POROUS ASPHALT – MORE THAN JUST SAFETY

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Porous Asphalt (PA) improves storm water quality

Outline

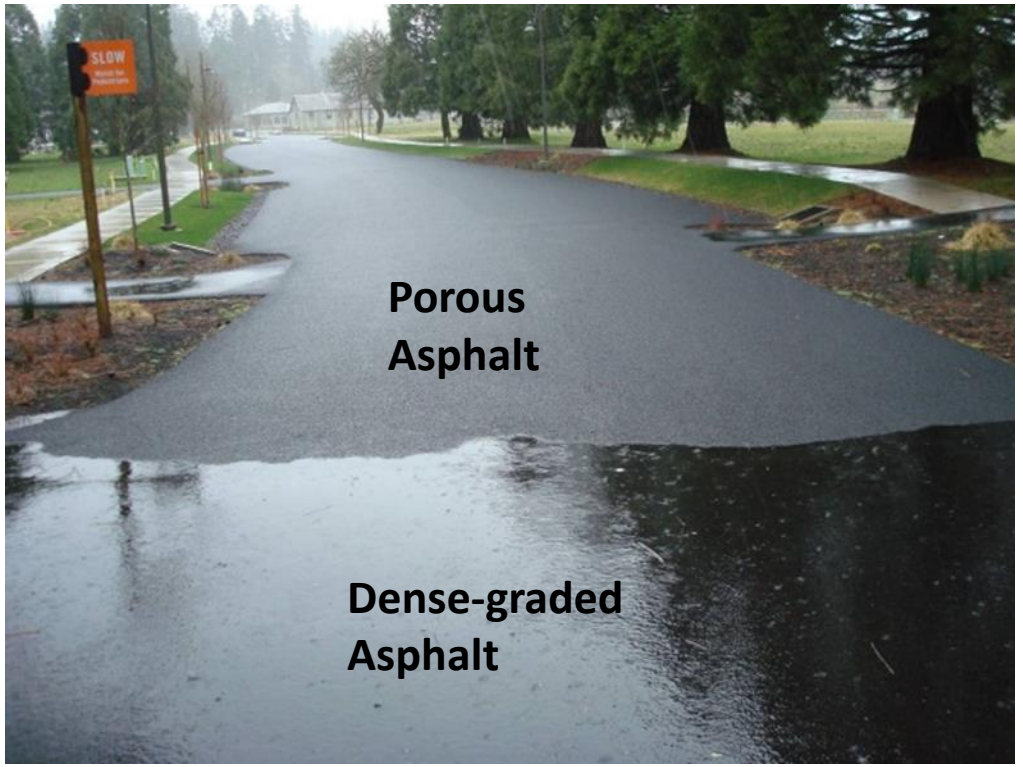
PA Properties and Pollution

International Research

Application to NZ

PA – Safety and Motorist Comfort Benefits

- Mix of choice for motorways
- Good skid resistance at high speed
- Water drainage properties:
  - hydroplaning & wet skidding ↓
  - road marking visibility ↑
  - spray and splash ↓
- Reduction in light reflection from road surface
- Smooth ride & driver comfort



Retrieved from: http://www.apao.org/porous_asphalt.html

PA – Environmental Benefits

- Noise reduction
- Reduction of Urban Heat Island Effect. “Cool” surfacing
- Improved storm water quality

Noise Pollution (cartoon). Retrieved from http://www.noisecontrol.com/wp-content/uploads/2012/10/Effectsofnoise.jpg

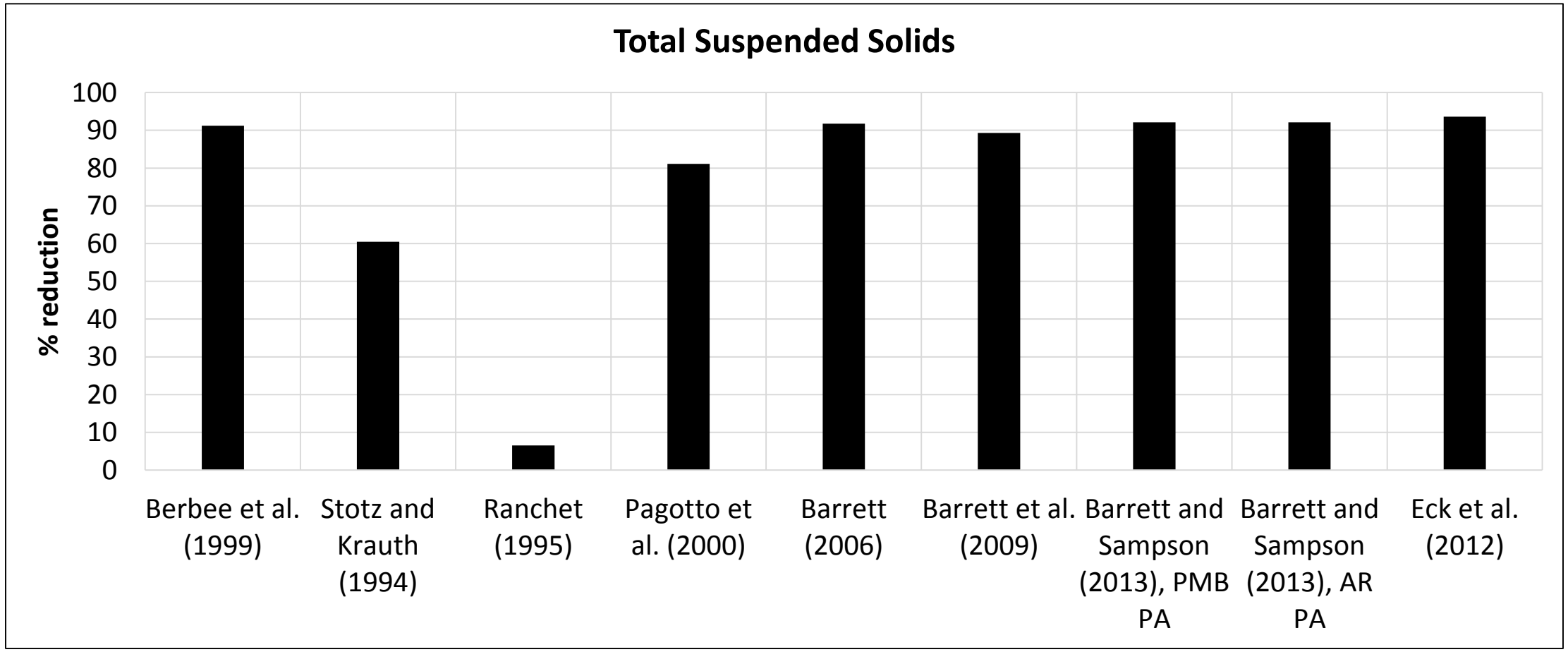
Source of Pollutants

- Direct and Atmospheric Deposition
- High traffic volume roads – a major source of pollutants: Polycyclic Aromatic Hydrocarbons (PAH), Heavy Metals, Suspended Solids and Mineral Oils
- Metal pollutants:
  - Zinc – wearing of tyres
  - Copper –brake linings
  - Lead – exhaust fumes (leaded petrol) and deteriorating paint from buildings/fences/infrastructure

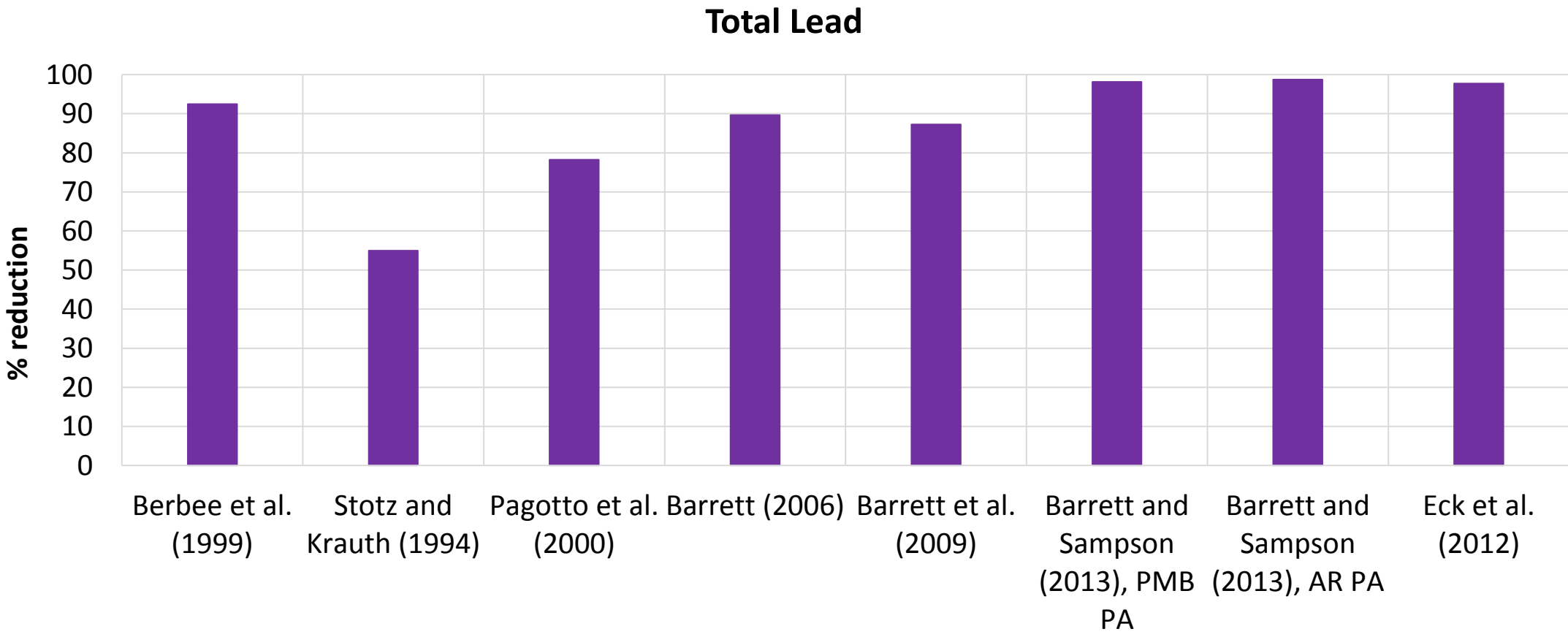
PA vs DG – International Research

- Research in four countries:
  - The Netherlands
  - Germany
  - France
  - USA
- Storm water quality from highways - PA vs DG
- Some of the pollutants investigated:
  - Suspended Solids
  - Metal pollutants (Lead, Zinc, Copper)
  - PAH

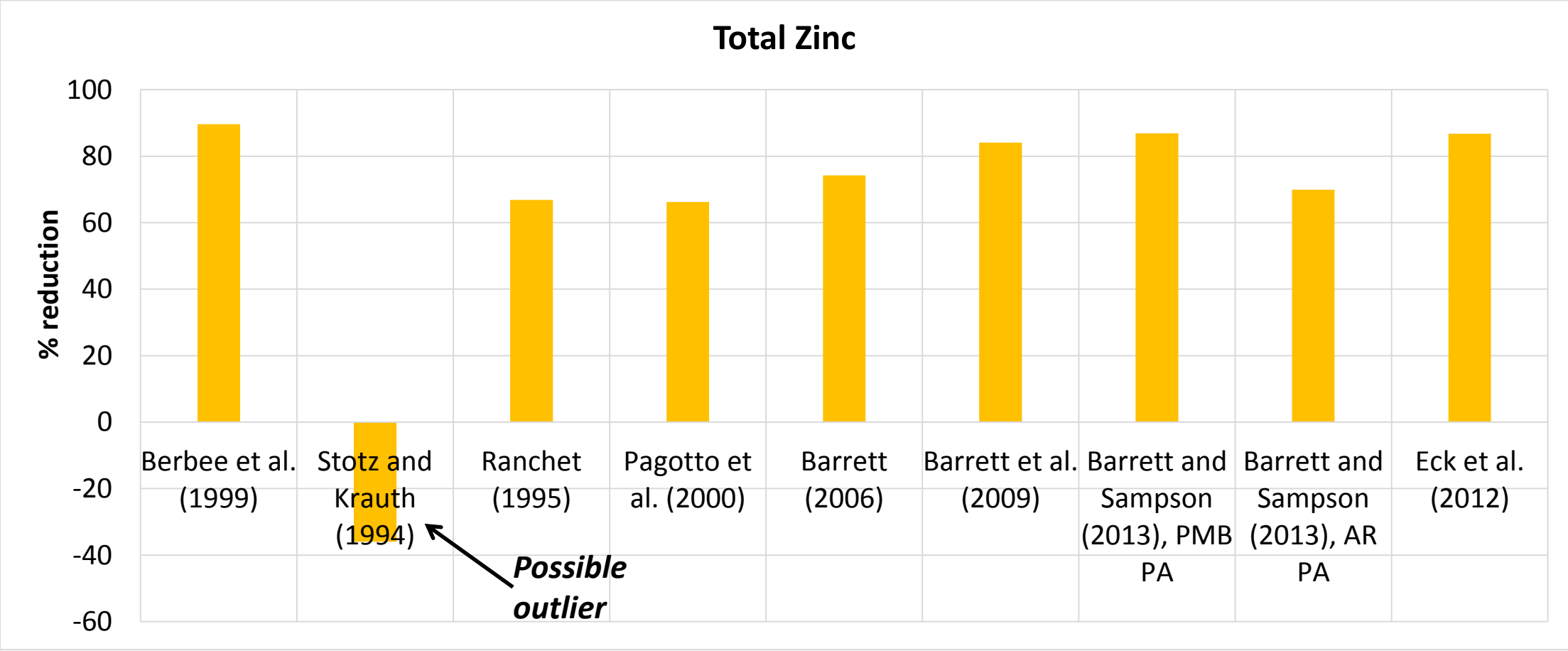
Total Suspended Solids (TSS)



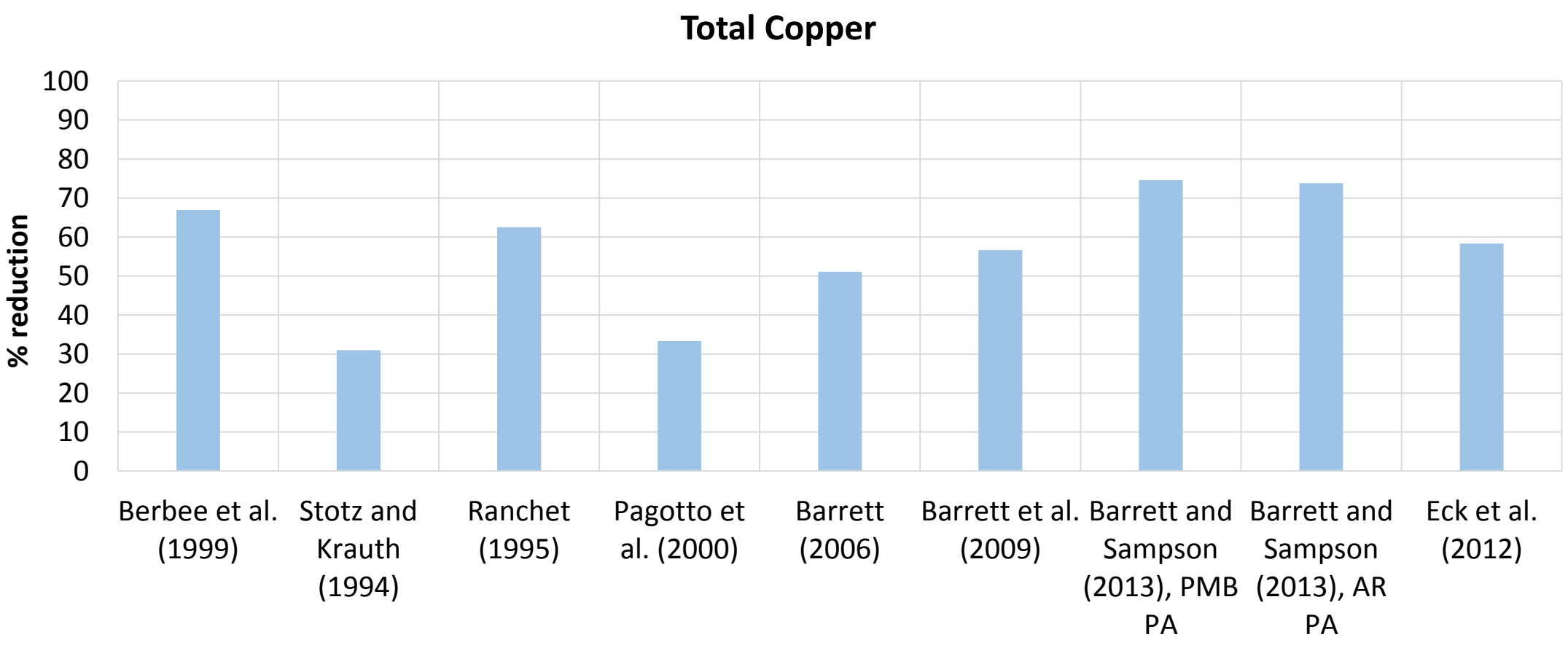
Lead


Total Lead
% reduction
100
90
80
70
60
50
40
30
20
10
0
Berbee et al. (1999)
Stotz and Krauth (1994)
Pagotto et al. (2000)
Barrett (2006)
Barrett et al. (2009)
Barrett and Sampson (2013), PMB PA
Barrett and Sampson (2013), AR PA
Eck et al. (2012)

Zinc


Total Zinc
% reduction
100
80
60
40
20
0
-20
-40
-60
Berbee et al. (1999)
Stotz and Krauth (1994)
Ranchet (1995)
Pagotto et al. (2000)
Barrett (2006)
Barrett et al. (2009)
Barrett and Sampson (2013), PMB PA
Barrett and Sampson (2013), AR PA
Eck et al. (2012)
Possible outlier

Copper


Total Copper
% reduction
100
90
80
70
60
50
40
30
20
10
0
Berbee et al. (1999)
Stotz and Krauth (1994)
Ranchet (1995)
Pagotto et al. (2000)
Barrett (2006)
Barrett et al. (2009)
Barrett and Sampson (2013), PMB PA
Barrett and Sampson (2013), AR PA
Eck et al. (2012)

PA Layer Thicknesses

Research paper	Country	PA layer thickness (mm)	Percentage of air voids in PA
Barbee et al. (1999)	The Netherlands	50	Not reported
Stotz and Krauth (1994)	Germany	40	19.1
Pagotto et al. (2000)	France	30	>20
Barrett (2006)	The USA	50	18-22
Barrett and Sampson (2013)	The USA	38	Not reported
Eck et al. (2012)	The USA	40	Not reported

NZ: ≈ 27mm (for PA10), 20-25% air voids

Key Findings - International Research

- Percent of pollutant reduced with the use of PA:

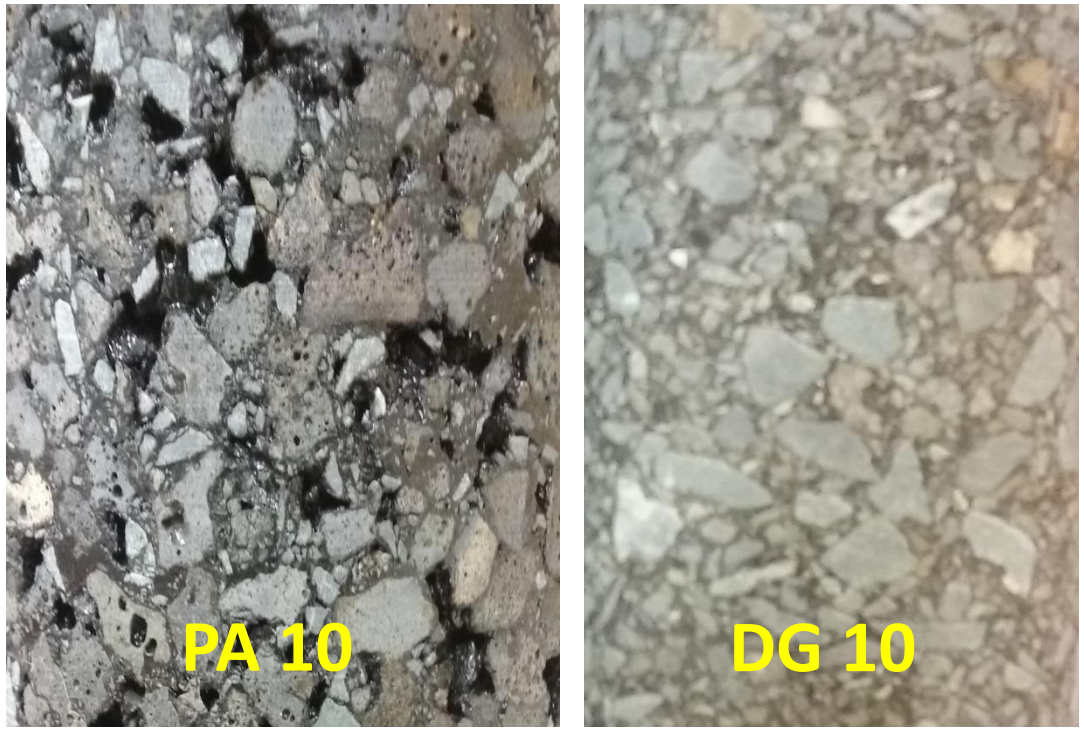
% of reduction	TSS	Total Lead	Total Zinc	Total Copper
Measured range	7 - 94	55 - 99	67 - 90	31 - 75

- Clear trend that PA can improve storm water quality→ should work in NZ too?
- PA with all binders used gave similar results

Holleran et al. 2016

Why Does PA Improves Storm Water Quality?

PA - traps pollutants in its porous structure



PA – drains water from road surface → less washing of vehicle underside

Holleran et al. 2016

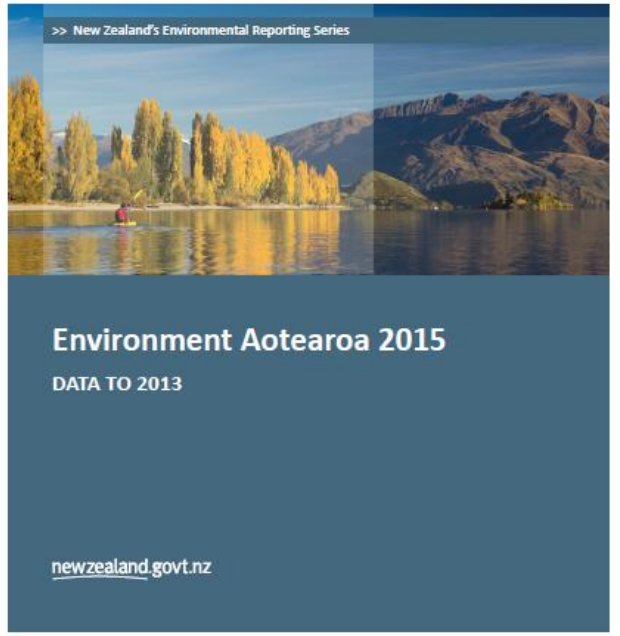
PA Properties and Pollution

International Research

Application to NZ

NZ –Focus on Fresh Water Quality

- Environment Aotearoa 2015 report:
  - comprehensive report
  - current state of NZ environment
  - main challenges – **fresh water**, climate change and bio-diversity



NZ – a Land of Second Hand Cars

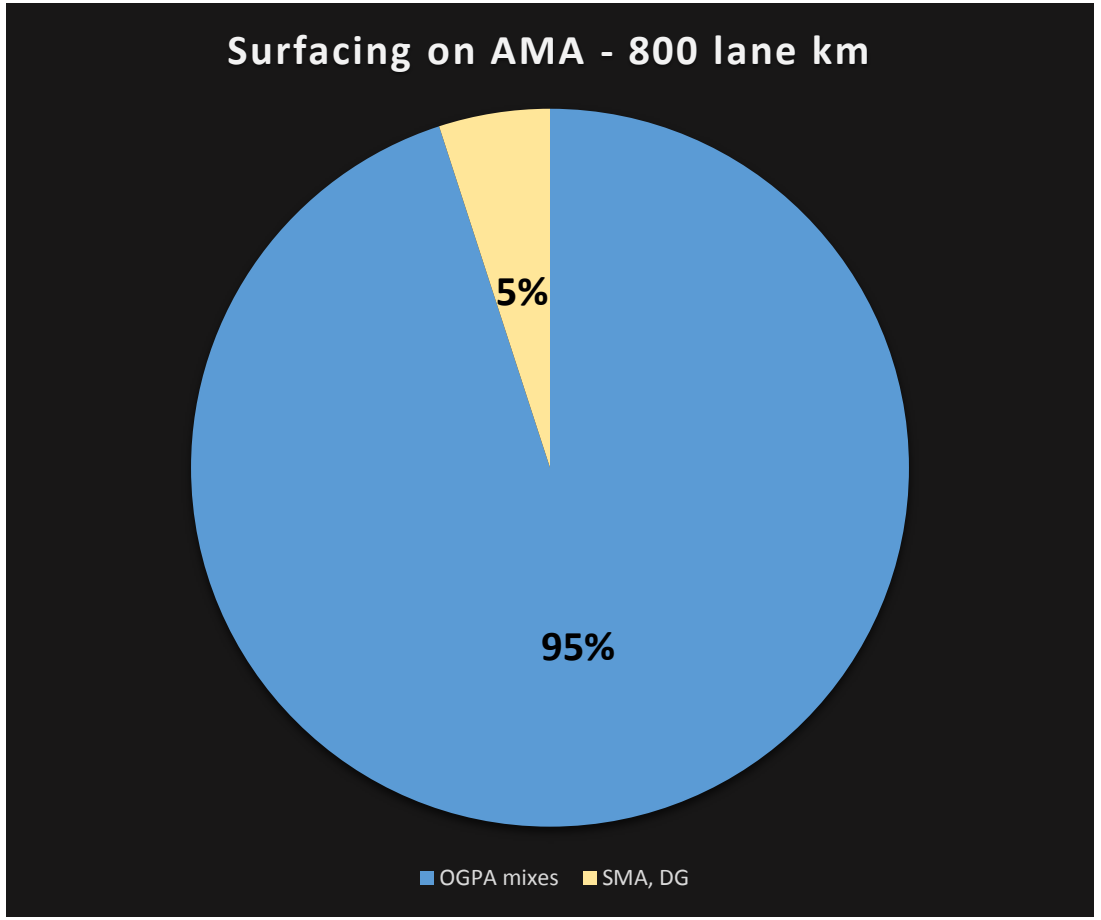
- Influx of second hand vehicles of varying quality
- The second highest ownership level of vehicles in the developed world (733 per 1000)
- The oldest fleet in the developed world and getting older
- Traffic is the main contributor to storm water pollution

Vehicles	2012	2013
Light passenger	13.35	13.53
Light commercial	12.23	12.21
Motorcycles	12.08	12.53
Trucks	15.3	15.7
Buses	15.1	15.3

Source: Ministry of Transport, 2014

PA on the AMA

- Auckland Motorway Alliance (AMA) – biggest user of PA in NZ
- 10 mm NMAS (PA10 / OGPA10)
- Takes the biggest traffic volume
- Average life - 10 years and rising with the use of PMBs and specialty design
- The volume of PA millings will increase significantly in the coming years
- PA millings are not routinely recycled into asphalt mixes



Questions Raised ???

NZ:

The second highest vehicle ownership level in developed world + **The oldest fleet in the developed world** + **PA endures the greatest traffic volumes in NZ** + **Traffic is a major source of pollutants** +

PA traps pollutants → **PA recyclability: what are the pollutant concentrations in our PA millings?**

Questions Raised ???

- Epoxy-modified PA – double the current PA life span:
  - high level of pollutants at the end of life? effect on recyclability?
  - can epoxy PA millings be recycled back to asphalt mixes at all?
- Optimizing performance of PA:
  - road vacuuming (like in the Netherlands)?
- “Greenroad” certification:
  - extra credits for PA recognizing its environmental benefits?
  - is PA with recycled polymers or tyre rubber a green option for NZ roads and a way forward?

Research in Progress

- Doctoral research at the University of Auckland, Faculty of Engineering
- Development of criteria for effective recycling of PA
- Design of new PA mixes with PA-derived RAP without compromising mix performance properties

PA millings from AMA

Collaboration

Academia and industry

Irina Holleran, PhD candidate, The University of Auckland

Dr. Doug Wilson, The University of Auckland

Dr. Bryony James, The University of Auckland

Dr. Lubinda Walubita, Texas A&M Transportation Institute

Glynn Holleran, Fulton Hogan Ltd

Dr. Bryan Pidwerbesky, Fulton Hogan Ltd

Bruce Chappell, Auckland Motorway Alliance

Summary

1. PA is a high value surfacing for:
   - motorist safety
   - motorist comfort
   - environment
2. PA reduces pollutant concentration in storm water compared to DG. How polluted are our PA millings?
3. Recyclability of PA in NZ:
   - PA millings are used in low value applications, not routinely utilized in asphalt mixes
   - need to find a way to use PA millings in a new high value PA mix
4. Research is underway

Porous Asphalt (PA) improves storm water quality

THANK YOU!

Comments, Contributions, & Questions?