ALTERNATIVE MATERIALS RESEARCH PROGRAMME

32nd Meeting of the Road Pavement Forum

CSIR International Conference Centre
7- 8 November 2016

M B Mgangira, Pr. Eng

CSIR Built Environment

our future through science

Introduction

Background

- Motivation
- Initiatives

Project Work Packages

- Coarse and fine ash
- Glass products
- Recycled Asphalt

CSIR
our future through science

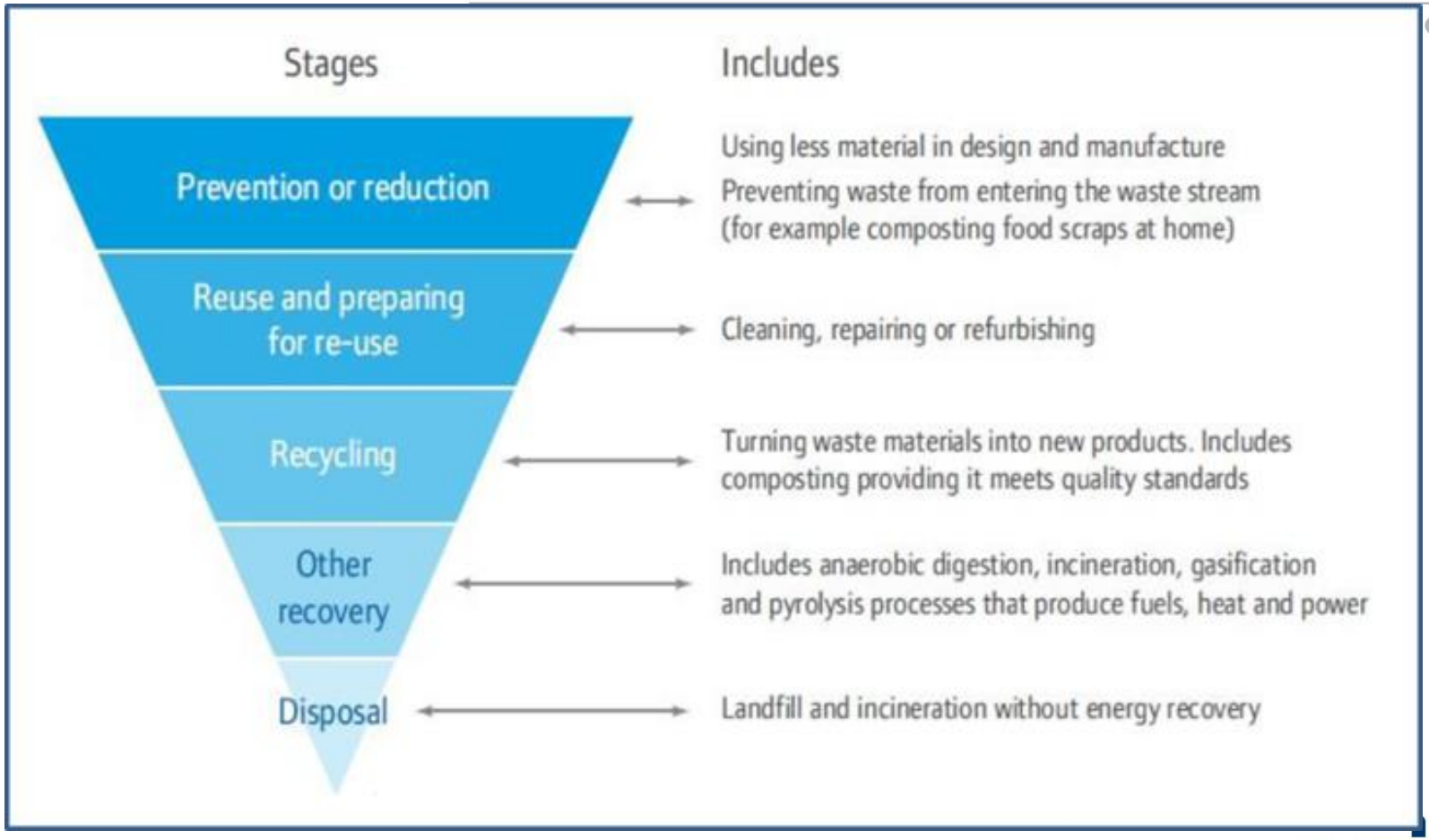
Motivation

A NATIONAL RESEARCH, DEVELOPMENT (R&D) AND INNOVATION ROADMAP FOR SOUTH AFRICA: PHASE 2: WASTE RDI ROADMAP

The economic benefits of moving up the waste management hierarchy in South Africa: The value of resources lost through landfilling

our future through science

Motivation



Source: DEA 2012

CSIR
our future through science

Motivation

Stream	BASELINE (2011)	
	Generated (t/yr)	Landfilled (t/yr)
Municipal waste (non-recyclable portion)	8 062 934	8 062 934
Organic component of municipal waste	3 023 600	1 965 340
Biomass waste from industry	36 171 127	36 171 127
Construction and demolition waste	4 725 542	3 969 455
Paper	1 734 411	745 797
Plastic	1 308 637	1 073 082
Glass	959 816	652 675
Metals	3 121 203	624 241
Tyres	246 631	236 766
WEEE	64 045	57 161
Slag (from mineral processing)	5 370 968	2 685 484
Ash (from power generation)	36 220 000	33 930 896
Waste oils	120 000	67 200
TOTAL	**101 128 914**	**90 242 158**

Source: DEA 2012

CSIR
our future through science

Motivation

Stream	Unit benefit (in terms of resource value only) (R/t)	Unit benefit (in terms of resource value plus avoided disposal costs) (R/t)	Current recycling rate (%)
Plastic	3119.54	3330.54	18
Waste oils	2777.78	2988.78	44
Metals	2270.00	2481.00	80
WEEE	1000.00	1211.00	11
Paper	744.47	955.47	57
Glass	490.00	701.00	32
Tyres	367.00	578.00	4
Municipal waste (non-recyclable portion)	367.38	578.00	0
Organic component of municipal waste	188.63	399.63	35
Biomass waste from industry	188.63	399.63	0
Slag	175.00	386.00	50
Construction and demolition waste	87.50	298.50	16
Ash	3.00	214.00	6

CSIR
our future through science

Background:

By-product utilisation studies

- Coal and incinerator ash (Sasol Ash)
  Blast and steel slag (ISCOR)
- Mineral and quarry by-products
  Fibres from waste plastic bottles
  Reclaimed asphalt (RA)

CSIR
our future through science

Background:

By-product utilisation studies

- Building and demolition rubble
- Crumbed rubber for bitumen rubber
- Foundry sand
- Phospho-gypsum (Chloorkop)

CSIR
our future through science

Background: Initiatives at CSIR

Horak and Maree (1982)
Slag as base in trial sections

Heath et al. (1996)

Fly ash + fly ash blends, lime and emulsion

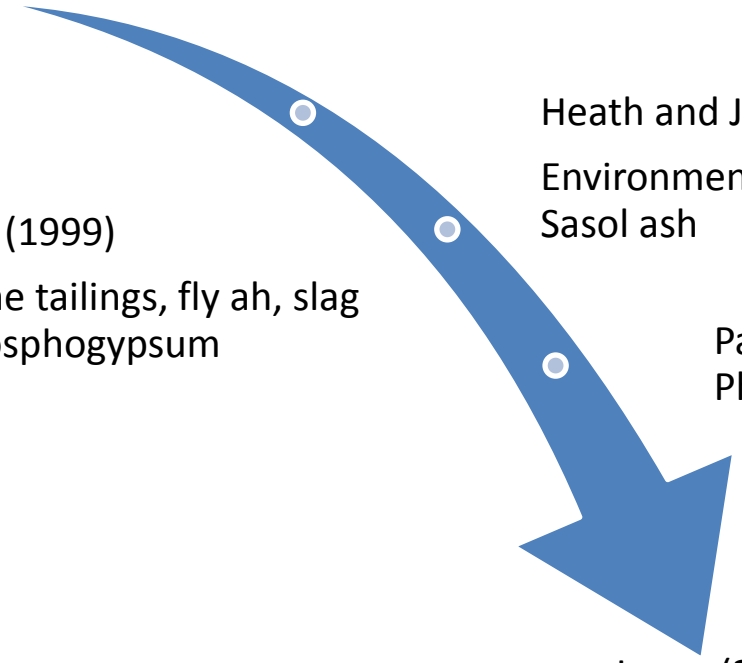
Heath and Jones (1997)

Environmental implication of using Sasol ash

Lea (1999)

Mine tailings, fly ah, slag phosphogypsum

Paige-Green and Gerber (2000)
Phospho-gypsum



Jones (2003)

Institute for Recyclable Materials

CSIR-University of Pretoria

CSIR
our future through science

Research Programme Objectives

- To provide coherent body of knowledge on alternative materials
- Review available test procedures for assessment
- Establish best material preparation
- Explore possible modifications to improve suitability
- Establish the required adaptation for use

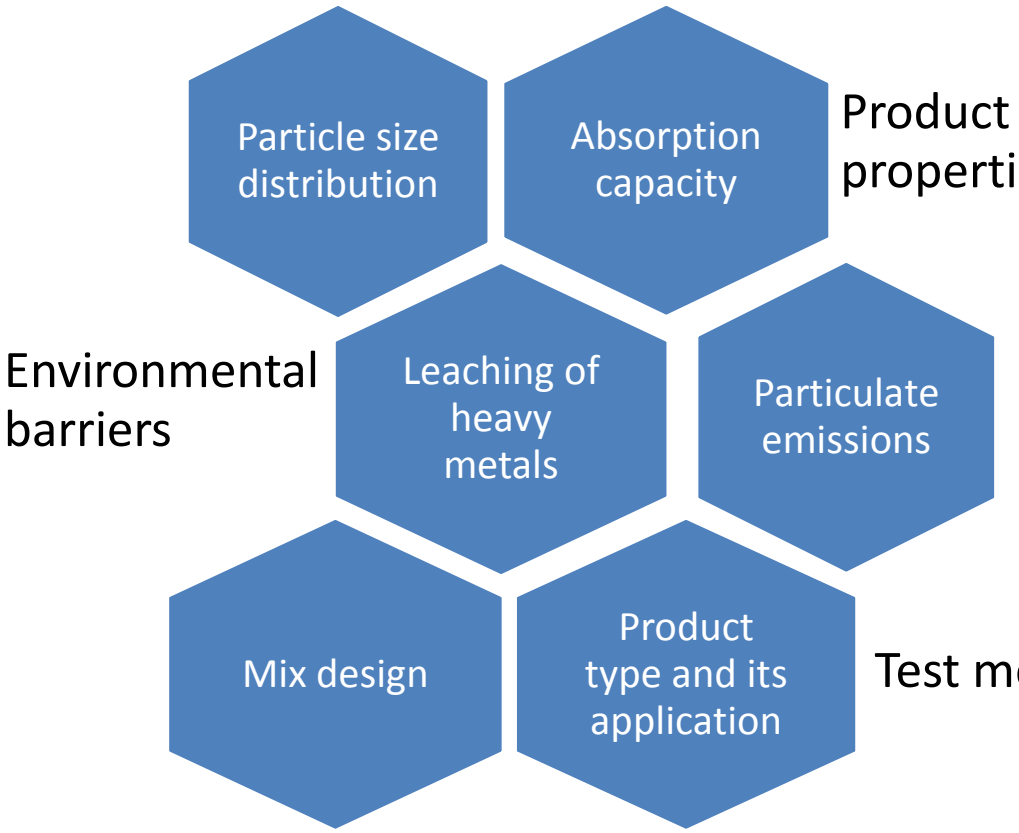
CSIR
our future through science

Produce

- Materials that meet engineering properties while maximizing material sustainability

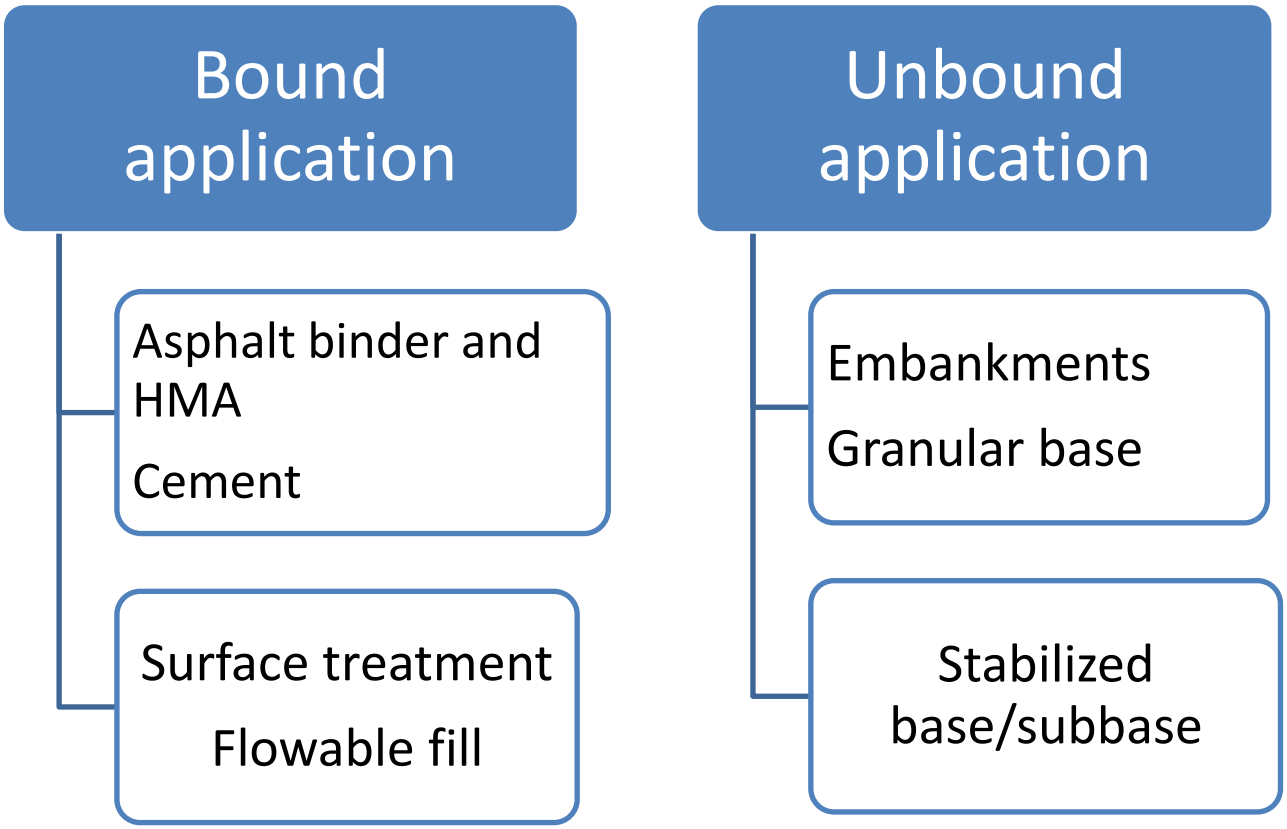
CSIR
our future through science

Work Package 1: Coarse and fly ash



CSIR
our future through science

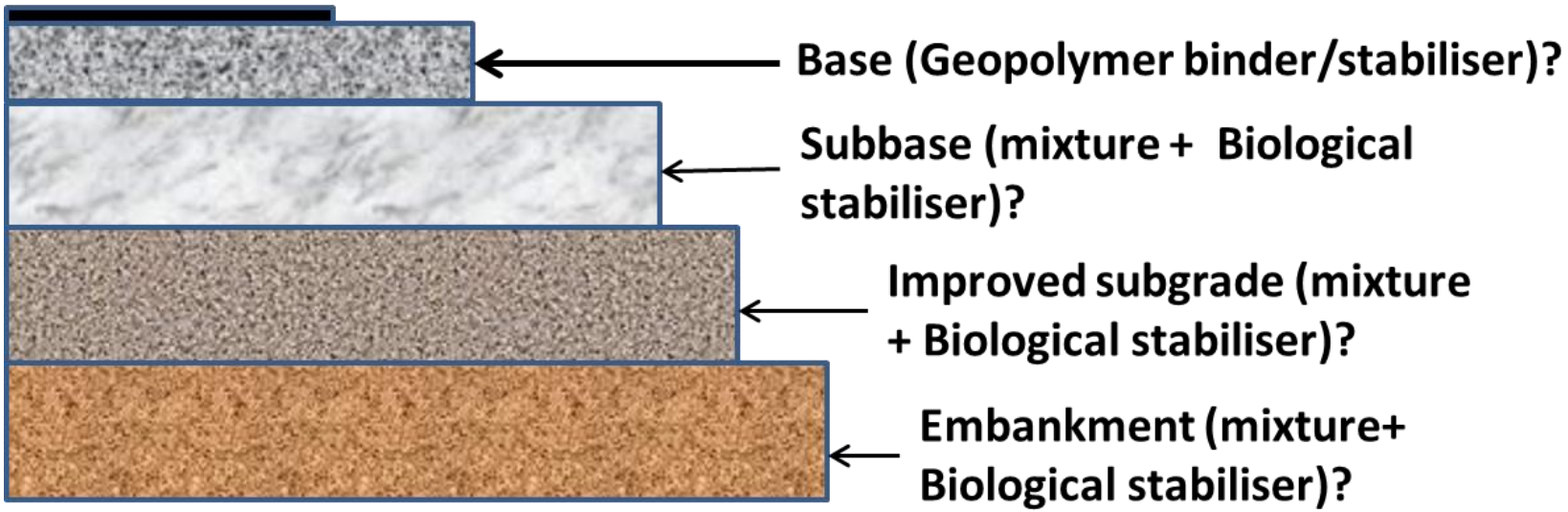
Work Package 1:Potential application of fly ash:



CSIR
our future through science

Work Package 1:Coarse and fly ash Application

Asphalt mix design (as filler)



CSIR
our future through science

Work Package 2: Recycled Asphalt

Objective

Maximum use of non-renewable resource in such a way that it maintains

- Cost Effectiveness
- Environmental friendliness
- Mix performance (especially fatigue)

Status

Initiation of project: early 2017

Work Package 2: Recycled Asphalt

Methodology

Determine effect of ratio of RA on mix fatigue life

- Four point beam fatigue
- Recovered binder fatigue parameters (Glover-Rowe and ΔTc

Addition of RA rejuvenating agents

- Re-evaluate effect on fatigue performance
- Cost Analysis

Work Package 3: Innovative and optimised asphalt surfacing mixes for high volume roads

Objective

Develop sustainable asphalt mix that utilises crushed glass (waste material) as aggregate replacement

Planned Tasks

- Develop optimal glass asphalt mix & associated design guideline
- Establish engineering properties for performance evaluation
- Conduct economic cost-benefit analysis

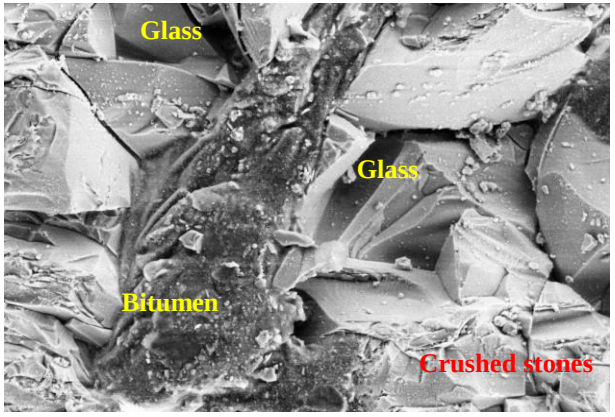
Work Package 3: Innovative and optimised asphalt surfacing mixes for high volume roads

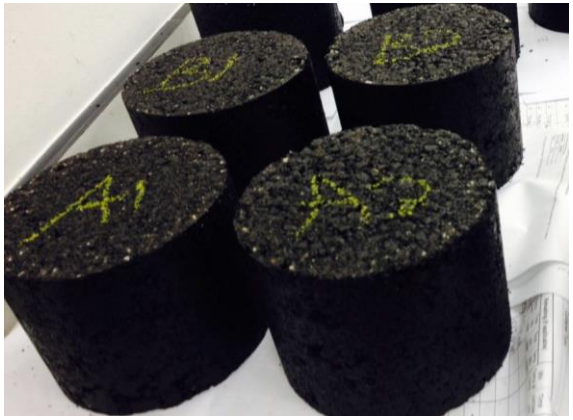
Conventional fine aggregates

Fine crushed glass

- **Intended outcome/impact:**
  - Glass asphalt mix (**product**)
  - **Sustainable and cost-effective** product for roads addressing **environmental** issues
  - **Skills** development -CSIR researchers
  - HCD (possibly, **two Masters**)
  - Min **one article, three conference papers, one guideline**

SEM results





Waste Glass for Asphalt Production

- On the average, **550,000** tons of waste glass finds its way into South Africa's landfills every year, while only **200,000** tons of all glass containers (glass bottles and jars) is retrieved for recycling (*Gauteng*)
- **Substantial amount of waste crushed glass materials are available for exploitation in SA...!**

Project Phases

Assessment for utilisation in road construction

Material Characterisation
Physical and chemical properties

Detailed laboratory studies
Variability testing
Engineering/durability properties
Chemical and environmental

Multi-Disciplinary Expertise

National Centre for Nanostructured Materials (NCNM)
Natural Resources & Environment
Biosciences

Trial sections
Monitor response due to HVS trafficking
Long-term performance assessment

Pavement Design
Structural design guidelines

CSIR
our future through science

GOAL

- To provide coherent body of knowledge on alternative materials
- Establish the required adaptation for use
- Contribute towards development of appropriate technical guidelines

CSIR
our future through science

Thank you