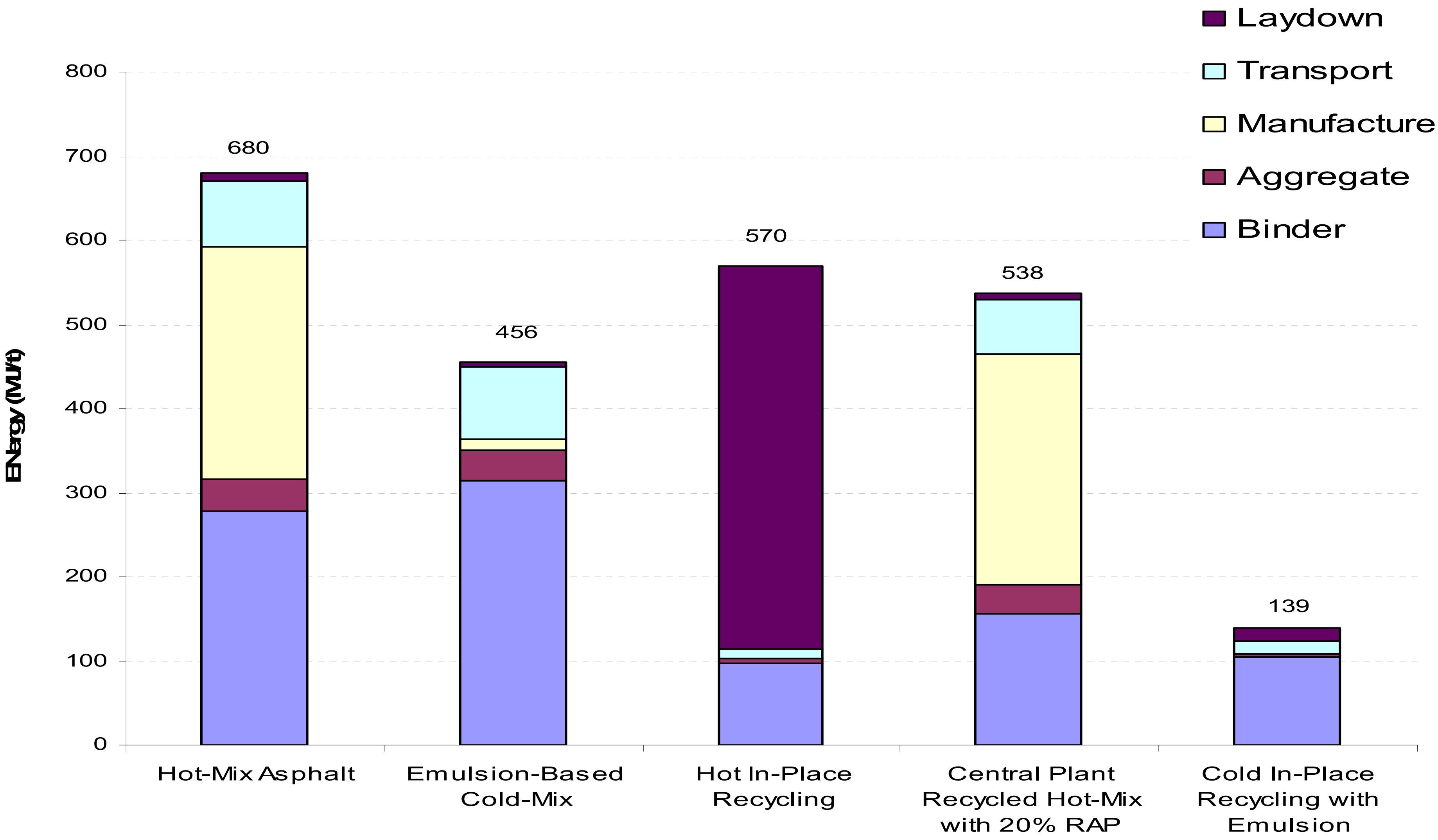
Sustainable Pavement Criteria

" ….safe, efficient, environmentally friendly pavements meeting the needs of present-day users without compromising those of future generations"

In-situ recycling technologies address the main criteria for a sustainable pavement:

- Optimizing the use of natural resources
- Reducing energy consumption
- Reducing greenhouse gas emissions
- Limiting pollution
- Improving health, safety and risk prevention
- Ensuring a high level of user comfort and safety

Energy Use Per Tonne Of Material Laid Down



Source: *The Environmental Road of the Future, Life Cycle Analysis* by Chappat, M. and Julian Bilal. Colas Group, 2003, p.34

Sustainable Pavements

- The report concludes that recycling technologies are the most promising tool to assist in the selection of environmentally friendly flexible pavements.
- MTO's primary pavement design/rehabilitation goal is to provide safe durable roads that maximize the use of recycled materials.

Ontario Case Study

Environmental Benefits of
In-place Recycling (CIR & CIREAM)
vs.
Mill and Overlay

Ontario

Impact Evaluation

- **PaLATE** software -

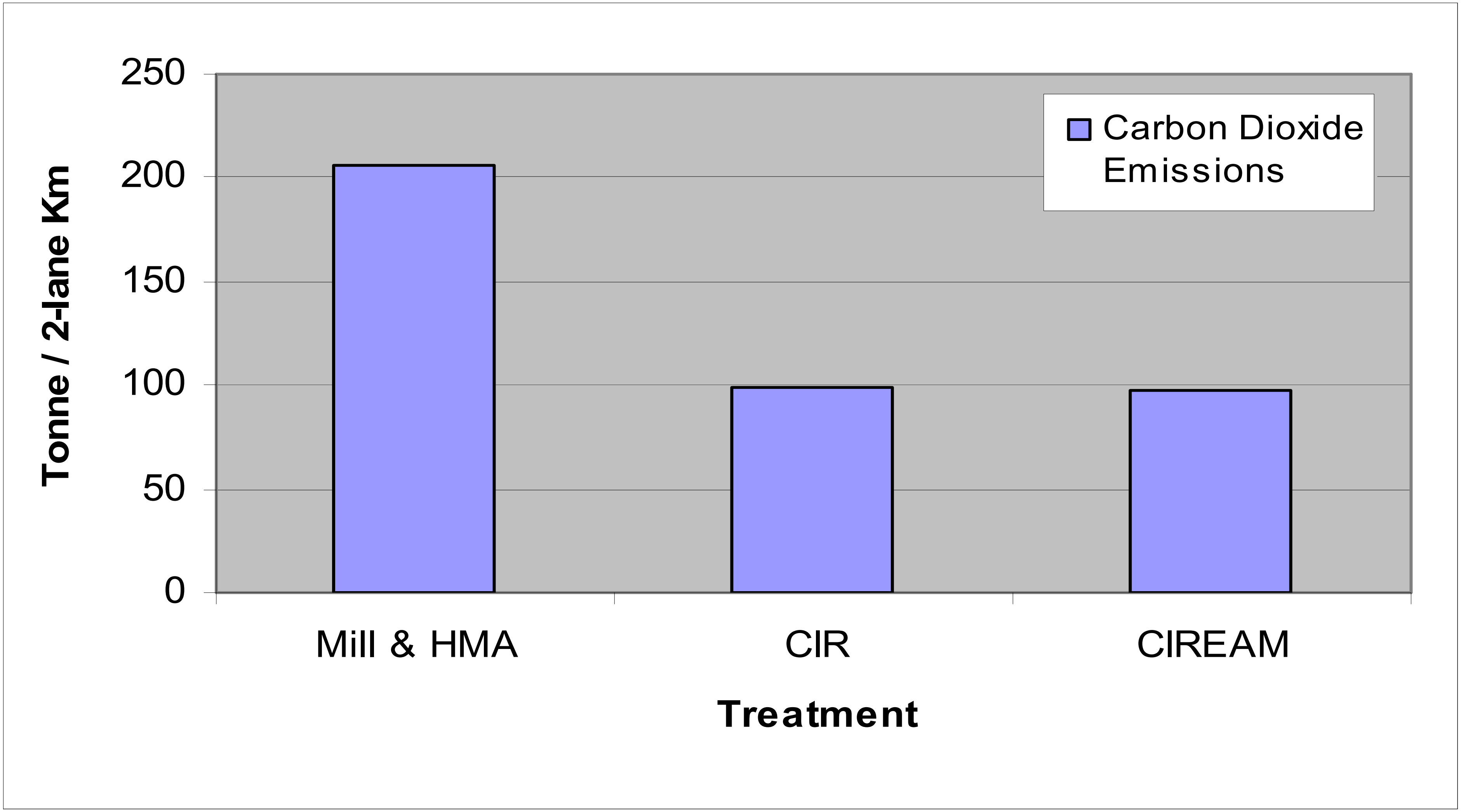
  Pavement Life-cycle Assessment for Environmental and Economic Effect
- Created by Dr. Horvath of the University of California at Berkley
- Assists decision-makers in evaluating the use of recycled materials in highway construction (both LCC and Environmental Impacts).

Study Assumptions

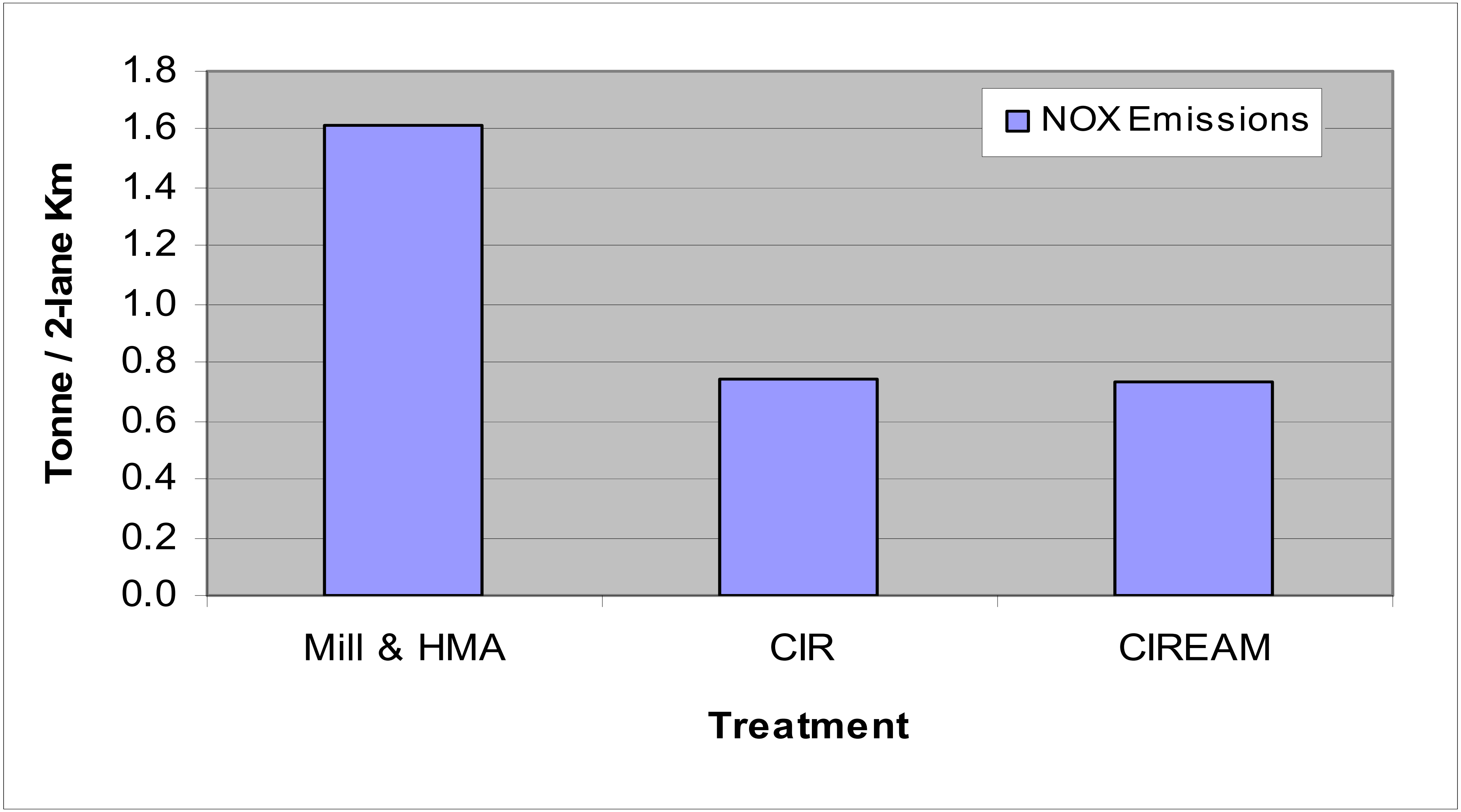
	CIR	CIREAM	M&O
Existing HMA Depth	150mm	150mm	150mm
New HMA	50mm	50mm	130mm
% AC	5%	1.0% & 5%	5%
% Emulsion	1.2%	0	0

Using PaLATE model, the following emissions were calculated and compared:

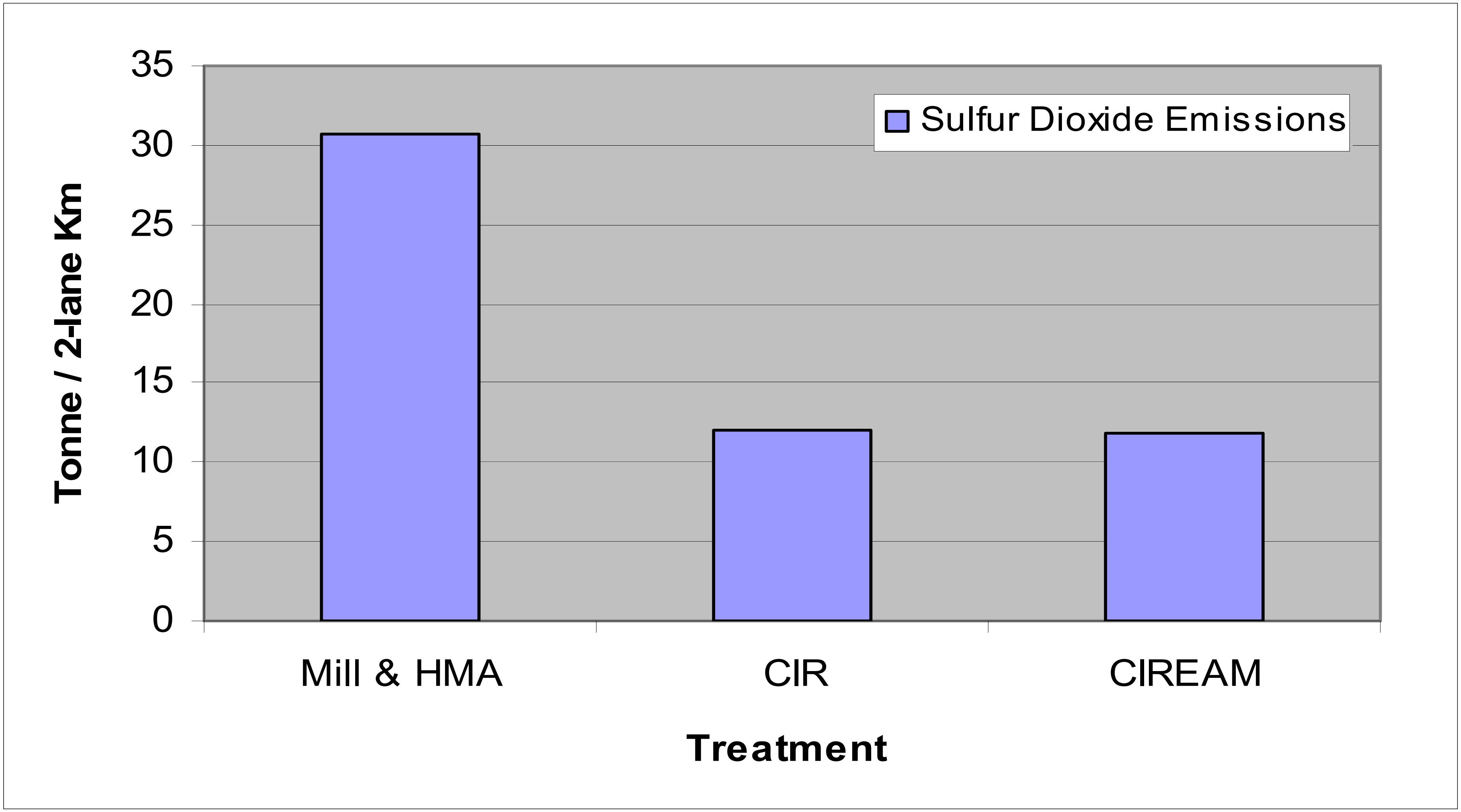
CO_2 Emissions



NO_X Emissions



SO_2 Emissions



Environmental Benefits

- Per 2-lane km, CIR/CIREAM emits approximately 50% less GHG, consumes 62% less aggregates, and costs 40-50% less when compared to a conventional mill and overlay treatments
- Since the implementation of CIR/CIREAM contracts, MTO has reduced GHG emissions by:
  - **144,400 tonnes** of CO_2
  - **1,200 tonnes** of NO_x
  - **25,200 tonnes** of SO_2

  And saved **1.98 million tonnes** of aggregates

Technology Transfer

- CIR & CIREAM are two of the most environmental friendly flexible pavement rehabilitation techniques available; they reduce Life Cycle Costs, reuse existing non-renewable material, minimize new materials and reduce on site transportation.
- MTO actively promotes CIR/CIREAM through technical papers, presentations and by example

What's next?

- Current Life Cycle Costing (LCC) includes:
  - Initial, and discounted main/rehab costs and remaining life costs
  - User costs
- We now have the tools to calculate GHG emissions and energy savings – PaLATE software
- MTO has developed a rating system to quantify and encourage pavement sustainability
- We are moving towards including an environmental component into LCC (Environmental benefits/credits).
- Insures that the best treatment is selected to benefit economic, social and environmental needs

  - a Sustainable Approach.

Existing Green Rating Systems

- LEED® for Buildings
- University of Washington Green Roads
- NYSDOT GreenLITES Project Design Certification Program
- Alberta/Stantec Green Guide for Roads
- TAC Green Guide for Roads

MTO Green Rating System Categories

Category	Goal	Points
Pavement Design Technologies	To optimize sustainable designs. These include long life pavements, permeable pavements, noise mitigating pavements, and pavements that minimize the heat island effect.	9
Materials & Resources	To optimize the usage/reusage of recycled materials and to minimize material transportation distances.	11
Energy & Atmosphere	To minimize energy consumption and GHG emissions.	8
Innovation & Design Process	To recognize innovation and exemplary efforts made to foster sustainable pavement designs.	4
	Maximum Total:	**32**

MTO Green Rating System Overview

Pavement Technologies — 9 points

- Long-life pavement design — 3 Points
- Permeable Pavements — 2 Point
- Noise Mitigation — 2 Points
- Cool Pavements — 2 Points

Materials & Resources — 11 points

- Recycled Content — 5 Points
- Reuse of Pavement — 2 Points
- Local Materials — 2 Points
- Construction Quality — 2 Points

Energy & Atmosphere — 8 points

- Reduce Energy Consumption — 3 Points
- GHG Emissions Reduction — 3 Points
- Rolling Resistance — 1 Point
- Pollution Reduction — 1 Points

Innovation & Design Process — 4 points

- Innovation in Design — 2 Points
- Exemplary Process — 2 Points

Summary

We will better achieve our sustainable pavement goals through:

- Building on current industry/ministry partnerships in the development of improved in-situ recycling specifications and design/construction procedures
- Encouraging continued innovation by the province's in-situ recycling contractors
- Supporting dedicated research programs to advance the technology
- Increasing technology transfer to accelerate adoption of in-situ recycling concepts

Conclusions

- There is an increased focus on sustainable asset preservation in Ontario, both at the provincial and municipal levels
- Pavement preservation and rehabilitation incorporating timely insitu recycling treatments can significantly extend pavement life and result in improved network performance over time
- Implementation of **sustainable** AM principles and performance measures are critical to addressing infrastructure investment requirements and **environmental stewardship** over the long-term

Thank you!

Questions?

Tom Kazmierowski, P. Eng.
Manager,
Materials Engineering and Research Office
Tel: 416-235-3512
Fax. 416-235-3919
Email:
tom.kazmierowski@ontario.ca