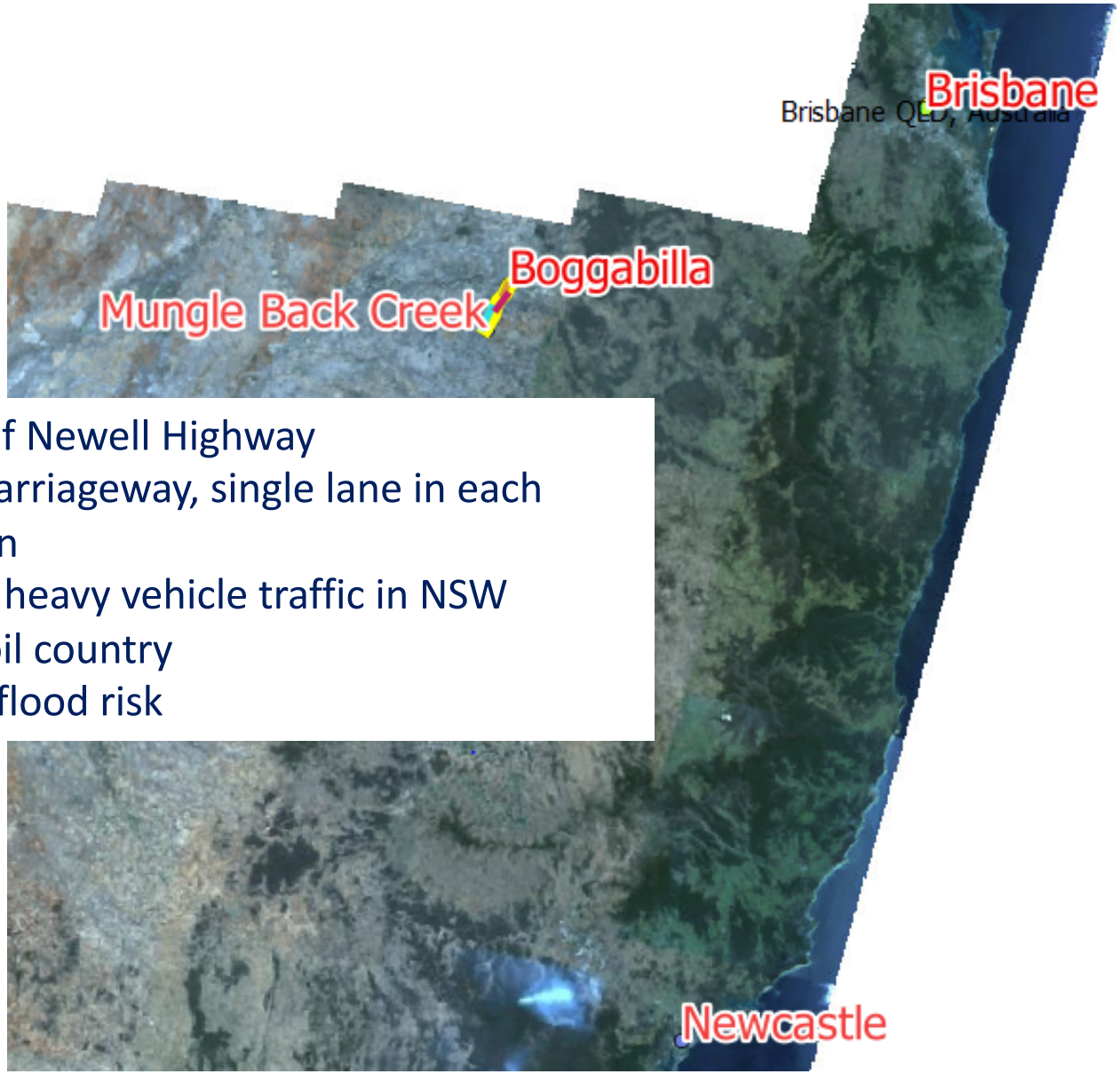
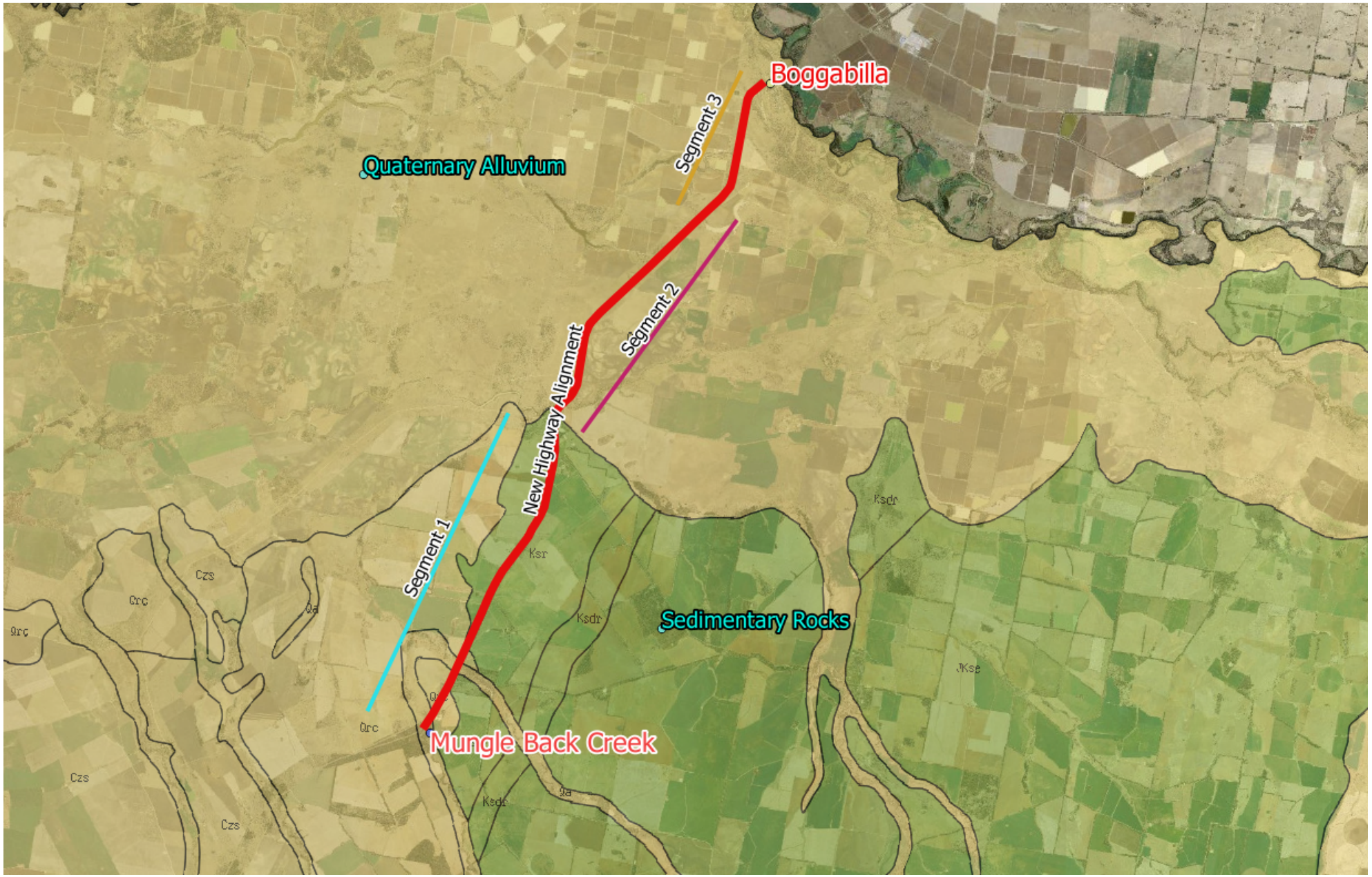
Newell Highway Upgrade Project



- 28 km of Newell Highway
- Single carriageway, single lane in each direction
- Highest heavy vehicle traffic in NSW
- Black soil country
- Annual flood risk

Regional Geology

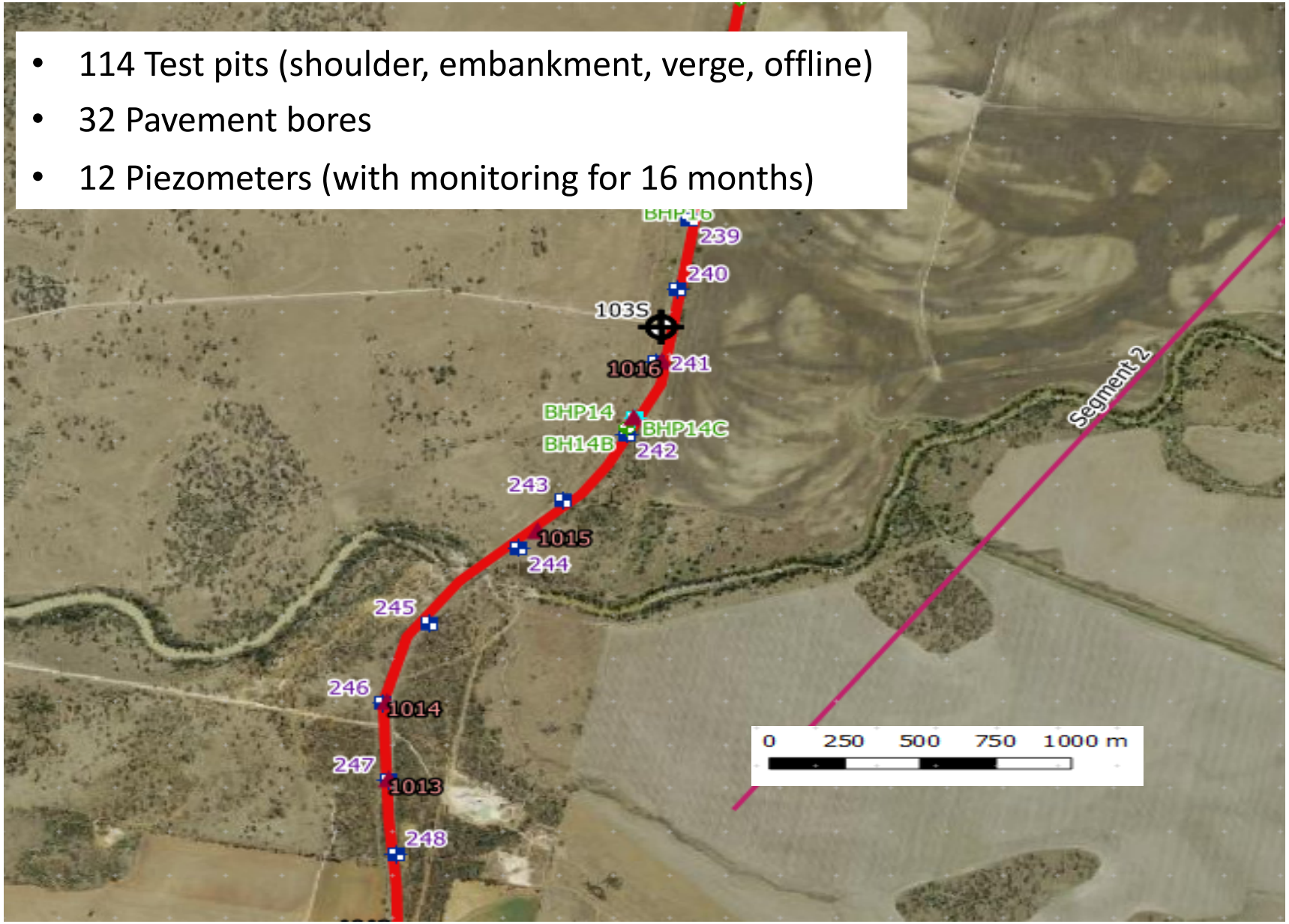


Scope of Investigation

- DP provided:
  - investigation services;
  - factual reporting for submission to RMS; and
  - laboratory testing.

Scope of Investigation

- 114 Test pits (shoulder, embankment, verge, offline)
- 32 Pavement bores
- 12 Piezometers (with monitoring for 16 months)



Scope of Investigation – Laboratory Testing

- Subgrade
  - CBR testing (4 day, 10 day and 21 day soak) – 105 tests;
  - Atterberg limits – 71 tests;
  - Particle size distribution including hydrometer – 24 tests;
  - Emerson – 21 tests
  - Acid sulfate testing – 50 tests
- Pavement Materials
  - CBR testing (4 day soak) – 16 tests
  - Atterberg limits – 16 tests
  - Particle size distribution including hydrometer – 16 tests;
- Verge, Cutting and Bridge Sized Structures
  - CBR testing (10 day soak) – 10 tests;
  - Atterberg limits – 10 tests
  - Particle size distribution including hydrometer – 10 tests;
  - Emerson - 4 tests
  - Acid sulfate testing – 45 tests
  - Soil Aggressivity testing – 8 tests

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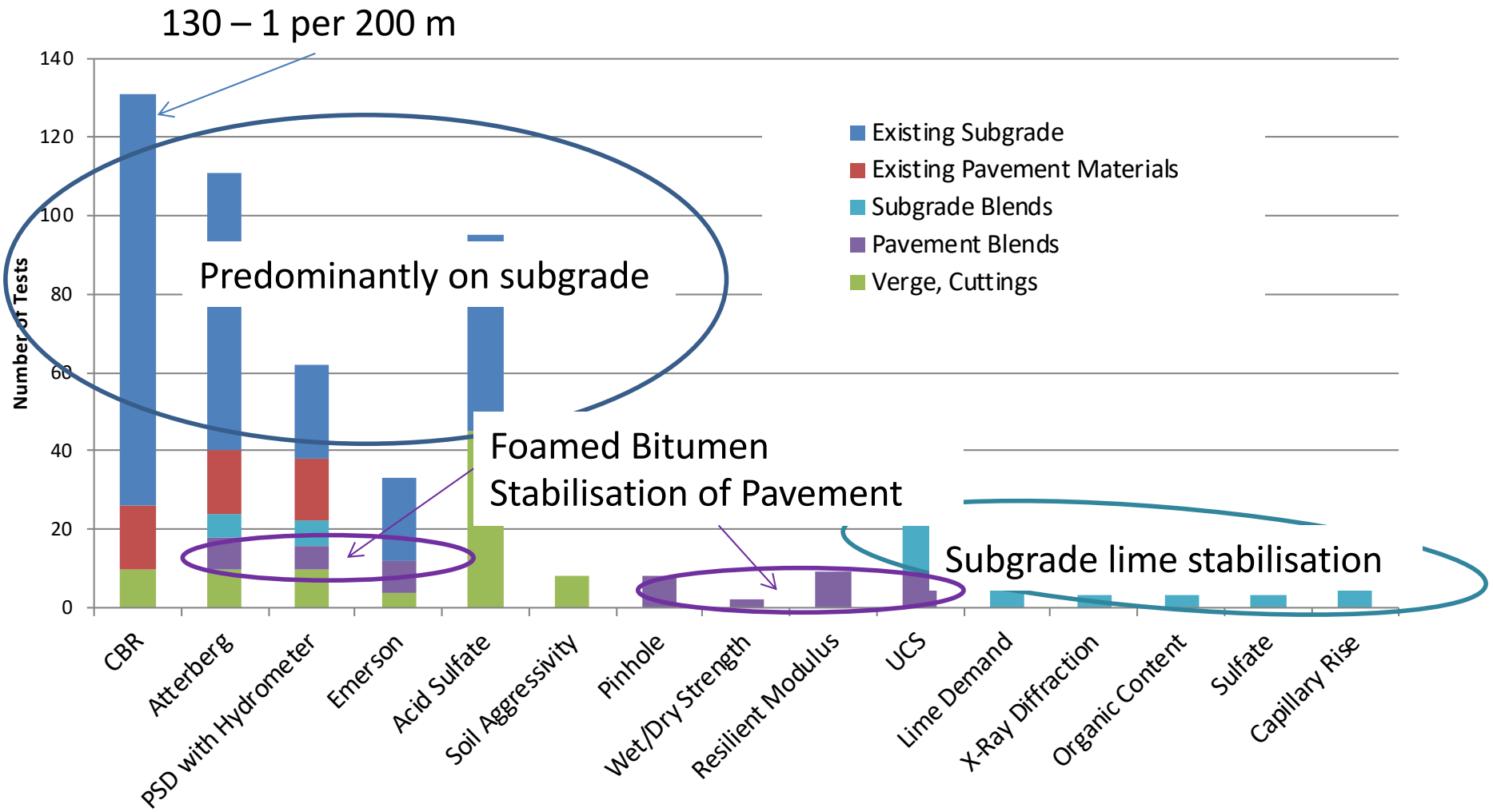
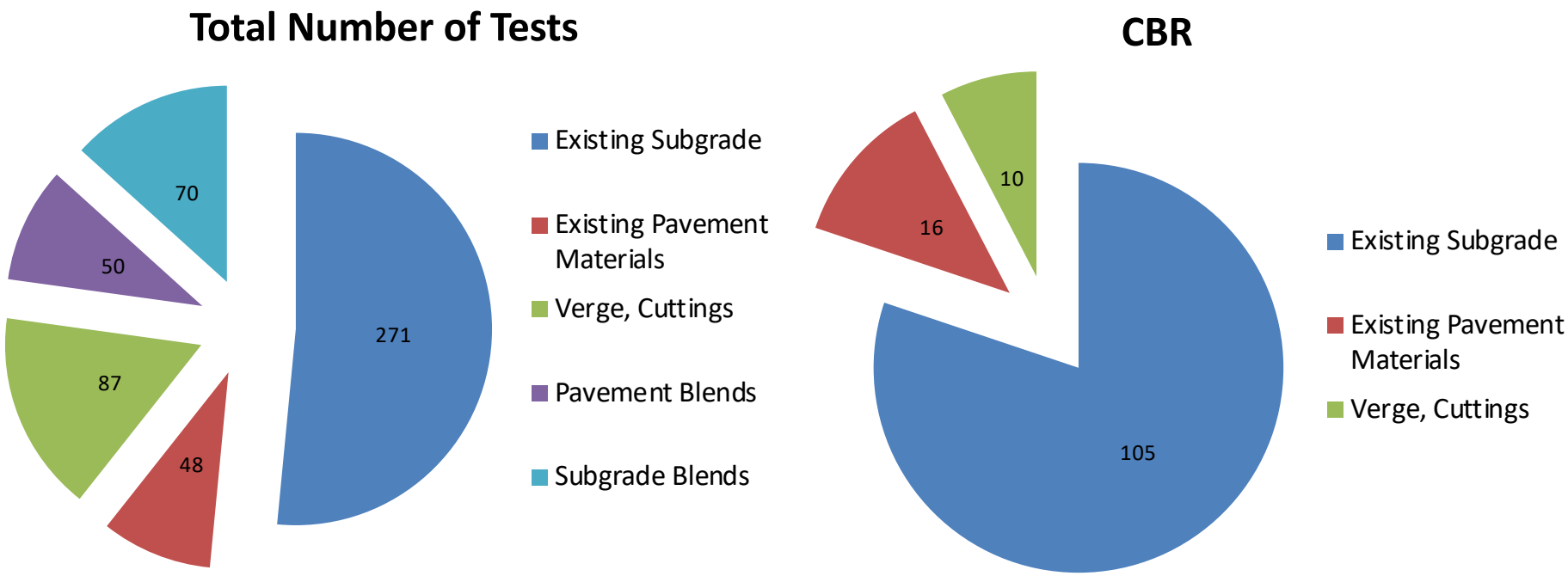
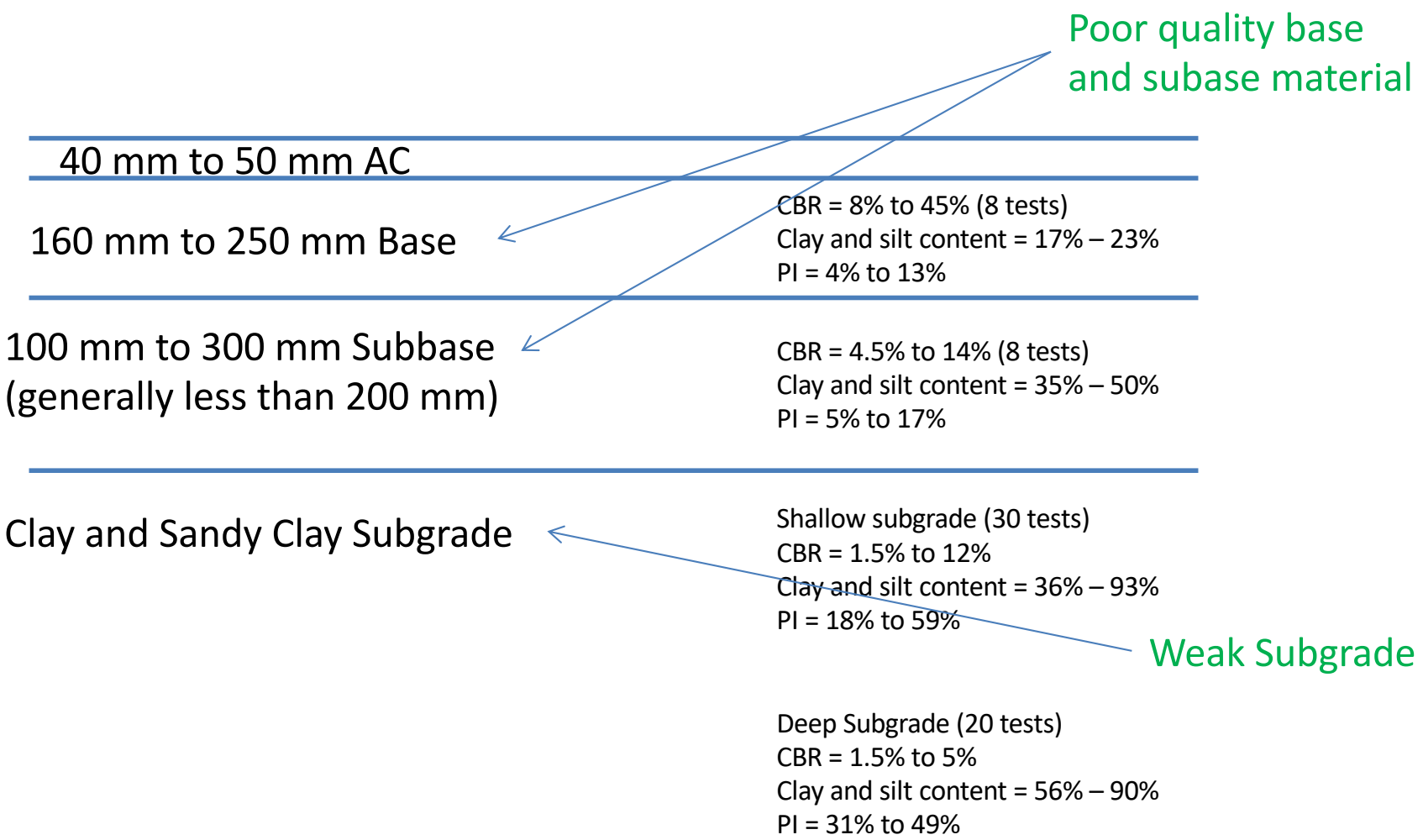



Total Number of Tests
271
48
87
50
70
Existing Subgrade
Existing Pavement Materials
Verge, Cuttings
Pavement Blends
Subgrade Blends
CBR
105
16
10
Existing Subgrade
Existing Pavement Materials
Verge, Cuttings

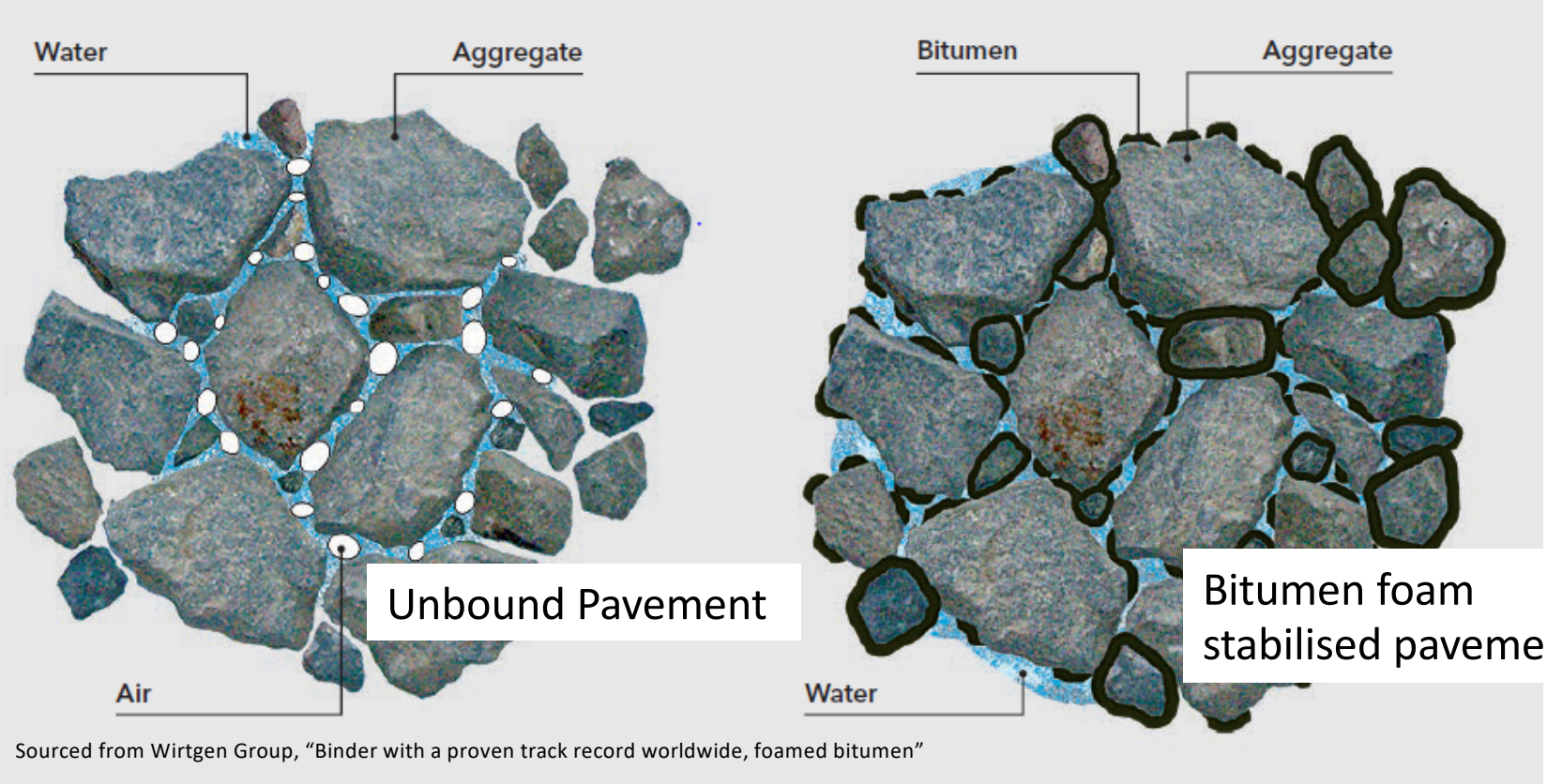
Existing Pavement



What is foamed bitumen?

- It is a mixture of air, water and bitumen
- The characteristics include:
  - Once a foaming agent is mixed, it expands about 15 times
  - Large surface area and low viscosity
  - When mixed with gravel material, the droplets coat the finer particles that binds them together

What benefits?



Sourced from Wirtgen Group, "Binder with a proven track record worldwide, foamed bitumen"

- Increases strength through stabilisation
- Modulus increases significantly, shear strength gains (similar to that of cement treated material) but with higher flexibility
- Higher flexibility reduces risk of fatigue (cemented material)
- Decreases the permeability of the pavement
- Less susceptible to heavy rainfall (i.e. copes with weather)

What Disadvantages?

- Not suitable for all pavements
- Purpose built equipment needed
- More expensive than other stabilisation methods

Costs over $50k

Where has it been done in Aus?

- Queensland Main Roads
  - 1.6 km of Cunningham Highway at Gladfield (near Warwick)
  - Gympie
  - Inglewood

Advantages for Pavement Design

- The fatigue relationship for asphalt can be used in calculations (CIRCLY), as follows

$$N = RF\left(\frac{6918(0.856VB+1.08)}{S_{mix}\ \mu\varepsilon}\right)^5$$

Where:

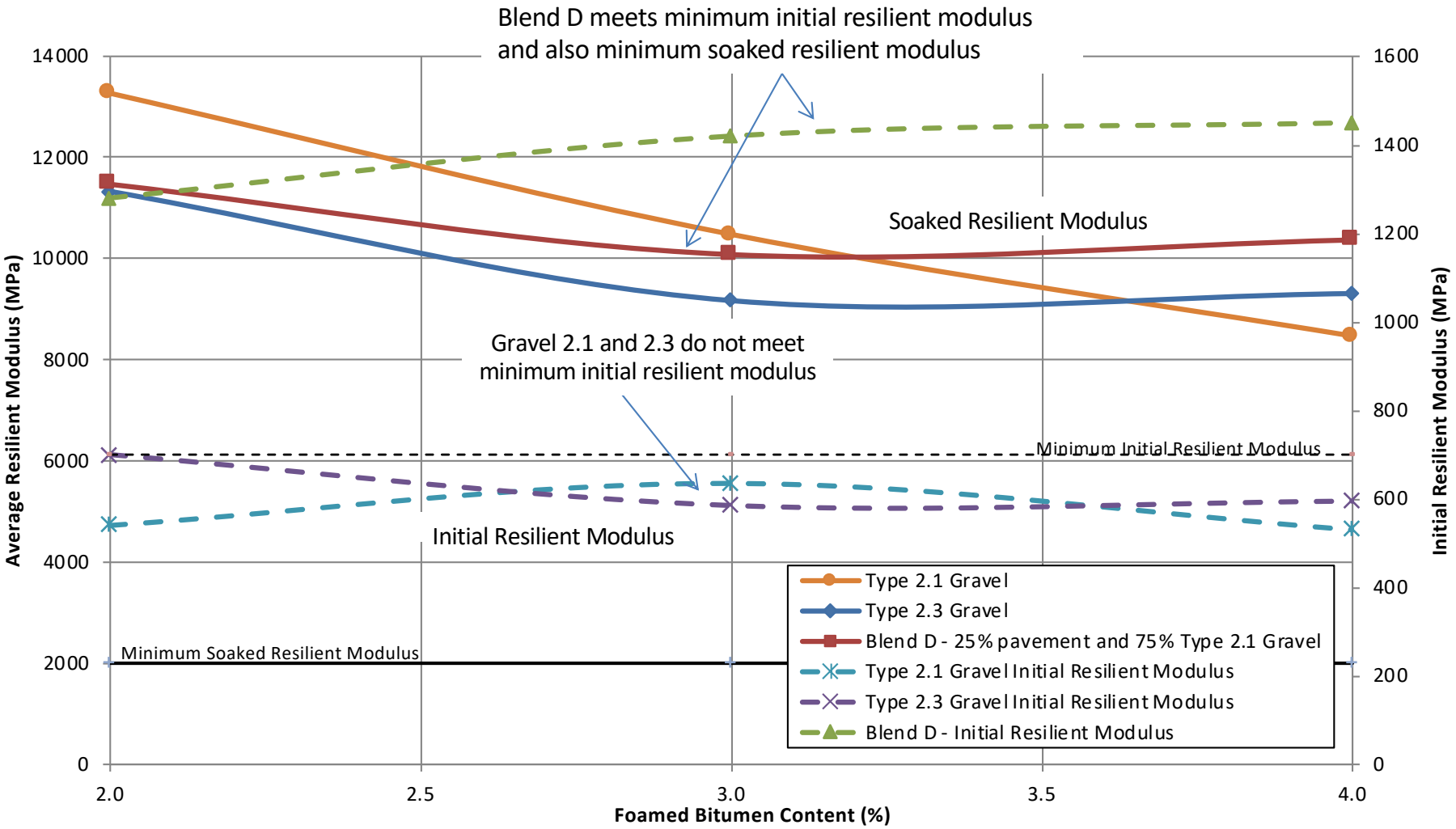
N = allowable repetitions
S_{mix} = Modulus of foamed bitumen stabilised material
V_B = % by volume of bitumen in the stabilised material
RF = reliability factor (=1 for rehabilitation)

- This means greater allowable repetitions for the same thickness of pavement layers
- RMS puts a cap on S_{mix} of 2500 Mpa (close to some asphalts)

Suitability Assessment

- Differs for RMS and QMR
  - RMS
    - Binder (RMS R76)
    - Foamed bitumen expansion ratio of 10 and minimum half life of 20 seconds
    - Particle distribution as for Material to be bound (RMS 3051)
    - Plasticity requirements (Austroads PI<10%) – lime can be added to reduce plasticity
    - Test material with foamed bitumen to obtain average resilient modulus
    - Plot the average resilient modulus against binder content to determine bitumen application rate require to satisfy table below

Suitability Assessment



Austroads Design Procedure for Foamed Bitumen

- Initial Modulus (needed because it is assumed that the road will be open within 3 hours of stabilisation)
- Adjustments for climate, rate of load

Table 7.2: Minimum mix design limits for dry modulus for foamed bitumen base

Average daily ESA in design year of opening	Minimum dry modulus (MPa)	Minimum soaked modulus (MPa)	Minimum retained modulus ratio
< 100	2500	1500	40%
100–1000	3000	1800	45%
> 1000	4000	2000	50%

es and Ramanujam (2008).

Table 7.3: Minimum mix design limits for dry modulus for foamed bitumen subbase

Average daily ESA in design year of opening	Minimum dry modulus (MPa)	Minimum soaked modulus (MPa)	Minimum retained modulus ratio
< 100	2500	1500	40%
100–1000	2500	1500	45%
> 1000	2500	1500	50%

es and Ramanujam (2008).

Austroads Design Procedure for Foamed Bitumen

- Then the following fatigue relationship is used in calculations (CIRCLY)

$$N = \left[\frac{6918(1.08 + 0.856V_b)}{S_{mix}^{0.36} \times \mu\varepsilon} \right]^5$$

- greater allowable repetitions for the same thickness of pavement layers
- RMS puts a cap on S_{mix} of 2500 Mpa (close to some asphalts)

Austroads Design Procedure for Foamed Bitumen

- Minimum Surface Requirements

  $< 1x10^7$ ESA Spray seal or hot mix AC

  $\geq 1x10^7$ ESA 30 to 40 mm AC (minimum)

Austroads Design Procedure for Foamed Bitumen

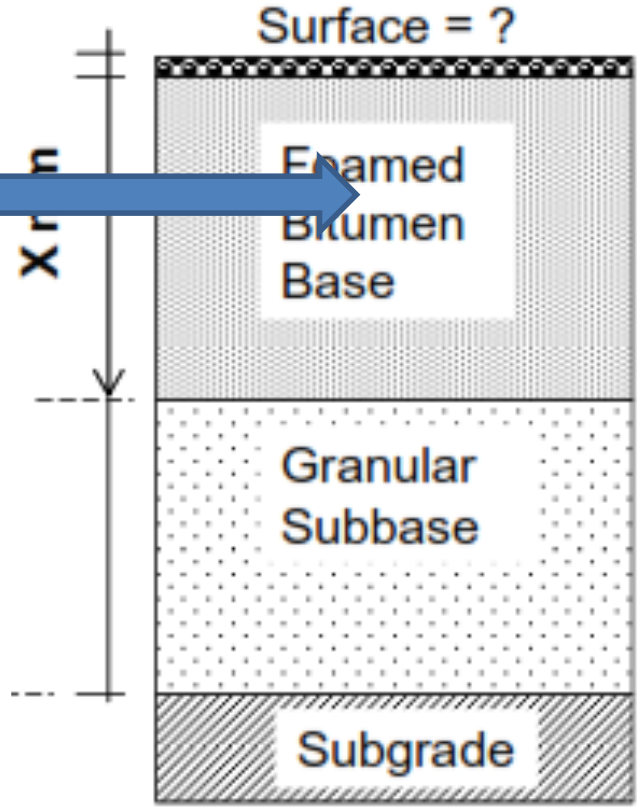
- Example 5 x 10^6 ESA

Reconstruction
(Austroads Mechanistic)
480 mm thickness
(Base and Subbase)

Check Uncracked and cracked phase for bound base

300 mm

100 mm



Existing Road
(poorly performing)

Proposed Stabilised Road

Newell Highway Proposed Stabilisation

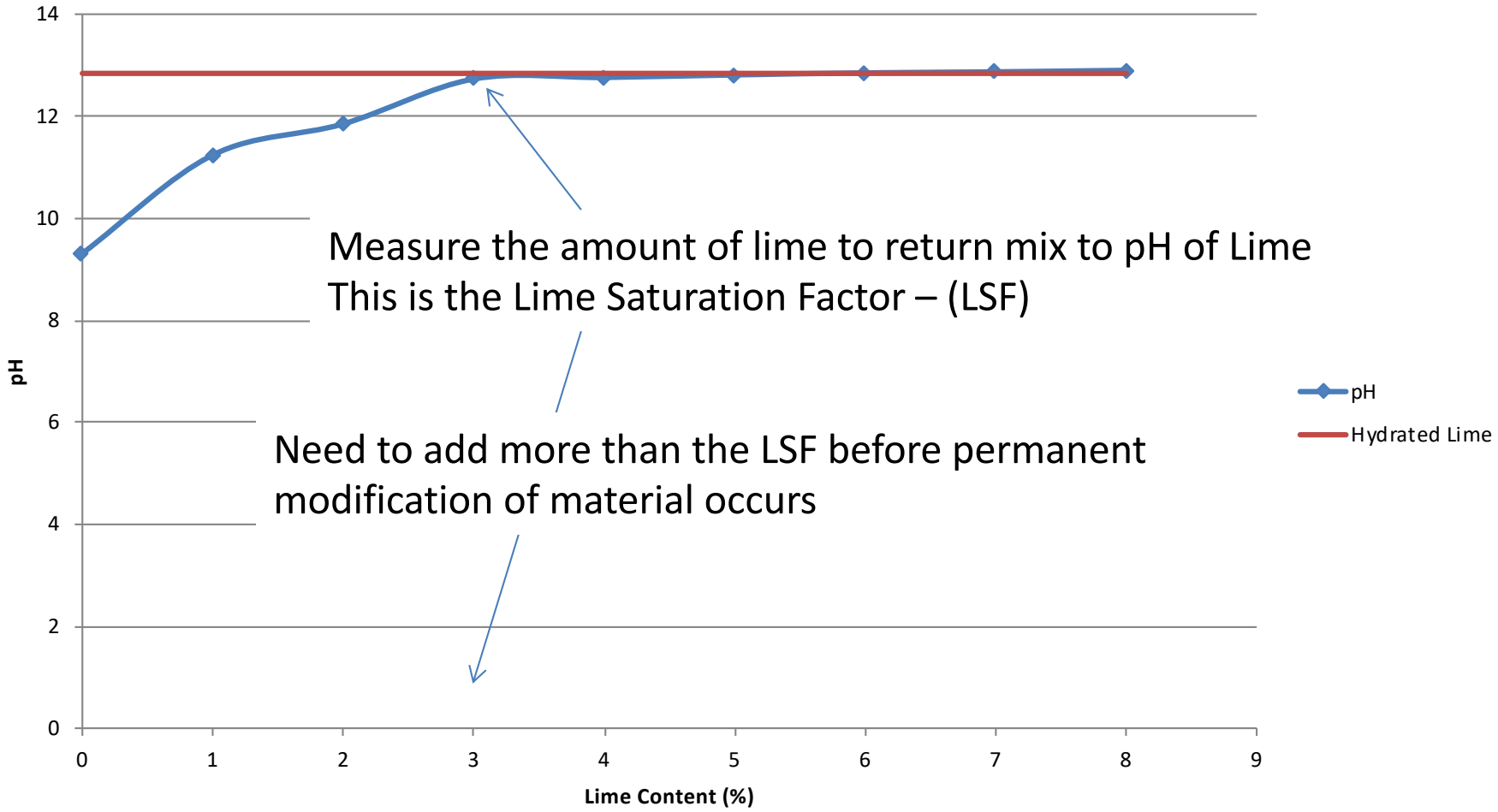
- Remove about 300 mm
- Lime stabilise remaining subbase and subgrade blend
- Re-use top 300 mm with foamed bitumen stabilisation


70098-C

Proposed Newell Highway Stabilisation Process

- Excavate to the proposed stabilisation depth
- Stockpile material
- Stabilise additional 300 mm of existing subbase and subgrade with 8% to 10% lime (LSF + 2%)
- Compact the stabilised material
- Place stockpiled material on exposed surface
- Apply quicklime to the surface
- Slake quicklime
- Mix the slake lime through the pavement
- Shape and lightly compact
- Apply foaming agent to hot asphalt in tank and stabilise through pavement

Lime Demand Test



Testing Regime

- Two Methods

UCS v CBR

- UCS testing of subgrade blends with lime
- Trialled different mixes at LSF LSF+2, LSF+4
- Lime, quicklime, hydrated lime

- Aim to get UCS of 2.5 MPa @ 28 days

- CBR testing on subgrade blends
- Mixes at LSF, LSF+2, LSF+4

- Aim to get increase in soaked CBR to allow improvement in thickness design and better support for foamed bitumen basecourse

CBR Method

Subgrade	3.5%
Deep Subgrade	2.5%
Pavement Subgrade	3.5%
Offline Subgrade	4.0%

Overall Subgrade after 110 tests???

3%