(R4884)

VICROADS FOAM BITUMEN INVESTIGATION WORKSHOP

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PRELIMINARY DESKTOP STUDY – THINGS WHICH SHOULD BE INCLUDED

PRELIMINARY DESKTOP STUDY – THINGS WHICH SHOULD BE INCLUDED

PAVEMENT NEEDS ?

ARE THERE ANY CONSTRAINTS?
i.e. Fixed Level, Underground Services, Construction under Traffic Etc.

ESTIMATED ALLOWANCE $$?

CURRENT MAINTENANCE REQUIREMENTS?

IMPORTANCE OF THE ROAD (HIERARCHY)?

LIKELY FOUNDATION SOIL (geology maps)?

TRAFFIC LOADING (traffic study information)?

PREVIOUS TREATMENTS THAT HAVE SUCSESSFULLY WORKED IN THE AREA?

PRELIMINARY DESKTOP STUDY – THINGS WHICH SHOULD BE INCLUDED

IMPORTANCE OF THE ROAD (HIERARCHY)?

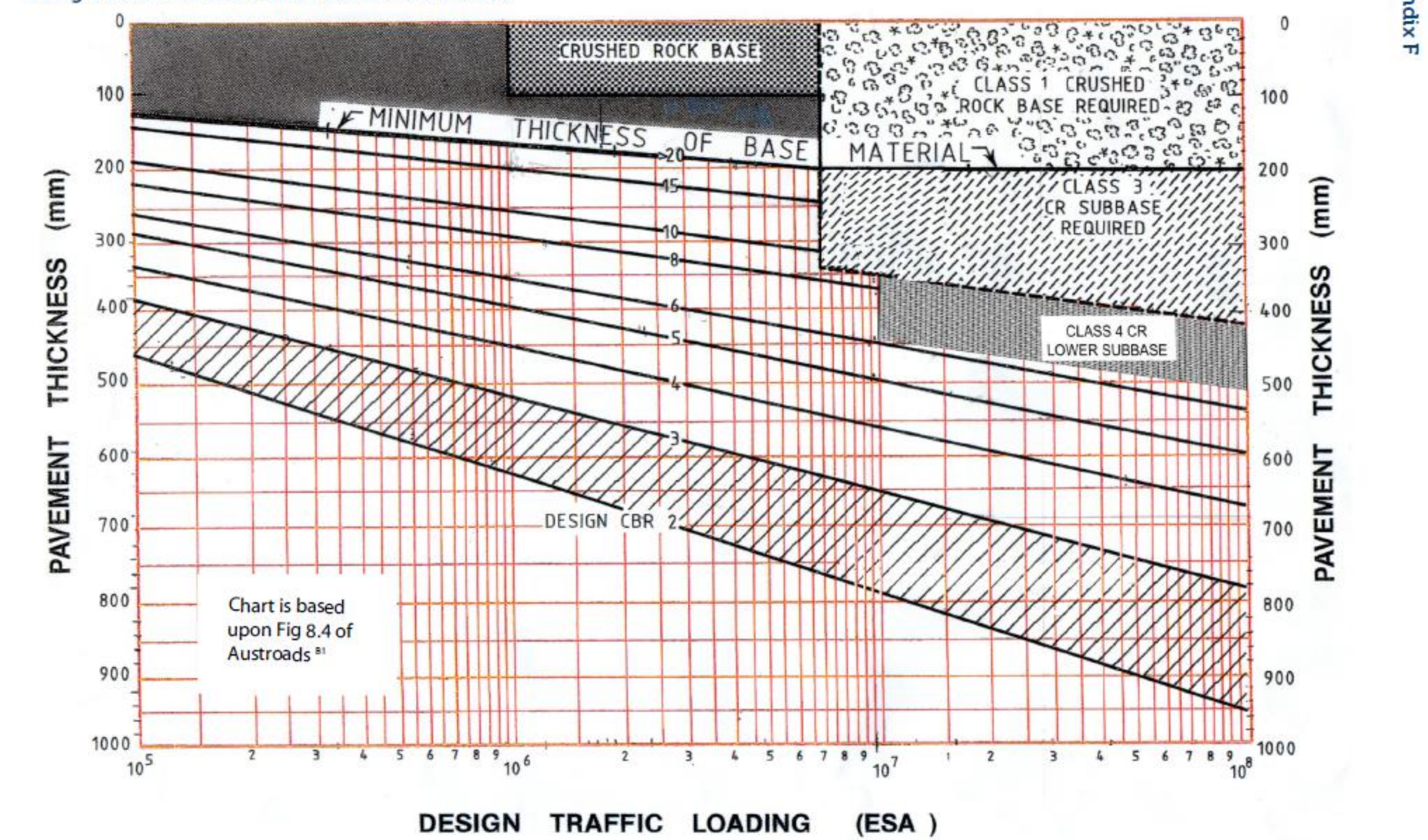
TRAFFIC LOADING (traffic study information)

LIKELY FOUNDATION SOIL (geology maps)?

RANGE OF ESA FOR A TYPICAL STREET (BASED ON A 20 YEAR DESIGN LIFE)

Street Type	Range of Computed ESA
Minor	$2 \times 10^3 - 6 \times 10^4$
Local Access	$3 \times 10^3 - 3 \times 10^5$
Collector	$6 \times 10^4 - 2 \times 10^6$
Distributor	above 3×10^5

Design Chart For Unbound Flexible Pavements



PRELIMINARY DESKTOP STUDY – THINGS WHICH SHOULD BE INCLUDED

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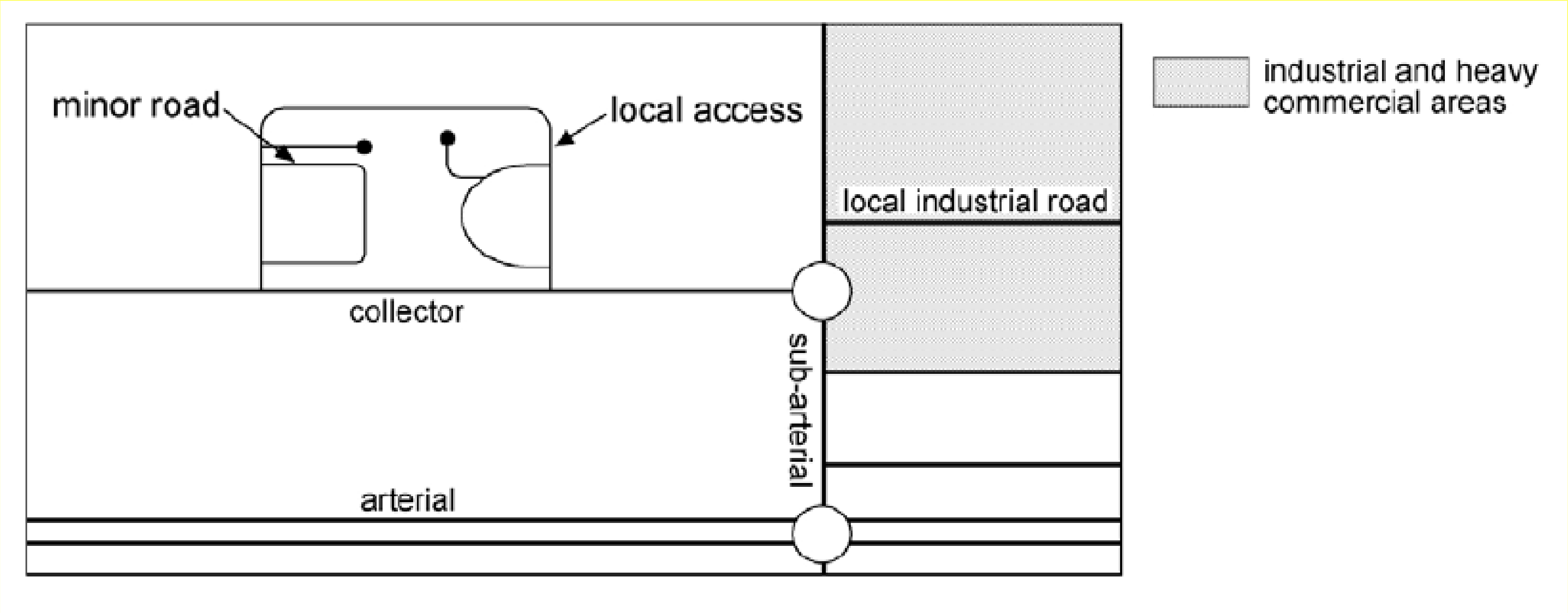

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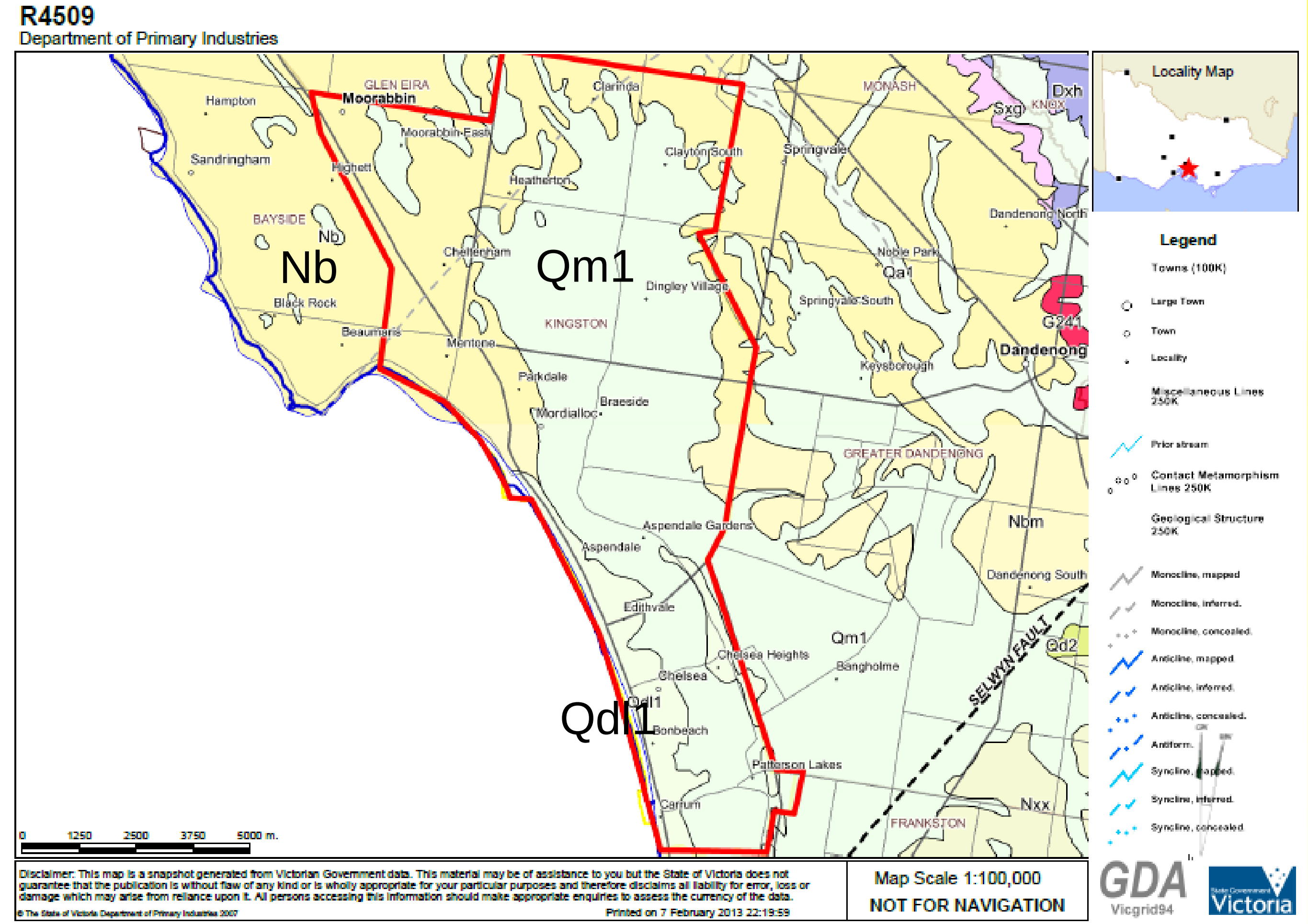


PLAN SOURCE: Department of Primary Industries

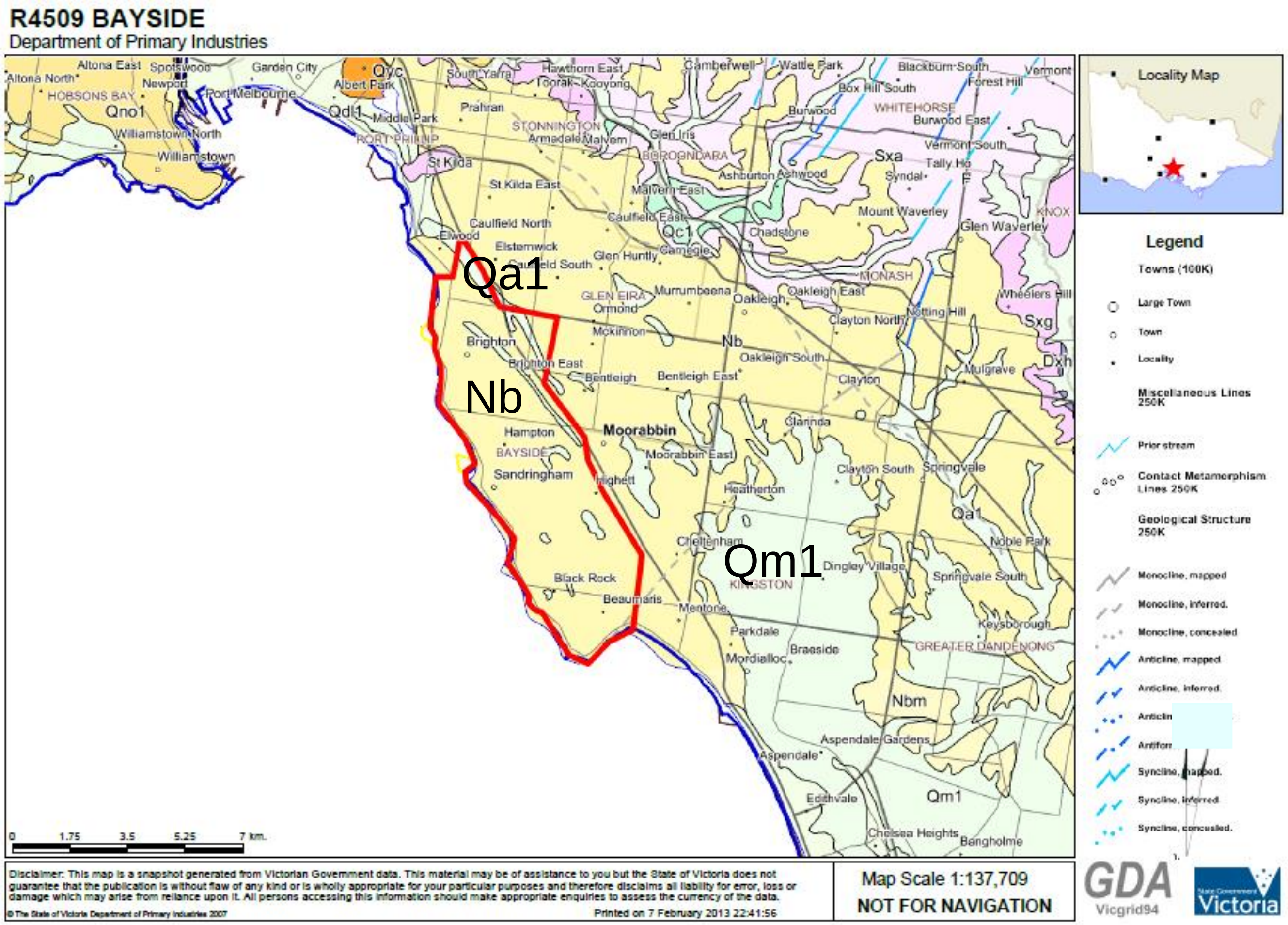
Nb - Brighton Group (Fluvial: gravel, sand, silt)

Qdl1 - Unnamed coastal dune deposits

Qm1 - Unnamed swamp and lake deposits

PRELIMINARY DESKTOP STUDY – THINGS WHICH SHOULD BE INCLUDED

LIKELY FOUNDATION SOIL (geology maps)?



PLAN SOURCE: Department of Primary Industries

Nb - Brighton Group (Fluvial: gravel, sand, silt)

Qa1- Unnamed alluvium

Qm1 - Unnamed swamp and lake deposits

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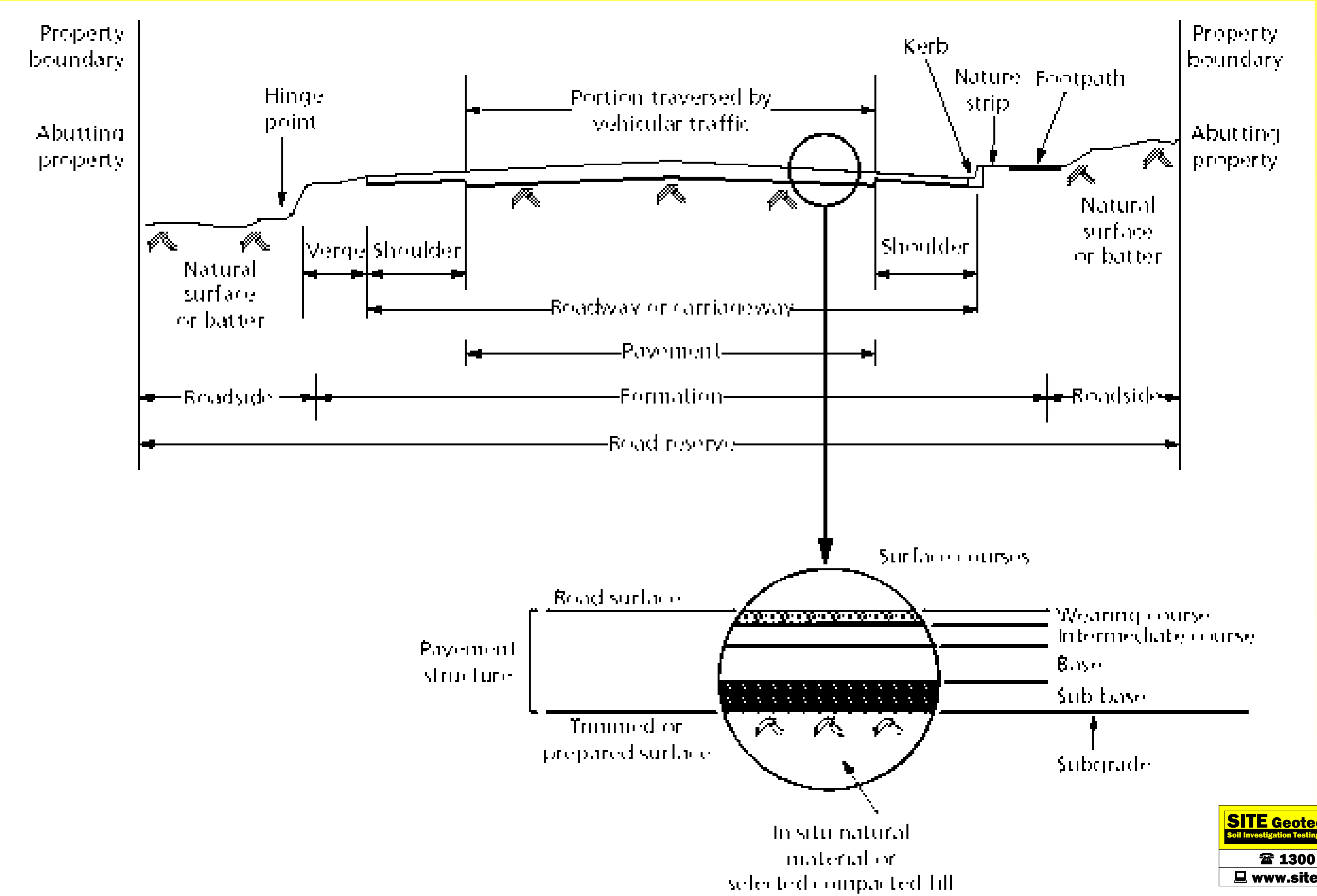
SITE INVESTIGATION

VISUAL SITE ASSESSMENT
FIELD TESTING
LABORATORY TESTING
SUBGRADE EVALUATION
CONSIDERATION FOR WATER SENSITIVE URBAN DESIGN

SITE INVESTIGATION

VISUAL SITE ASSESSMENT



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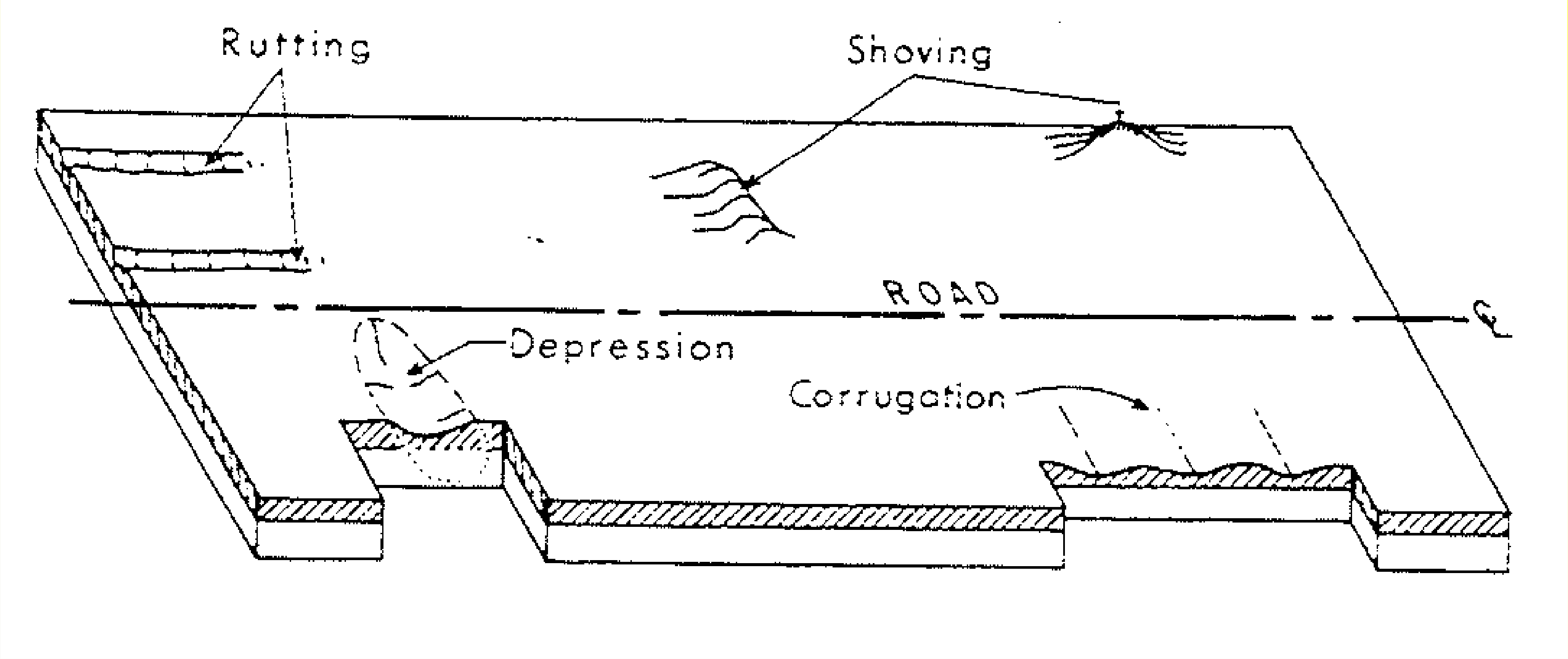
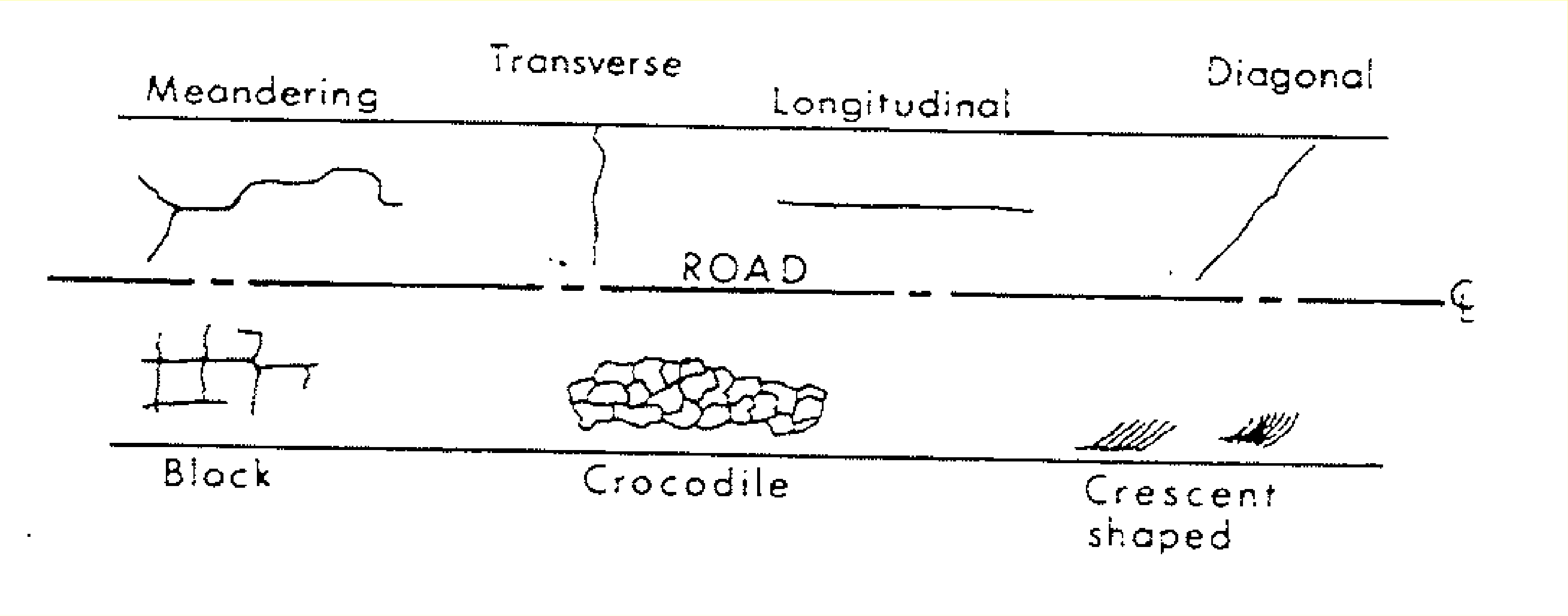
SITE INVESTIGATION

VISUAL SITE ASSESSMENT



SITE INVESTIGATION

VISUAL SITE ASSESSMENT



SITE INVESTIGATION

VISUAL SITE ASSESSMENT

Crocodile Cracking

Crocodile cracking is likely associated with a fatigued pavement, inadequate pavement thickness or material and / or a brittle or aged bitumen

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SITE INVESTIGATION

VISUAL SITE ASSESSMENT

Minor/ major patching treatments

Various patches are likely associated with routine maintenance of developing defects over the years and associated upgrading.

SITE INVESTIGATION
VISUAL SITE ASSESSMENT

Block Cracking

Block Cracks are commonly associated with cemented materials, likely caused by shrinkage or fatigue cracking of a underlying bound layer with reflective cracking eventually coming up through to the surfacing.

SITE INVESTIGATION

VISUAL SITE ASSESSMENT

Meandering cracking

Meandering cracking observed is likely associated differential moisture conditions or settlement within filled areas.

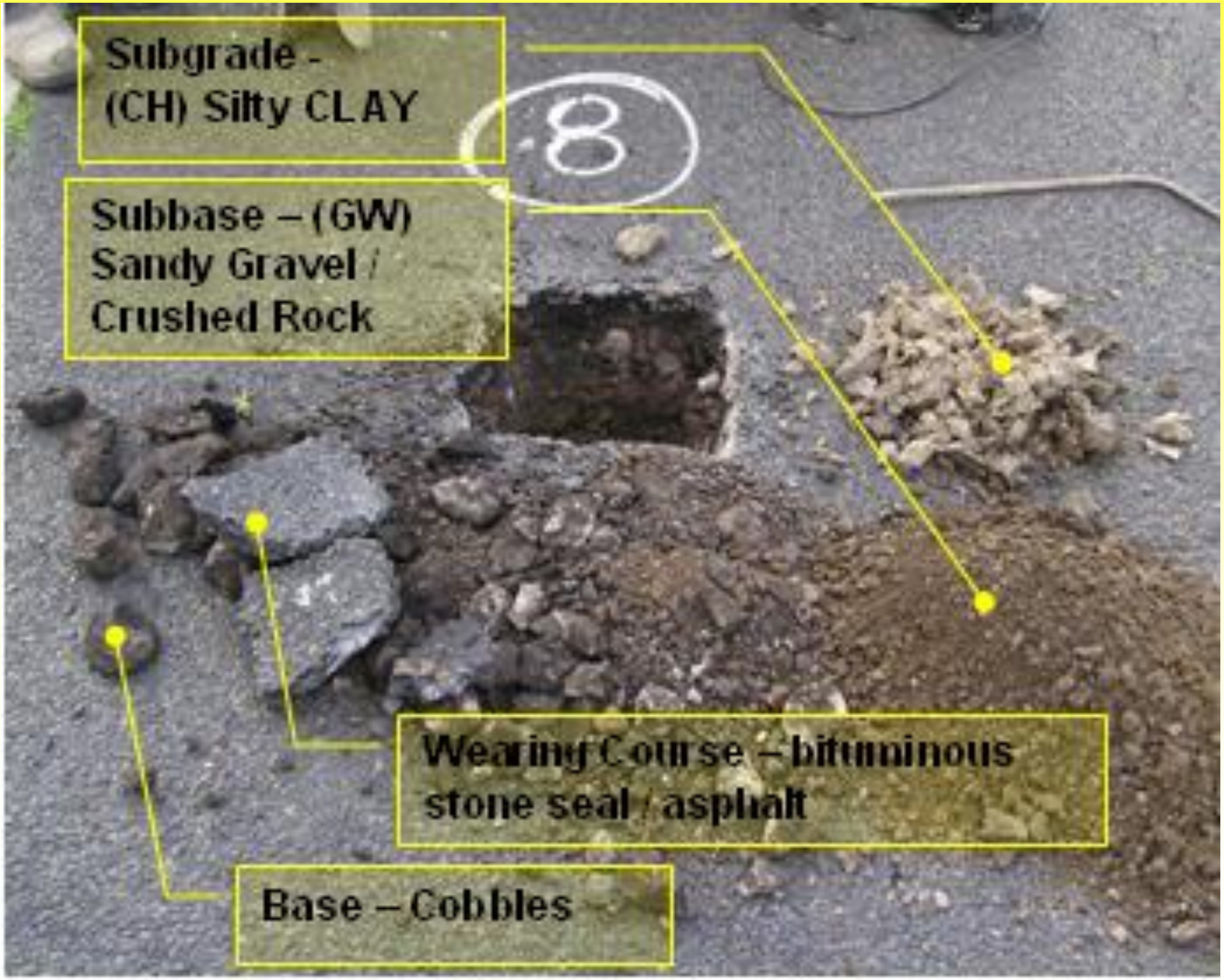
SITE INVESTIGATION

VISUAL SITE ASSESSMENT

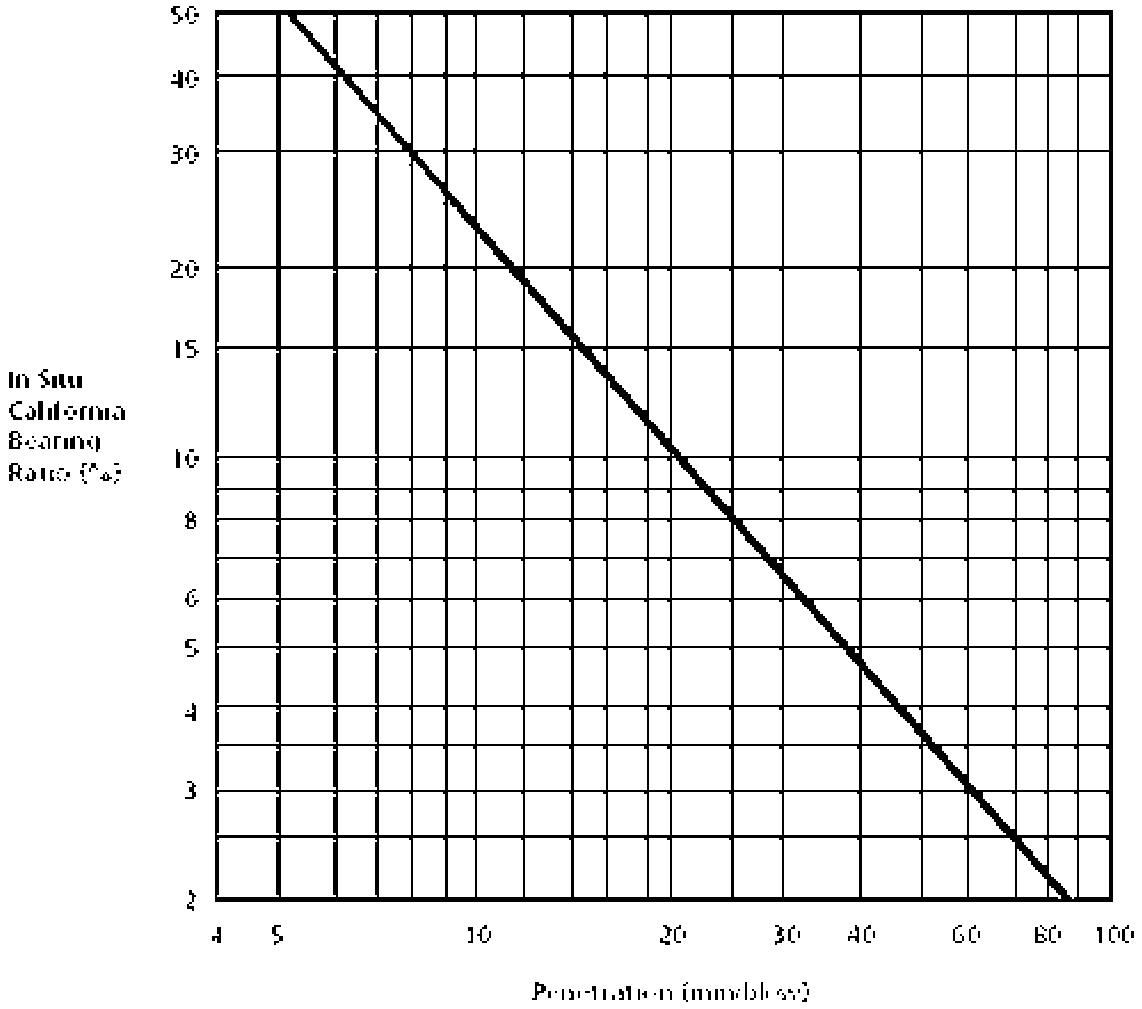
Longitudinal and Transverse cracking

Longitudinal and Transverse cracking is likely associated with volume change of the underlying expansive subgrade, cyclical weakening and differential settlement or moisture conditions

SITE INVESTIGATION
FIELD TESTING



SITE INVESTIGATION
FIELD TESTING



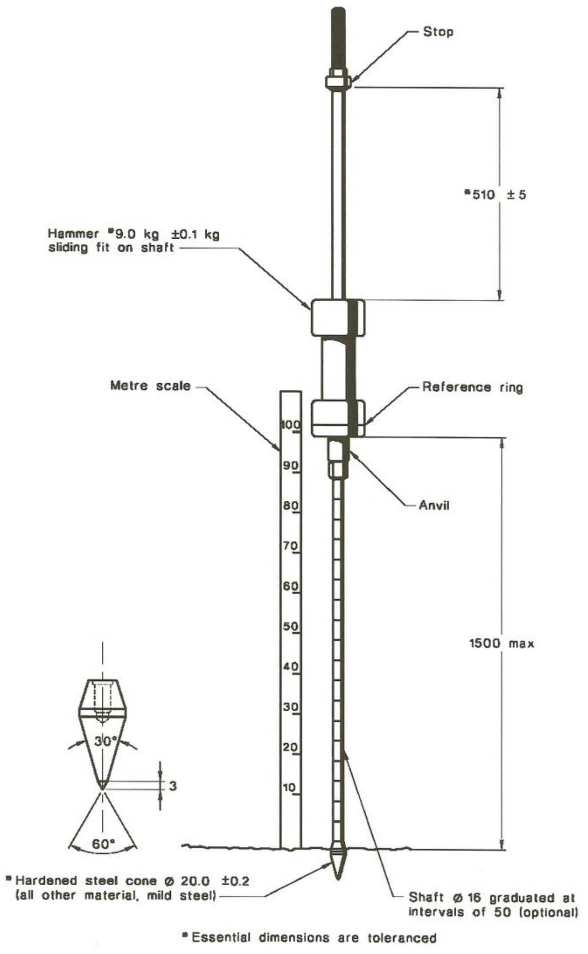


FIGURE 1 DYNAMIC CONE PENETROMETER

SITE INVESTIGATION

FIELD TESTING

Principle Soil Type	Descriptive Term	Size	Familiar Example
Coarse - Grained Soils	**Boulders**	>200mm	Football or Watermelon
	Cobbles	200 to 63mm	melon or Grapefruit
	Coarse Gravel	63 to 20mm	Mandarin or Peanut
	Medium Gravel	20 to 6mm	Grape or Sultana
	Fine Gravel	6 to 2.36mm	Pea
	Coarse Sand	2.36 to 0.6mm	Rock Salt
	Medium Sand	0.6 to 0.2mm	Openings of a window screen
	Fine Sand	0.2 to 0.075mm	Table Salt or Sugar

SITE INVESTIGATION

FIELD TESTING

(field identification)

Group Symbol	Typical Names	Field Identification
GW	Well graded gravels, gravel - sand mixtures, little or no fines	Wide range in grain size and substantial amounts of all intermediate sizes, not enough fines to bind coarse grains, no dry strength
GP	Poorly Graded gravels and gravel - sand mixtures, little or no fines, uniform gravels	Predominantly one size or range of sizes with some intermediate sizes missing, not enough fines to bind coarse grains
GM	Silty Gravels Gravel - sand-silt mixtures	Dirty' material with excess of non-plastic fines, zero to medium dry strength
GC	Clayey gravels, gravel-sand-clay mixtures	Dirty' material with excess of plastic fines, medium to high dry strength
SW	Well graded sands and gravely sands; little or no fines	Wide range in grain size and substantial amounts of all intermediate sizes, not enough fines to bind coarse grains, no dry strength
SP	Poorly graded sands and gravely sands; little or no fines, uniform sands	Predominantly one size or range of sizes with some intermediate sizes missing, not enough fines to bind coarse grains
SM	Silty sands, sand-silt mixtures	Dirty' material with excess of non-plastic fines, zero to medium dry strength
SC	Clayey sands, sand-clay mixtures	Dirty' material with excess of plastic fines, medium to high dry strength

SITE INVESTIGATION

FIELD TESTING

(field identification)

Group Symbol	Typical Names	Field Identification
ML	Inorganic silt and very fine sands, rock flour, silty or clayey fine sands with slight plasticity	dry strength = none to low, toughness = none
CL, CI	Inorganic clays of low to medium plasticity, gravely clays, sandy clays, silty clays, lean clays	dry strength = medium to high, toughness = medium
OL	Organic silts and organic silty clays of low plasticity	dry strength = low to medium, toughness = low
MH	Inorganic silts, micaccous or diatomaccous fine sandy or silty soils, classic silts	dry strength = low to medium, toughness = low to medium
CH	Inorganic clays of high plasticity, fat clays	dry strength = high to very high, toughness = high
OH	Organic clay of medium to high plasticity, organic silts	dry strength = medium to high, toughness = low to medium

SITE INVESTIGATION

LABORATORY TESTING

SUBGRADE EVALUATION

SITE INVESTIGATION LABORATORY TESTING

CBR (California Bearing Ratio) –

Measurement of Subgrade Strength, usually a re-compacted sample is soaked for four days and its strength then measured under load.

Classification Testing (Plasticity Index, Liquid Limit, Plastic Limit, Linear Shrinkage & Sieve analysis) –

Usually obtained to classify or categorize the soil and its properties. Can be used to assist in the assessment of material quality against specifications.

UCS (Unconfined Compressive Strength)
Measurement of subgrade strength, usually a recompacted sample is compressed after 3, 7 or 28 days to confirm strength (similar test to that the check the strength of concrete), well suited for cementitious modified materials with strengths around 1MPa.

Density Testing (Rapid Hilf Compaction Test)

Used for comparing in-place density and moisture against quality standards

SITE INVESTIGATION
SUBGRADE EVALUATION

Description of subgrade		Typical CBR values (%)	
Material	USC classification	Well drained	Fair to poor drainage
Highly plastic clay	CH	5	2–3
Silt	ML	4	2
Silty clay	CL	5–6	3–4
Sandy clay	SC	5–6	3–4
Sand	SW,SP	10–15	5–10

Source: Austroads (2004).

SITE INVESTIGATION SUBGRADE EVALUATION

Level 1 Inspection & Testing (Inspection & Supervision of Earthworks) – Key Aims;

Meet Project Specification Requirements
Full Time Supervision of Earthworks including Site Visit Records
Material Approval
Base and/or Working Platform Approval
Proof Rolling
Moisture Conditioning
Compaction Control / Testing
Material Strength Testing (UCS, CBR Testing, Deflection Testing)
Soil Testing for Slab & Footing Construction

Based on the inspection and testing provide validation that the site could be reclassified from class P "Problem" to a standard type 'Class S, M, H1, H2 or E' site in relation to slab and footing construction.

SITE INVESTIGATION

PERCIEVED BENEFITS AT THE HARVEY NORMAN PROJECT

Subgrade Preparation of Working Platform
Harvey Norman Homemaker Centre: 917 Princes Highway
(Corner Princes Highway and Westall Road)
Springvale

26 August 2009
Report R1462-8
(Map Ref: 79H2)

For
Calardu Springvale Pty Ltd
C/- Norwood Hall Pty Ltd
2/358 Lower Plenty Road
Rosanna VIC 3084

· Provide a stable 'working platform' on which to operate construction equipment.
· Facilitate the provision of a uniform bearing surface under the pavement.
· Reduce deflection at joints, thus ensuring effective long-term load-transfer across joints by interlock (especially if no other load-transfer devices are provided).
· Assist in the control of excessive shrinking and swelling of expansive subgrade soils.
· Prevent 'pumping' at joints and pavement edges.

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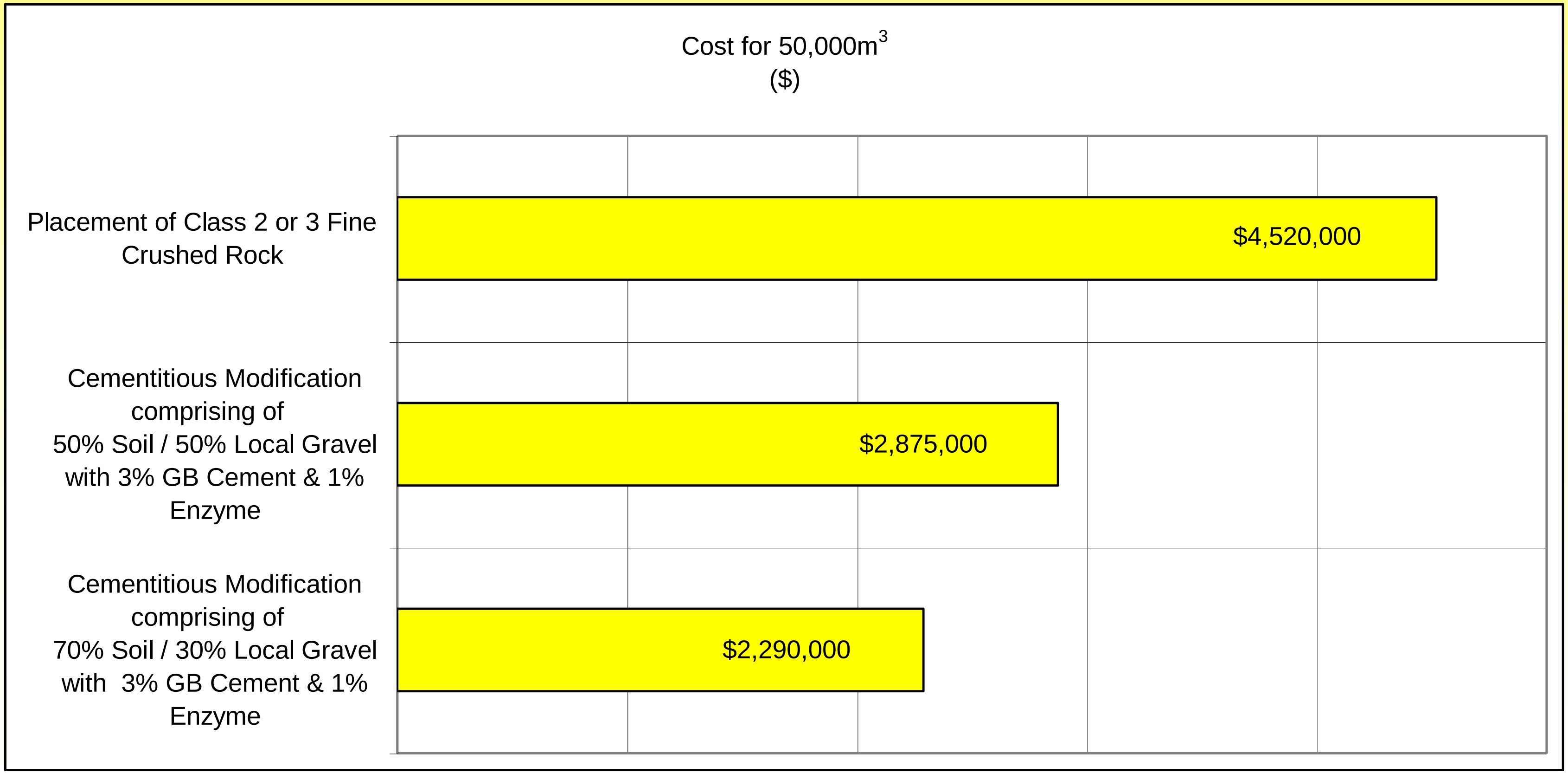
SITE INVESTIGATION

PERCIEVED BENEFITS AT THE HARVEY NORMAN PROJECT

· Observations of a good working platform even after heavy rain which has allowed construction to proceed

ESTIMATED COST BENEFITS

Typical Example of a 50,000m^2 Commercial Site Requiring 1.0m depth of Crushed Rock Fill	Cost ($/m^2)	Cost for 50,000m^3 ($)	Cost Comparision with Fine Crushed Rock
Placement of Class 2 or 3 Fine Crushed Rock	$90.40	$4,520,000	100%
Cementitious Modification comprising of 50% Soil / 50% Local Gravel with 3% GB Cement & 1% Enzyme	$57.50	$2,875,000	64%
Cementitious Modification comprising of 70% Soil / 30% Local Gravel with 3% GB Cement & 1% Enzyme	$45.80	$2,290,000	51%



ESTIMATED COST OF VARIOUS TREATMENTS

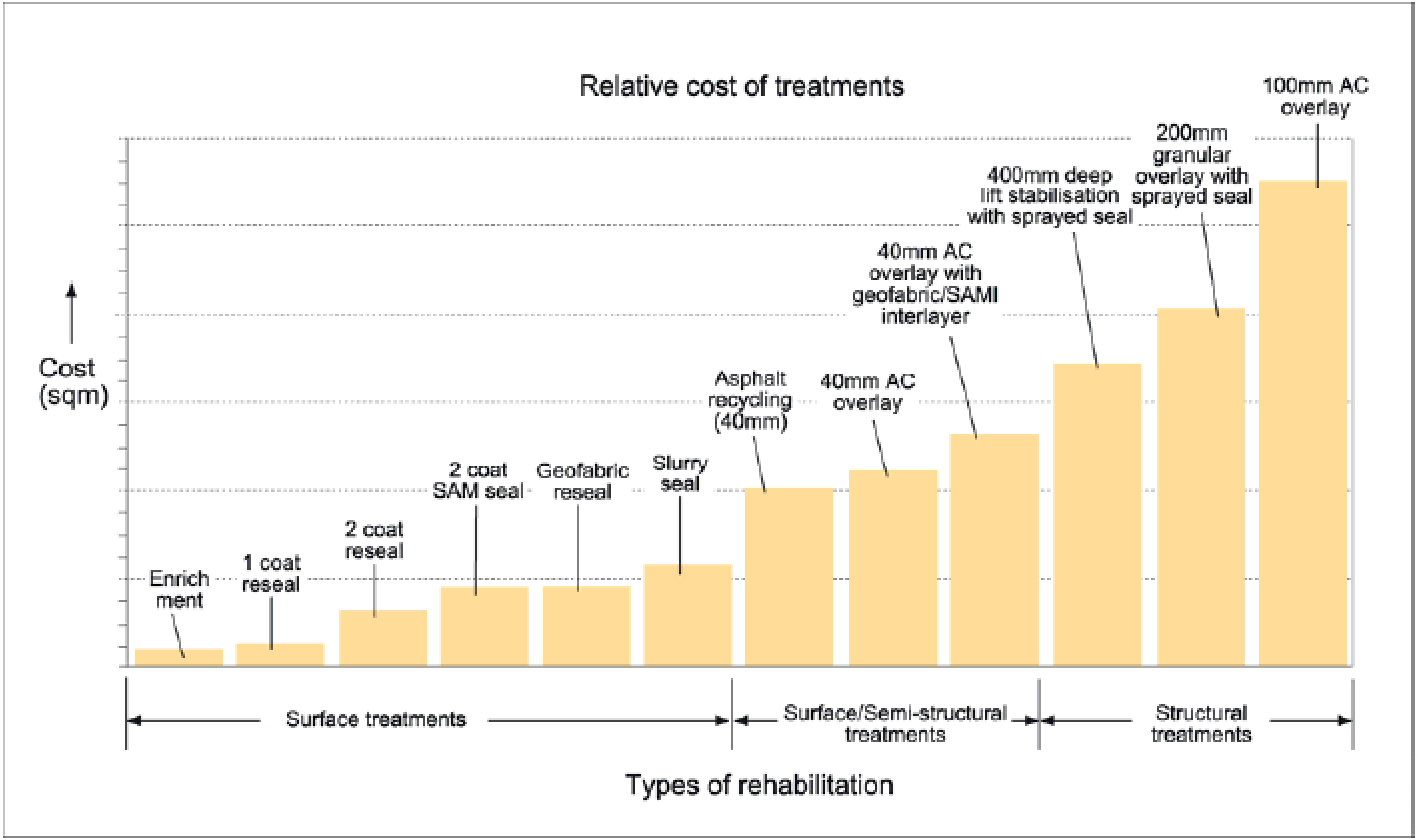


Figure F.1 : Relative Costs of Rehabilitation Treatments
(Adapted from Ramanujam, 1998)

ESTIMATED COST OF VARIOUS STABILISATION TREATMENTS

Treatment	Cost $\$/m^2$
2% GB cement (300 mm)	15
Bitumen (2%), emulsion/cement (2%) (250 mm)	18
Foamed bitumen (250 mm)	22
Note : Costs are indicative only	

(SOURCE: DESIGN, CONSTRUCTION AND PERFORMANCE OF INSITU FOAMED BITUMEN STABILISED PAVEMENTS, QUEENSLAND ROADS EDITION NO 7 MARCH 2009)

SITE INVESTIGATION

LABORATORY TESTING

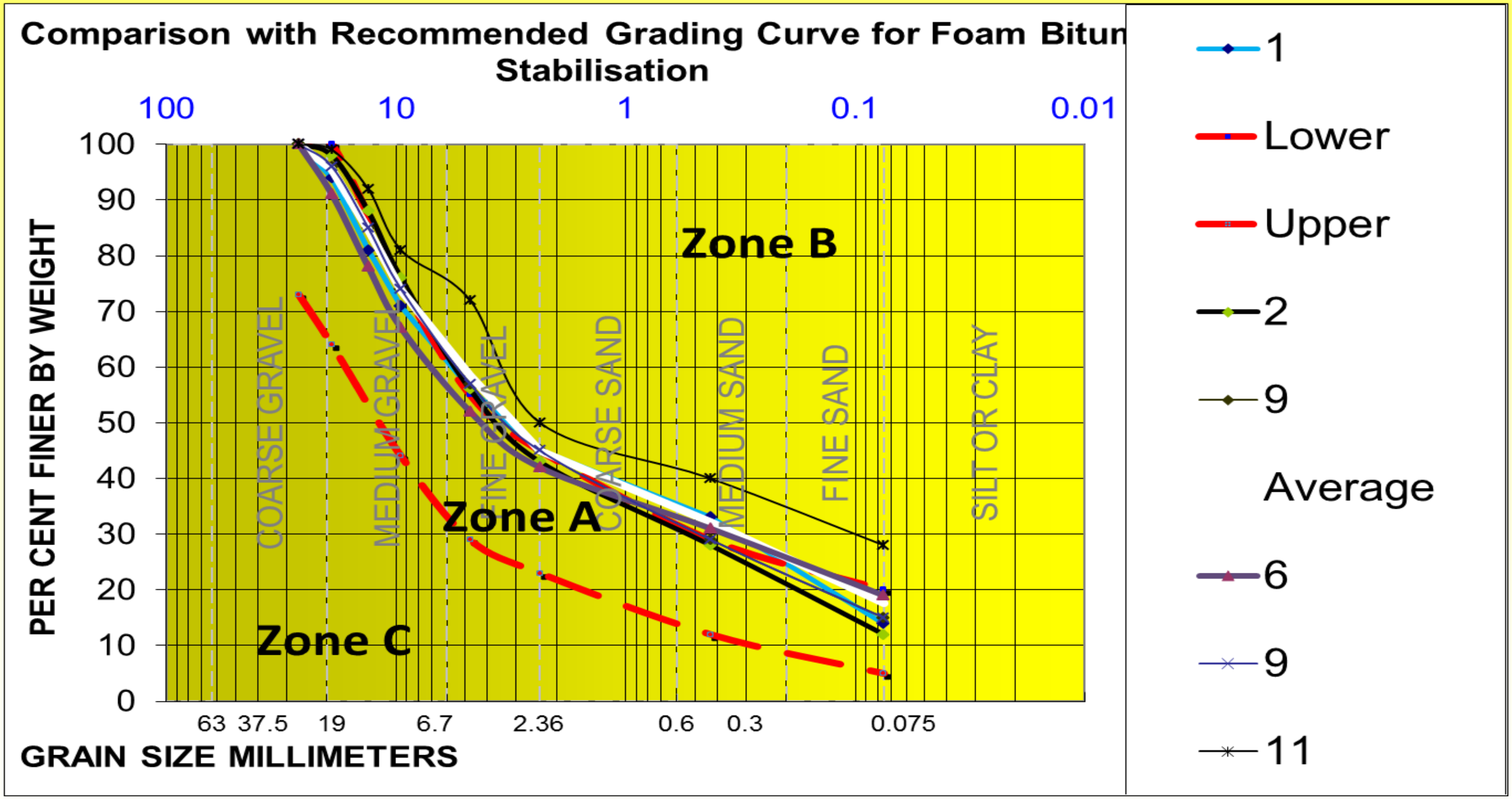
The Great Ocean Road

Sieve Analysis (% Passing)							RECOMMENDED GRADING LIMITS FOR FOAM BITUMEN STABILISATION Grading Limits (Table 308.051, VicRoads July 2010)	
Sieve Size (mm)	1	2	6	9	11	Average	Upper	Lower
26.5	100	100	100	100	100	100	100.0	73.0
19	94	98	91	96	99	96	100.0	64.0
13.2	81	88	78	85	92	85	87.5	54.0
9.5	71	76	67	74	81	74	75.0	44.0
4.75	56	56	52	57	72	59	55.0	29.0
2.36	45	43	42	45	50	45	45.0	23.0
0.425	33	28	31	29	40	32	29.0	12.0
0.075	14	12	19	15	28	18	20.0	5.0

SITE INVESTIGATION

LABORATORY TESTING

The Great Ocean Road



PAVEMENT DESIGN

THE RELATIONSHIP BETWEEN THE TRAFFIC, SUBGRADE SUPPORT AND SUBSEQUENT PAVEMENT THICKNESS AND/OR COMPOSITION

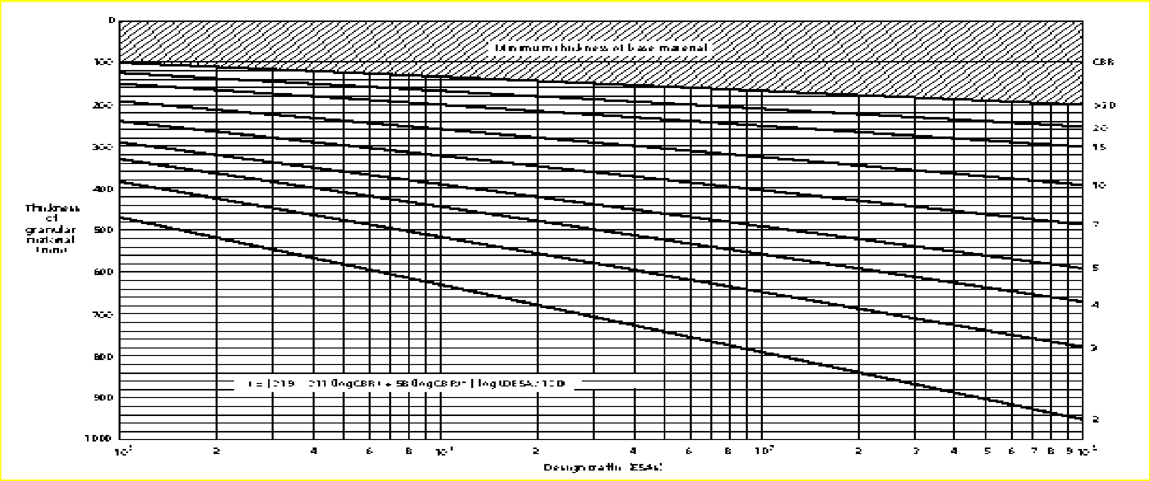
DESIGN TRAFFIC LOADING

SUBSURFACE DRAINAGE

ENVIRONMENTAL CONSIDERATIONS

PAVEMENT DESIGN

THE RELATIONSHIP BETWEEN THE TRAFFIC, SUBGRADE SUPPORT AND SUBSEQUENT PAVEMENT THICKNESS AND/OR COMPOSITION



Minor / Local Access	Collector	Distributor

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PAVEMENT DESIGN

DESIGN TRAFFIC LOADING (DTL)

Table 12.2: Indicative heavy vehicle axle group volumes for lightly-trafficked urban streets

Street type	AADT two-way	Heavy vehicles (%)	Design AADHV (single lane)	Design period (years)	Annual growth rate (%)	Cumulative growth factor (Table 7.3)	Axle groups per heavy vehicle	Cumulative HVAG over design period	ESA/HVAG	Indicative design traffic (ESA)
Minor with single lane traffic	30	3	0.9	20	0	20	2.0	13,140	0.2	3×10^3
				40	0	40	2.0	26,280	0.2	5×10^3
Minor with two lane traffic	90	3	1.35	20	0	20	2.0	19,710	0.2	4×10^3
				40	0	40	2.0	39,420	0.2	8×10^3
Local access with no buses	400	4	8	20	1	22.0	2.1	128,480	0.3	4×10^4
				40	1	48.9	2.1	285,576	0.3	9×10^4
Local access with buses	500	6	15	20	1	22.0	2.1	240,900	0.3	8×10^4
				40	1	48.9	2.1	535,455	0.3	1.5×10^5
Local access in industrial area	400	8	16	20	1	22.0	2.3	256,960	0.4	1.5×10^5
				40	1	48.9	2.3	571,152	0.4	3×10^5
Collector with no buses	1200	6	36	20	1.5	23.1	2.2	607,068	0.6	4×10^5
				40	1.5	54.3	2.2	1,427,004	0.6	10^6
Collector with buses	2000	7	70	20	1.5	23.1	2.2	1,180,410	0.6	8×10^5
				40	1.5	54.3	2.2	2,774,730	0.6	2×10^6

Note : Direction factor is 0.5, except for Minor Street with single lane traffic where DF= 1.0

PAVEMENT DESIGN

SUBSURFACE DRAINAGE

Types of Subsurface Pavement Drains

Table 6.1 Selection of Type of Subsurface Drain & Filter Type.

Sugrade Type	Permeability Range m/sec	Type of Pavement Drain (SD 1601)	Grades of Granular Backfill Material
Homogenous clay with very low permeability	$< 10^{-9}$	Type 3 or Type 4	Sand (Grade A1 to A3)
Silty or sandy clays and stratified clays with moderately low permeability	10^{-9} to 10^{-5}	Type 2, Type 3 or Type 4	Sand (Grade A4 to A6)
Clean sand or gravel with high permeability	$> 10^{-5}$	Type 1 or Type 2	Aggregate (Grade B1 or B2)
Solid rock or clean broken rock with high permeability or permeable fissures	Not applicable	Type 1	Aggregate (Grade B3 or B4)

PAVEMENT DESIGN

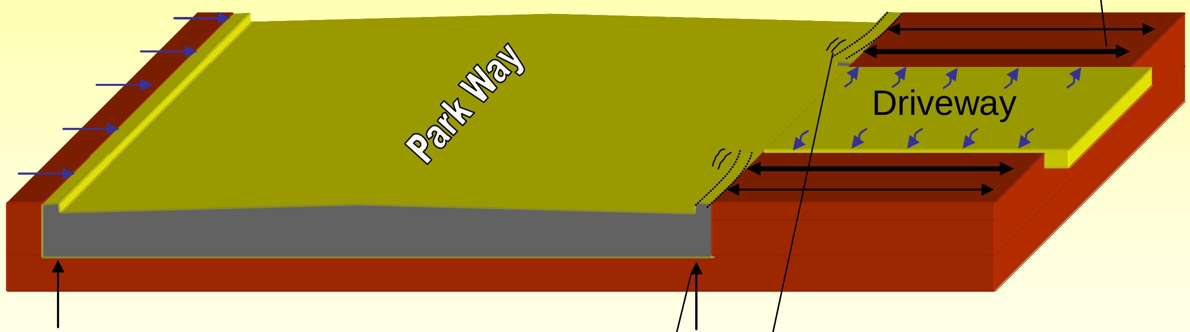
SUBSURFACE DRAINAGE

Expansive Nature		Liquid Limit		Plasticity Index		PI x %<0.425mm	
very high	☐	>70	☐	>45	☐	>3200	☐
high	☑	>70	☐	>45	☐	2200-3200	☑
moderate	☐	50-70	☐	25-45	☑	1200-2200	☐
low	☐	<50	☑	<25	☐	<1200	☐

PAVEMENT DESIGN

SUBSURFACE DRAINAGE

Differential horizonal loading exerted by reacive soils within road reserve. Concentrated Horizonal Forces from Road Reserve soils being wet up from adjacent driveway and road reserve runnoff together with soils underlying driveways remaining under equilibrium conditions (i.e. potential cause of differential movement).



Little or no Verical displacements observed within distressed areas. Likely reason due to adequate cover with low reactive subgrade improvement materials

All failures observed are in the vicinity of driveways and include kerb and channel displacement and subsequent shoving of asphalt surfacing

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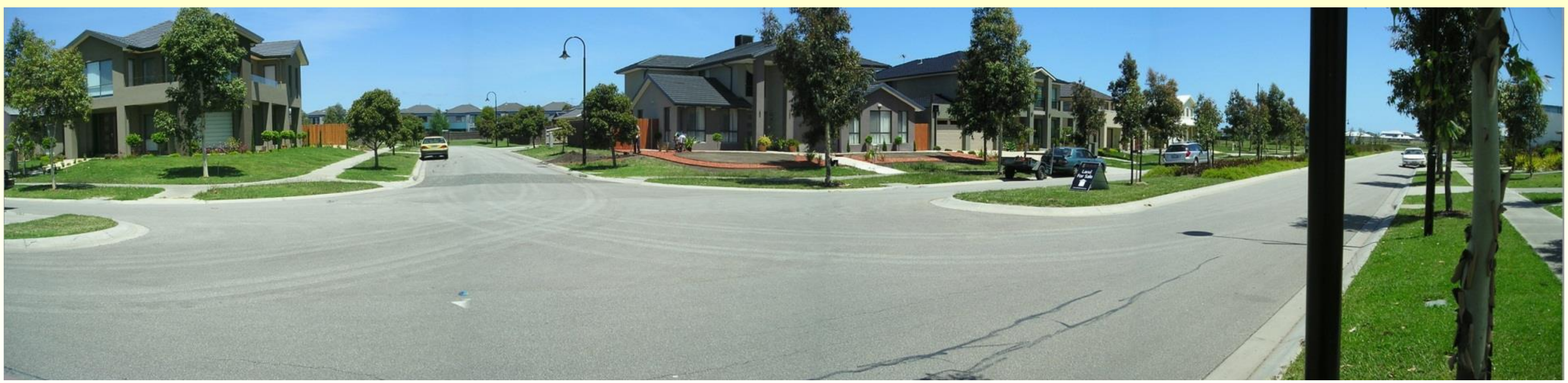
PAVEMENT DESIGN

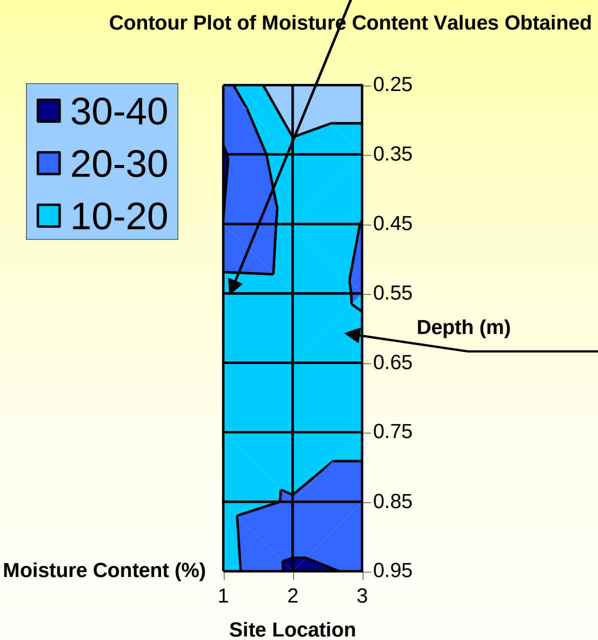
SUBSURFACE DRAINAGE

Expansive Nature		Liquid Limit		Plasticity Index		PI x %<0.425mm		Potential swell (%)	
very high	☐	>70	☐	>45	☐	>3200	✓	>5.0	☐
high	✓	>70	☐	>45	☐	2200-3200	☐	2.5-5.0	✓
moderate	☐	50-70	✓	25-45	✓	1200-2200	☐	0.5-2.5	☐
low	☐	<50	☐	<25	☐	<1200	☐	<0.5	☐



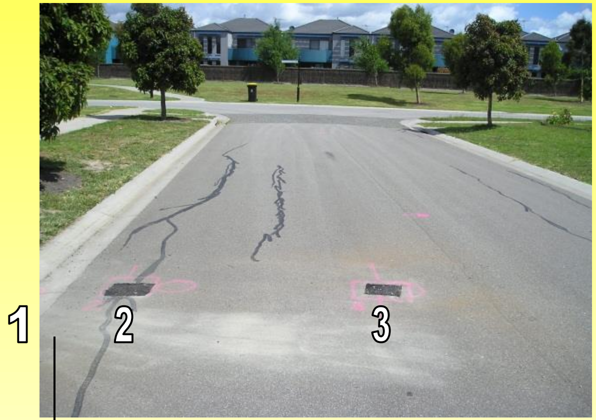
PAVEMENT DESIGN

SUBSURFACE DRAINAGE



SITE 1 - BENEATH THE NATURE STRIP
The moisture content contour plot shows the subgrade is relatively moist near to the surface within the nature strip (test site 1). Moisture contents within the upper soil horizon in this area were found to range approximately between 20% to 30%. Nevertheless the plot also shows the moisture contents to be relatively drier down deep (typically ranging between 15% to 20%). This dryness is likely caused by the installation of efficient subsurface drainage and / or services acting or assisting as subsurface drainage consequently drying out the subgrade.

SITES 2 & 3 - BENEATH THE PAVEMENT
The moisture content contour plot shows almost the opposite effect to moisture content (and likely subsequent ground movement) beneath the existing pavement (test sites 2 & 3) to that found within the nature strip (test site 1). Moisture contents within the upper soil horizon (beneath the pavement) were namely found to range between 13% to 21% while the lower soil horizon was found to range between 20% to 30%.



Efficient deep subsoil drains causing shrinkage

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PAVEMENT DESIGN

ENVIRONMENTAL CONSIDERATIONS

Soil Reactivity

The expansive nature of the foundation soils can play a major role in the long term performance of pavements. A guide to the identification and qualitative classification of expansive soils is presented in Table 5.2 of Austroads (2004). Comparison of laboratory test results can be used to assist in the determination of the expansive nature of the subgrade.

Expansive Nature	Liquid Limit	Plasticity Index	PI x %<0.425mm	Potential swell (%)
very high ☐	>70 ☐	>45 ☐	>3200 ☐	>5.0 ☐
high ☐	>70 ☐	>45 ☐	2200-3200 ☐	2.5-5.0 ☐
moderate ☐	50-70 ☐	25-45 ☐	1200-2200 ☐	0.5-2.5 ☐
low ☐	<50 ☐	<25 ☐	<1200 ☐	<0.5 ☐

Guide to classification of expansive soils (Table 5.2 Ausroads 2004)

PAVEMENT DESIGN
ENVIRONMENTAL CONSIDERATIONS

Swell Potential
Materials with percentage swells > 2.5% shall be considered as expansive. For expansive materials, the potential seasonal volume changes and resulting shape loss shall be minimised by undertaking some of the following steps:

Provision of a Capping Layer

- Permeability < 5×10^{-9} m/sec
- Swell < 2.5%
- Typical minimum thickness 150 mm
- Extension of the capping layer beyond K&C
- Preferred minimum cover 400mm
- It is preferred that Subsurface pavement drains be designed to function wholly within the capping layer.
- Appropriate Landscaping Design, planting of trees and shrubs (see VicRoads Technical Report No. 75).

PAVEMENT DESIGN

ENVIRONMENTAL CONSIDERATIONS

Minimum Cover Over Expansive Material

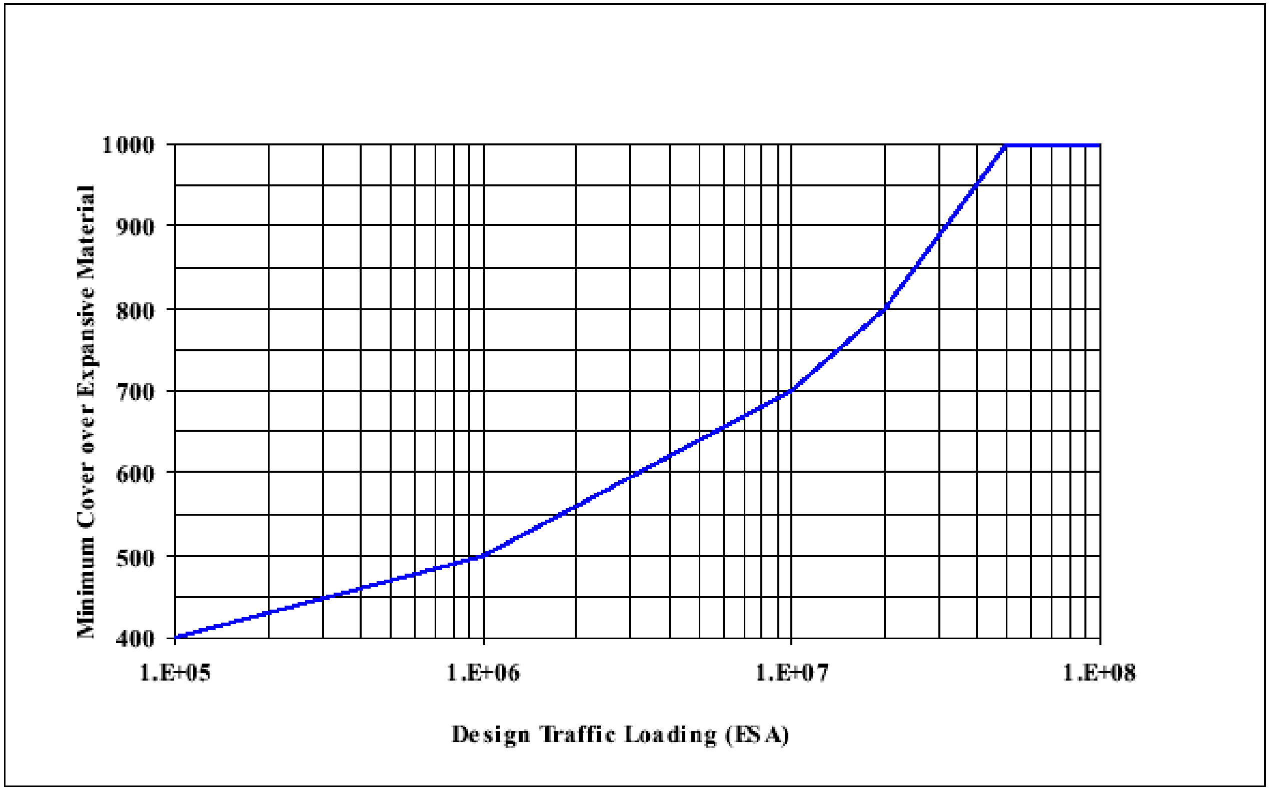


Figure 5.1 Minimum Cover Over Expansive Material

PAVEMENT REHABILITATION

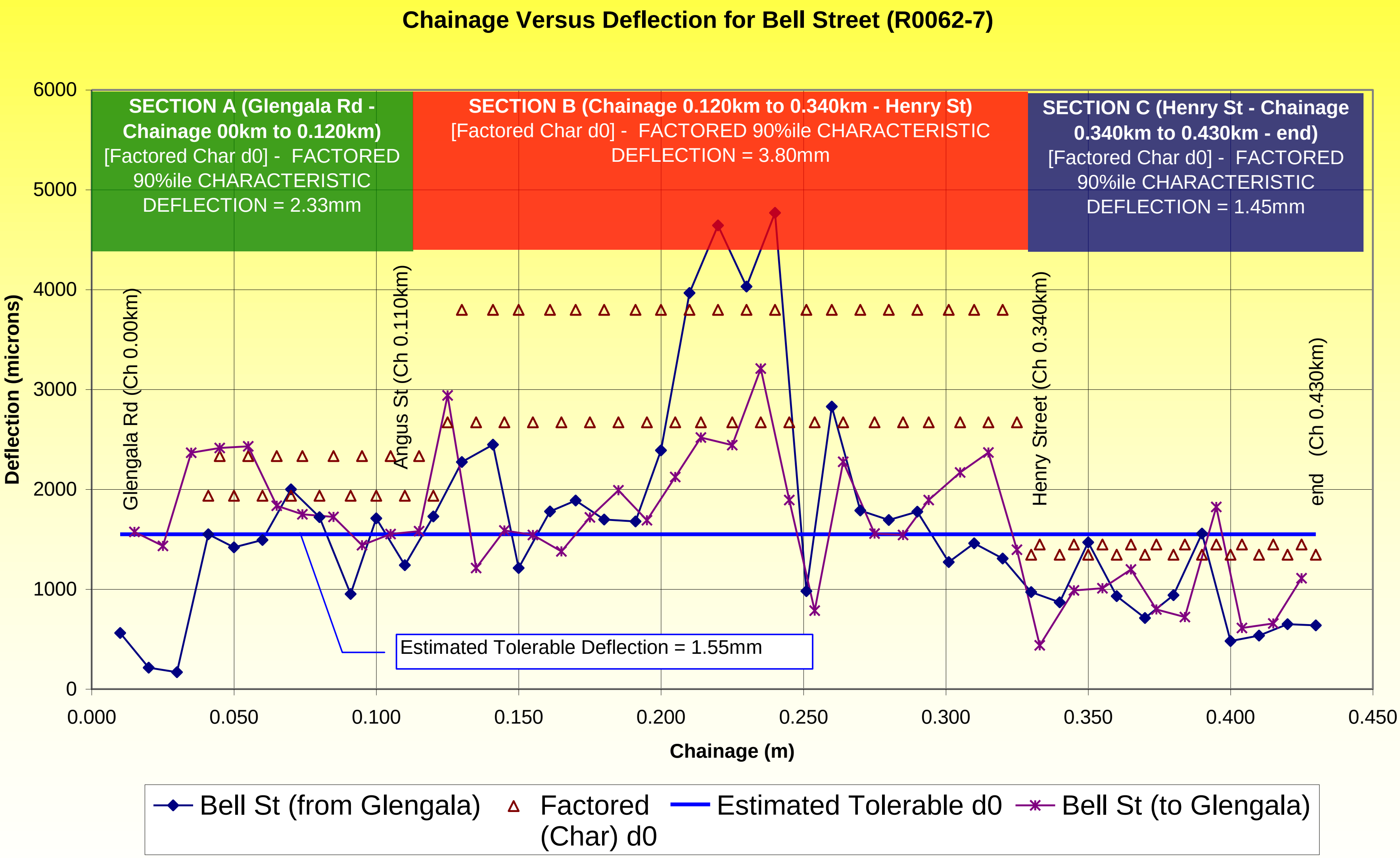
FALLING WEIGHT DEFLECTOMETER (FWD) AND PaSE VEHICLE DEFLECTION TESTING AND ASSESSMENT OF DATA FOR PAVEMENT REHABILITATION OF EXISTING ROADS

CONSTRUCTION AND DESIGN CONSIDERATIONS

AUSTROADS Pavement Rehabilitation Guide

PAVEMENT REHABILITATION

FALLING WEIGHT DEFLECTOMETER (FWD) AND PaSE VEHICLE DEFLECTION TESTING AND ASSESSMENT OF DATA FOR PAVEMENT REHABILITATION OF EXISTING ROADS



PAVEMENT REHABILITATION

FALLING WEIGHT DEFLECTOMETER (FWD) AND PaSE VEHICLE DEFLECTION TESTING AND ASSESSMENT OF DATA FOR PAVEMENT REHABILITATION OF EXISTING ROADS

Pavement Section	Appropriate Treatment Options
SECTION A (Glengala Rd - Chainage 00km to 0.120km)	The characteristic curvature and deflection information indicates that an asphalt overlay thickness in the order of **80mm** is required to withstand a fatigue life greater than 6.0 x 10^4 ESA's. This analysis compares well with theoretical analysis undertaken through the use of Circly.
SECTION B (Chainage 0.120km to 0.340km - Henry St)	The existing pavement in this area was found to be in a very poor condition with extensive failures observed. The characteristic curvature and deflection information indicates that a relatively thick asphalt overlay is required. Theoretical analysis has determined that an asphalt overlay thickness in the order of **100^+mm** thick would be required (without taking into consideration environmental factors related to subgrade reactivity). Given the relatively thick overlay required in this area it may be preferred that the existing pavement be reconstructed and incorporate the construction of a subgrade improvement / capping layer.
SECTION C (Henry St - Chainage 0.340km to 0.430km - end)	The characteristic curvature and deflection is less than tolerable values therefore requires **no structural upgrading** in relation to FWD data. Nevertheless it may be preferred to provide an asphalt overlay to strengthen distressed areas and remedy surface deficiencies.

PAVEMENT REHABILITATION

FALLING WEIGHT DEFLECTOMETER (FWD) AND PaSE VEHICLE DEFLECTION TESTING AND ASSESSMENT OF DATA FOR PAVEMENT REHABILITATION OF EXISTING ROADS

Defects	**Defects** observed within the existing pavement have predominantly included various cracking and patching upgrading works as described below:
Block Cracks are likely associated with ageing and hardening of the surfacing, and were observed in the vicinity of the rigid pavement, and are likely associated with reflection from underlying joints.	**Block Cracking** 
Various patches were observed throughout the investigated road length and are likely associated with routine maintenance of developing defects over the years and associated upgrading.	**Minor/major patching treatments** 
Meandering cracking observed is likely associated differential moisture conditions or settlement within filled areas. Some sinking and rutting was also observed within areas inferred to have been filled.	**Meandering cracking & Sinking**
Crocodile cracking is likely associated with a fatigued pavement, inadequate pavement thickness or material and / or a brittle or aged bitumen	**Crocodilel Cracking** 

PAVEMENT COMPOSITION

PAVEMENT SURFACINGS

STABILISATION

SUBGRADE IMPROVEMENT

PAVEMENT COMPOSITION

PAVEMENT SURFACINGS

Course		AADT / Lane [2]		Designation [1]	
		HV's	Total	Current	Former
Wearing	Light Duty	< 25	< 500	L	L
	Medium Duty	25 – 300	500 - 3000	N	N
	Heavy Duty	> 300	> 3000	H	H
	Heavy Duty	> 500	> 5000	V[4]	V
	Heavy Duty	> 1000	> 10000	HG[4][5]	-
	High Performance and/ or Flexibility	> 200 *	> 2000 *	HP[4]	H_m
Structural	Intermediate	25 - 1000	500 - 10000	SI	T
	Heavy Duty Intermediate	> 1000	> 10000	SS	T (600)
		> 1000	> 10000	SG[5]	-
		> 1000	>10000	SI	T
	High Performance Intermediate	> 1000	> 10000	SP	Tm
	Base	All	All	SI	T
		All	All	SF	R

Source: Manual of Codes of Practice Code of Practice RC 500.22

Guide for Selection of Dense Graded Asphalt Types

Course		AADT / Lane [2]		Designation [1]	Binder Class	Minimum PSV	Standard Mix Sizes [3]	Remarks
		HV's	Total					
Wearing	Light Duty	< 25	< 500	L	C170 or C320	-	7 & 10	C170 binder must be used if mix contains more than 10% RAP
	Medium Duty	25 – 300	500 - 3000	N	C170 or C320	-	7, 10 & 14	C170 must be used if mix contains more than 10% RAP
	Heavy Duty	> 300	> 3000	H	C320	48	10 & 14	Standard heavy duty wearing course
	Heavy Duty	> 500	> 5000	V[4]	C320	54[6]	10 & 14	Restricted to signalised intersections and roundabouts
	Heavy Duty	> 1000	> 10000	HG[4],[5]	M (600/170)	48[6]	10 & 14	
	High Performance and/or Flexibility	> 200 #	> 2000 #	HP[4]	PMB (A10E)	48[6]	10 & 14	# For medium and heavy duty use. Specialist advice should be sought.
Structural	Intermediate	25 - 1000	500 - 10000	SI	C320	-	14 & 20	Standard Structural Mix. Generally Size 20
	Heavy Duty Intermediate	> 1000	> 10000	SS	C600	-	20	
		> 1000	> 10000	SG[5]	M (600/170)	-	20	
		> 1000	>10000	SI	C320	-	20	Type SS preferred within 100 mm of finished surface level (excluding OGA) for freeways and large scale works
	High Performance Intermediate	> 1000	> 10000	SP	PMB (A10E)	-	20	Alternative PMB Class may be appropriate. Specialist advice should be sought prior to use
	Base	All	All	SI	C320	-	20	Standard Structural Mix
		All	All	SF	C320	-	20	Min. Layer thickness of 75mm and Min. Cover of 100 mm of DGA is required

(1) Standard Types of Dense Graded Asphalt (DGA)

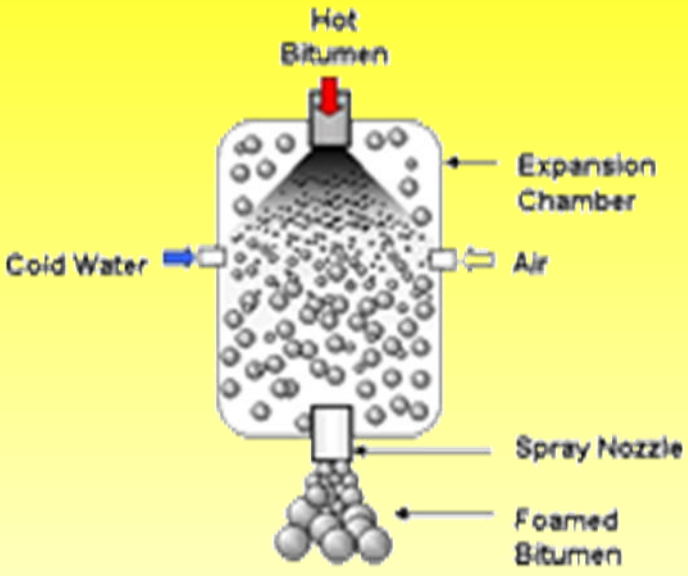
Source: Manual of Codes of Practice Code of Practice RC 500.22

PAVEMENT COMPOSITION

CEMENTITIOUS MODIFICATION

Modified granular material – achieved by adding small amounts of cementitious binder and / or granular material. This process is undertaken to remedy deficiencies in the granular material with modified material being considered as (improved) granular material with enhanced strength characteristics. Further laboratory testing including UCS testing should be carried out to determine the most appropriate amount and type of binder to be used. Typically UCS strengths in the order of 1.0MPa are required with higher values likely to result in reflective / shrinkage cracking, unless significant unbound granular or asphalt cover is provided.

FOAM BITUMEN STABILISATION



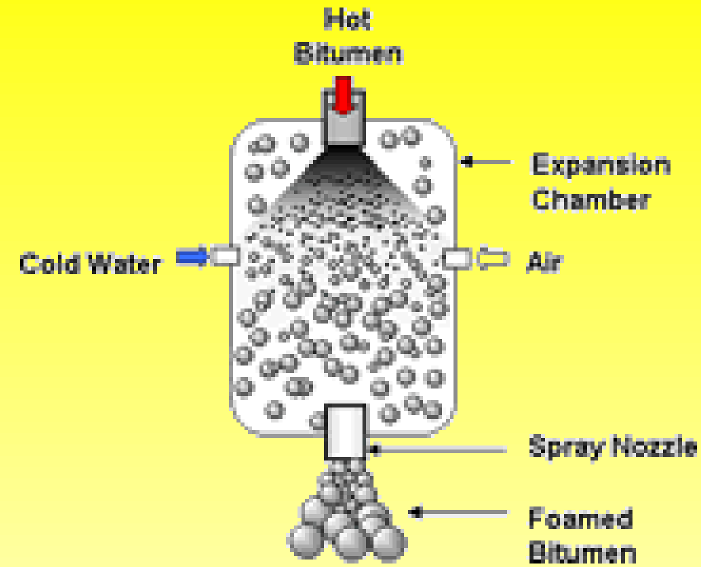
Performance of this treatment to date has been encouraging. Superior long term performance and lower maintenance is possible using the foamed bitumen stabilisation method compared to other more conventional stabilisation treatments, provided proper investigations, mix designs and quality control in construction is performed.

Foamed bitumen stabilisation can be undertaken using one of two methods:

• **Insitu mixing** — the existing pavement material is milled and the foamed bitumen and additives are mixed directly into the material without removal from site.
• **Pugmill/paver** — the existing material is milled and hauled to a central batch plant where foamed bitumen and additives are added followed by thoroughly mixing. The modified product is then hauled back to site for laying.

PAVEMENT COMPOSITION

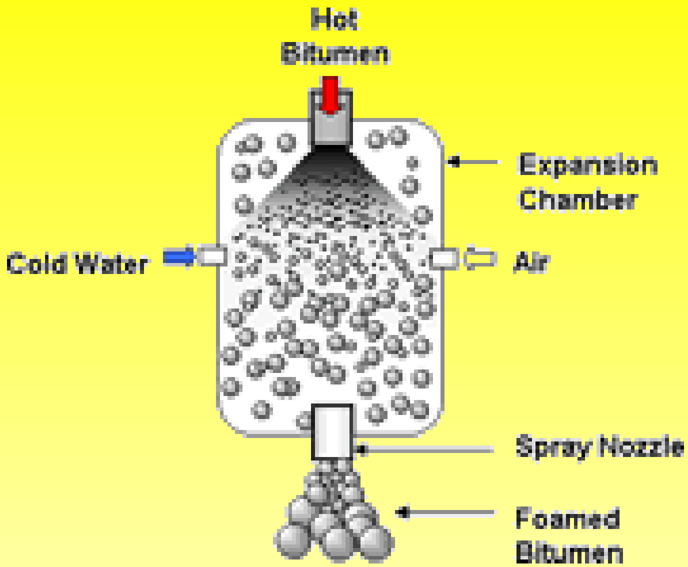
FOAM BITUMEN STABILISATION



Improvement in granular material achieved by adding small amounts of bituminous binder (Usually 3% to 4% bitumen) a A foaming agent, and / or lime or cement and/or granular material. This process is undertaken to remedy deficiencies in the granular material with foam bitumen stabilised material being considered as (highly improved) granular material with enhanced strength characteristics. Further laboratory testing including modulus testing should be carried out to determine the most appropriate amount and type of binder to be used. Typically indirect tensile resilient modulus strengths in the order of 1,500MPa to 2,000MPa are required.

UCS may also be considered to be used at the same time as density testing to assist with simple daily quality control.

PAVEMENT COMPOSITION



FOAM BITUMEN STABILISATION

Average daily ESAs in the design lane in the year of opening	Initial modulus[1] (MPa)	Minimum cured modulus[3] (MPa)	Minimum soaked modulus[4] (MPa)	Minimum retained modulus ratio[5]
< 100	500	2500	1500	40%
100 – 1000	700	3000	1800	45%
> 1000	700[2]	4000	2000	50%

[1] Samples initially cured at 25°C for 3 hours prior to initial modulus testing
[2] Recommend wheel tracker testing be completed to confirm curing time required
[3] Samples cured at 40°C for 3 days prior to cured modulus testing
[4] Cured modulus test samples conditioned in a water bath under vacuum for 10 minutes prior to testing
[5] Retained modulus ratio = soaked modulus / cured modulus

PAVEMENT COMPOSITION

SUBGRADE IMPROVEMENT

Subgrade Improvement is often required when the CBR value of the subgrade at the time of construction falls below 5%.

A relatively simple method of determining subgrade improvement requirements is to use the Japan Road Association Formula (refer Austroads, Equation 9.1)

$$CBR_m = \left[\frac{\sum_i h_i \times CBR_i^{0.33}}{\sum_i h_i} \right]^3$$

(Austroads, Equation 9.1)

where CBR_i is the CBR value in layer thickness h_i, and

$\sum h_i$ is taken to a depth of 1.0m

PAVEMENT COMPOSITION

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PAVEMENT COMPOSITION

SUBGRADE IMPROVEMENT

Table 1 Suitability of additive to soil type.
[Note: * Depends upon grading. Single size sands require higher additive contents]

Key: Usually very suitable, Usually satisfactory & Usually not suitable.

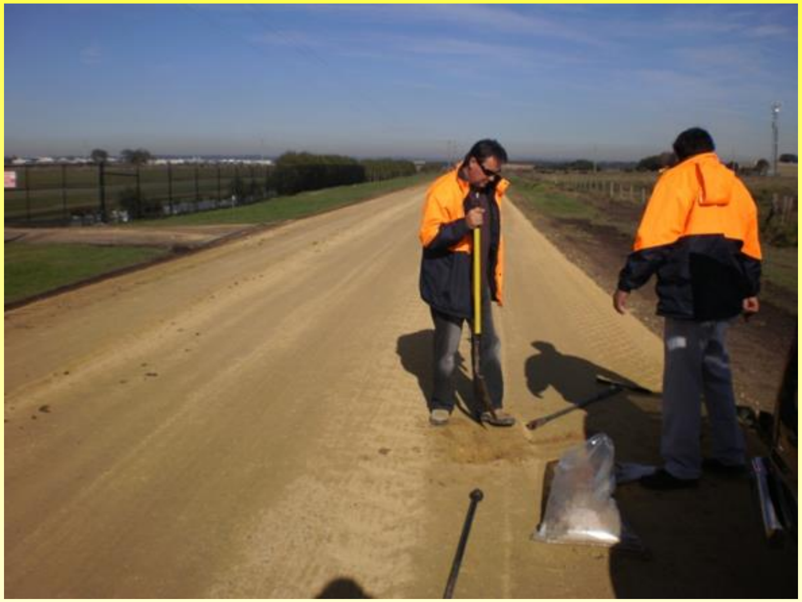
Binder Classification	Crushed rock	well graded gravel	silty/ clayey gravel	sand*	Sandy / silty clays	heavy clays
GP Cement						
GB Cement						
Cementitious blends						
Lime						
Lime & cement						
Lime & fly ash						
Bitumen						
Bitumen/Cement						
Insoluble polymer						

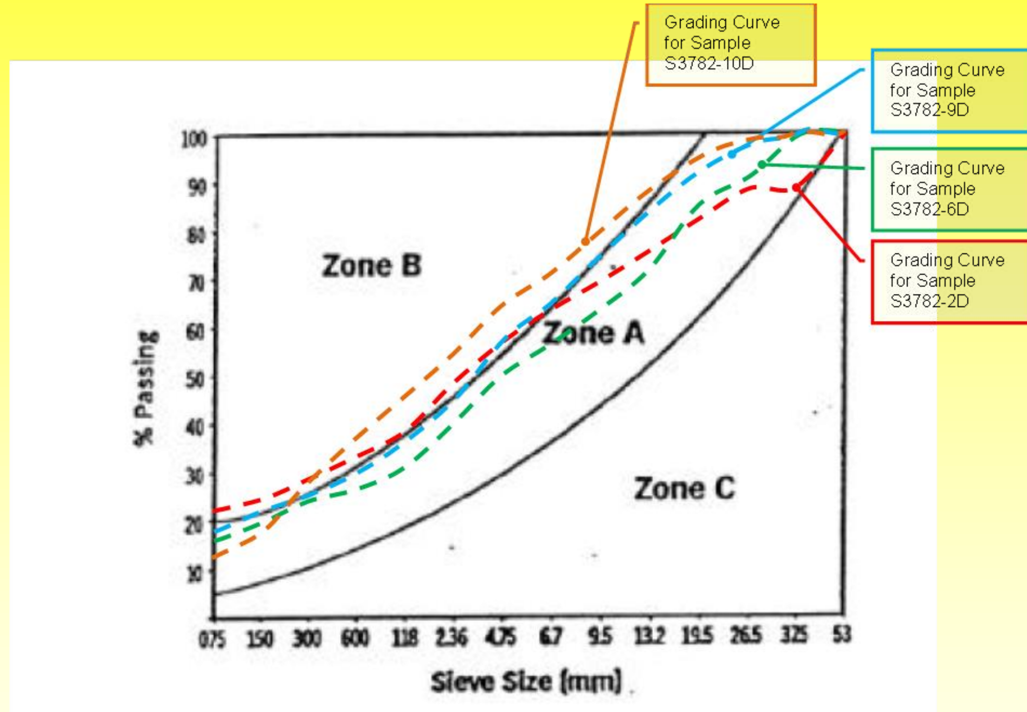
Learmonth, Wadsley & Robinson Roads, Carrum Downs

February 2012

February 2013

Learmonth, Wadsley & Robinson Roads, Carrum Downs (Ref R3782 & R4105)

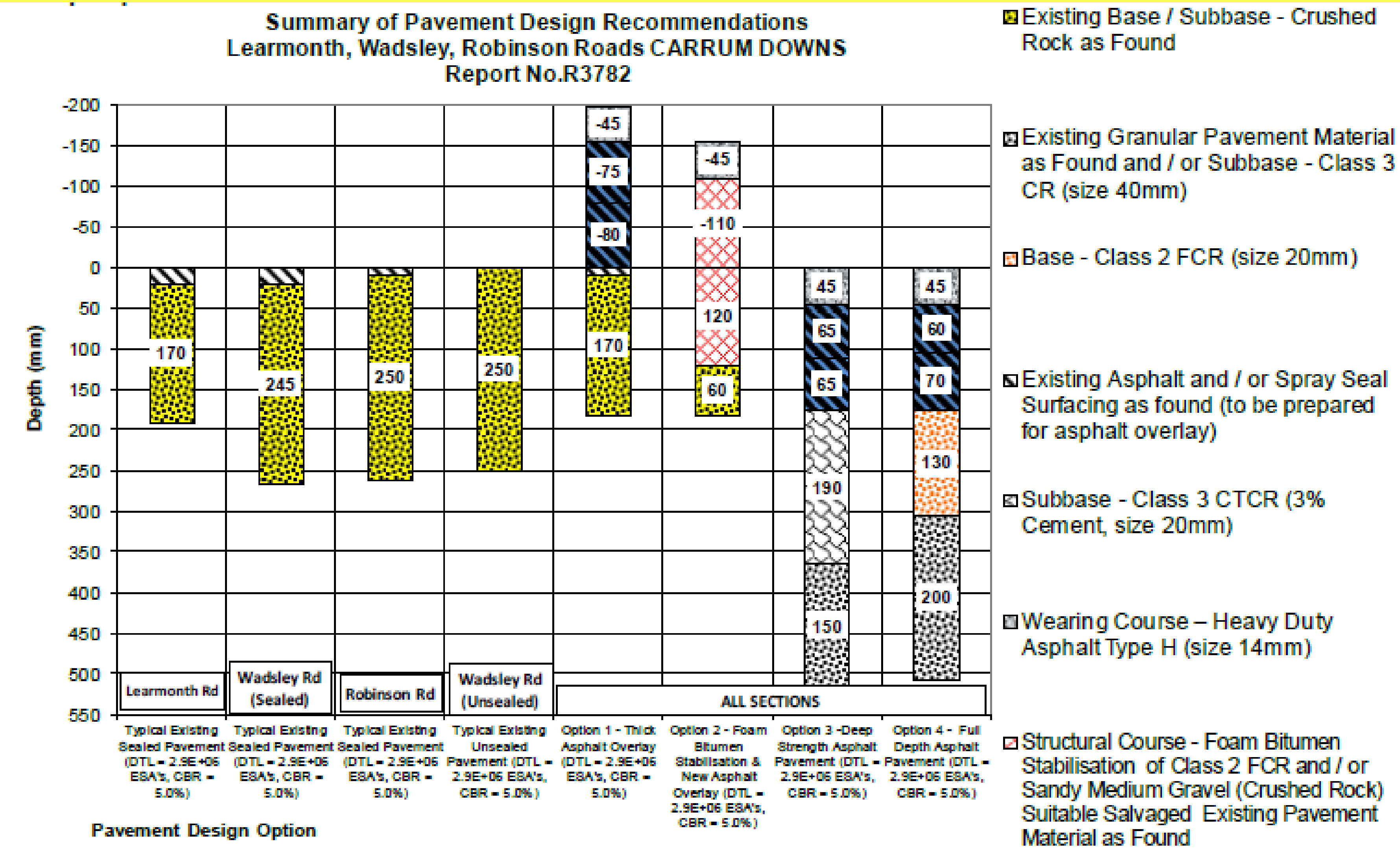




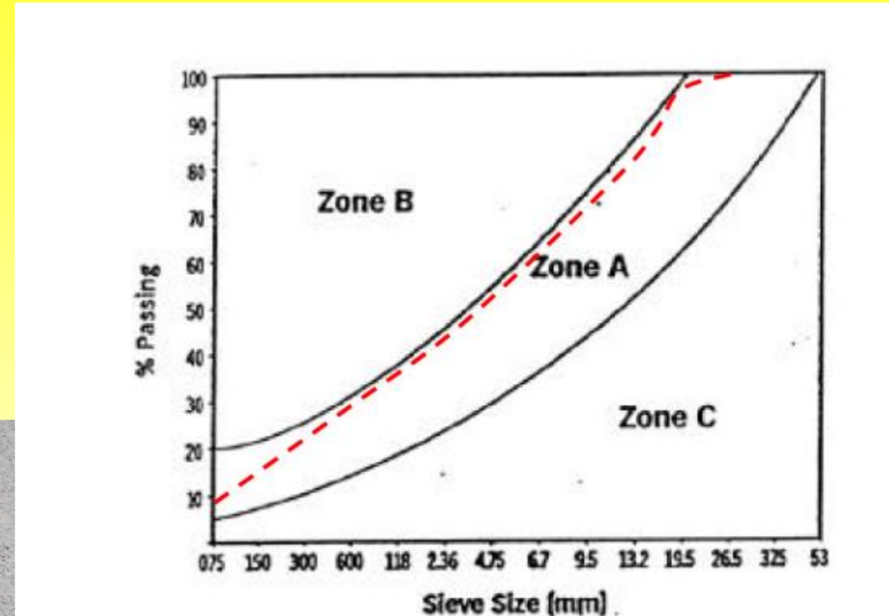
June 2012

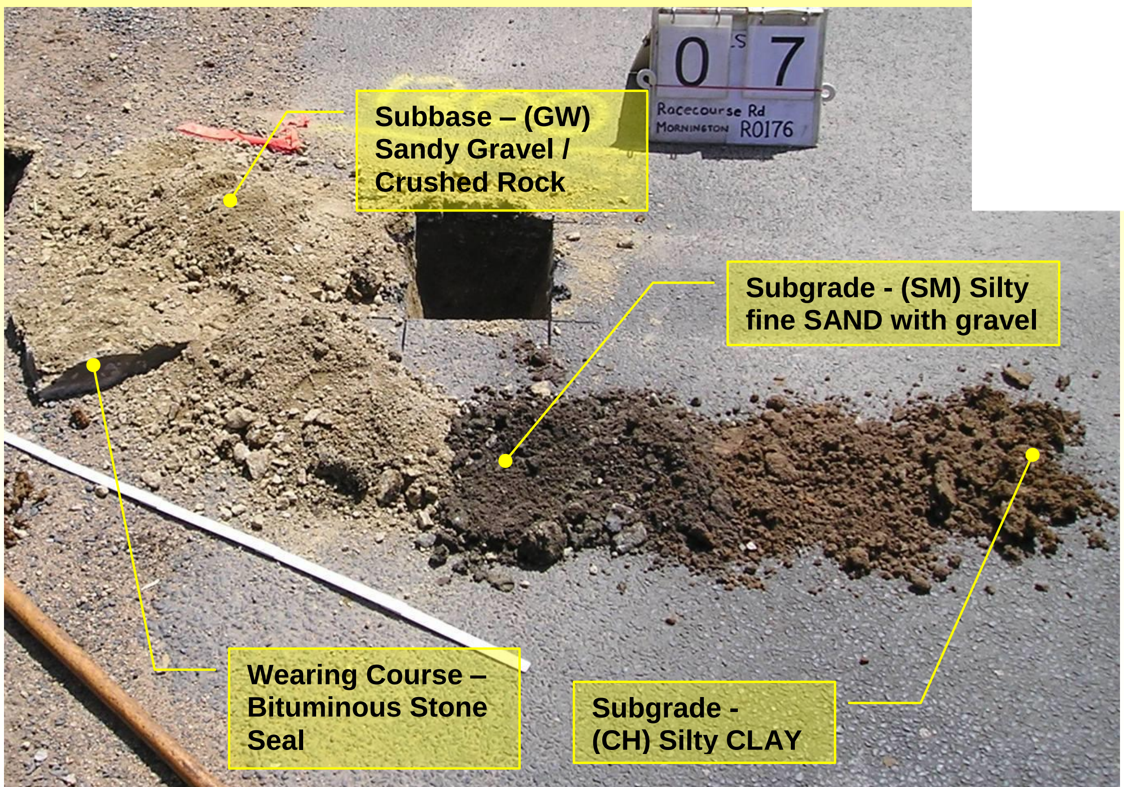
Sieve Analysis

Learmonth, Wadsley & Robinson Roads, Carrum Downs



Racecourse Road MORNINGTON Ref R0176





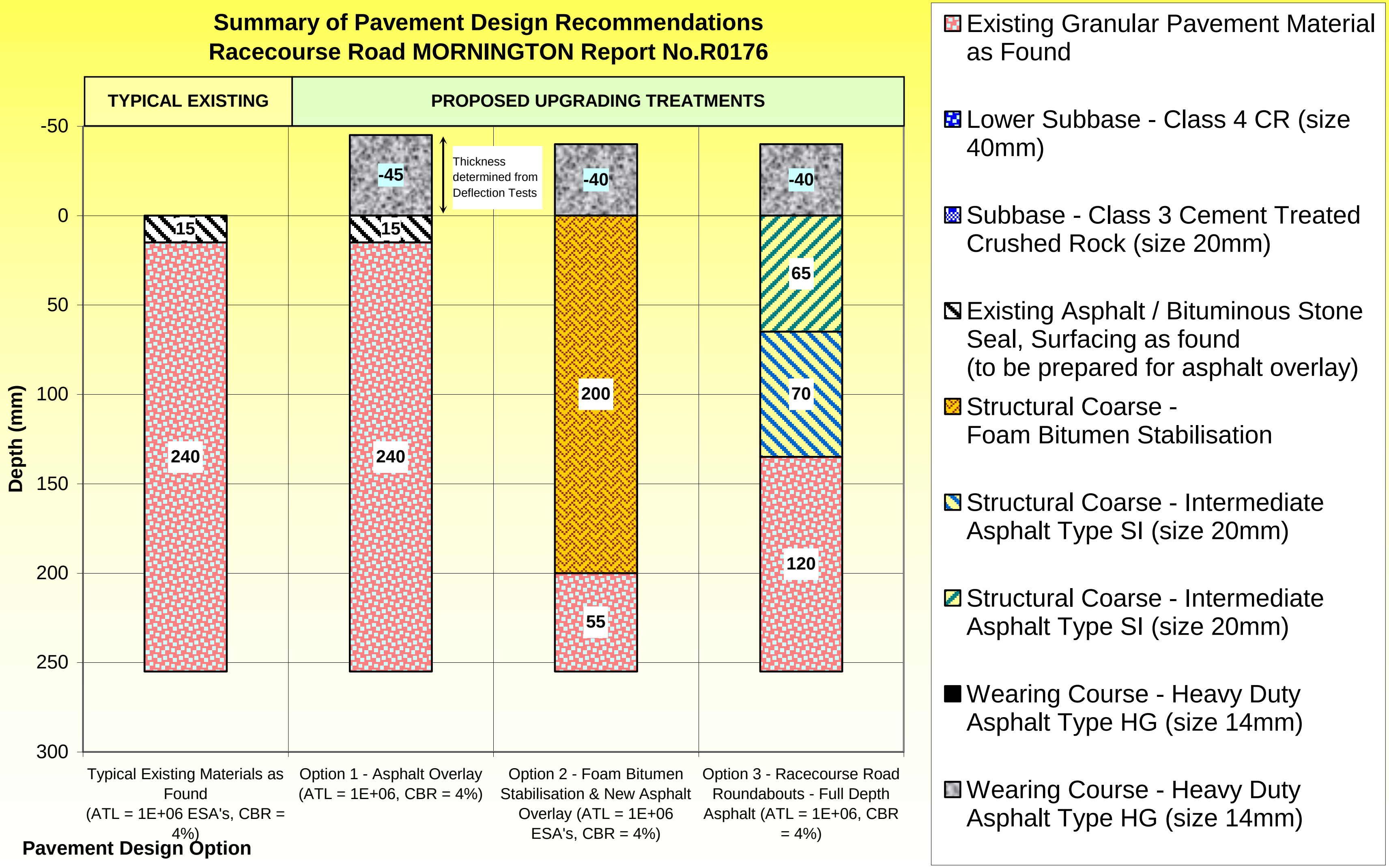
Racecourse Road MORNINGTON Ref R0176

August 2013

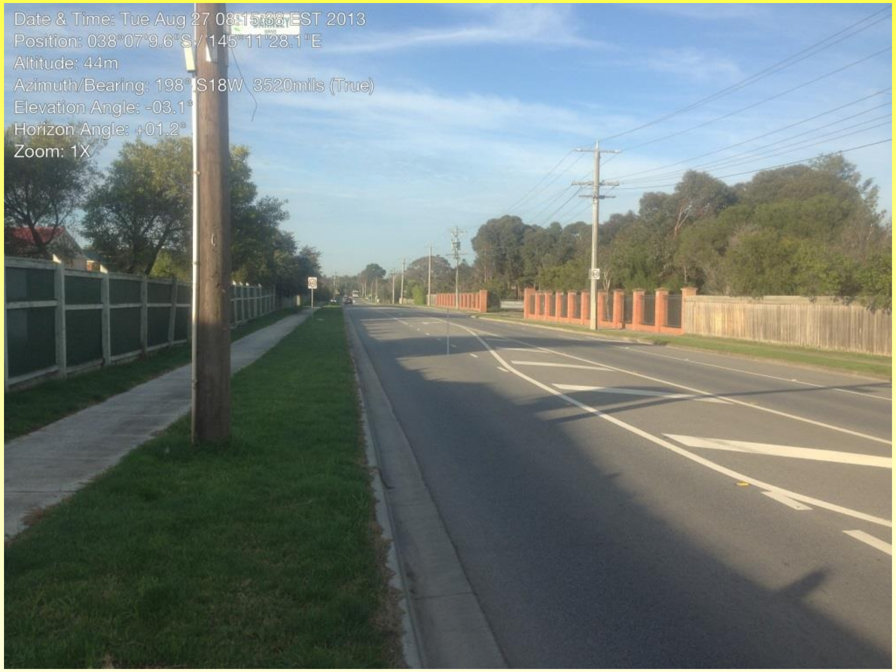
January 2007


December 2012

Racecourse Road MORNINGTON Ref R0176



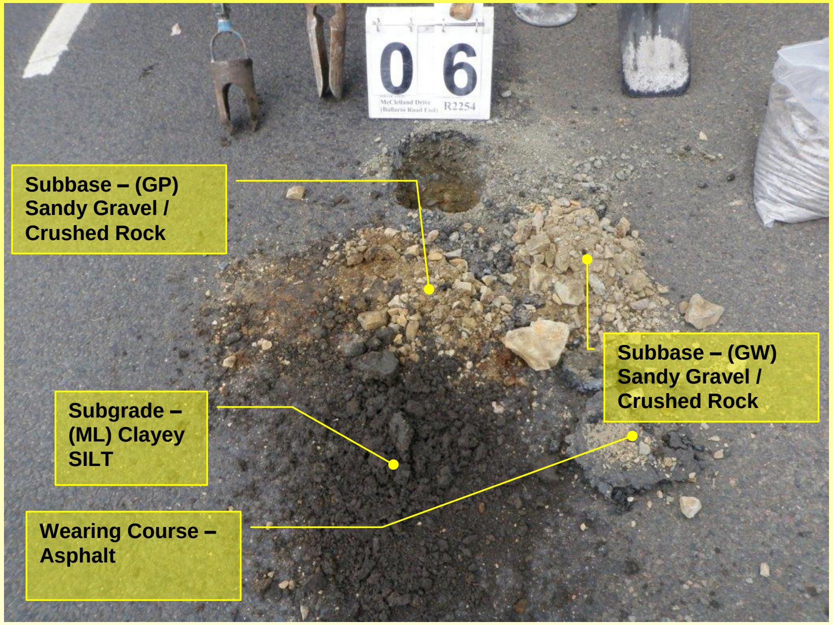
McClelland Drive FRANKSTON



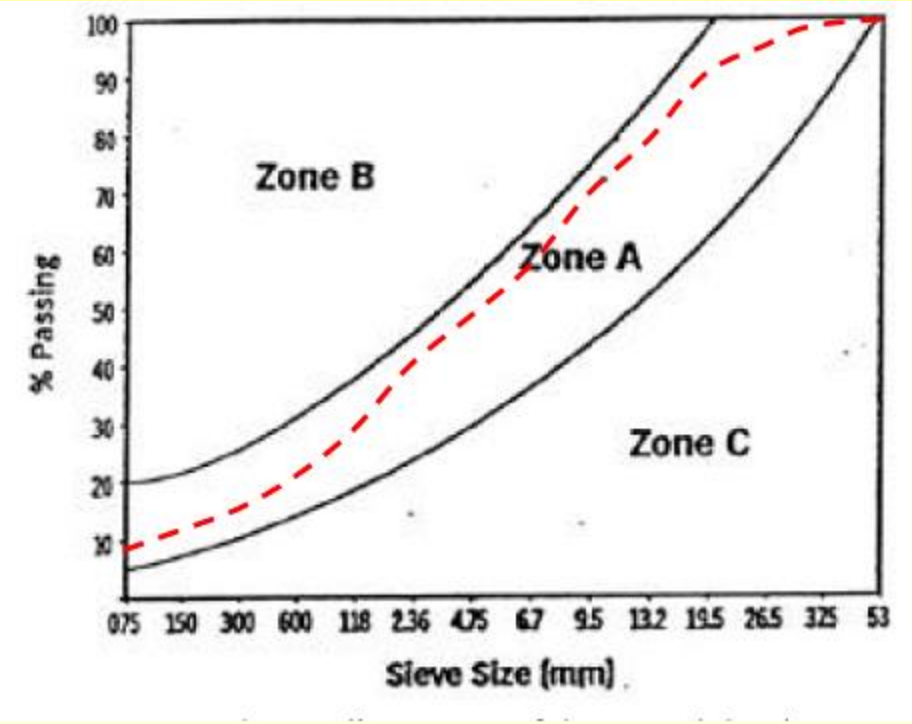
February 2012

August 2013

McClelland Drive FRANKSTON



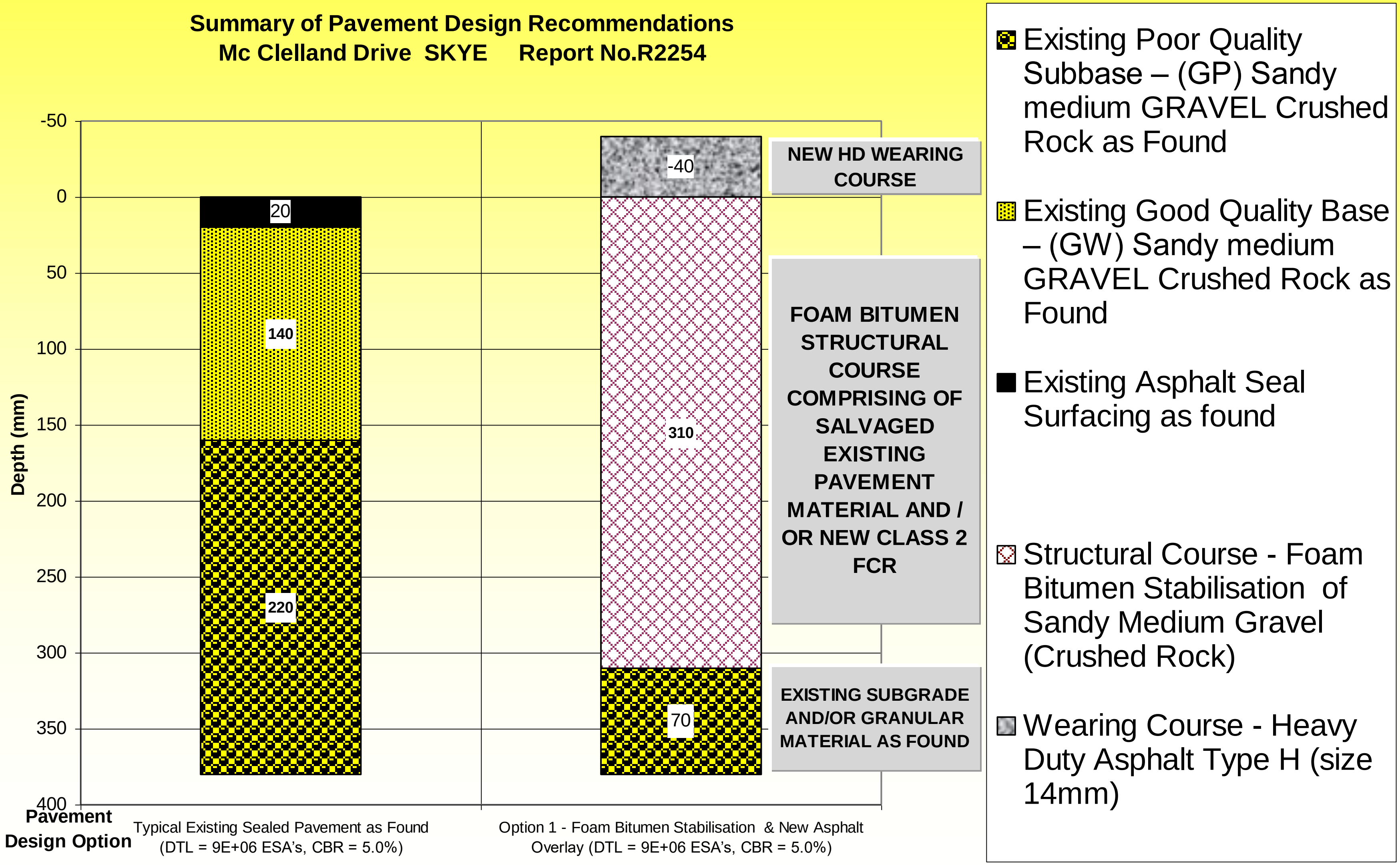
Typical Pictorial view of underlying pavement and subgrade materials encountered



Sieve Analysis (average grading)

Specimen Identification		Mean Resilient Modulus [1] (MPa)
S2254-13A	13A (Composite) Stabilised with 3% Bitumen & 1.5% Hydrated Lime	Wet = 2842 Dry = 5427
S2254-13B	13B (50% Composite, 50% Quarry Crushed Rock) Stabilised with 3% Bitumen & 1.5% Hydrated Lime	Wet = 5807 Dry = 7194

McClelland Drive FRANKSTON

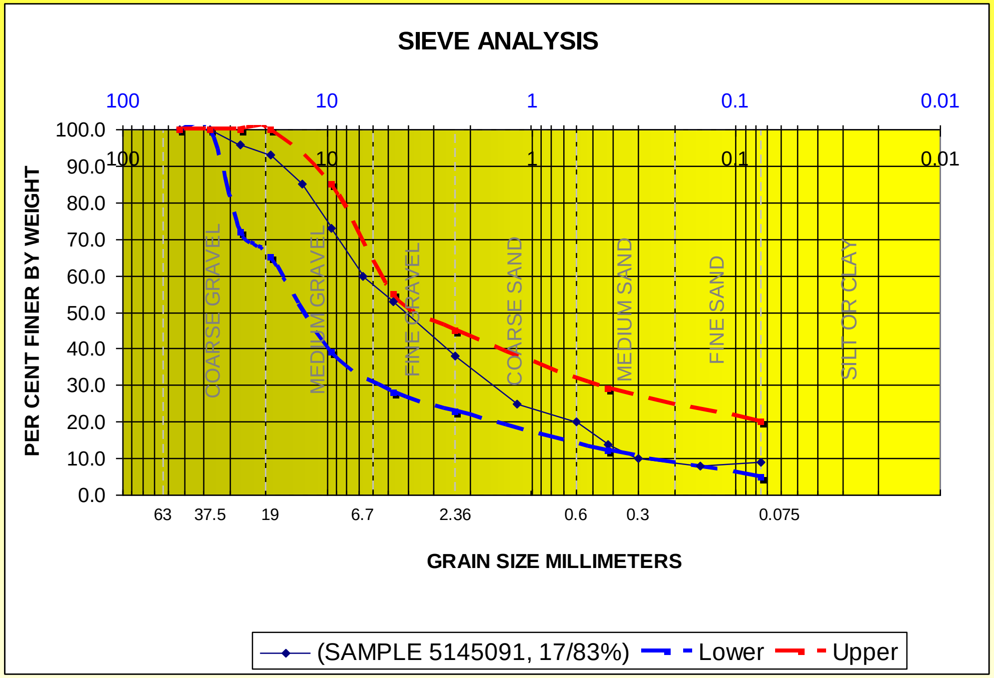


Brushy Park Road Wonga Park Ref R2169-1

Unknown (Google earth)

August 2013

Brushy Park Road Wonga Park Ref R2169-1



Sieve Analysis

Modulus Results		Mean	Individual Results		
Resilient Modulus (MPa) on sample with 3.5% Bitumen & 1.5% Hydrated Lime	dry	**5478**	5641	5158	5636
	wet	**2810[4]**	3254	3034	2142

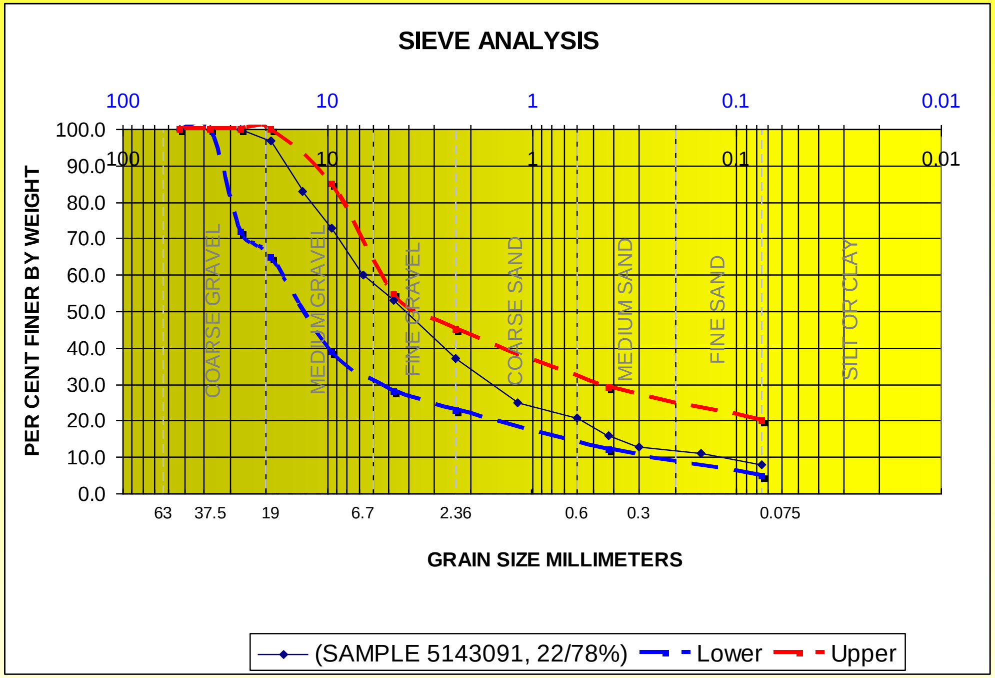
Figure 5-3 Foam Bitumen Modulus Results related to 83% Granular Materials & 17% RAP Mix

Tuckers Road TEMPLESTOWE **Ref R2169-2**

Unknown (Google earth)

August 2013

Tuckers Road TEMPLESTOWE Ref R2169-2



Sieve Analysis

Modulus Results		Mean	Individual Results		
Resilient Modulus (MPa) on sample with 3.5% Bitumen & 1.5% Hydrated Lime	dry	**3949**	4702	2975	4169
	wet	**17764**	2884	1501	2051

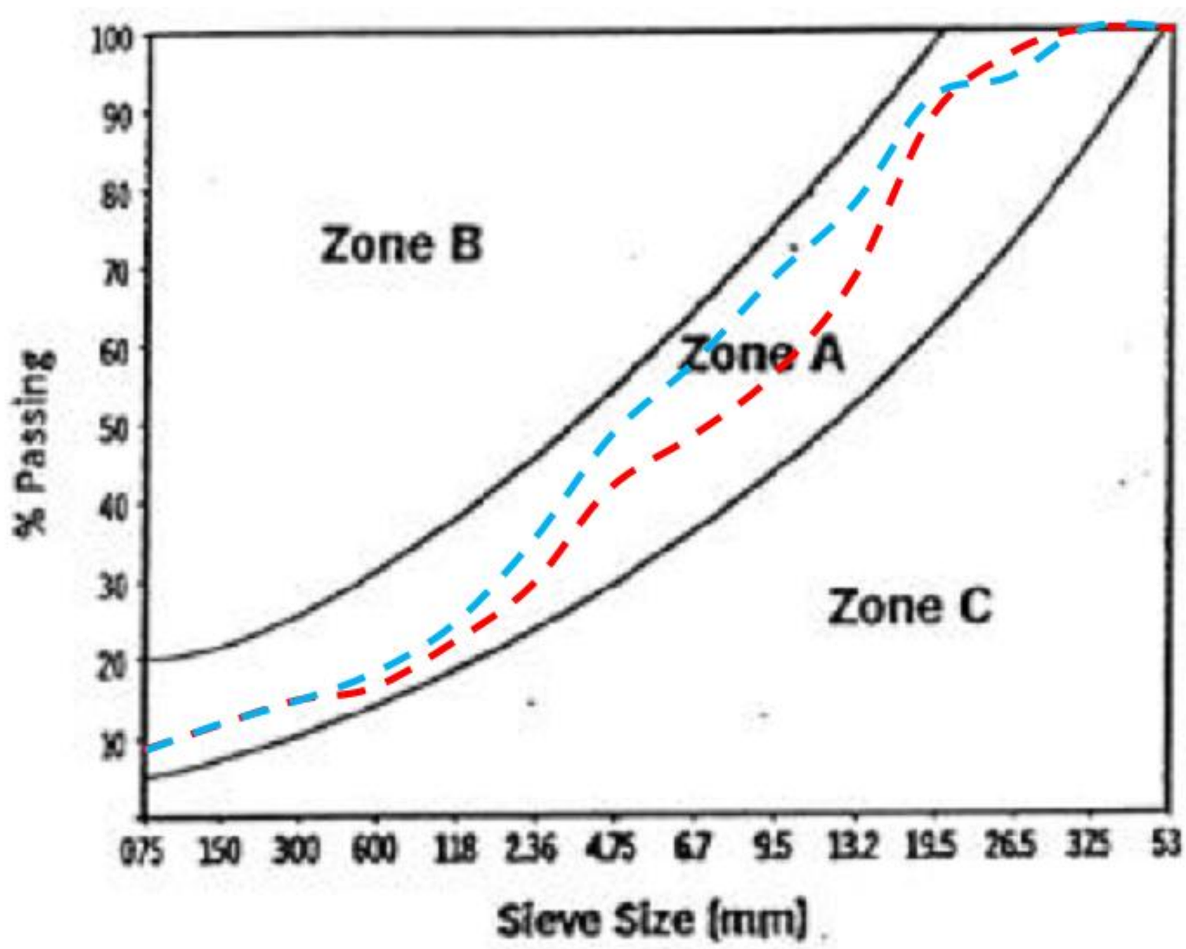
Foam Bitumen Modulus Results related to 78%Granular Materials & 22% RAP Mix

Brysons Road WARRANWOOD Ref R3306

Unknown (Google earth)

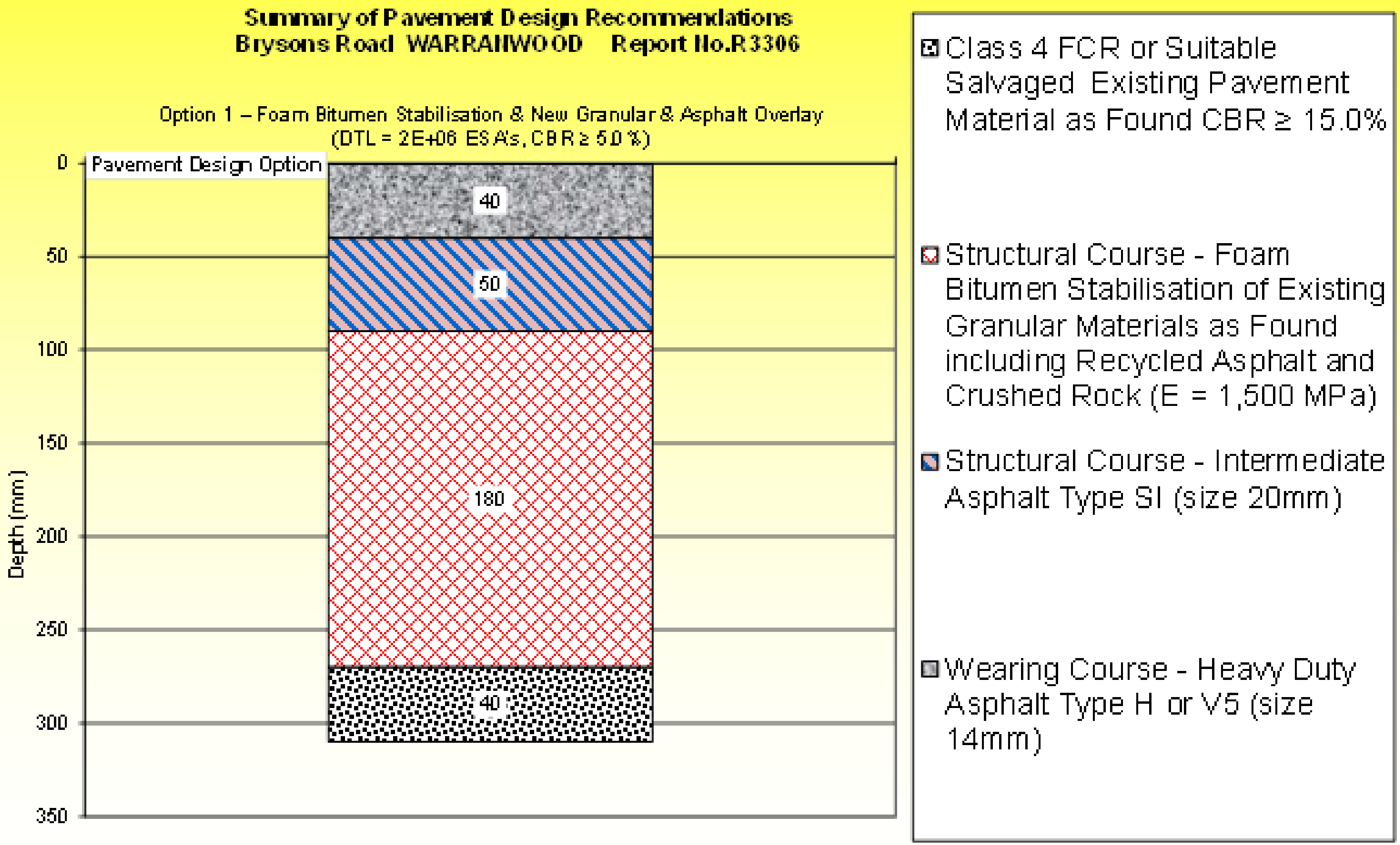
August 2013

Brysons Road WARRANWOOD Ref R3306



Sieve Analysis

Brysons Road WARRANWOOD Ref R3306

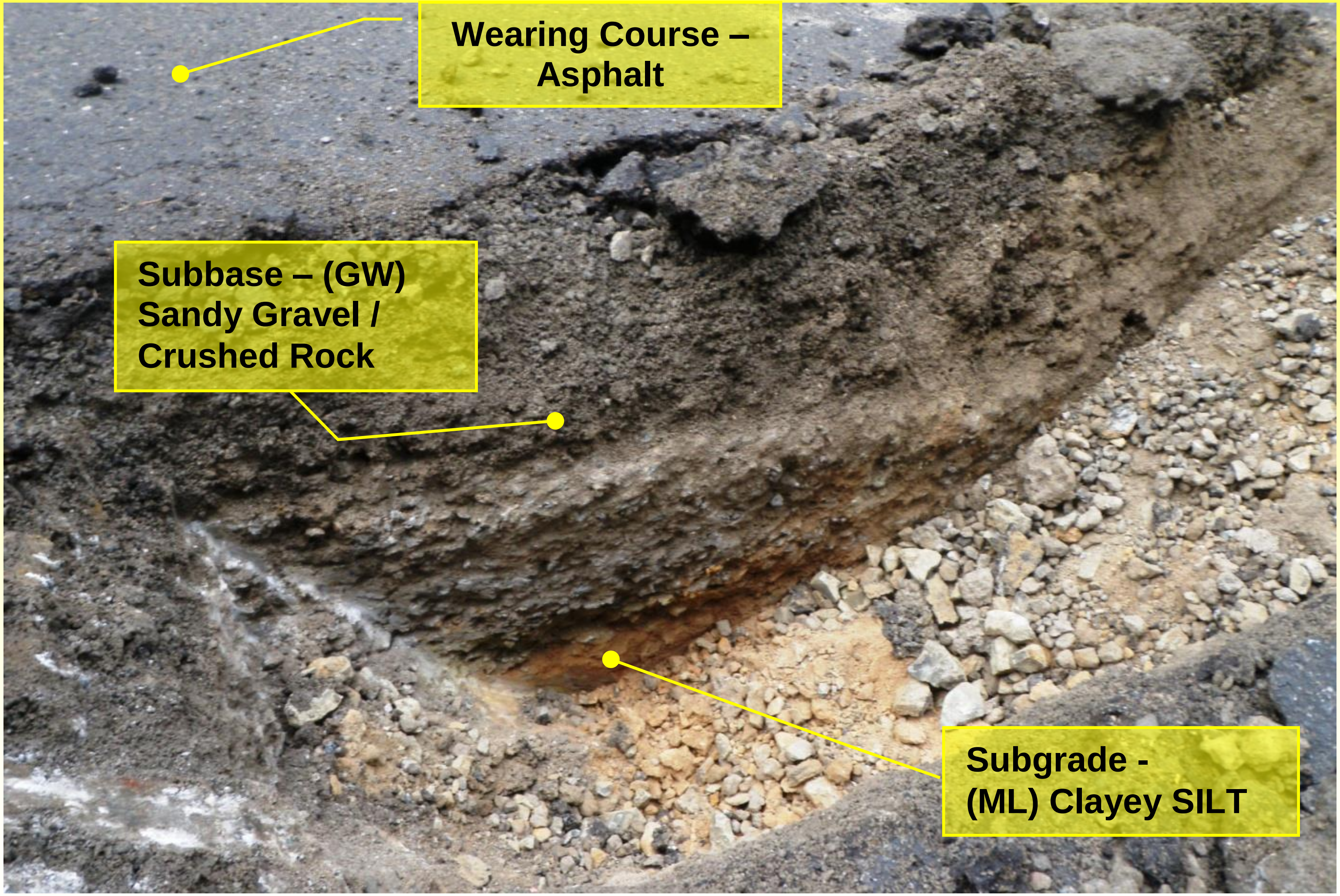


Old Warrandyte Road DONVALE Ref R4139-3-r

July 2012

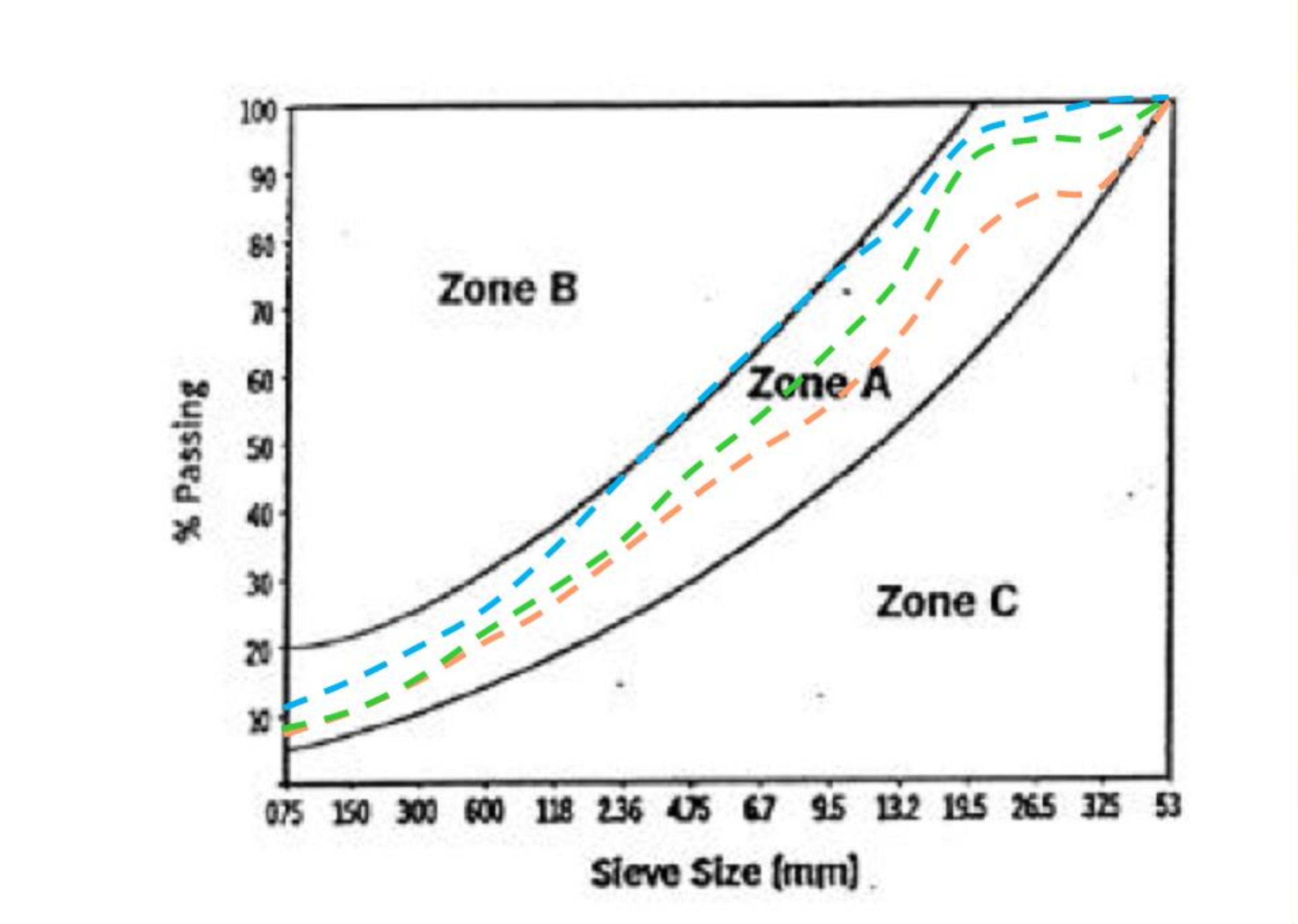
August 2013

Old Warrandyte Road DONVALE Ref R4139-3-r



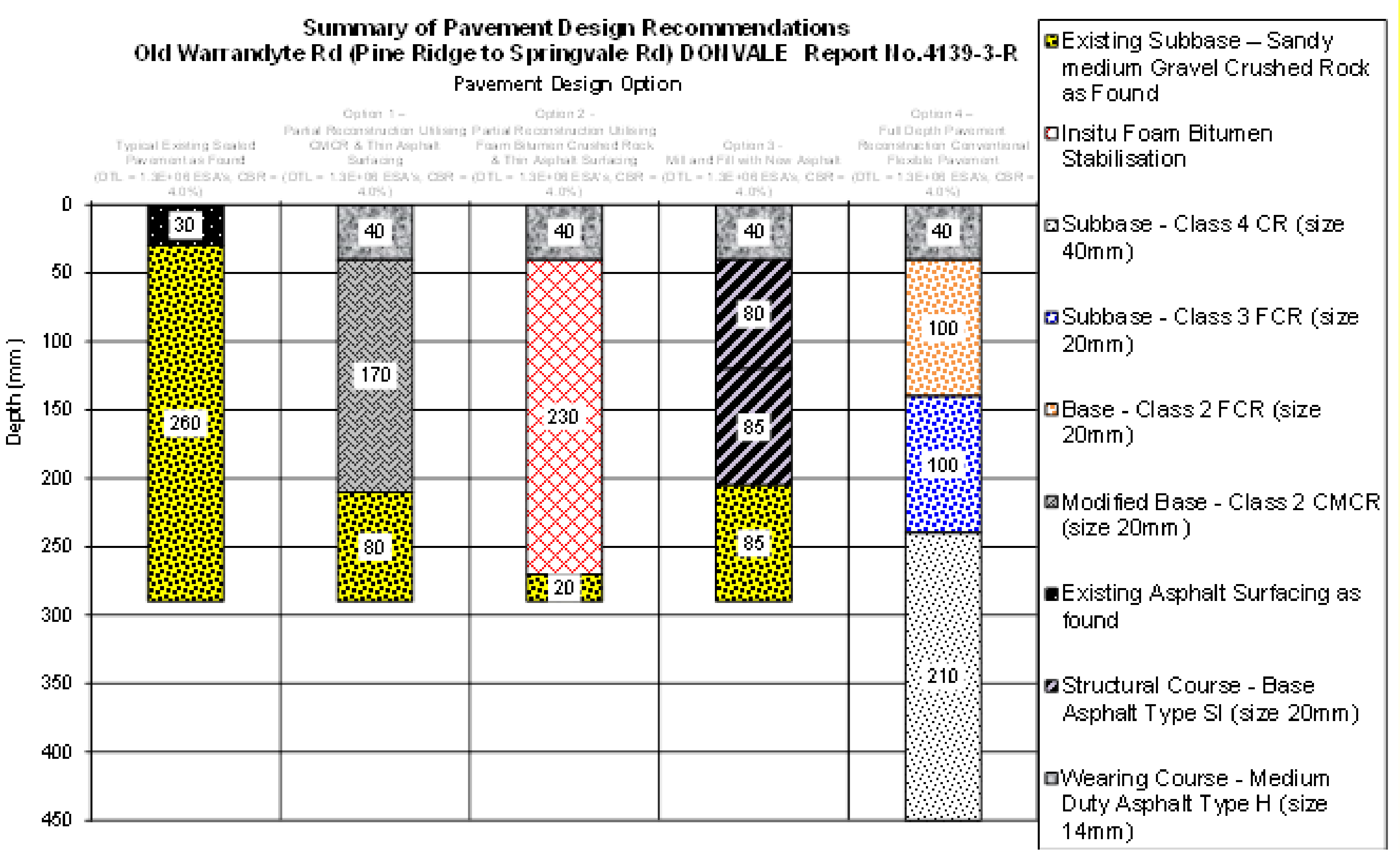
Typical Pictorial view of underlying pavement and subgrade materials encountered

Old Warrandyte Road DONVALE Ref R4139-3-r



Sieve Analysis

Old Warrandyte Road DONVALE Ref R4139-3-r



DENSITY TESTING & PROCEDURES

General Procedure

After soil / gravel has been compacted field density/moisture results are taken (Field Results)

These results are later compared with figures determined within the laboratory

Comparison between the Field and Laboratory results are used to give a ratio or percentage

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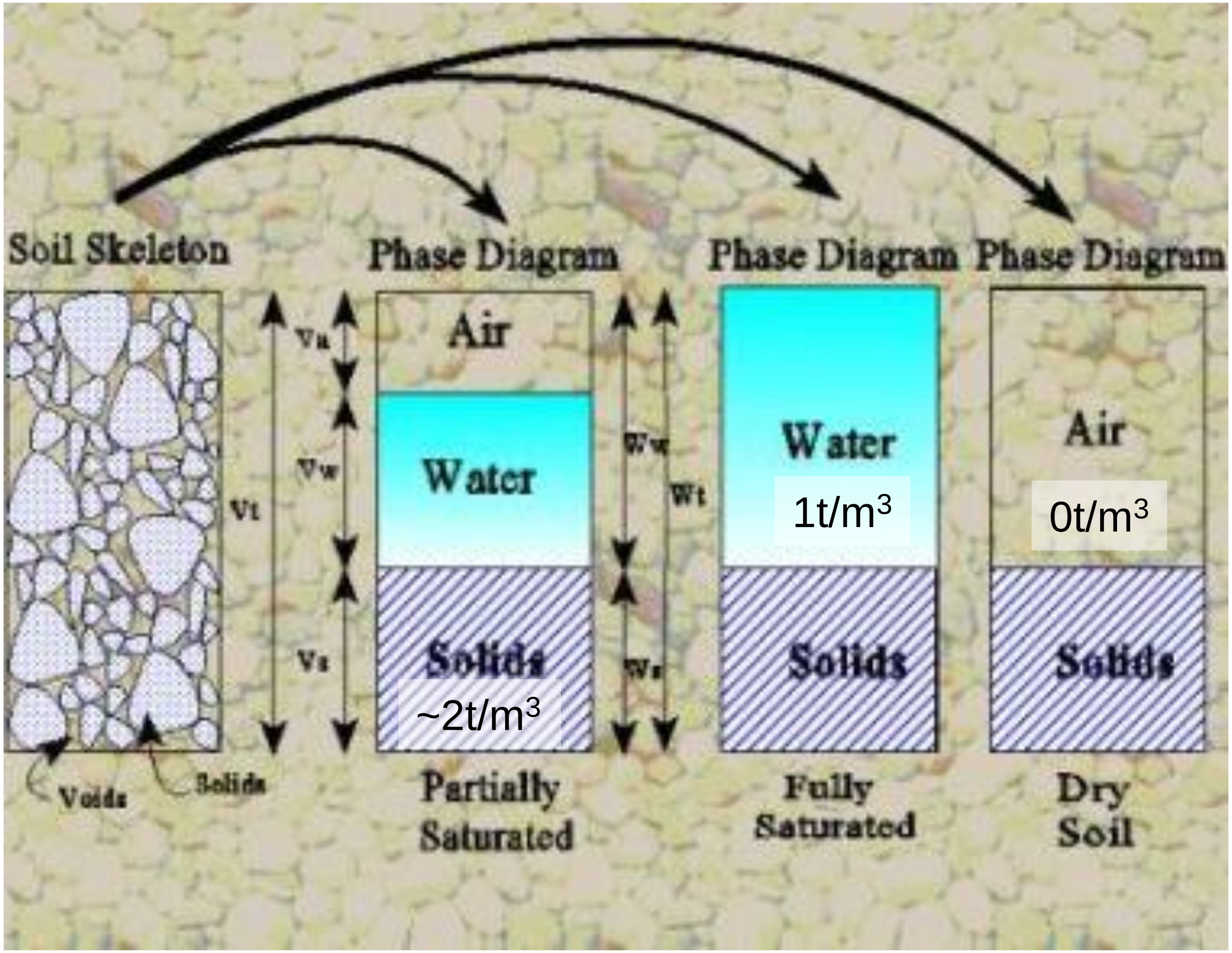
DENSITY TESTING & PROCEDURES




SUCCESS
FAILURE