Feedback on Asphalt Recycling & Warm Mix Asphalt initiatives

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RPF 12 November 2008

Challenges to sustainability

- Generation of GHG is main cause of global warming
- Consumption on non renewable resources

Status on Asphalt Recycling

- Resolution passed at Nov 07 RPF that a task team be established to develop best practice guidelines for the use of RAP in HMA
- Task team has met twice on
  - 24 April 2008
  - 22 September 2008

AR Task Team

- Clients
  - Dennis Rossmann
  - Adreo Brits
  - Rob Lindsay
  - Eric Lathlief/ Krishna Naidoo
- Engineers
  - Derick Pretorius
  - Tony Lewis
  - Nico vd Walt
  - Benoit Verhaeghe
- Manufacturers & Contractors
  - Bennie Greyling
  - Herman Marais
  - Wynand Nortje
  - Gary Catin

Plan of action

1. Use existing TRH 21 (1996) as the basis
2. Update with latest international best practice
3. Identify appropriate documents
4. Agree on content of new TRH 21
5. Sabita appointed Tony Lewis in June to draft a revised TRH21
6. Identify specialists from task team to act as peer reviewers for each section
7. Completed first draft by Nov RPF

Way forward

- Post the first draft on www.sabita.co.za
  - November 2008
- International peer review by global asphalt associations
  - January 2009
- Publish best practice document
  - March 2009
- Workshop best practice document
  - April/May 2009

Progress on Warm Mix Asphalt

- SAT seminar held in Pretoria on 9 July on Warm Mix Asphalt techniques
- Interest group formed to investigate the performance & benefits of WMA to reduce the carbon foot print of HMA
- Meeting held on 5 September with Sabita members & eThekwini Municipality to plan the construction and evaluation of field trials

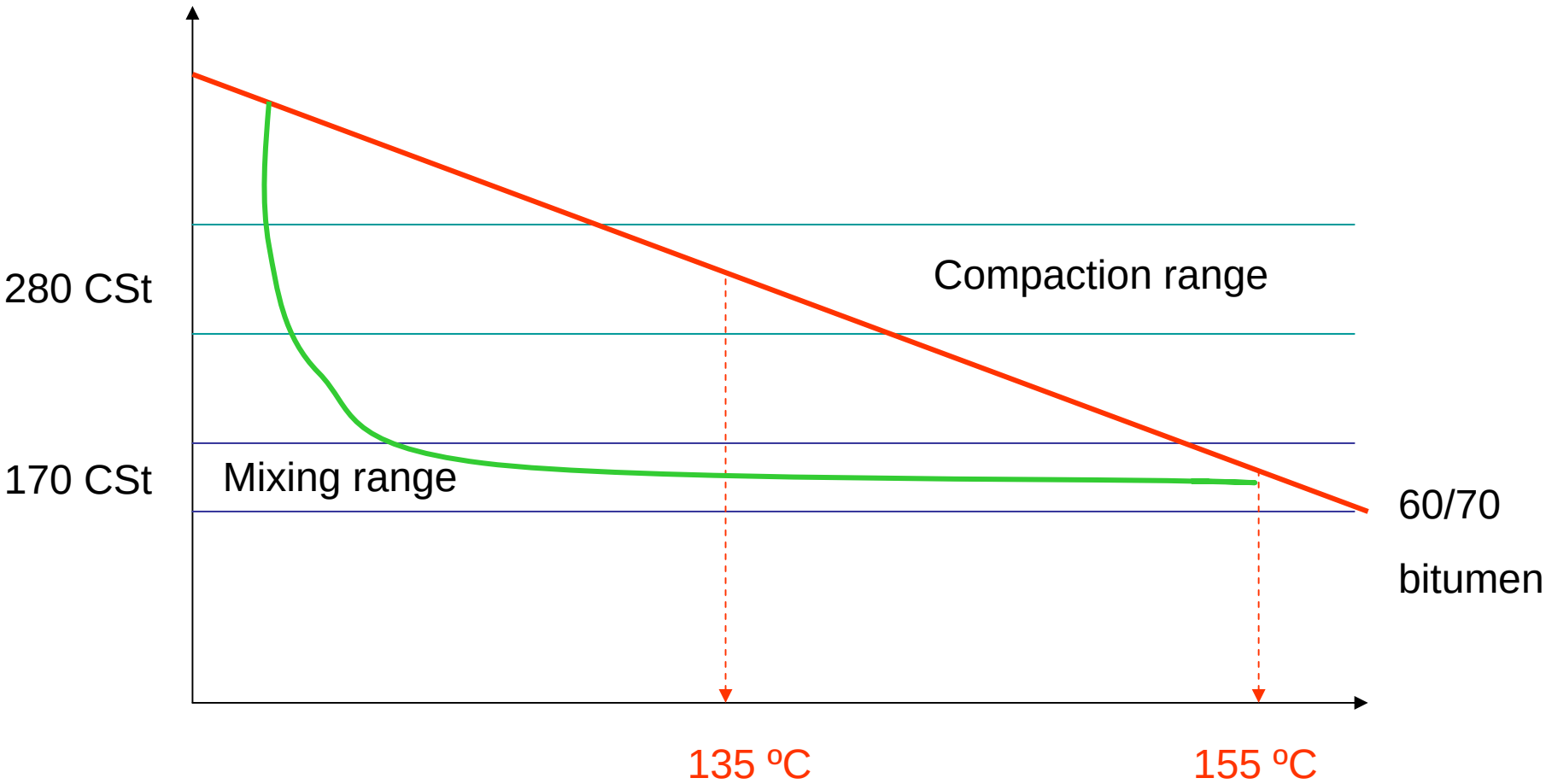
Why WMA?

- Industry should strive to take actions that continually improve HSE
- Logical step is to lower asphalt mixing & paving temperatures which will result in:
  - Lower GHG emissions
  - Reduction in energy consumption
  - Improved working conditions
    - Bitumen fumes at temperatures > 130 ^{o}C & rate doubles for every 10^{o} C increase

How do we reduce asphalt mixing temperatures?

- Reduce the viscosity of the binder during mixing & application
- What are the challenges?
  - Ensure complete coating of aggregate
  - Adequate drying of the aggregate
  - Temperature high enough to prevent condensation in the baghouse

Temperature/viscosity

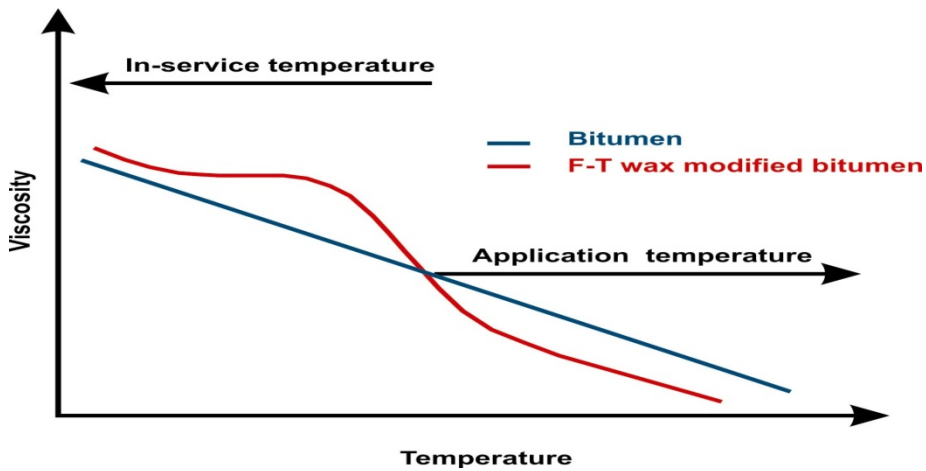


Asphalt mixing classification

	Coldmix	Warm Mix	Hotmix
Mix temp ^{o}C	Ambient	100 - 135	140 - 180
Binder types	Emulsion Cutback	Foam Additives	Penetration Modified

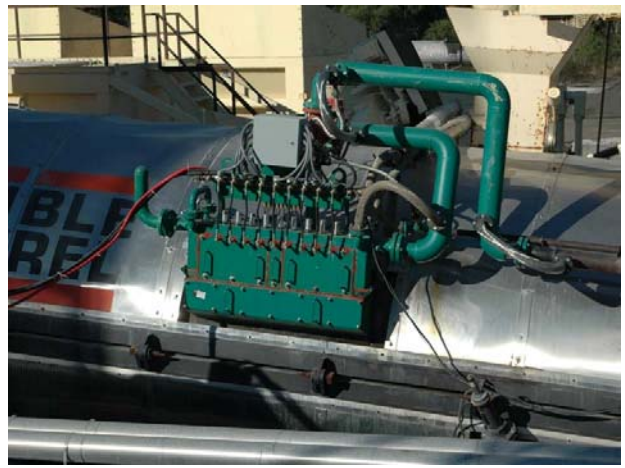
WMA techniques

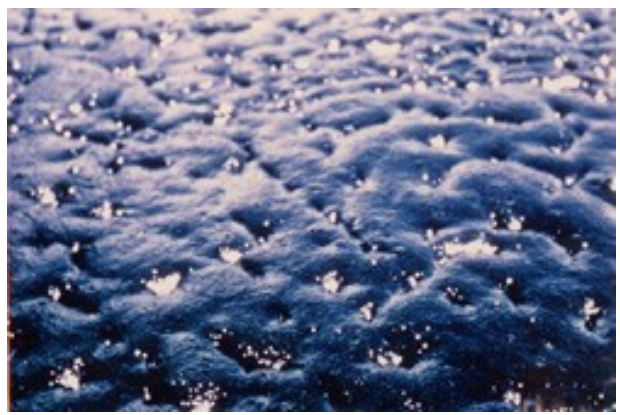
1. Chemical additives
   - Evotherm (DAT process by Westvaco)
   - Rediset WMX (Akzo Nobel surfactants)
   - Revix (Mathy Technology)
   - Sasobit (also modifies binder properties)



WMA techniques

2. Foaming methods
   - Astec foam attachment
   - Shell WAM foam technology
   - Alpha min (Zeolite)
   - Terex





Benefits of WMA

Construction

- Less oxidation of mixes = longer life
- Longer haul distance
- Longer paving season
- Pave in cooler weather
- Improved workability of stiff mixes
- Ideal for hand work and patching
- Extended paving window for thin layers
- Open to traffic sooner
- Improved compaction on longitudinal joints

Benefits of WMA

HSE

- Reduced GHG emissions
- Safer working conditions
  - Reduces fumes
  - Reduced odours
- Reduced fuel usage
- Use of higher % RAP

Reduced fuel usage

- Savings of 20 - 35% in burner fuel
- Reduced fuel consumption = reduced GHG emissions
- Dependant on plant design & aggregate moisture content
  - 10% increase in fuel for 1% aggregate moisture content

Adding RAP to WMA

- Use 10 – 20% RAP
- Superheat aggregate to 140 ºC
  - removes moisture & increases temperature to baghouse
- Less oxidation of binder helps rejuvenate RAP
- Using RAP stiffens WMA & improves rut resistance of mix

‘green-on-green’ =

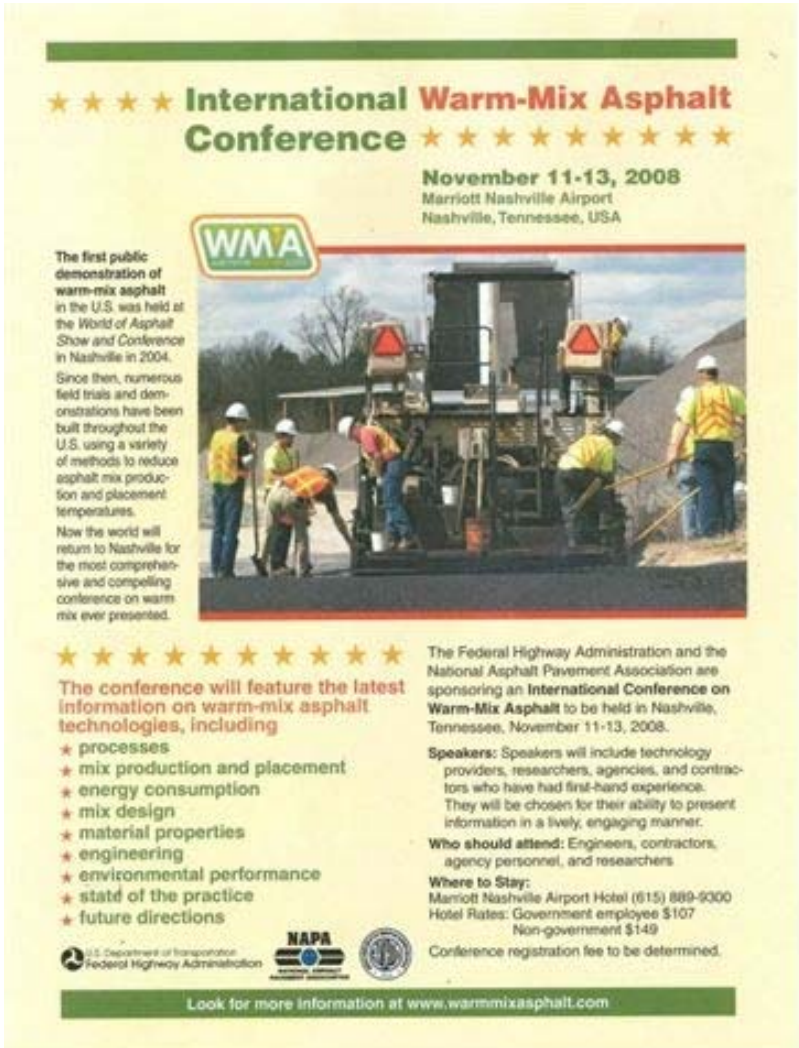
Who would you prefer as your neighbour?

50% of asphalt produced in USA will be WMA by 2013 – Mike Acott
Astec have orders for 75 Double drum green plants

Way forward

- Keep a watching brief on global developments in WMA
- Extend WMA trials to include other techniques

www.warmmixasphalt.com



TRH 21 HOT-MIX RECYCLED ASPHALT UPDATE

"Update TRH 21: 1996 utilizing the latest developments in hot-mix asphalt recycling world-wide, highlighting the environmental and economic benefits of the process."

Proposed change in acronym for "RECLAIMED ASPHALT"

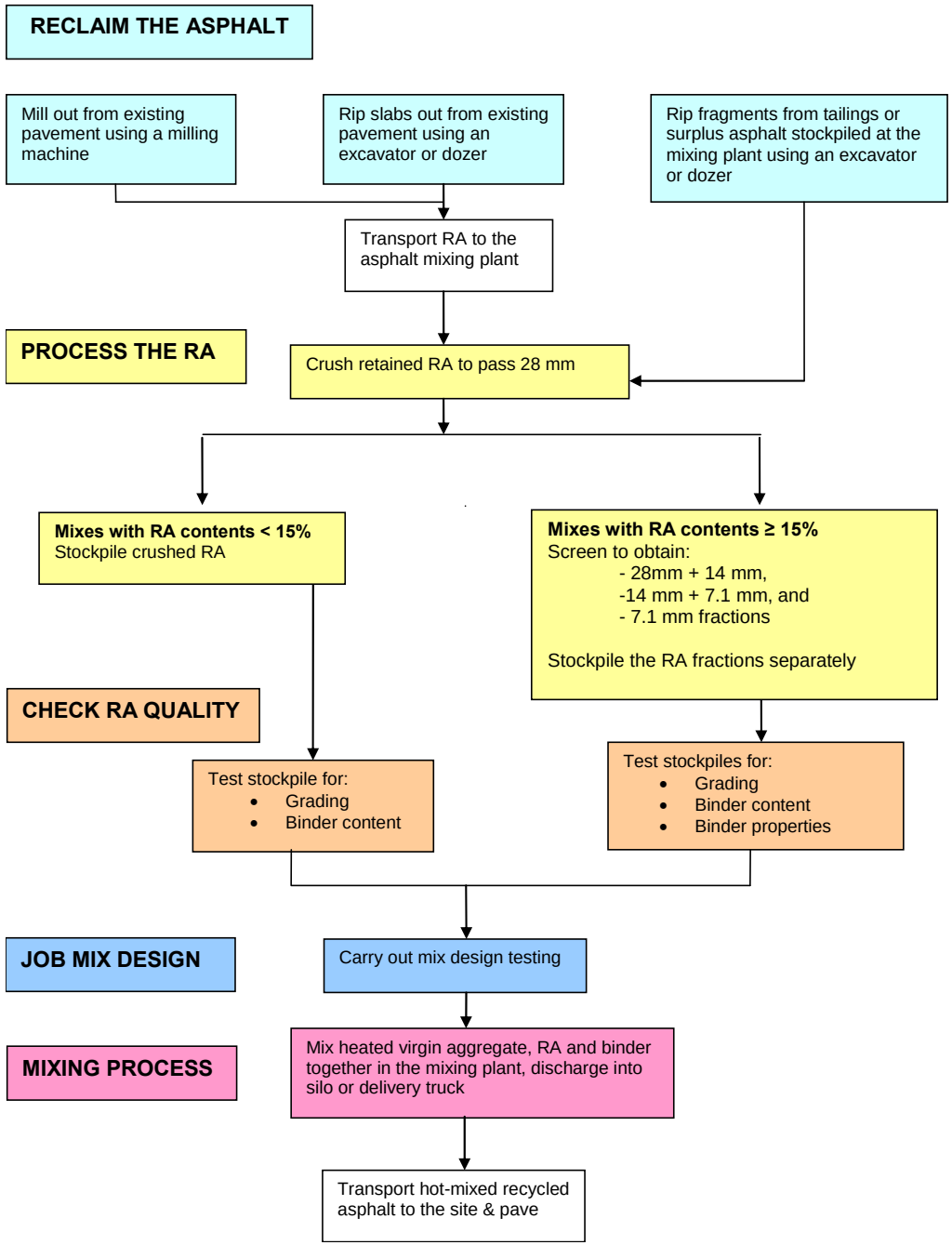
Change from reclaimed asphalt pavement "RAP" to reclaimed asphalt "RA"

The European CEN Standard EN 13108-8 uses the acronym "RA":

"Reclaimed asphalt (RA) comprises asphalt reclaimed from milling road layers, by crushing slabs ripped up from asphalt pavements, lumps from slabs, and asphalt from reject or surplus production"

Layout:

- Principles of hot-mix asphalt recycling
- Challenges and solutions to hot-mix recycling
- Factors that influence availability and quality of RA
- Investigation of RA sources
- Reclaiming, preparing and stockpiling RA
- Mix design procedures
- Mixing plant requirements
- Quality control of hot-mix recycled asphalt
- Economic considerations
- Occupational health, safety and the environment
- Case studies


RECLAIM THE ASPHALT
Mill out from existing pavement using a milling machine
Rip slabs out from existing pavement using an excavator or dozer
Rip fragments from tailings or surplus asphalt stockpiled at the mixing plant using an excavator or dozer
Transport RA to the asphalt mixing plant
PROCESS THE RA
Crush retained RA to pass 28 mm
Mixes with RA contents < 15%
Stockpile crushed RA
Mixes with RA contents ≥ 15%
Screen to obtain:
- 28mm + 14 mm,
-14 mm + 7.1 mm, and
- 7.1 mm fractions
Stockpile the RA fractions separately
CHECK RA QUALITY
Test stockpile for:
Grading
Binder content
Test stockpiles for:
Grading
Binder content
Binder properties
JOB MIX DESIGN
Carry out mix design testing
MIXING PROCESS
Mix heated virgin aggregate, RA and binder together in the mixing plant, discharge into silo or delivery truck
Transport hot-mixed recycled asphalt to the site & pave

Challenges and solutions to hot-mix recycling

Main inhibitors to recycling (according to PIARC review):

- client education regarding benefits of recycling
- legislation to promote & increase use of recycling
- economy and supply/demand

Factors that influence availability and quality of RA

- Geographic distribution of asphalt pavement in RSA – major routes and cities
- Mix types – continuously graded, gap-graded
- Other factors influencing RA quality – tar, geosynthetics, bitumen rubber

Investigation of RA sources

- Desk study
- field investigations – cores, milling machine

- don't discard RA source due to low pen – regard as "black aggregate"
- consider use of tailings and returns at asphalt plants as RA sources

Reclaiming, preparing and stockpiling RA

- Milling – consider need for selective milling
- Stockpiling – try to reduce moisture – 3 phases
- Crushing
- Fractionating

Grading of the fractionated RA	Typical usage in recycled asphalt mixes
- 28 mm + 14 mm	Asphalt base mixes
- 14 mm + 7.1 mm	Asphalt base, coarse & medium continuously graded mixes
- 7.1 mm	All above, plus fine continuously graded mixes

Emphasize utilisation of the whole RA product

Mix design procedures

Preliminary mix design required when:

- Using high RA (>30%) mixes
- Modified binder in RA
- RA includes surfacing seals with highly modified binders

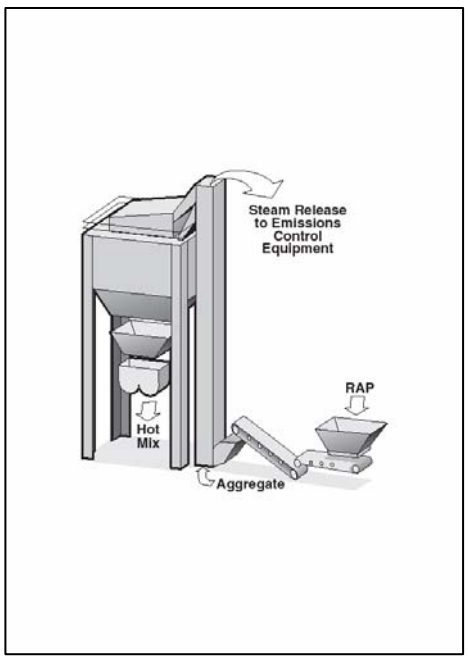
Job mix design:

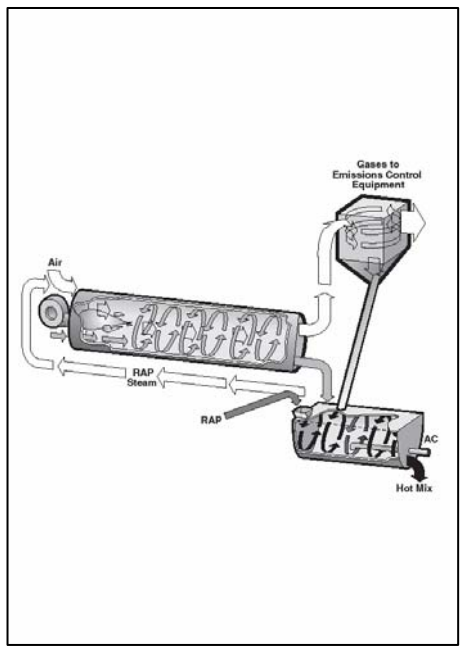
- Sample from prepared RA stockpiles
- Consider recommended % RA depending upon mix type

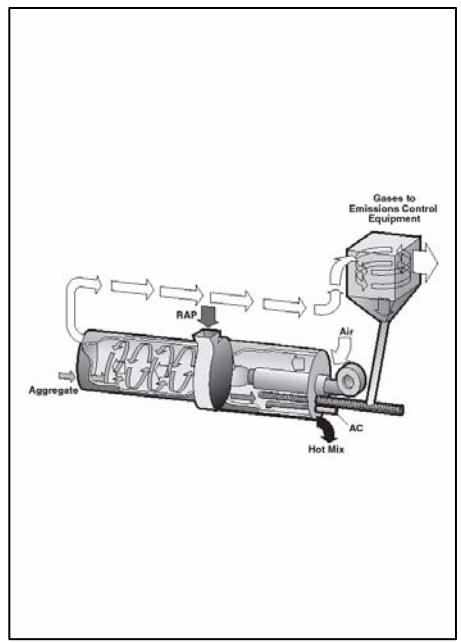
RA CONTENT IN MIX	ADDITIONAL BINDER GRADES	RA AGGREGATE QUALITY
0% to 15%	No change in binder grade	No testing required
15% to 30%	Use one grade softer base bitumen	Check coarse aggregate for strength (ACV, 10% FACT)
30% to 50%	Determine recovered binder properties of the RA. Use blending chart to decide on appropriate binder grade or if rejuvenator agent required	Check coarse aggregate for strength (ACV, 10% FACT), check fine aggregate quality (sand equivalent)

Mixing plant requirements

- Cold feed systems
- Mixing plant types – batch plants, parallel flow and counter flow continuous drum mixers, double drum continuous mixing plants







Economic considerations

Direct savings in terms of:

- lower virgin aggregate consumption
- lower bitumen consumption
- reduced bitumen transport costs
- eliminating waste disposal costs

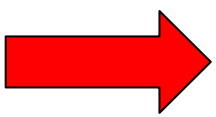
The way forward:

- Post as a draft on the SABITA website – end November
- Peer review by international organizations – February 2009
- Finalise and post on SANRAL website - March 2009
- Workshops at various centres – April 2009

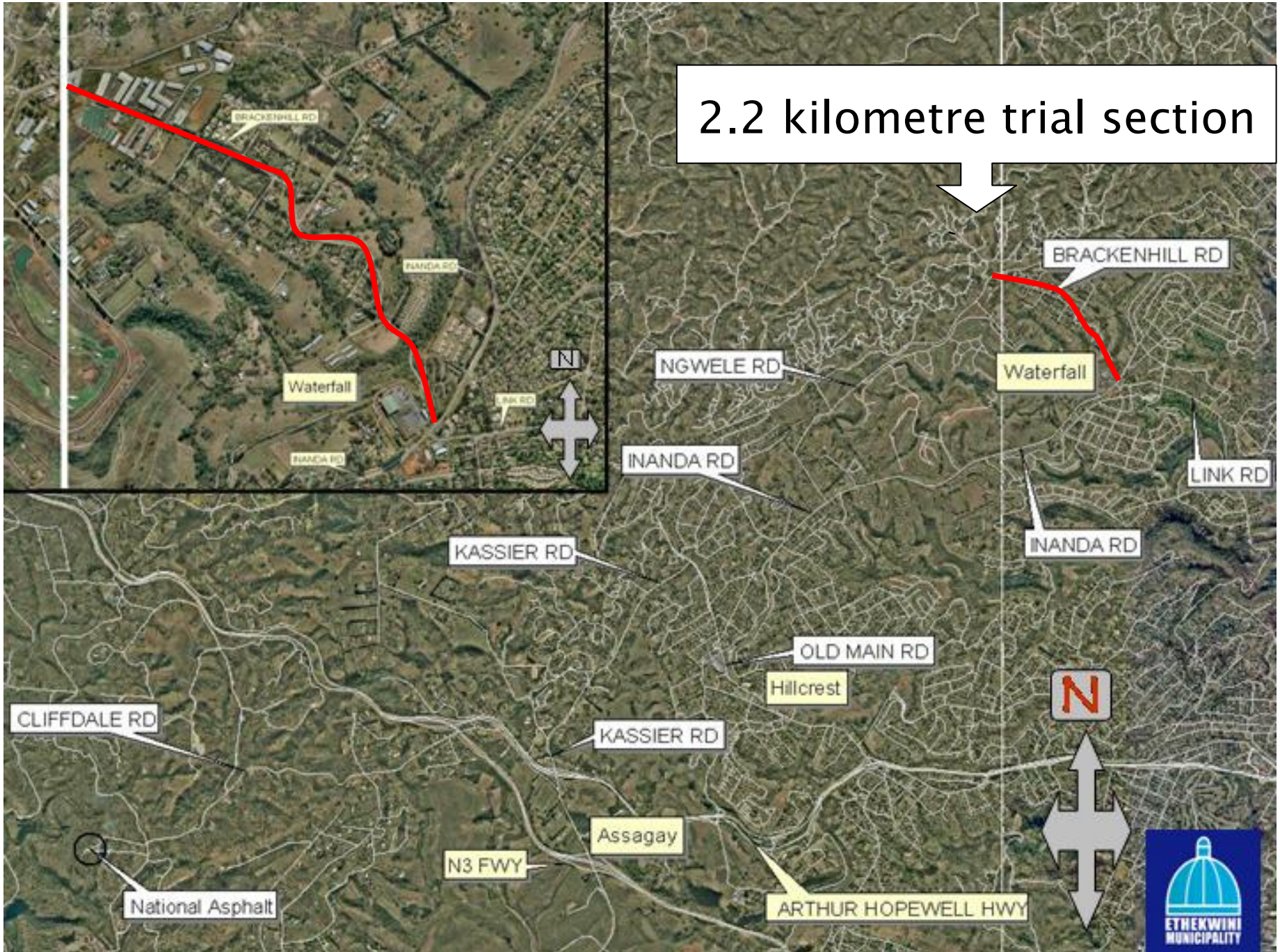
WMA TRIALS

Scope of the trials

- Mixing plant
  - mixing temperatures
  - burner fuel consumption
  - emissions
  - mix properties
- Paving site
  - mix temperatures
  - rate of cooling
  - compaction
  - fumes



- Effect of additions of RA to the WMA mixes

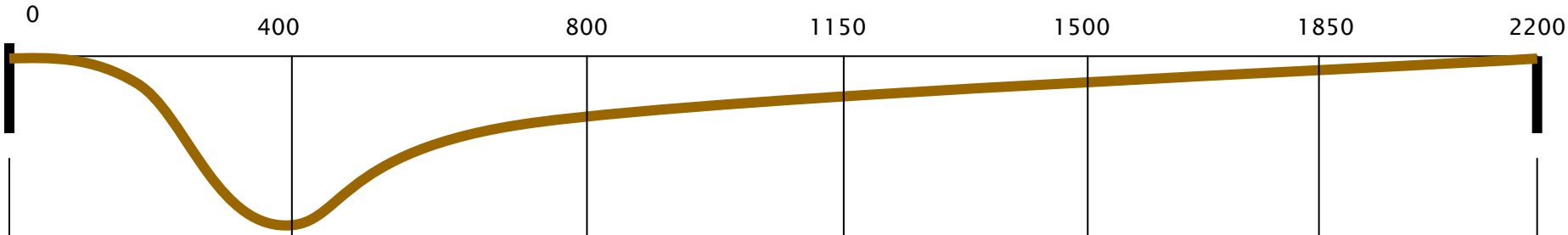

2.2 kilometre trial section
BRACKENHILL RD
Waterfall
INANDA RD
N
NGWELE RD
Waterfall
BRACKENHILL RD
INANDA RD
LINK RD
INANDA RD
KASSIER RD
OLD MAIN RD
Hillcrest
CLIFFDALE RD
KASSIER RD
N
Assagay
N3 FWY
National Asphalt
ARTHUR HOPEWELL HWY
ETHEKWINI MUNICIPALITY

WMA TRIALS

- Mixing plant
  - mixing temperatures
  - burner fuel consumption
  - emissions
  - mix properties
- Paving site
  - mix temperatures
  - rate of cooling
  - compaction
  - fumes
- Effect of additions of RA to the WMA mixes
- Include high-RA (20% and 30%) trial sections

WARM MIX ASPHALT TRIALS BRACKENHILL ROAD

INANDA ROAD — FISCHER ROAD

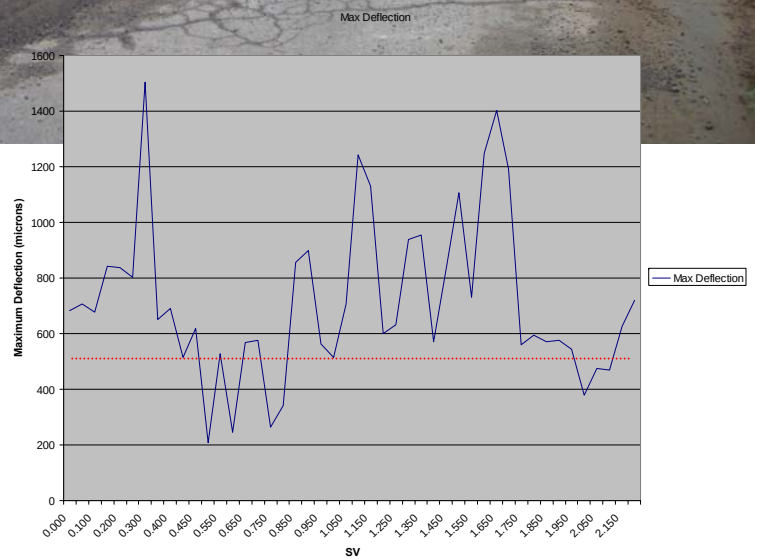


LAYER THICKNESS 40 mm

Hot recycled mix containing 20% RA	Hot recycled mix containing 30% RA	Control mix "D"	Mix "D" plus 1.5% wax	Mix "D" plus 10% RA	Mix "D" plus 10% RA plus 1.5% wax
225 tons	225 tons	200 tons	200 tons	200 tons	200 tons
RA Components: - 8 mm 10% - 16 mm 10%	RA Components: - 8 mm 10% - 16 mm 20%			RA Components: - 8 mm 10%	RA Components: - 8 mm 10%
60/70 pen	60/70 pen, modified with 2% EXP 1655 wax	40/50 pen	40/50 pen modified with 1.5% wax	40/50 pen	40/50 pen modified with 1.5% wax

Sampling & testing at plant:	
A) Mix temperature at plant exit	Measure in skip at 10 min intervals
B) Mix temperature in truck	Each truck load
C) Burner fuel consumption	Flow meter readings at start and end of production run
D) Bitumen storage temperature	Before each production run
E) Binder pen, SP, viscosity	Each mix
F) Bitumen content, grading, voids	3 samples per mix
G) Marshall Stab & Flow, ITS, resilient modulus, MMLS @ 50°C, ¼ speed, modified Lottman	One set of each test per mix
H) Recovered pen, SP	Each mix
I) Moisture content of aggregates and RAP	Daily
J) Moisture content of newly mixed asphalt	3 samples per mix, using Dean & Starke
K) Thermal imaging	At plant and at paving site – track trucks
L) Bag house emissions	Each production run
Sampling & testing at paver:	
A) Mix temperature	Each truck
B) Mix temperature	Behind paver after each truckload
C) Time for mix to cool to 50°C	Each mix type
D) Thermal imaging as mix cools	Each mix
E) Measure ambient and road temperatures, wind speed	Set on each mix type
F) Operator's exposure to fumes	Each mix
Testing of compaction	
Nuclear gauge	Measure at random positions during compaction and once compaction is complete
Core testing	7 randomly distributed cores per mix type

Poor condition of the existing pavement



Patching the severely distressed areas

Reclaimed asphalt from eThekwini road rehabilitation projects is scalped on a 28 mm screen.

The RA is loaded into the feed hopper of the mixing plant

The RA is blended together with 15% crusher dust and mixed together with 2% foamed bitumen and 1% cement in the cold mixing plant

The cold mix is paved as a 125mm compacted layer

PRODUCTION OF THE ASPHALT MIXES


RA feeds into
central ring

Paving the recycled asphalt mix containing 20% RA on steep grade

Compaction equipment used:

- 2 ton double drum vibrating roller
- 8 ton double drum vibrating roller
- 15 ton PTR
- 22 ton PTR

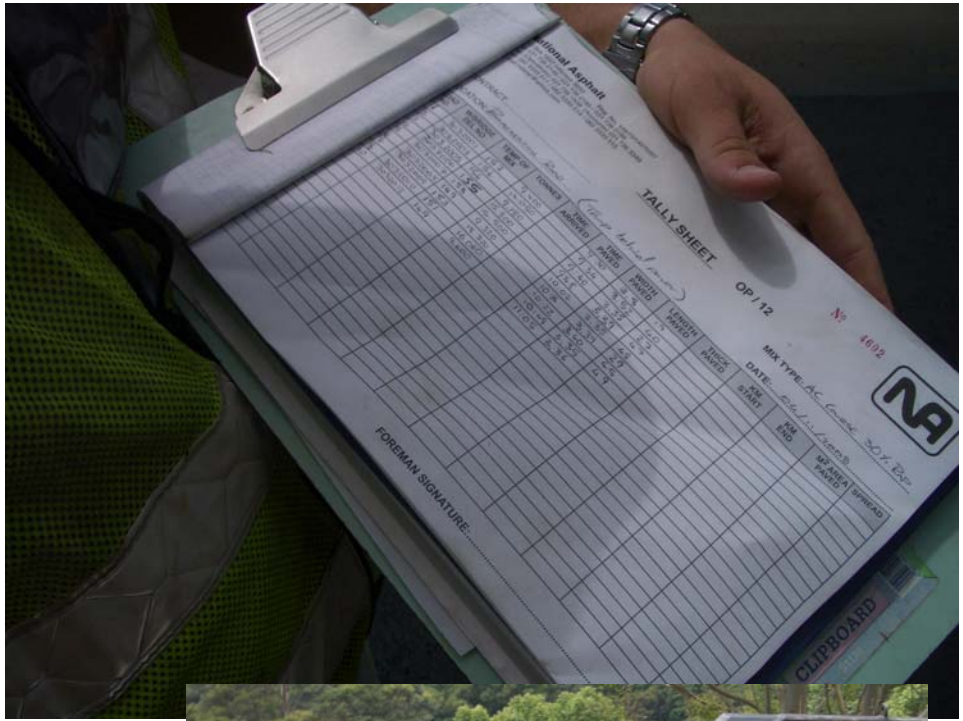
WARM MIX ASPHALT TRIALS BRACKENHILL ROAD

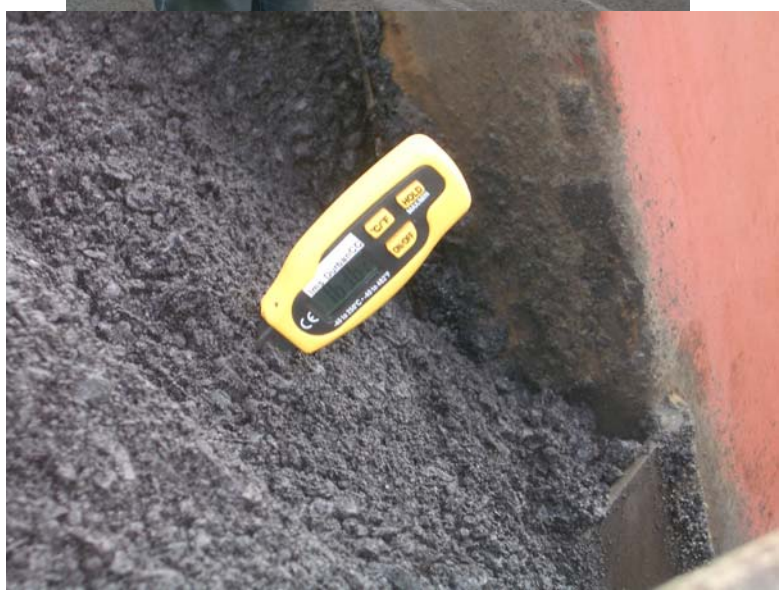
Recycled asphalt mix containing 30% RA plus 2% EXP 1655 wax based additive

Paving up steep grade using mix containing 30% RA

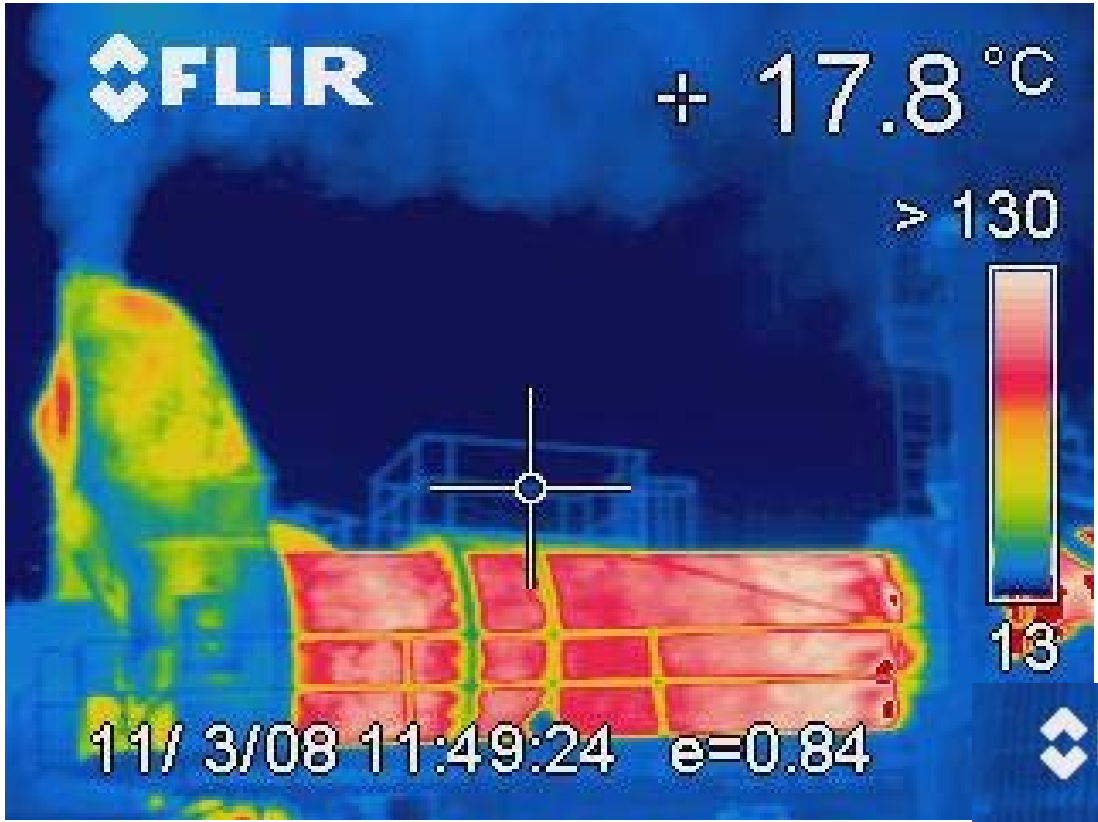

Cold mix base
MITSUBISHI
NPN 55693

WARM MIX ASPHALT TRIALS BRACKENHILL ROAD



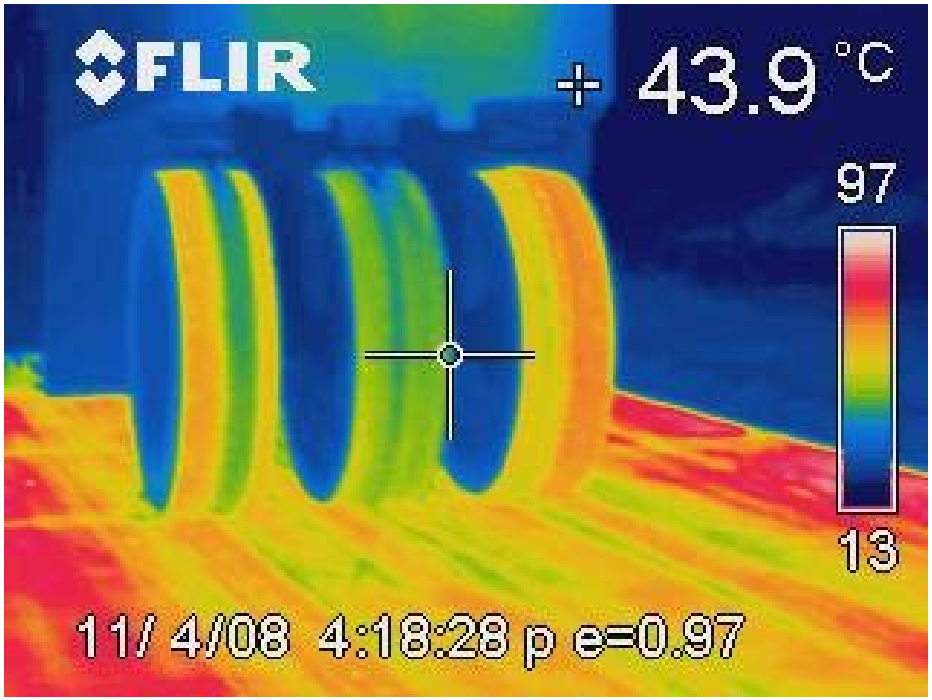


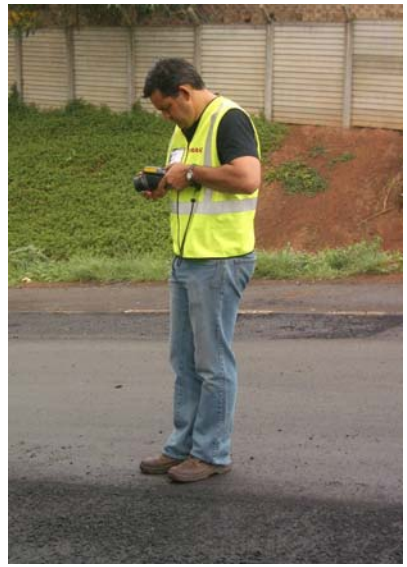
WARM MIX ASPHALT TRIALS BRACKENHILL ROAD

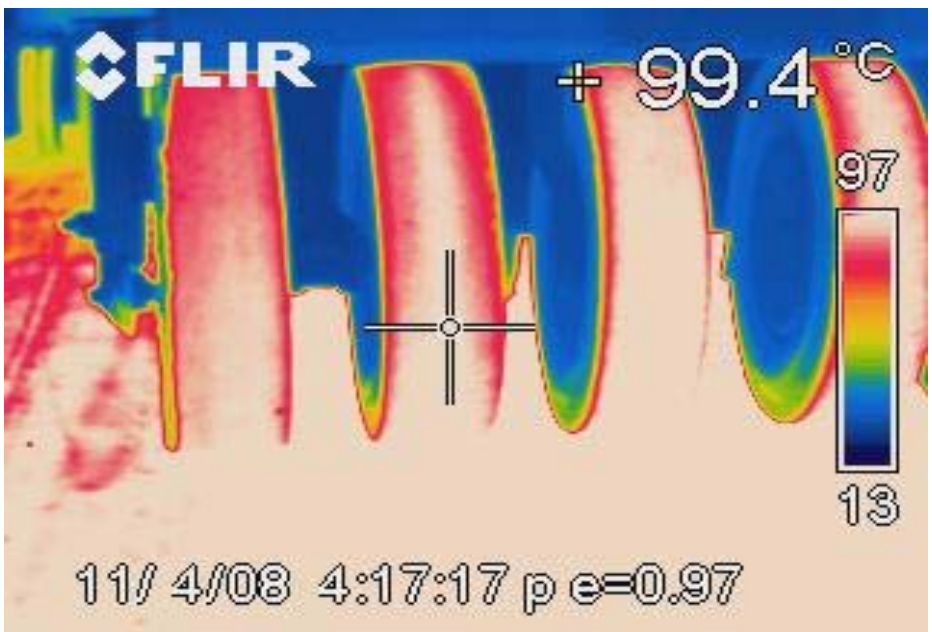


Thermal image showing the drier/heater drum

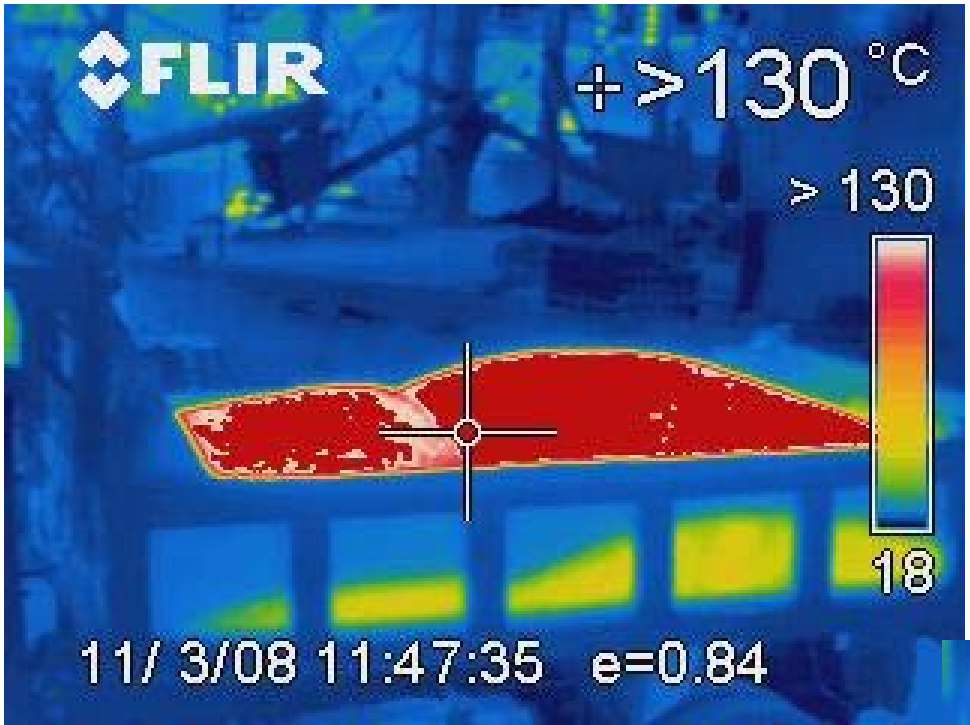
Thermal image showing the skip and hot-mix silo



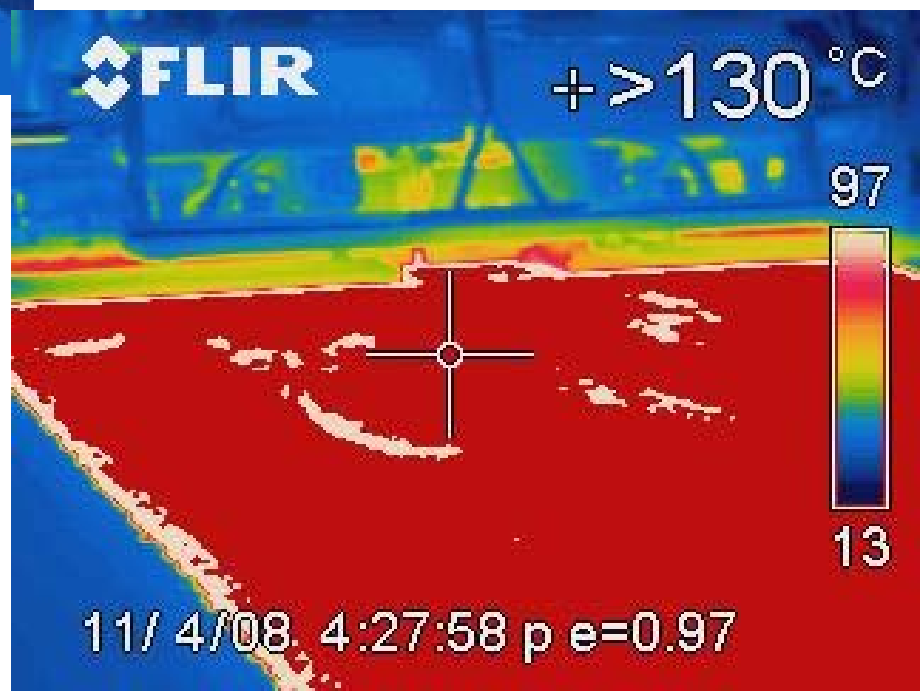




Effect of BituGlide on temperature of PTR wheels



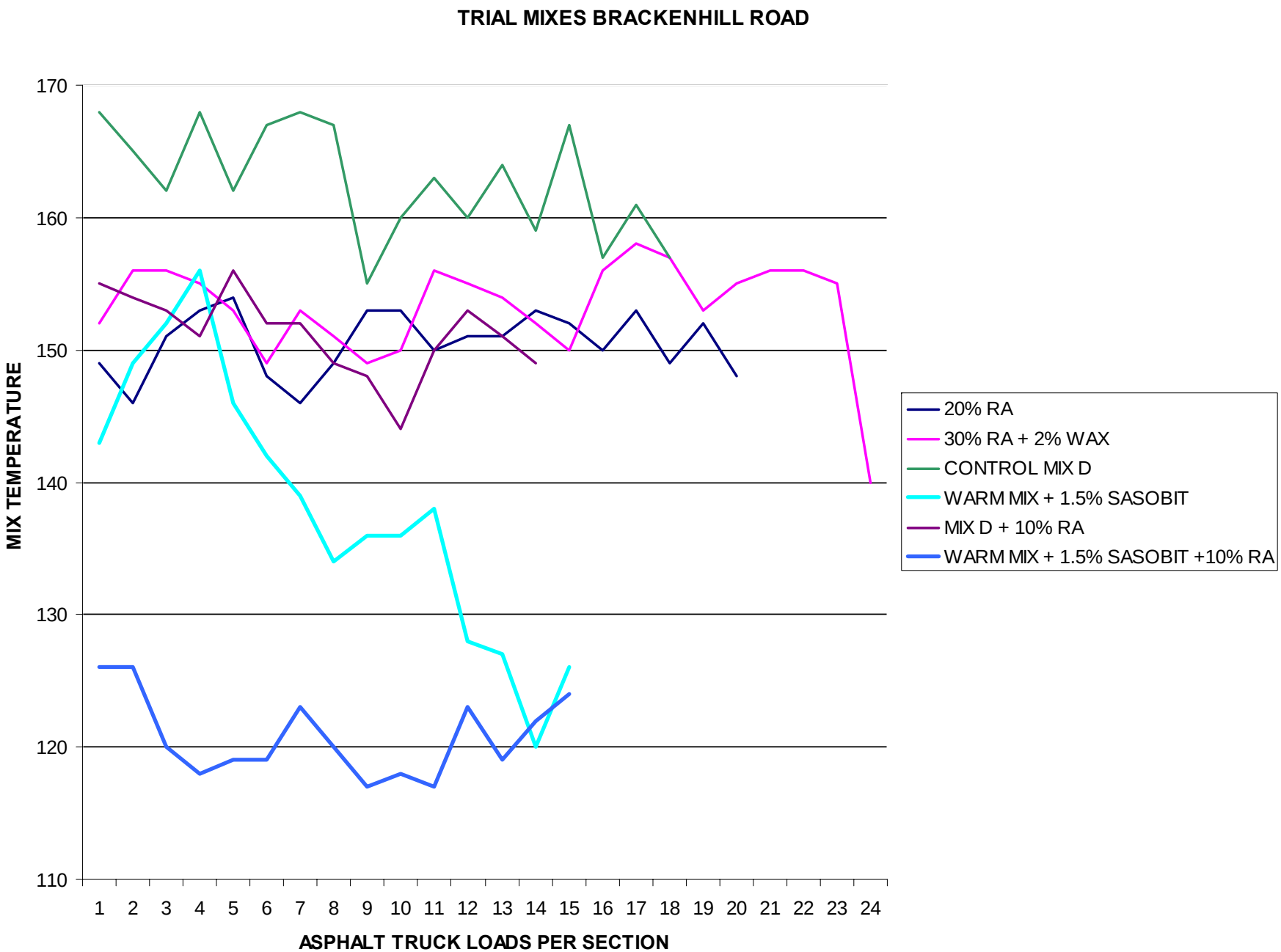
Hot asphalt in the truck



Hot asphalt behind the paver

Section	Average Binder Content (%)	Average Void Content (%)	Average Marshall Stability & Flow	Average ITS (kPa)
Hot recycled mix containing 20% RA	5.1	2.9	16.7/3.1	1202
Hot recycled mix containing 30% RA plus 2% waxed based additive (EXP 1655)	5.2	1.9	14.9/3.0	1286
Control mix “D”	4.7	5.0	13.7/2.9	1230
Mix “D” plus 1.5% Sasobit	4.9	4.4	14.5/3.0	1286
Mix “D” plus 10% RA	5.3	3.5	14.5/3.1	1391
Mix “D” plus 10% RA plus 1.5% Sasobit	5.0	3.3	12.5/2.9	1272

Section	Burner Fuel Usage (l/ton)	Average Mix Temperature at paver (°C)	Roller passes required
Hot recycled mix containing 20% RA		151	4
Hot recycled mix containing 30% RA plus 2% waxed based additive (EXP 1655)		153	5
Control mix "D"	7.3	163	5
Mix "D" plus 1.5% Sasobit	6.3	**138**	7
Mix "D" plus 10% RA	7.2	151	4
Mix "D" plus 10% RA plus 1.5% Sasobit	6.4	**121**	5


TRIAL MIXES BRACKENHILL ROAD
MIX TEMPERATURE
170
160
150
140
130
120
110
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
ASPHALT TRUCK LOADS PER SECTION
20% RA
30% RA + 2% WAX
CONTROL MIX D
WARM MIX + 1.5% SASOBIT
MIX D + 10% RA
WARM MIX + 1.5% SASOBIT +10% RA

EXPERIENCE GAINED TO DATE:

- Mixing plant
  - Reduced burner fuel consumption
  - Challenges in achieving stable reductions in mix exit temperatures
- Paving site
  - Complete coating achieved at lower mix temperatures
  - Stiffer mixes may require additional compaction

AWAITED:

- Moisture contents of warm mixes
- Compaction results
- Full set of mix properties
- Results of emission and fume monitoring

The way forward:

- WMA trials using other additives
- WMA trials using foamed bitumen
- Increased proportions of RA in WMA