



CITY OF CAPE TOWN & SABITA

**FEEDBACK ON STUDY ON IMPACT OF GREY
WATER ON ASPHALTS IN INFORMAL
SETTLEMENTS**

TWENTY-SEVENTH ROAD PAVEMENT FORUM

GATEWAY HOTEL, UMHLANGA, KWAZULU-NATAL
20 MAY 2014

WELCOME AND INTRODUCTION

- **PRESENTER**

- André Greyling

- **CLIENTS**

- SABITA & CITY OF CAPE TOWN
- Represented by:
 - Ian Bowker & Ian McDonald
 - Saied Solomon

WELCOME AND INTRODUCTION

• STUDY GROUP

- MyCube Asset Management -Gerrie Van Zyl
- University of Stellenbosch - Kim Jenkins
- BVi Consulting Engineers - André Greyling
- Zebra Surfacing -Jonathan Pearce

ROAD PAVEMENT FORUM

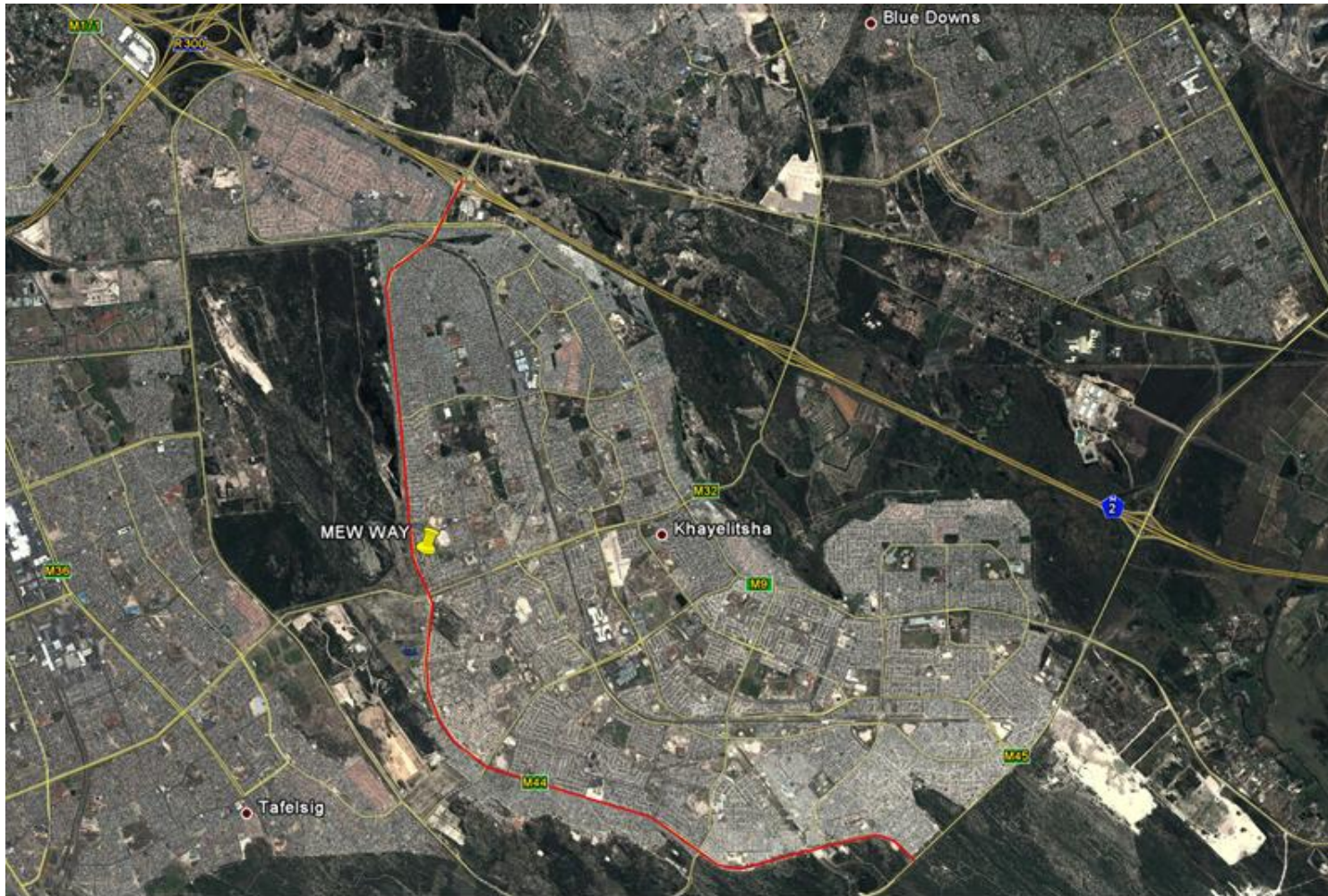
- **ADVANTAGES OF FORUMS AND GROUPS?**



PROJECT LOCATION

- Specific Focus on Mew Way Road
- City of Cape Town Metropolitan Area
 - Khayelitsha Area
 - Includes various other roads in Informal Settlement Areas
- Found that roads & especially surfacing just don't last in grey water areas.
- Therefore the need for a more sustainable solution

PROJECT LOCATION



GREY WATER STUDY PROJECT

PRESENTATION OVERVIEW

- **SECTION 1 – MEW WAY CONDITION OVERVIEW**
- **SECTION 2 – FEEDBACK FROM TCT WORKSHOPS**
- **SECTION 3 – LITERATURE STUDY**
- **SECTION 4 – LABORATORY TESTING**
- **SECTION 5 – FIELD TRIAL SECTIONS**
- **SECTION 6 - CONCLUSIONS**

SECTION 1

- **MEW WAY CONDITION OVERVIEW**

GREY WATER ON MEW WAY



STANDPIPE & ROAD DAMAGE



STANDPIPE & ROAD DAMAGE



STANDPIPE & ROAD DAMAGE



RAVELLING AND CRACKING



GREY WATER STUDY PROJECT

LOSS OF FILLER & SMALLER FRACTIONS



NOTE SURFACE DAMAGE



CRACKING



GREY WATER STUDY PROJECT

CARWASH – NOTE RAVELLING



RAVELLING & SCOUR



FAILURE MECHANISMS

- What did we find?
- Identified failure mechanisms
 - Mastic , Stone and Bitumen Loss
 - (Adhesion & Cohesion)
 - Ravelling
 - Cracking
 - Patches
 - Pavement Failure

SECTION 2

- **WORKSHOP FEEDBACK**

SECTION 2- WORKSHOP FEEDBACK

- Representatives from all Municipal Regions of City of Cape Town Responsible for Maintenance
- Various interesting discussions
- Conclusion
 - **Same, definite problem everywhere**
- Identified Outcome
 - Short, Medium and Long Term Strategies

SECTION 2- WORKSHOP FEEDBACK

- Short Term Strategy
 - **Grey Water Resistant Asphalt**
 - Moisture Insensitive Pavements
- Medium Term
 - **Entire Design Strategy Rethink**
 - Geometric Design Changes
 - Standpipe Position Changes
 - Pavement & Surfacing Design Changes
 - Improved Sewer Reticulation

SECTION 2 - WORKSHOP FEEDBACK

- Long Term Strategy
 - **Education and Training**
 - Social Awareness of Grey Water Damage to Roads and Environment
- **Purpose of this Study**
 - **To Concentrate on the Immediate and Short Term Strategies**



SECTION 3

LITERATURE REVIEW

SECTION 3 – LITERATURE REVIEW

Endeavoured to Answer the following questions:

1. What is Grey Water?
2. What damage does potable water do to asphalt? (Moisture Damage)
3. How and why is grey water damage different to potable water damage? (Grey Water Damage)
4. What factors will influence this damage?
5. What steps can be taken to reduce this damage?

3.1 - WHAT IS GREY WATER ?

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- General Definition:
 - “grey water is defined as the wastewater from bath tubs, showers, washbasins and washing machines”
 - “50 Shades of Grey ” Water
 - Does not include Black Water
 - **Most important ingredient is Water**
 - Havellyn Peterson – Thesis – Door to Door Survey in the Mew Way Areas

3.1 - WHAT IS GREY WATER ?

- Conclusion ?
 - Water
 - Washing Powder
 - Dishwashing Liquids and Soap
- Confirmed by City of Cape Town Water Quality Measurement @ Storm water pond site next to Mew Way Road
 - High Conductivity (Sodium)
 - Medium Ammonia (Washing Powder)
 - Medium Phosphorous (Washing Powder)

3.1 - WHAT IS GREY WATER ?

- The Major Ingredients of Washing Powder and Dishwashing Liquids are **Surfactants**
- “Surfactants can be defined as a compound that lowers surface tension (or interfacial tension) between two liquids or between a liquid and a solid.”
- Major Ingredients (>50%)
 - Sodium Dodecylbenzenesulfonate
 - Sodium Laurel Ether Sulfate (SLS)
 - Stearic Acid & Various Other Compounds

3.1 - WHAT IS GREY WATER ?

- Conclusion
- Grey Water Can Consist of Anything
- With realistic certainty conclude that Grey Water consist of :
 - 99%+ Water
 - Dissolved Surfactants
 - Various other less concentrated ingredients

3.2 - MOISTURE DAMAGE

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- Moisture/water damage as a starting point to understand the effect of grey water damage to asphalt .
- The major failure mechanisms - ***Disbonding or Adhesion Failure.***
- This occurs when there is a break in the bitumen/aggregate bond leading to:
 - stripping, ravelling, loss of stiffness and strength and other adhesion related failures.

3.2 - MOISTURE DAMAGE

- As adhesion failure progresses it will eventually lead to the ***cracking and breaking up of asphalt.***
- This occurs when the adhesion loss leads to cracking and damage to the structural integrity of the asphalt layers.
- Further damage can then occur due to water ingress in support layers and also the loss in flexibility of the asphalt due to premature ageing of asphalt.

3.2 - MOISTURE DAMAGE

- Mechanisms of Moisture Damage
- Shell Bitumen Handbook & Prof Dallas Little
 - Detachment
 - Displacement
 - Chemical Disbonding
 - Pore Pressure
 - Hydraulic Scour

3.3 - GREY WATER DAMAGE

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- Various Literature Sources on Chemical Damage to Bitumen (Not Asphalt)
- Most Bitumen binders and Aggregates are **not negatively** influenced by Surfactants.
- Soap does not generally dissolve bitumen or aggregates
- The nature of Surfactant is however to **Break Bonds** and there is an expected influence on the Bitumen Aggregate Bond

3.3 - GREY WATER DAMAGE

- Peterson **submerged** various asphalt mixtures in a water surfactant mixture for 30 min , 24-hour & 7 Days
- His results confirmed the **severe degradation** of asphalt bricks after 3-4 days with all sample combinations disintegrating when handled. No testing possible.
- Worst case scenario and severe conditions - 1% Surfactant @ 60°C – 1kg of Omo per 20 litre of water

3.3 - GREY WATER DAMAGE



GREY WATER STUDY PROJECT

3.4 - FACTORS THAT WILL INFLUENCE MOISTURE DAMAGE

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- The various mechanisms described above will occur at different rates and severity based on a combination of factors. The major requirements remains:
 - Asphalt surface contact with water and grey water – **The longer the contact the more likely moisture damage will occur.**
 - Water and grey water ingress into voids of asphalt layer – **The moisture needs to get into the asphalt layer to do damage .**

3.4 - FACTORS THAT WILL INFLUENCE MOISTURE DAMAGE

- Without these two actions no water or grey water damage can take place.
- The obvious solution would then be to limit water contact with the asphalt layer but this will be impossible as rain and other factors will always ensure water on a road.
- What is required is a more holistic look to ensure the understanding of all the possible factors that will influence the rate and severity of water and grey water damage on asphalt.

3.4 - FACTORS THAT WILL INFLUENCE MOISTURE DAMAGE

- Aggregate Properties
 - Basic for improved adhesion
- Bitumen Properties
 - Modification increase adhesion & chemical resistance (EVA& SBS)
- Asphalt Mixture Properties
 - Continuously graded , Active Filler (Lime)
- External Factors
 - Compaction, layer thickness etc

3.5 - REDUCING MOISTURE DAMAGE

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- Continuously Graded Mixture
- Asphalt designed to have 2.5% Voids post traffic compaction
- 1-3% Hydrated Lime as filler
- EVA or SBS Polymer Modified Binder to ensure increased strength and adhesion characteristics
- F-T Wax as compaction agent and to increase chemical resistance.

3.5 - REDUCING MOISTURE DAMAGE

- Constructed Field Void Content of less than 7%
- Layer thickness of more than 40mm
- Mineral filled modified emulsion sealant in critical areas.

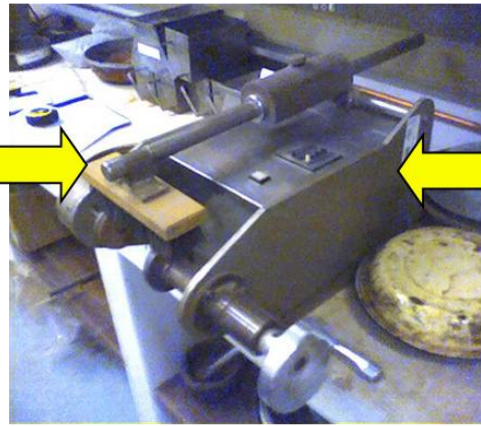
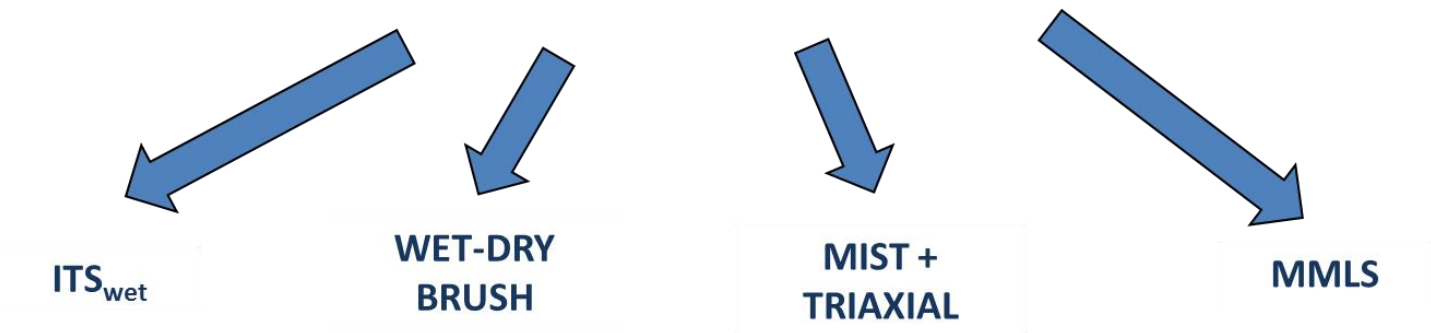


SECTION 4 - LABORATORY TESTING AT STELLENBOSCH UNIVERSITY

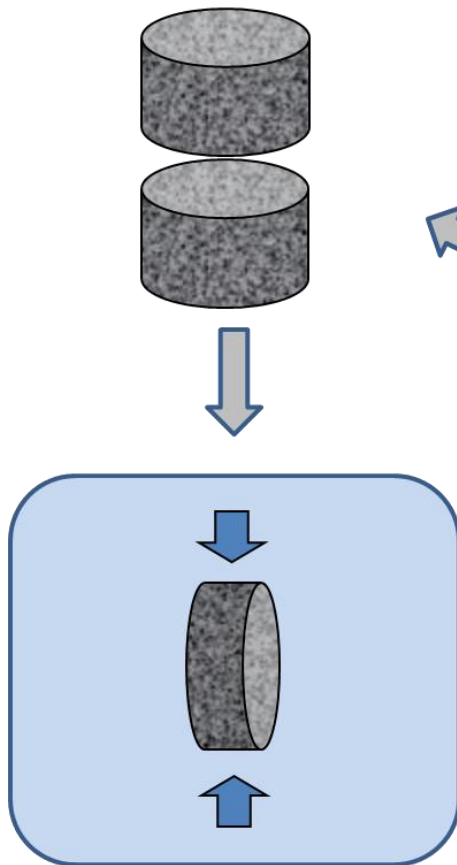
SECTION 4 - LABORATORY TESTING AT STELLENBOSCH UNIVERSITY

- Select one standard Cape Town surfacing mix
- Prepare gyratory specimens
- Study damage of grey water versus clean H₂O
- Condition asphalt specimens with pulsing water at 40°C
- Use MIST device with extended conditioning time

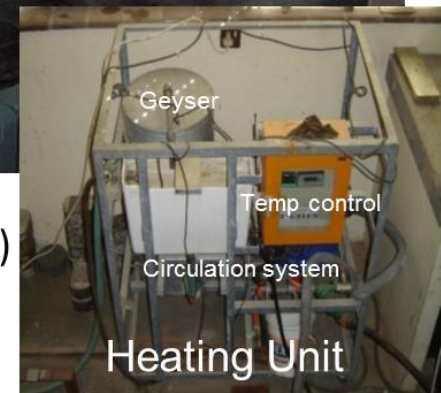
4.1 - WATER SUSCEPTIBILITY TESTS FOR MATERIALS



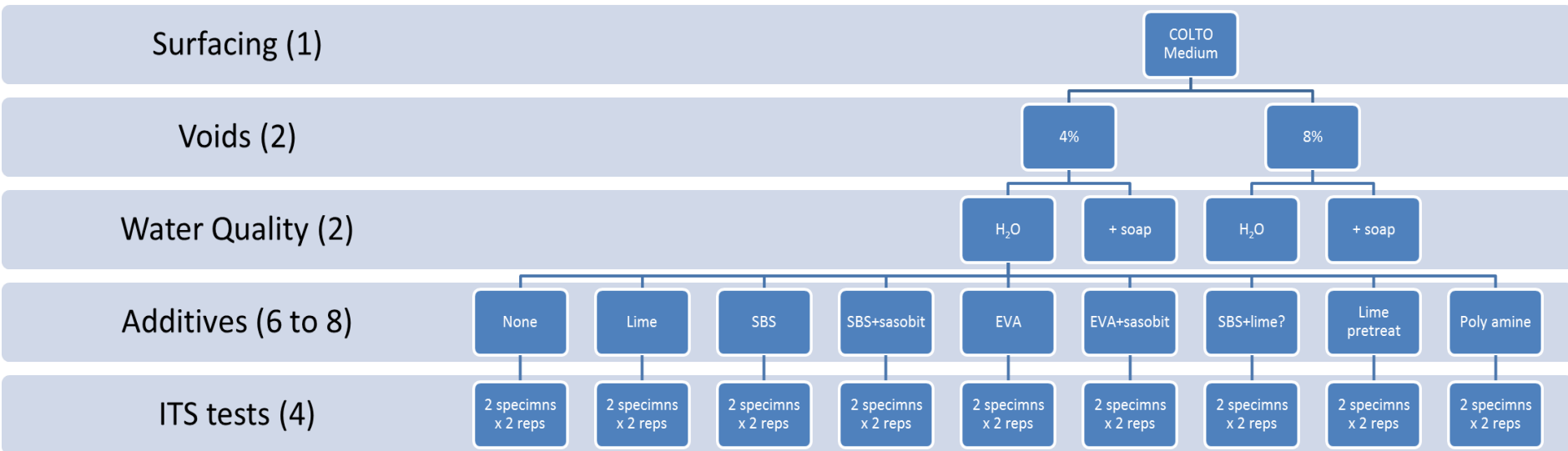
4.2 - MIST device (Twagira) Moisture Inductions Simulation Test



Pulsing pressure 140 kPa (up to 600kPa)
Load time 0.54s then 1.4s rest period



4.4 - EXPERIMENTAL DESIGN





SECTION 5 -SITE EXPERIMENTS

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- Rehabilitation Project on Mew Way Road
- GIBB & Brink & Heath /Mokwena Surfacing
- Four Test Sections
- Based on the Results of the Laboratory Testing
- Valuable in Service Data
- “Proof is in the Pudding”

SECTION 6 -CONCLUSION

SECTION 6 -CONCLUSION

- Confident that we will find a feasible solution.
- Not just for Grey Water damage but also moisture damage in general.
- The study is also a good opportunity towards improved understanding of moisture insensitive asphalt mixtures and pavements.
- Also a great opportunity to further understand the additive combinations planned for use.

QUESTIONS & DISCUSSIONS



THANK YOU