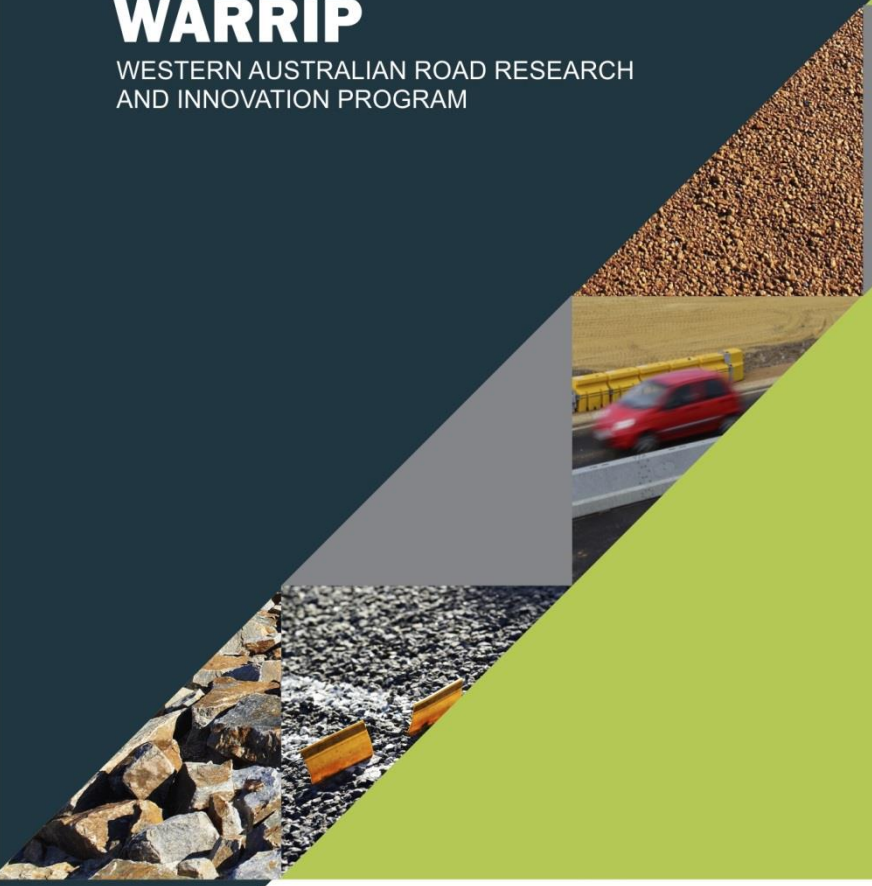
WARRIP

WESTERN AUSTRALIAN ROAD RESEARCH AND INNOVATION PROGRAM



Investigation of Pavement Temperatures for Asphalt Pavements in WA

MRWA Meeting and WAPG
February 2018

AN INITIATIVE BY:

THE GOVERNMENT OF WESTERN AUSTRALIA

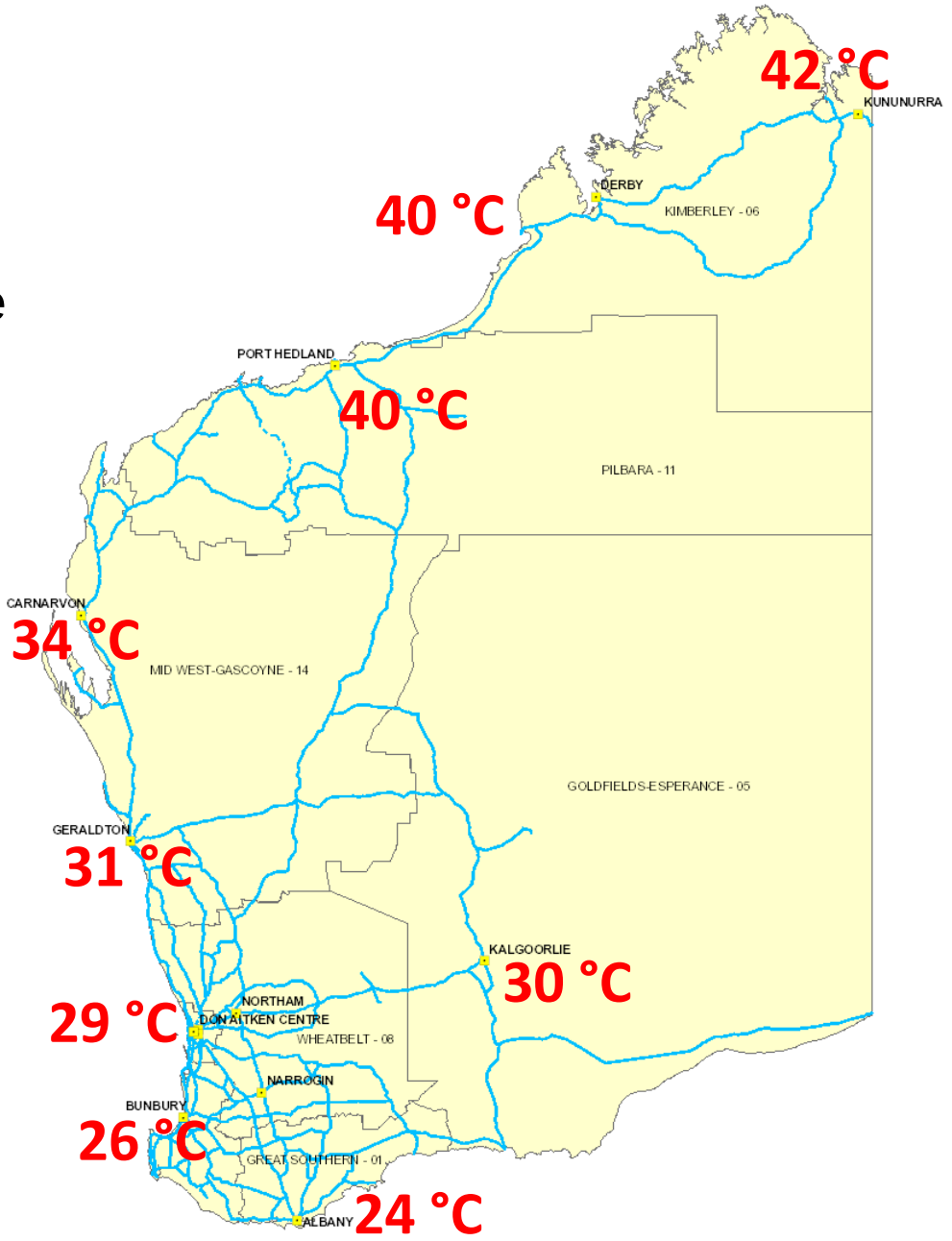
mainroads WESTERN AUSTRALIA

arrb AUSTRALIAN ROAD RESEARCH BOARD

Introduction

- Predicted pavement temperature is a major component in our current design methodology through the WMAPT value

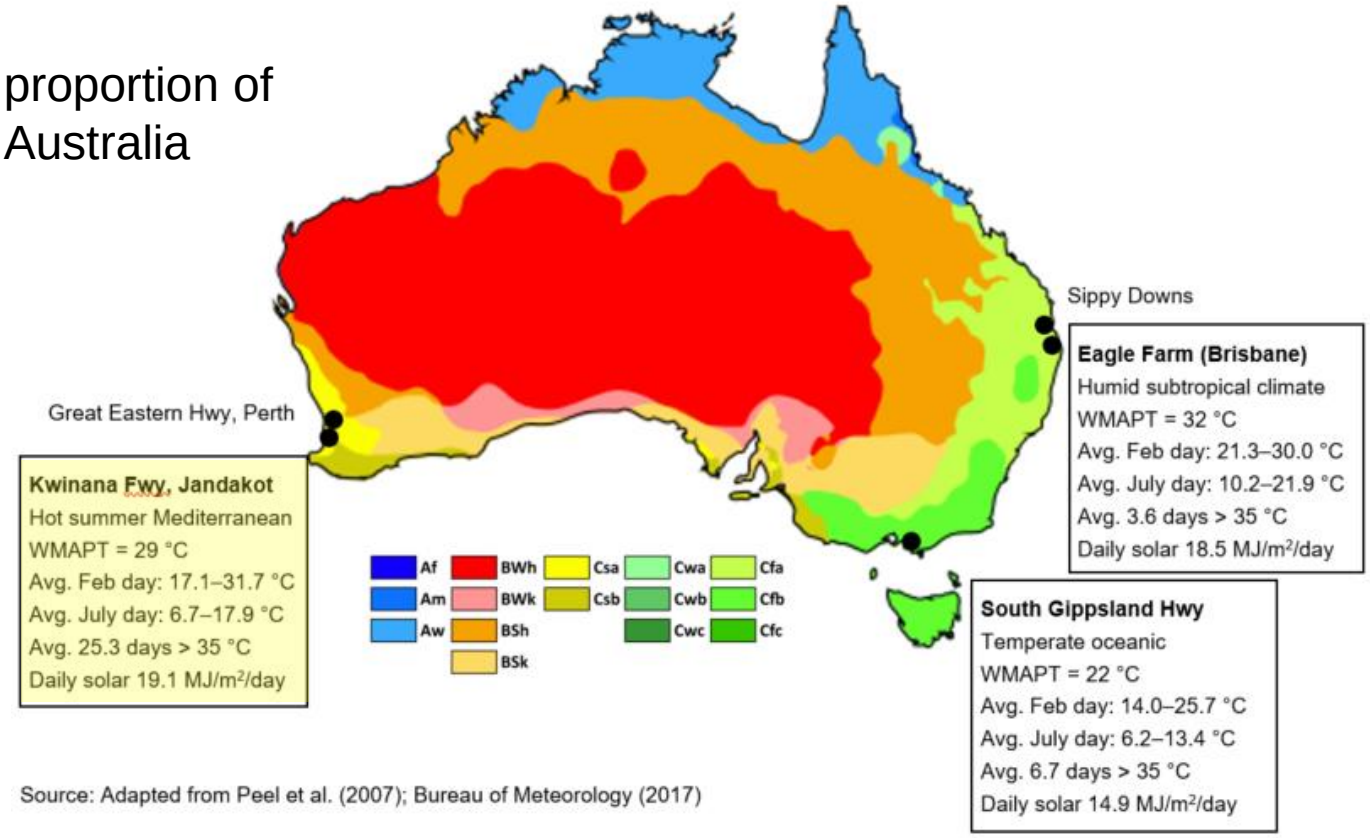
- WMAPT does not consider:
  - asphalt thickness
  - underlying material properties
  - localised weather
  - climate trends



Previous projects

- Curtin University instrumented two pavements on the Great Eastern Hwy
- Two sites at EME2 trials

- Sites cover high proportion of climate zones in Australia

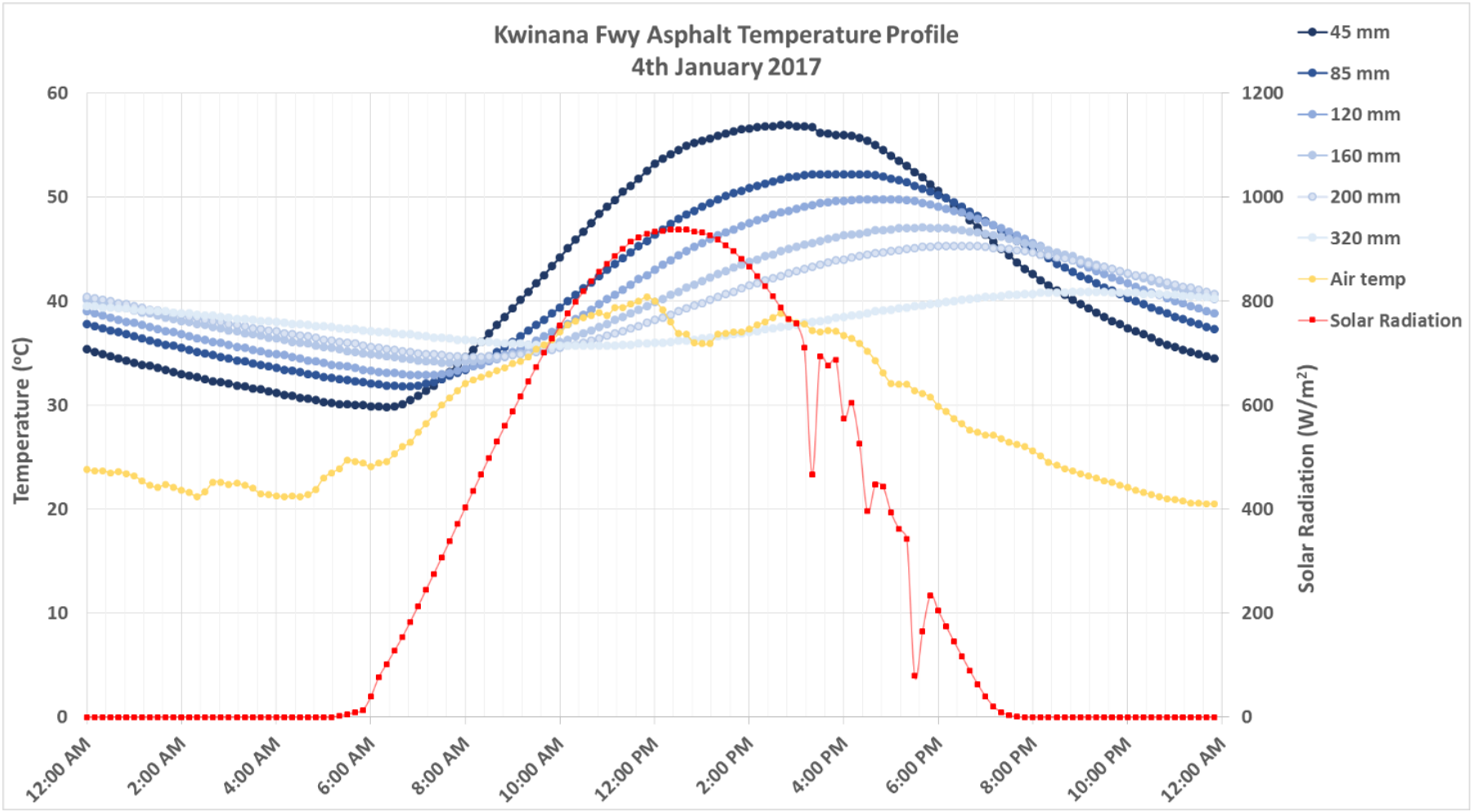


Source: Adapted from Peel et al. (2007); Bureau of Meteorology (2017)

What did we do?

- Installed on Kwinana Freeway near Berrigan Drive overpass in Jandakot in Sept 2016
- Six temperature probes at depths of 45mm down to 320mm
- Linked to weather station with sensors for ambient temperature, solar radiation, rainfall, humidity, wind speed
- Data provided over 4G modem to live web portal, downloaded monthly and analysed before being sent to MRWA

Observations



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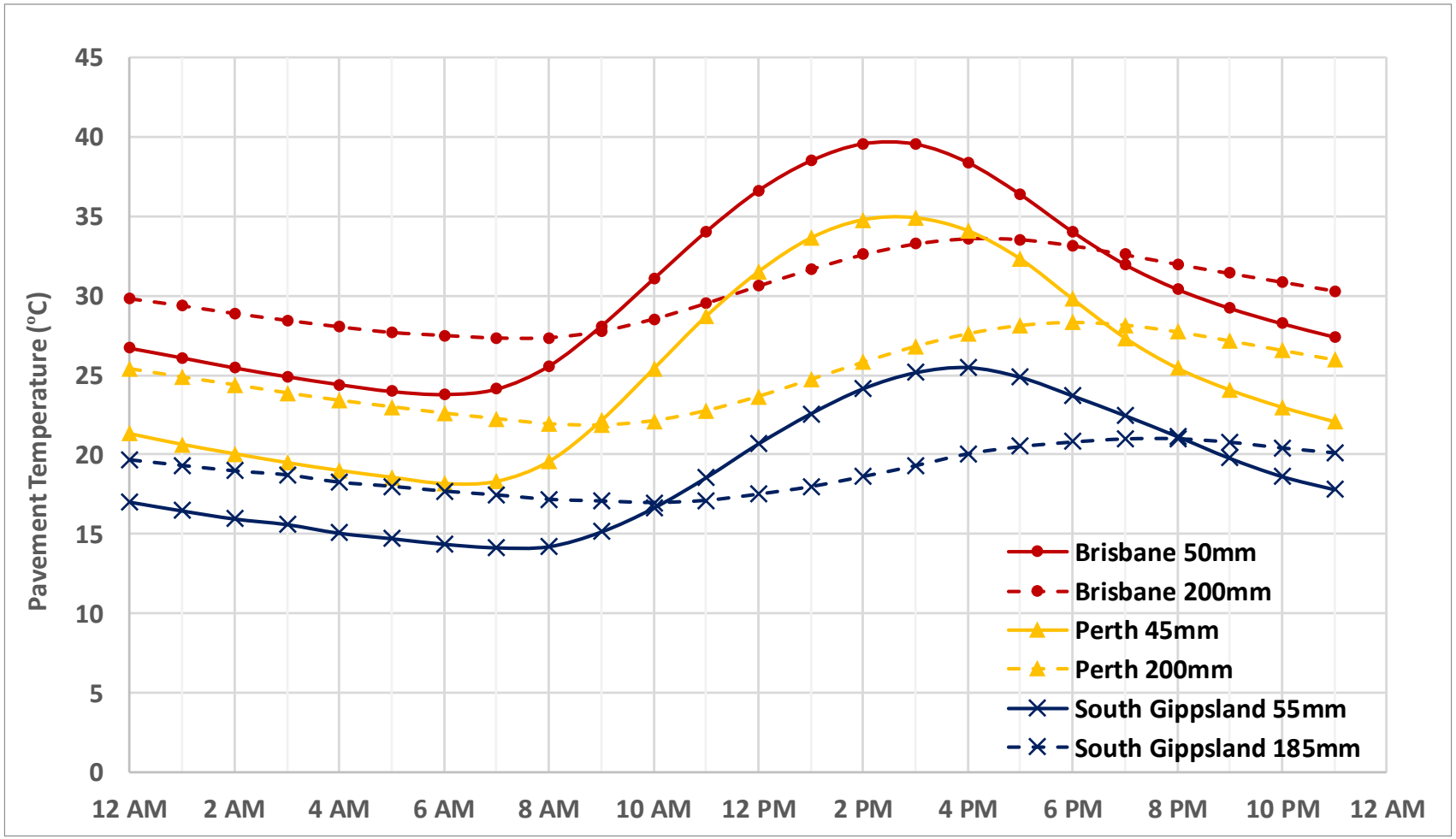

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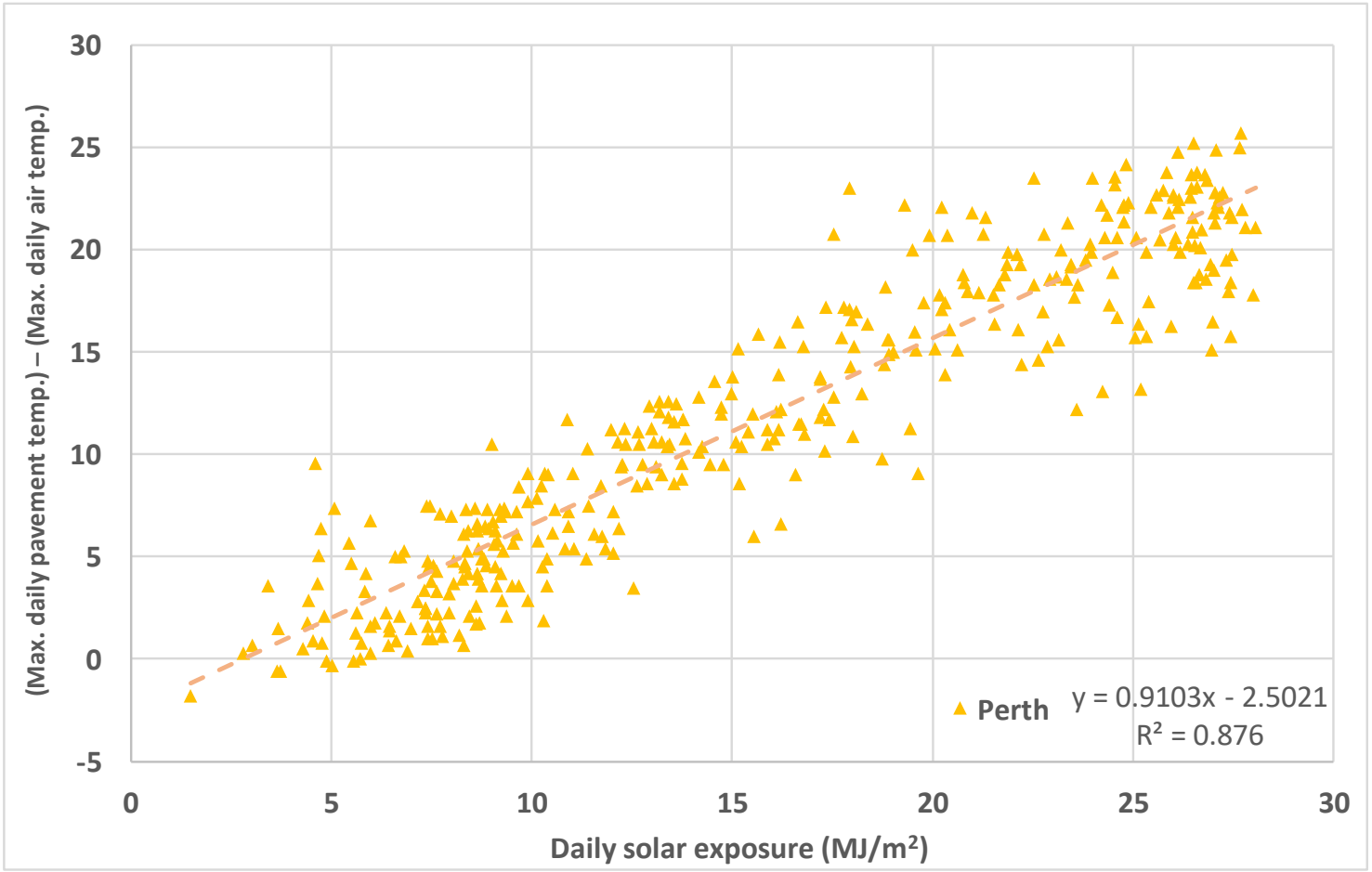

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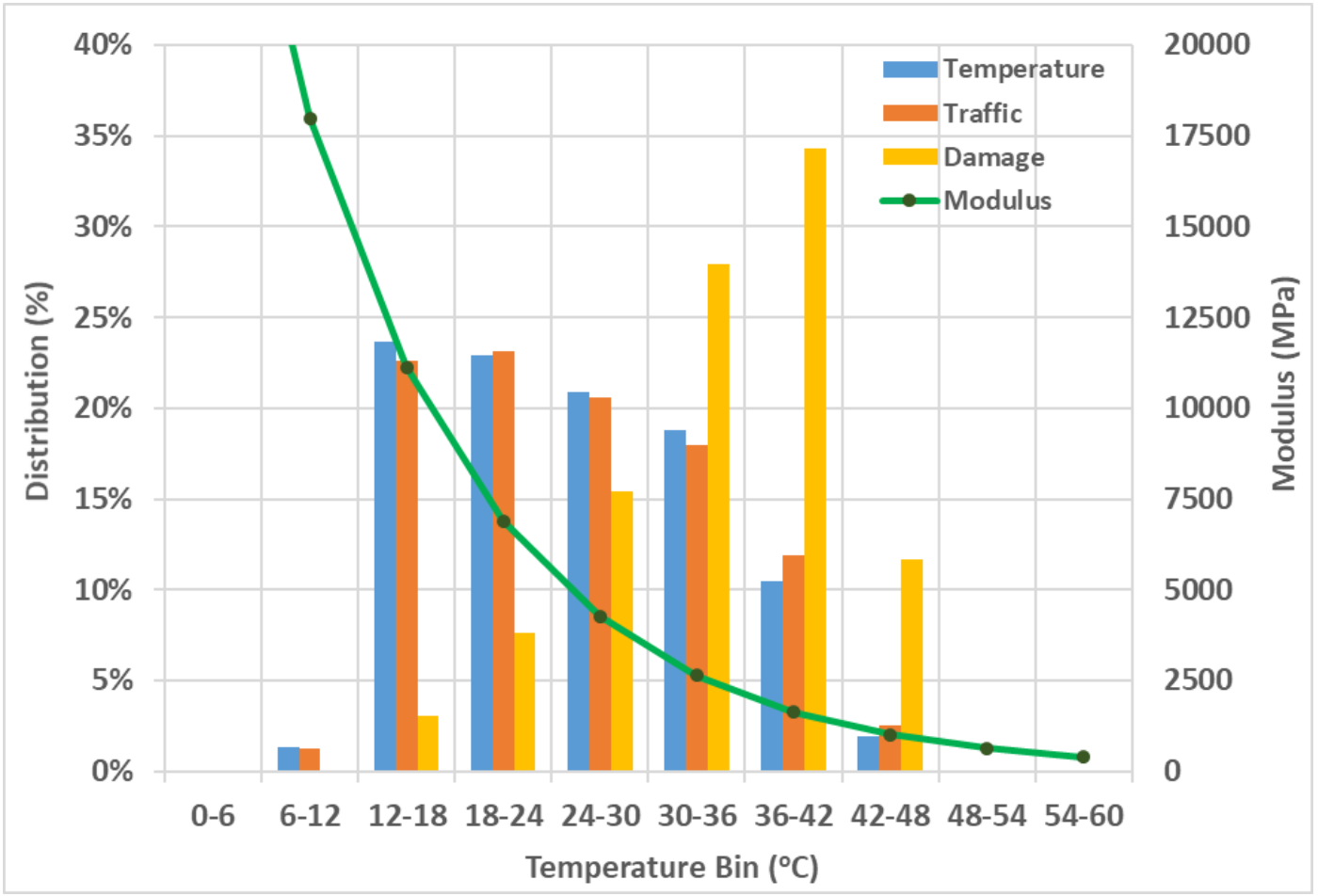
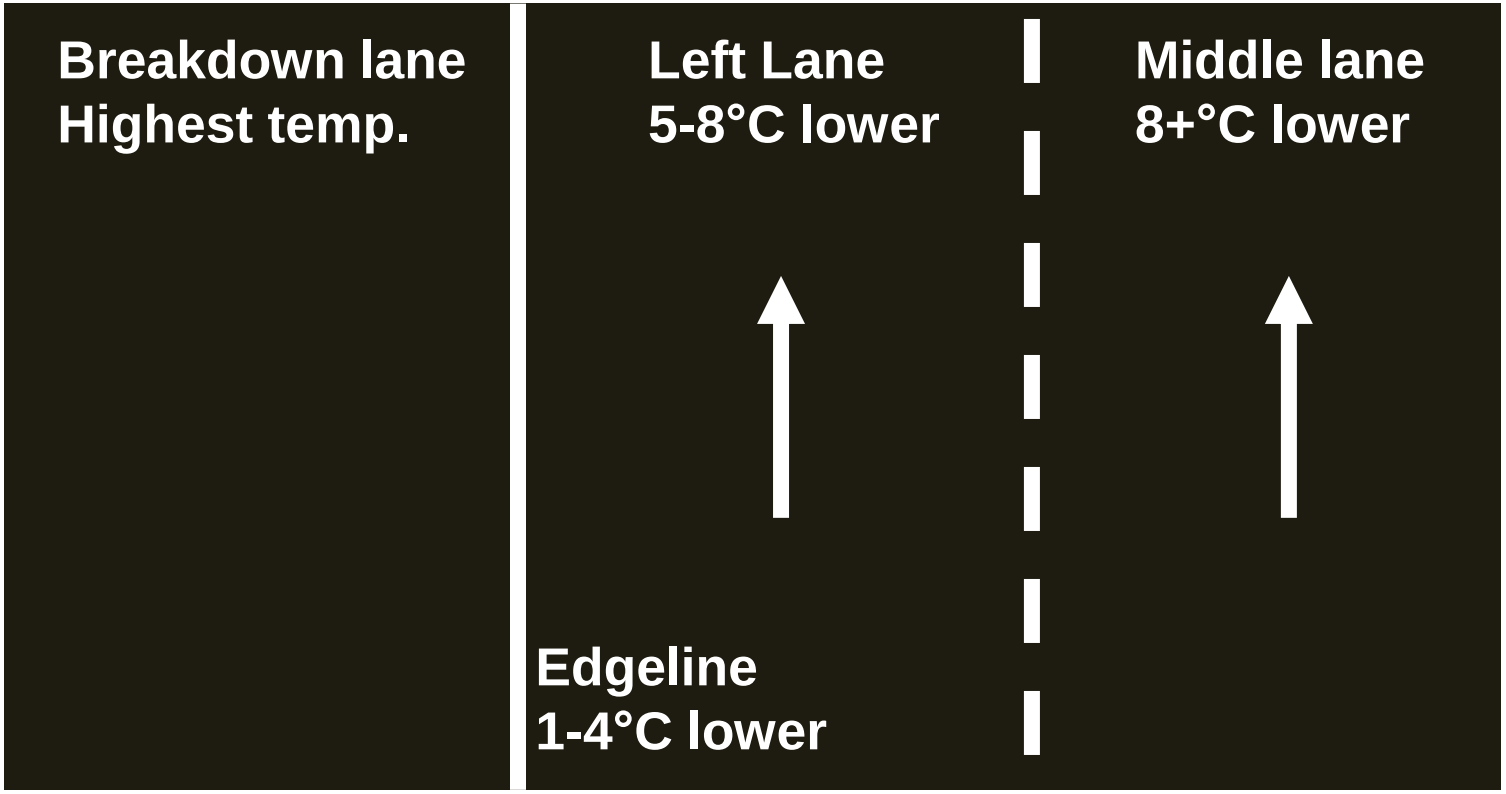


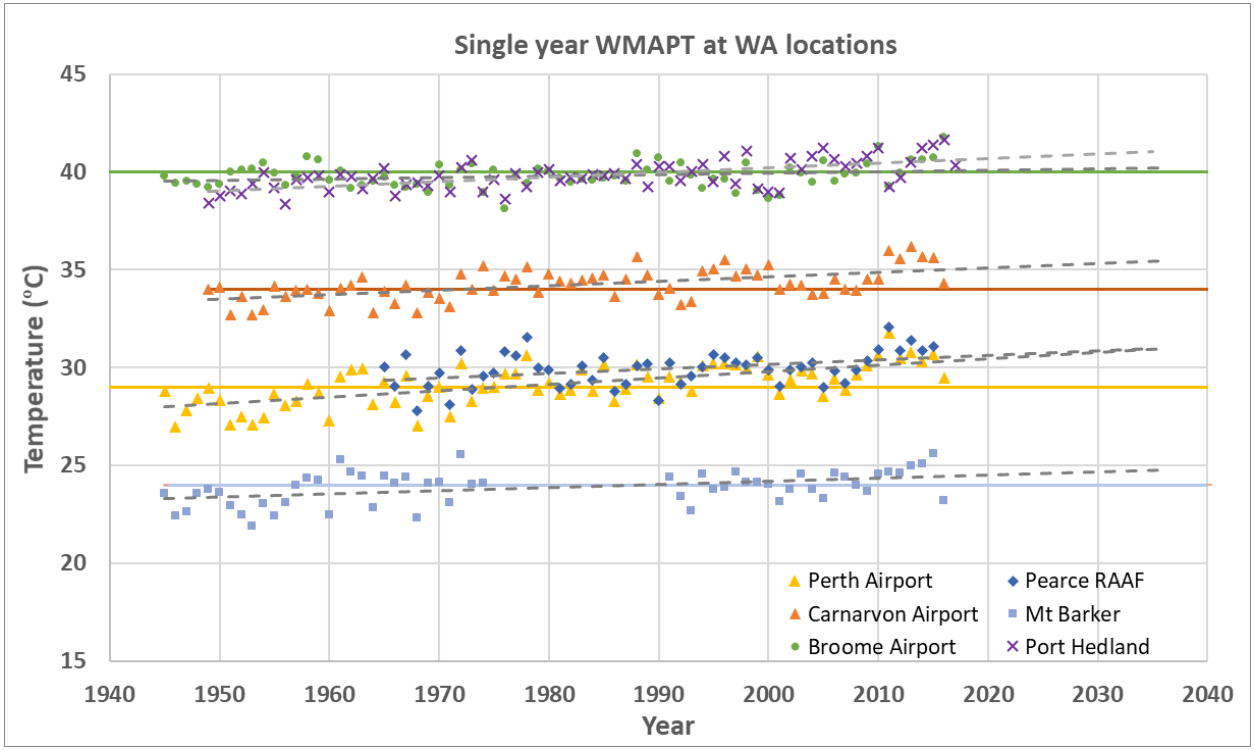
Observations

- Surface temperatures vary by location across road



Implications for design

- Climate change has led to growth in temperatures over last 70 years
- WMAPT have not been adjusted upwards
- 'Average' WMAPT in Perth over 40-year design life should be **31°C**
  - Equivalent to reduction in design life of 17% (7 years of design traffic)



Implications for design

- WMAPT was adopted from the Shell Pavement Design Guide (1978)
- How does this compare to temperatures at the instrumented site?
  - Average annual pavement temperature (similar for all depths) is 25.3°C

- Closest methodology is to adjust for recent climate data, then use the Shell PDM chart but interpolate for the correct depth

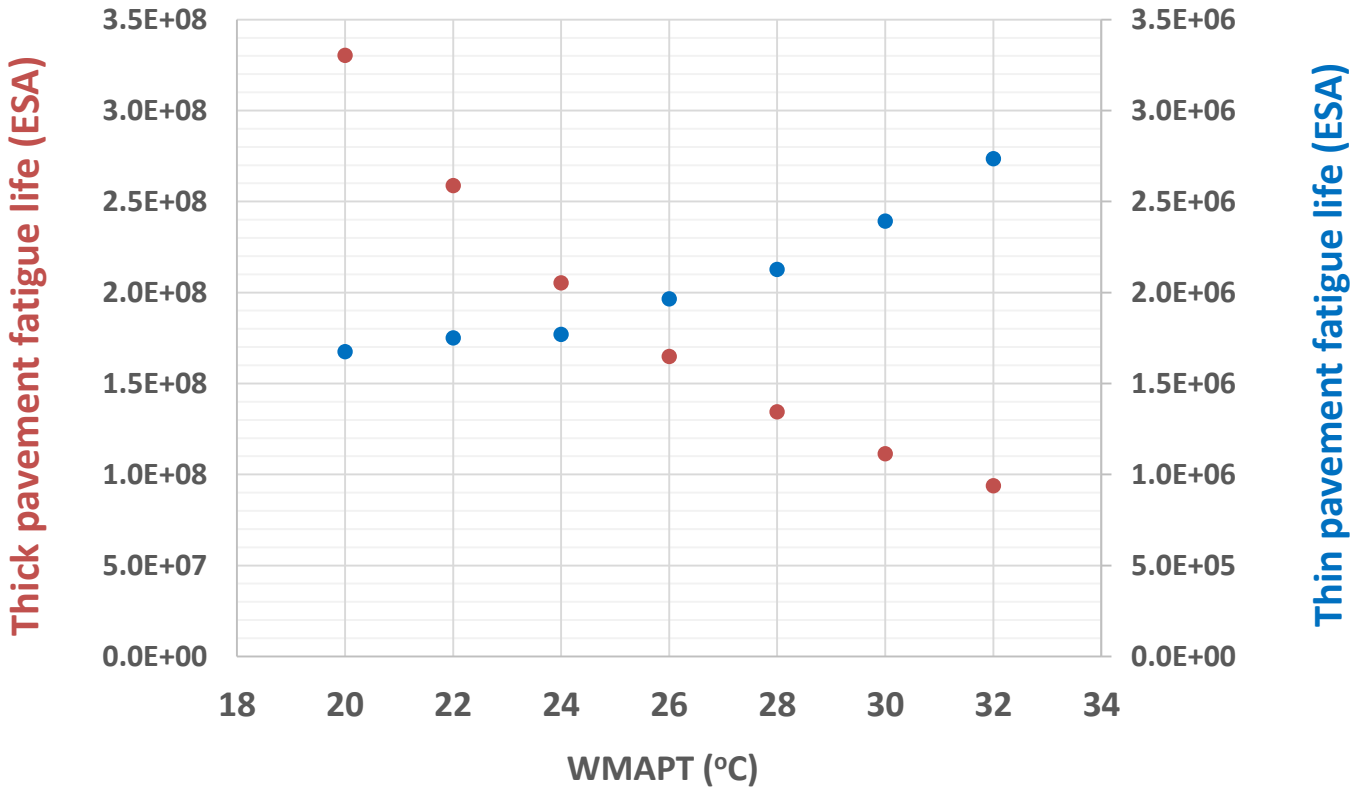
- Same holds true for data from South Gippsland and Brisbane

Methodologies for calculating WMAPT – Perth 2016/17		
Average annual pavement temperature at 100 mm (°C)		**25.3**
Austroads WMAPT (2017)	WMAPT (°C)	29
	Offset to actual (°C)	3.7
Calculate WMAPT from 2016/17 weather station data	WMAPT (°C)	28.2
	Offset to actual (°C)	2.9
Shell PDM Chart RT (correcting for depth)	WMAPT (°C)	26.8
	Offset to actual (°C)	1.5
Shell PDM Chart RT (2016/17 weather station data)	WMAPT (°C)	26.0
	Offset to actual (°C)	0.7

Implications for design - Examples

Thick pavement = 300mm

Thin pavement = 100mm



Implications for design - Examples

- Generic thick pavement at various temperatures

Implications for design - Examples

- Generic thin pavement at various temperatures

Modelling

- Several models have been proposed previously
- A model with relatively simple inputs and outputs can improve accuracy of our fatigue life predictions

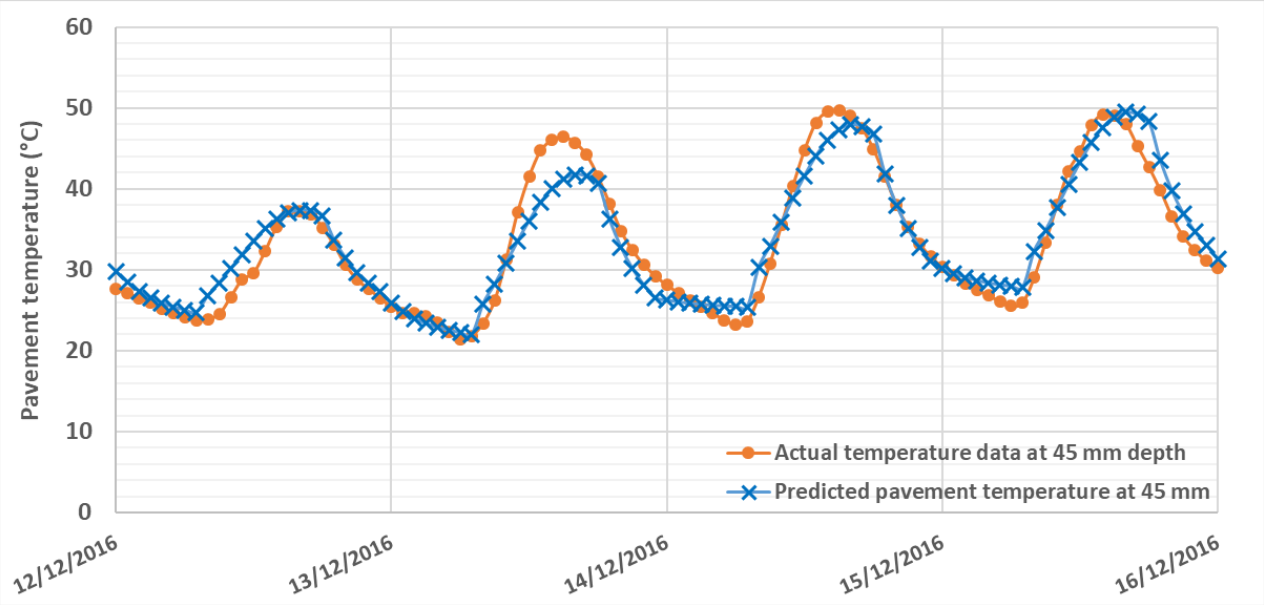
INPUTS	OUTPUTS
Daily maximum air temp. (BoM)	Maximum pavement temp. at any depth
Daily minimum air temp. (BoM)	Minimum pavement temp. at any depth
Daily total solar exposure (BoM)	
Four constants (α, β, γ, δ)	
Pavement depth	
Sunrise/sunset times (day/night mode)	

$$T_{p\,max\,(at\,depth\,D)} = \alpha + \beta * (T_a\ \max) + \gamma * \frac{SR}{1000} + \delta * (D)$$

$$T_{p\,min\,(at\,depth\,D)} = \alpha + \beta * (T_a\ \min) + \gamma * \frac{SR}{1000} + \delta * (D)$$

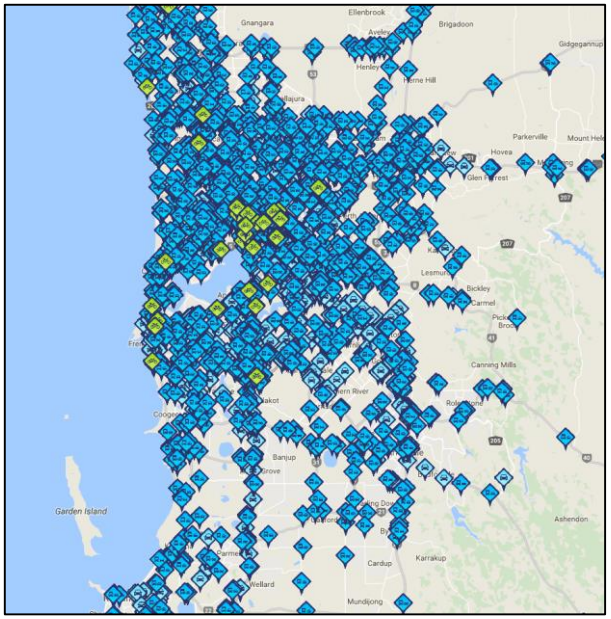
Modelling

- Use max & min daily pavement temp. and two part function to calculate hourly pavement temperature
  - Sine curve during daylight hours, proportionate drop-off during night
- Merge with traffic distribution from WiM site or counter
- Calculate fatigue life estimate based on 8760 (=24*365) data points



Benefits of this approach

- We have a more localised and accurate understanding of the pavement response to climate and traffic
- Compatible with mix-specific fatigue relationships and changes to Austroads methodology
- May not be suitable to all projects but relevant when looking at major projects



Summary

- Project due for finalisation in June 2018
- Second instrumented site planned for later in 2018 or early 2019
- Continuous monitoring until at least end of 2nd full year at each site