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Photo from Astec Industries

Warm is the New Hot - Using Warm Mix Asphalt to Reduce Environmental Impact and Improve Pavement Performance

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- **FHWA**
- **NAPA**
- **Astec Industries**

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"What's Wrong with Hot Mix?"

Nothing really, but we can do better.

- **What if we could produce asphalt concrete with less fuel?**
- **What if we could produce asphalt concrete with fewer emissions?**
- **What if we could haul asphalt longer distances?**
- **What if we could add more RAP?**
- **What if we could extend the paving season?**
- **What if we could improve longitudinal joint performance?**
- **What if we could improve compaction consistency?**
- **What if we could improve working conditions?**
- **What if we could have longer service life?**

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History of Warm Mix

1995 – experimental WMA with zeolites

1996 – German MOL considers reducing worker fume exposure

- **German Bitumen Forum founded to find ways to reduce asphalt production temperatures**
- **Shell and Kolo Veidekke start to develop WAM-Foam process**

1997 – Kyoto Protocol Treaty signed

- **Other WMA processes investigated in Europe**

2002 – NAPA Study Tour of European countries

2003 – NCAT research trials

2005 – NAPA/FHWA WMA Technical Working Group

- **Goal to develop a generic specification**

2007 – AASHTO/FHWA Scan Tour

- **City of Ottawa field trials with three WMA processes**

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"How Do We Do That?"

We need to reduce the viscosity of the mix during mixing and placement – without the heat!

- **Less heat = less fuel = less emissions**
- **Two main mechanisms**
- **1) Addition of a viscosity-reducing compound (wax, surfactant or ester)**
  - Lower melting point than straight asphalt cement
  - Surfactants improve coating
- **2) Add a small amount of water**
  - Steam expands the asphalt by a factor of 1673 times

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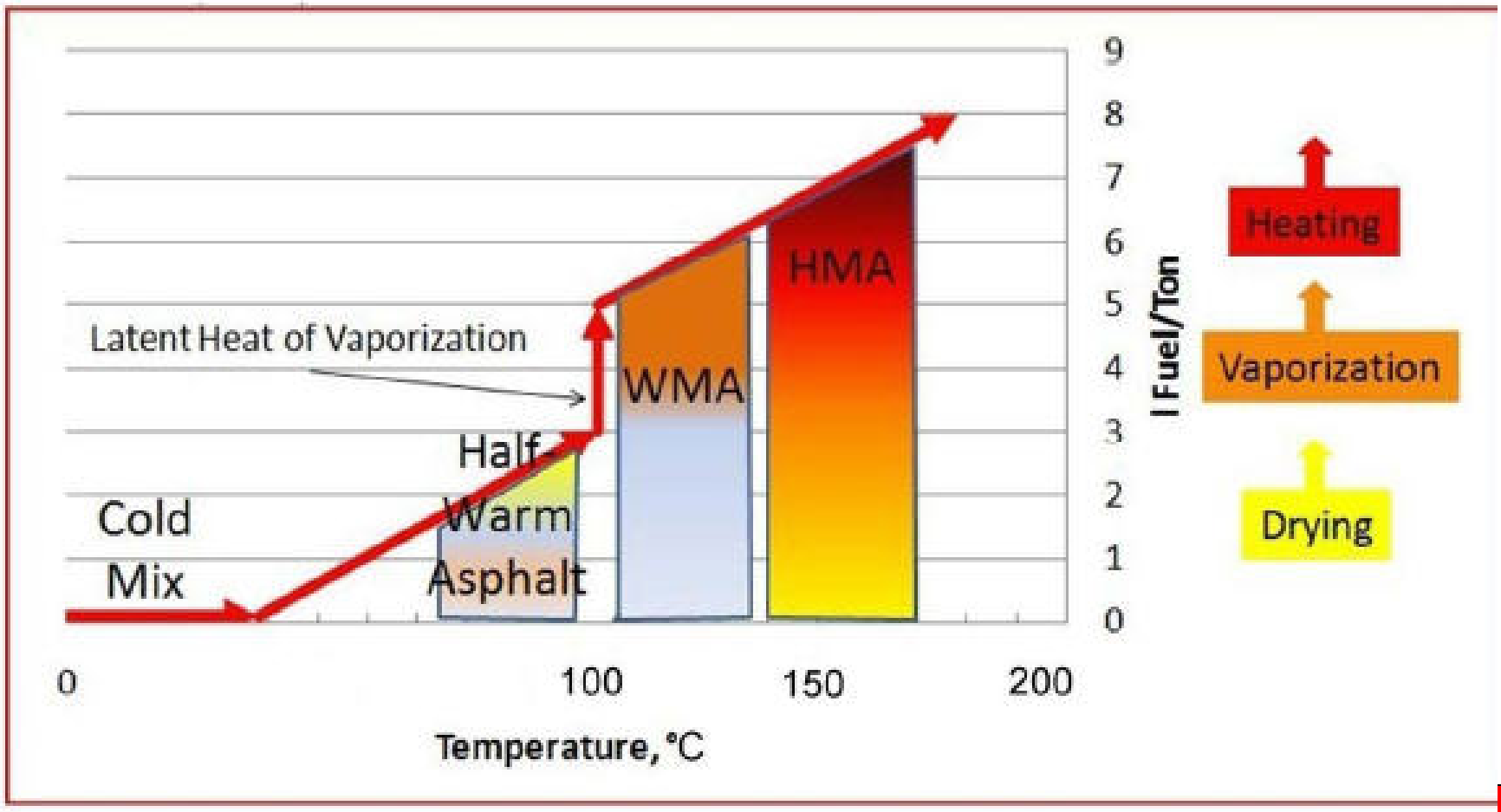
Temperature Classification



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Warm Mix Additives

Product	Description	Dosage	Plant Temp. Reduction
Asphaltan B® (Romonta GmbH, Germany)	Ester compound is a byproduct of the toluene extraction of brown coal.	2 to 4% (by mass of AC)	20 to 30°C
Evotherm® (Meadwestvaco, USA)	Blend of surfactants and adhesion promoters. Available as an emulsion, concentrate or blended AC.	5% (by mass of AC)	50 to 75°C
Rediset™ WMX (Akzo Nobel, Sweden)	Blend of surfactants and organic modifiers added in solid form. Also provides anti-stripping effect.	1.5 to 2.5% (by mass of AC)	20 to 30°C
Sasobit® (Sasol Wax, South Africa)	Synthetic paraffin wax derived from coal gasification.	0.8 to 3% (by mass of AC)	20 to 30°C

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Foaming Technologies

Product	Description	Dosage	Plant Temp. Reduction
Advera® (National Silicates, USA)	Aluminosilicate zeolite powder added to plant.	0.3% (by mass of Mixture)	10 to 20°C
Aspha-Min® (aspha-min GmbH, Germany)	Synthetic zeolite powder added to plant.		30°C
Double Barrel® Green (Astec Industries, USA)	System of foaming nozzles added to an existing hot mix plant.		10°C
Low Energy Asphalt (Fairco, France)	Special process where only the coarse aggregates are heated and dried, followed by the addition of cold and wet fine aggregate and hot asphalt to create a foam.		30°C
WAM-Foam (Shell and Kolo Veidekke)	Two-component system where soft asphalt cement is mixed with the aggregates at lower temperature followed by the addition of a stiff asphalt cement in foam form.		50°C

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“We Fear Change…”

Mix Design Modification?

- Additives (Evotherm, Sasobit, zeolites, simply batched with traditional ingredients
- Double Barrel Green and WAM-Foam require lab foaming kits

Plant Modification?

- Evotherm 3G, Sasobit, Revix can be blended at the AC terminal
- Double Barrel Green is a plant-installed injection manifold
- Evotherm DAT and Revix require injection pump
- Sasobit and zeolites can be added into the RAP or fibre feeder

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“We Fear Change…”

Wirtgen Laboratory Foamer (left)

Double Barrel Green manifold

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Benefits of WMA

Compaction Aid

- If used at traditional compaction temperatures (not WMA temperatures), aids compaction of stiff/modified mixes
- Sasobit particularly good for this purpose

Cold Weather Paving and Extended Haul Distances

- Reduced viscosity of mix allows mix easier to compact
- Rate of cooling reduced due to smaller difference between mix and ambient temperatures

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Benefits of WMA

Allows Higher Percentage of RAP

- Reduced viscosity of mix allows mix easier to compact
- Virgin binder less oxidized so final binder blend more resilient

Extended Performance???

- Virgin binder less oxidized, so should last longer than HMA
- Longitudinal joint may be stronger than HMA

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Benefits of WMA

Reduced Fuel Usage

- Theoretical calculations suggest that a 28°C reduction in temperature saves 11% of fuel
- Various factors involved, but reductions of 20 to 35% typical
- Evotherm Trials in Aurora, Ontario (23% fuel reduction) and Ramara Township, Ontario (55% fuel reduction)

Reduced Fumes and Emissions

- Less fuel = less emissions (future Carbon credits?)
- Improved worker comfort
- May be able to pave during smog days

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Benefits of WMA

Emissions Reductions (%) with WMA
(adapted from FHWA Warm Mix Asphalt: European Practice)

Emission	Norway	Italy	France	Canada
CO_2	31.5	30-40	23	45.8
SO_2	n/a	5	18	41.2
VOC	n/a	50	19	n/a
CO	28.5	10-30	n/a	63.1
NO_X	62.5	60-70	18[1]	58
Dust	54	25-55	n/a	n/a

Notes: 1. Reported as NO_2
n/a is not applicable
CO_2 is carbon dioxide
SO_2 is sulphur dioxide
VOC is volatile organic compound
NO_X are oxides of nitrogen

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Barriers to Implementation

New technology = Fear

- North American pilot projects are new, unproven
- Many available products/processes – which is best?
- People relunctant to change (need new specs,

Cost

- Additives cost money, Plant modifications cost money, agencies have NO money
- Fuel savings, extended paving season, performance and environmental benefits should offset

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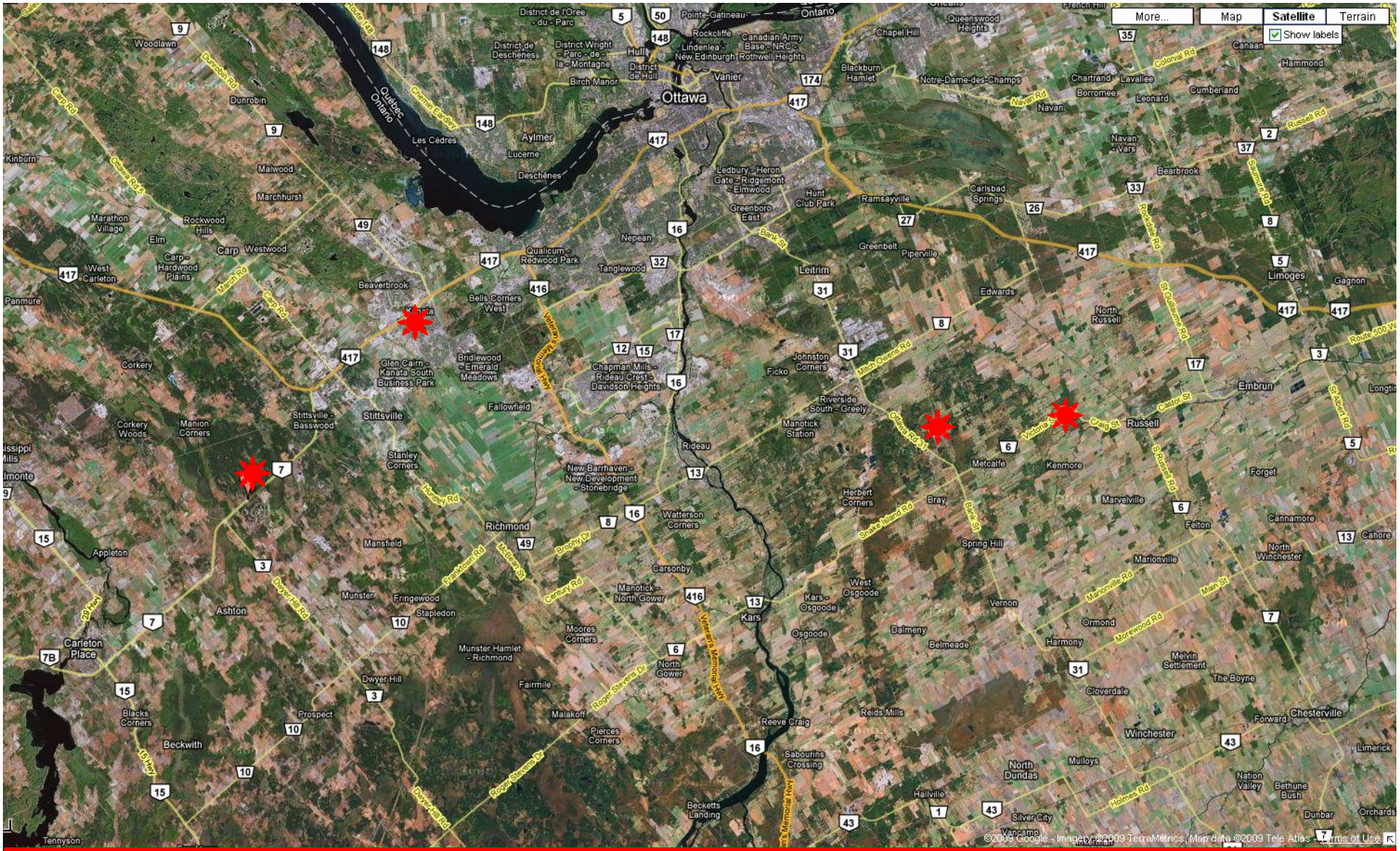
WMA Locations in Ottawa



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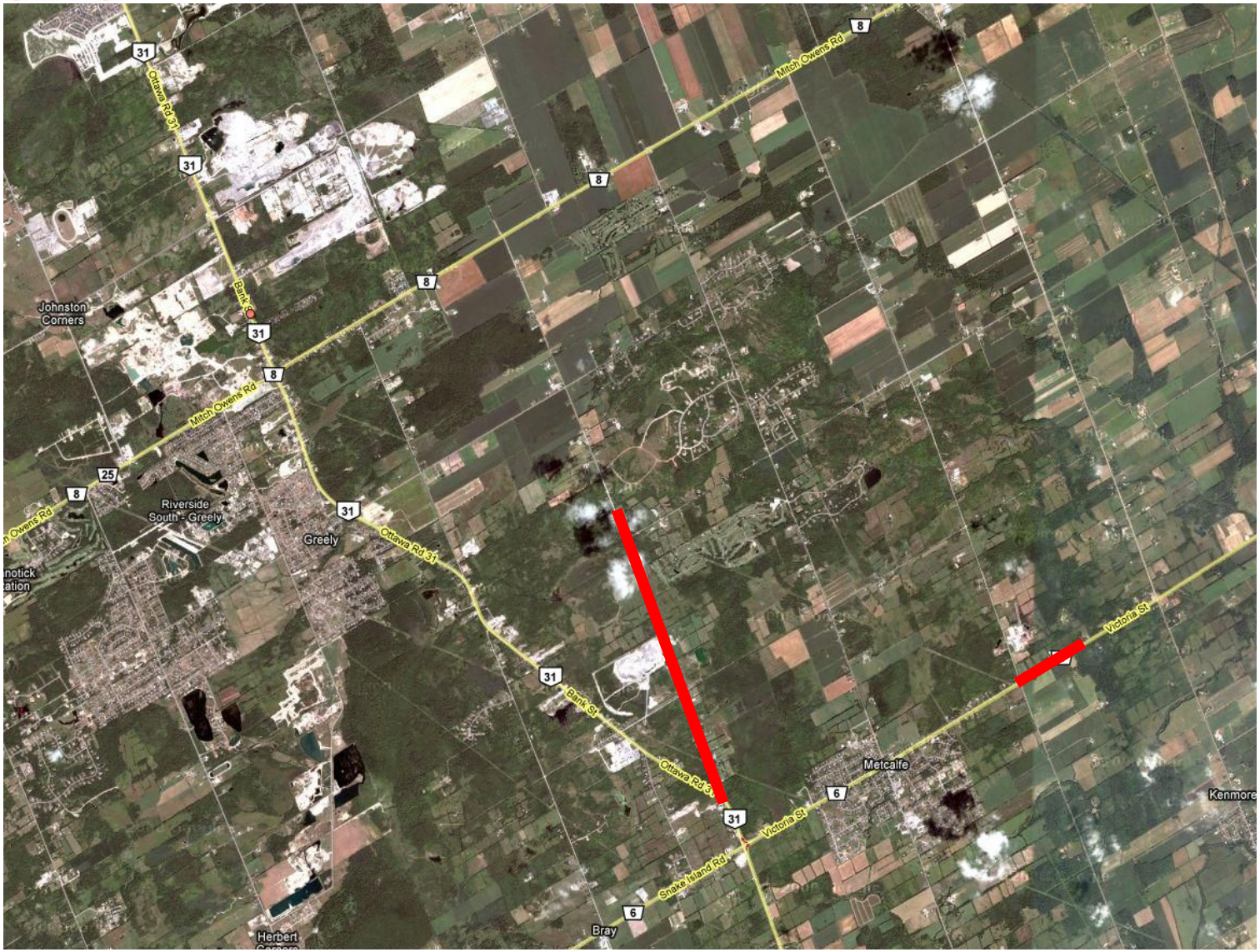
WMA Locations (Rural East)



John Quinn Road and Victoria Road

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John Quinn Road – Bank to Mitch Owens

7.7 km Rural collector road

- Rehabilitated in 2007 by pulverizing, additional granular base and single lift of hot mix
- Cruikshank Construction Limited paving contractor
- Contractor requested warm mix trial (half of project)
- City negotiated $2.50/tonne premium for additive

Evotherm DAT

- Section from Bank Street to Cooper Hill Road (3.8 km)
- McAsphalt supplied Evotherm DAT system
- 3,433 tonnes of Evotherm modified Superpave 12.5 Level B with PG 58-34

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Evotherm DAT

Concentrate – Injection System

Batch Plant

- Into pugmill
- Spray bar in pugmill

Drum Plant

- Injected into AC line
- Prior to drum

John Quinn Road – Bank to Mitch Owens

I must have a cold,
I can't smell a thing!


John Quinn Road – Bank to Mitch Owens
March 2009

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Victoria Road – Yorks Corners to OR 6A

2 km Rural arterial road

- Rehabilitated in 2007 by in-place recycling (expanded asphalt) and single lift of hot mix
- R.W. Tomlinson Limited paving contractor
- Contractor requested warm mix trial (half of project)
- City negotiated $2.50/tonne premium for additive

Sasobit

- Section from Yorks Corners for 1 km east
- Sasobit provided by Bitumar
- 950 tonnes of 1.5% Sasobit modified Superpave 12.5 Level C with PG 58-34 and 15% RAP

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Victoria Road – Yorks Corners to OR 6A

Sasobit

- Soluble in asphalt with melting point between 85 and 115°C
- Can be added in prills (1mm or 5mm diameter) or 3mm chips
- No modification to mix design
- Terminally blended or added at plant with fibre injection system

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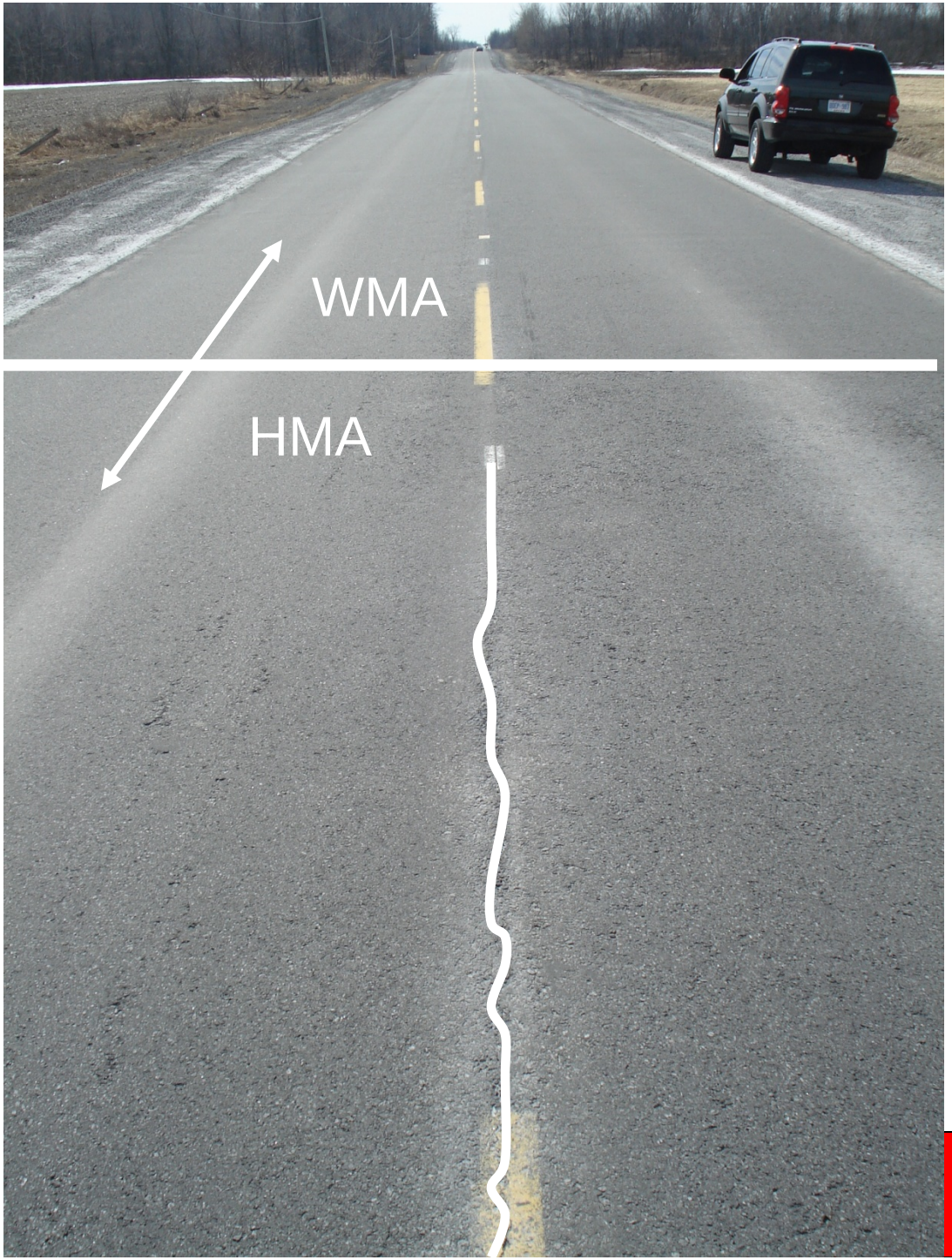
Victoria Road – Yorks Corners to OR 6A



Victoria Road – March 2009

WMA section displays virtually no centreline joint cracking and tighter mat compared to HMA section after 2 winters

Victoria Road – March 2009

Centreline joint along

- **HMA section (top) now open, while almost undetectable in WMA section (bottom)**

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WMA Locations (Rural West)

Westleigh Road and Carlisle Circle

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Westleigh Road and Carlisle Circle

Rural Residential Roads

- Rehabilitated in 2007 by tack and overlay on existing surface (no milling)
- Lafarge North America paving contractor
- City negotiated $2.50/tonne premium for additive

Hypertherm

- 1600 tonnes of Hypertherm modified Superpave 4.75 FC1 Level C with PG 58-28
- Mix placed at 25 to 30 mm thick
- Mixing temperature of 120°C and placement at 90°C (versus 145°C and 120°C for HMA, respectively)


October 2007
INCHES
CENTIMETRES


March 2009

WMA Locations (Urban West)

Katimavik Road – Castlefrank Road to Terry Fox Drive

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Katimavik Road – Eagleson to Terry Fox

Urban Collector Road

- Rehabilitated in 2007 by tack and overlay on existing surface (no milling)
- Lafarge North America paving contractor
- Half of project HMA, half of project WMA
- City negotiated $2.50/tonne premium for additive

Hypertherm

- 1600 tonnes of Hypertherm modified Superpave 4.75 FC1 Level C with PG 58-28
- Mix placed at 25 to 30 mm thick

Significant reflective cracking in both WMA and HMA sections after 2 years, including joint

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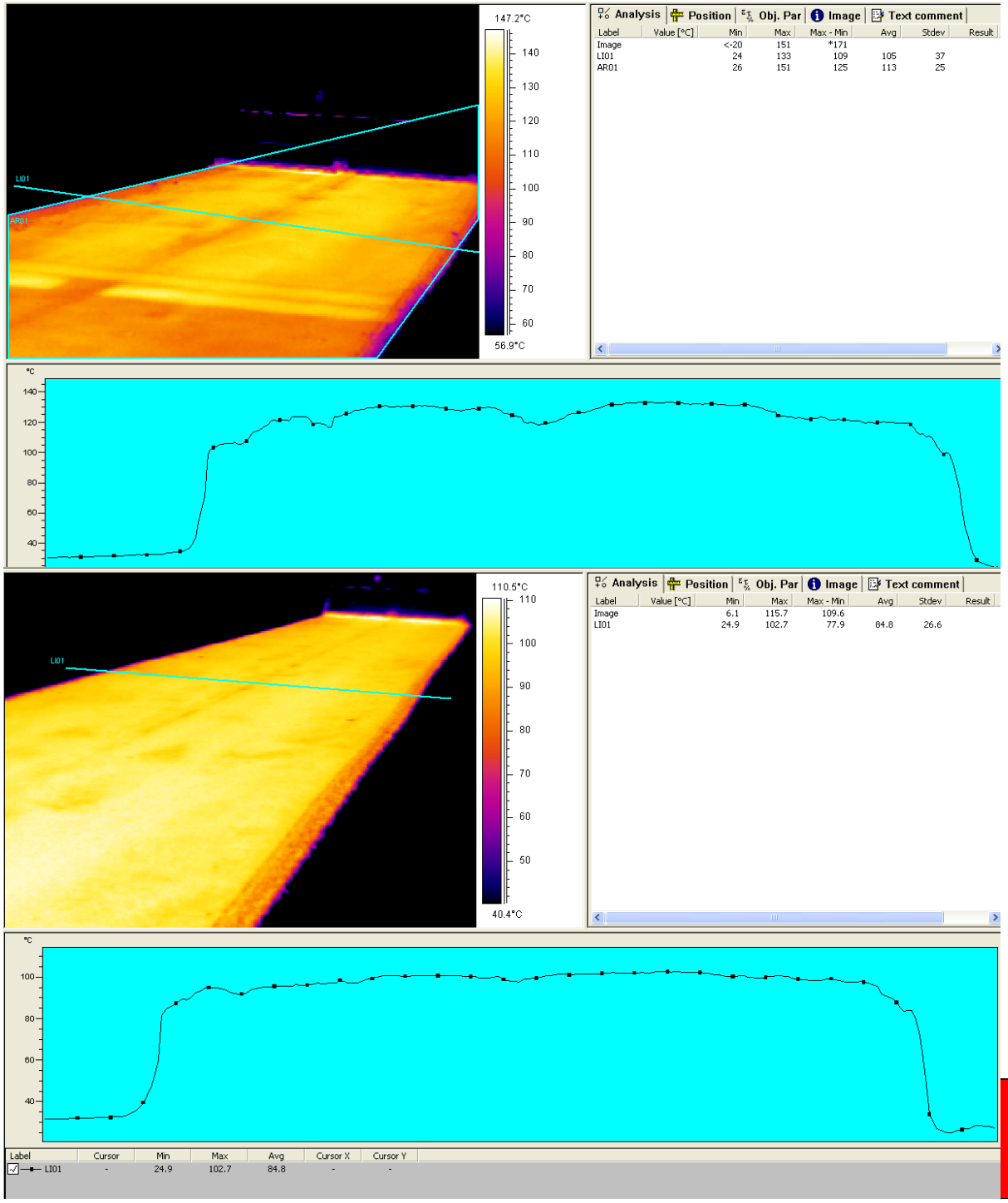
Results to Date for Ottawa Projects

Three WMA technologies (Evotherm, Sasobit and Hypertherm) have been successfully placed

All three projects performing well after 2 years

- **Considerable reflective cracking on Katimavik in both HMA and WMA sections**
- **Little or no distress on WMA sections of John Quinn Road and Victoria Road**
- **Little or no distress on HMA section of John Quinn Road**
- **Slight ravelling and longitudinal joint cracking on HMA section of Victoria Road**

No definitive results yet, but WMA sections at least as good as HMA sections, and may provide better joint performance



Thermal Imaging Project

Warm vs. Hot

- Victoria Road (Sasobit)
- Carleton University to collect thermal images of HMA (top) and WMA (bottom) immediately after placement, but before compaction
- Note more consistent temperature cross section with WMA

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Tendering and Specifications

Tendering

- Initial tenders should have separate item for additive (with option to remove if too expensive)
- May wish to have “approved products list” to avoid unproven technologies (talk to your local suppliers)
- Expect about $4/tonne premium at this time

Mix Designs

- No current mix design practices specific to WMA (NCHRP 9-43 underway)
- OPSS 1150 and 1151 still appropriate
- City of Ottawa requires full HMA design with WMA confirmation

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Tendering and Specifications

Placement

- Can probably reduce existing minimum OPSS placement temps, but not below freezing
- Equipment exactly the same

Performance

- OPSS 310 requirements for quality, surface appearance, etc. still applicable
- No changes to ERS testing and pay factors (OPSS 313)
- Only question is recompaction temperature…

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Maximizing Fuel Savings (WMA or HMA)

Reduce Stockpile Moisture

- 10% increase in fuel for every 1% increase in aggregate moisture
- Load aggregate from high side of the pile (water flows downhill)
- Cover the aggregate (at least the RAP)

Burner Adjustment

- Keep it tuned

Maintain Baghouse Temperature

- Must prevent condensation and plugging
- Reduce the drum slope (but this increases dwell time)
- Remove flights closest to the burner
- Increase combustion air to burner

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Summary

WMA reduces the viscosity of a traditional asphalt mix allowing mixing and placement at lower temperature

WMA is produced by adding viscosity reducing compounds or foaming the hot AC

- **Multiple processes/products available, so good competition**

Benefits of WMA include reduced fuel and emissions, improved compaction, increased haul distance and paving season, improved worker conditions, and increased RAP usage

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Summary

Barriers to Implementation include cost, fear of change and lack of performance data

- **Most of these barriers will be solved with time**
- **Numerous municipalities and the MTO have placed WMA**

Issue of recompaction temperature must be addressed by suppliers

<u>Steve's Prediction</u> – WMA will <u>replace</u> HMA within 10 years

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Do you want Hot, or the “New” Hot (WMA)