





Traffic Speed Deflectometer

The Application of TSD Data in New Zealand for Asset Management and Design

Report prepared for: NZTA

Report prepared by: GeoSolve Limited

Distribution: NZTA GeoSolve Limited (File)

November 2016 GeoSolve Ref: 150003

Revision	Issue Date	Purpose	Author	Reviewed
1	01/11/2016	Client issue	DS	GAS
2	21/01/2020	Updated Logo	ELH	









PAVEMENTS



Table of Contents

1		Intro	bd	uction	1	
2		Data Formats and Parameters				
	2.1	1	Ba	asic bowl profiles	2	
	2.2	2	Go	oodness of Fit Parameter	3	
	2.3	3	Re	eliability ranking of bowl shapes	4	
	2.4	1	Re	epeatability	4	
3		Trar	nsf	formation of TSD to FWD-equivalent	9	
	3.1	1	In	troduction	9	
	3.2	2	Μ	lethods	9	
		3.2.1 Stati	on	Application of Transfer Function generated from TSD vs FWD relationship – Route Specific	9	
		3.2.2	2	QMR (Queensland Main Roads) Method 1	3	
3.2.3 Applic Specific Indiv		3 cifi	Application of Transfer Function generated from TSD vs FWD relationship – Network ic Individual Offset Method 1	3		
	3.3	3	Сс	onclusions1	5	
4		Stru	ct	ural Treatment Length Sectioning1	6	
5		Reality Check: Review of TSD Interpretation17				
6		Strain Gauge Modification				
7		Applicability				

1 Introduction

Traffic Speed Deflectometer (TSD) testing has now been carried out on New Zealand highways in 2015 and 2016 with the raw data available on RAMM. Worldwide, there has been considerable effort collecting and filing TSD information, but most agencies use only the central deflection, or central deflection and curvature¹, despite the availability of six laser readings.

Pavement practitioners can adopt a variety of empirical or mechanistic approaches from the TSD such as:

- Central deflection (equivalent to Benkelman Beam)
- Central deflection and curvature
- Central deflection and CBR
- Mechanistic analysis (of the full deflection bowl) using a linear layered elastic model
- Mechanistic analysis that accommodates either linear or non-linear moduli

General discussion on these approaches is given in the Austroads Guide² and the RIMS publications.³

The purpose of this study is to establish a nationally consistent, readily updatable database, and to document procedures intended to make all TSD deflection data more useable (able to be applied to all forms of pavements for both rehabilitation design and asset management by practitioners electing to use any of the above approaches).

Owing to the differences in the load configurations and forms of sensors used to calculate deflection bowls resulting from the FWD and TSD machines, a conversion is required to generate a directly comparable output. The TSD device records the deflection slope measured from the device's Doppler lasers, and a deflection bowl is calculated using integration, whereas the FWD vertical deflections are determined by geophones.

The aim is to allow the TSD data to be converted to the more familiar FWD output which would allow any TSD data collected to be directly compared to any historically collected FWD dataset.

An excel workbook is available, which will execute the various calculations documented in this report.

² Austroads 2012 Guide to Pavement Technology

¹ While the Curvature Function in Austroads is defined as the standardised (40 kN) value of D0-D200, overseas literature tends to use the similar Surface Curvature Index D0-D300 or SCI 300.

³ RIMS Body of Knowledge

http://rimsnz.yolasite.com/resources/Documents/RIMS_BoK_Documents/3.4ii.%20BoK%2011_001%20Collection%20Pavement%20Structural%20Parameters%20Part %201%20.pdf

http://rimsnz.yolasite.com/resources/Documents/RIMS_BoK_Documents/3.4ii.%20BoK%2011_001%20Collection%20Pavement%20Structural%20Parameters%20Part%2_ 0II.pdf

2 Data Formats and Parameters

2.1 Basic bowl profiles

FWD bowls are typically stored with deflections for offsets at 0, 200, 300, 450, 600, 750, 900, 1200 and 1500 mm from the centre of the 300 mm diameter load plate.

The TSD deflections necessarily differ from the FWD because different forms of load are applied (as shown in the following diagrams).

Falling Weight Deflectometer

- Force applied through stationary plate
- Deflections measured with Geophones
- High Accuracy
- Zero speed for measurement (static)
- Directions of stress and strain vectors remain constant during test

Traffic Speed Deflectometer

- Force applied through wheels
- Deflections integrated from velocity measurements with Doppler lasers
- Accuracy loss compensated by averaging
- High measurement speed
- Short measurement intervals
- Dynamic load is highly representative of actual traffic loading
- Vectors for stresses and strains rotate during test



Figure 2.1-1: Falling Weight Deflectometer profile



Figure 2.1-2: TSD Deflectometer profile

Because the loadings differ, any correlation between the two devices is dependent on the visco-elastic properties of the underlying pavement. Unless visco-elastic parameters can be adequately characterised for a proper dynamic analysis of the test, a rigorous correlation cannot be developed that encompasses all pavement/subgrade types.

Much international research is being directed towards this question, but until dynamic viscoelastic procedures are established, accurate transformations of TSD into FWD bowls can only be achieved with a specific algorithm developed empirically for each pavement/subgrade configuration, as shown in the following sections.

The dataset received from the supplier contains 2 different deflection bowls:

• the Greenwood bowl which considers any asymmetry of the bowl and extends from the bowl centre to 900 mm offset. However, no deflections are calculated for the customary FWD offsets at 1200 and 1500 mm.

• the ARRB bowl which assumes all bowls are symmetrical but does determine deflections at both 1200 and 1500 mm offsets.

Users of the data, therefore, have the option of using somewhat different bowls. Because the technology is new, there is not yet a consensus on which interpretation provides the more appropriate bowl for any specific circumstance, so it will be important for users to note which option they are adopting for any project.

Early trials with New Zealand data indicated that each of the two bowls could give more typical FWD bowl shapes in different circumstances, but on balance the ARRB bowl provided slightly more consistency. For that reason, only the ARRB bowl was used in subsequent transformations to "equivalent FWD" bowls. The equivalent bowl is intended to be used by practitioners with back-calculation software, layer modular ratios and fatigue criteria in exactly the same way as if the data were obtained from traditional Dynatest FWD equipment which has been used to populate the RAMM database over the last 20 years.

It should be noted that the deflection bowls and velocity slopes that are stored in the RAMM UDT tables have NOT been standardised to a standard load.⁴ The readings apply to the wheel load used at the time, including any dynamic load from road roughness, eccentric loading from road camber, rotational momentum (acceleration/braking), cross-wind etc., represented by the strain gauge reading.

In order to make suitable comparisons between FWD and TSD (especially over multiple years), all deflections referred to in this report from this point on will be regarded as standardised to a 40 kN load.

To distinguish the TSD data from any future developments in technology, datasets containing the ARRB interpreted bowl are here referred to as ARRB-12⁵, while the datasets for the transformed FWD equivalent bowl are referred to as NZ-16.1⁶.

The basic deflection bowls may also be used to provide <u>very approximate</u> estimates of empirical parameters, i.e.

- Subgrade Modulus (MPa) = $25000 \times D_{600}^{-1.14}$ (where D_{600} is in microns)⁷
- CBR = 0.1 x Subgrade Modulus

2.2 Goodness of Fit Parameter

While R² is the most widely used and reported measure of error and goodness of fit, a model that provides a statistical evaluation of the 1:1 relationship between observed vs. predicted variables while maintaining the typical 0-1 range of goodness of fit was preferred.

The equation developed to express the relationship is:

1:1 Correlation Statistic =
$$\frac{\sum_{i=1}^{n} \min\left(\frac{obs_i}{pred_i}, \frac{pred_i}{obs_i}\right)}{n}$$

http://rimsnz.yolasite.com/resources/Documents/RIMS_BoK_Documents/3.4i.%20BoK%2011_001%20Collection%20Pavement%20Structural%20Parameters%20Part%20 l%20.pdf

⁴ Richard Wix (ARRB), pers. comm.

⁵ Relates to the original paper, Muller & Roberts ARRB 2012

⁶ NZ 16.1 indicates 2016 derivation.

⁷ RIMS BoK details conversion of this isotropic modulus to anisotropic values used in CIRCLY

http://rimsnz.yolasite.com/resources/Documents/RIMS_BoK_Documents/3.4ii.%20BoK%2011_001%20Collection%20Pavement%20Structural%20Parameters%20Part%2_ Oll.pdf

This equation looks at the minimum of observed/predicted and predicted/observed (which will always be less than 1), sums all of those values up, and divides by the number of points.

2.3 Reliability ranking of bowl shapes

The reliability of any given bowl may be judged by inspection of the goodness of fit, which quantifies the relative compliance of any particular measured bowl with any other bowl generated from a methodical approach (e.g. integration of deflection slopes, forward analysis of moduli/layer thickness system etc.).

Typical ranges for NZ TSD data are:

Goodness of Fit	Typical Reliability of Moduli	Typical Percentage of Values
1.000 - 0.975	Very Good	75%
0.975 - 0.950	Good	20%
0.950 - 0.850	Fair	5%
0.850 - 0.000	Poor	<1%

 Table 2.3-1: Goodness of Fit – Typical Ranges

This parameter is useful for determining when decisions should give more weight to factors other than the TSD information, i.e. the visual survey and experience with historic performance, as well as indicating the need for as-built information or additional subsurface investigations.

2.4 Repeatability

Repeatability studies carried out without delay at the same vehicle speed have been undertaken by many agencies (see figure below), with most publications showing that, for all practical purposes, results carried out on the same day are essentially the same.



Figure 2.4-1: Vehicle Speed Comparison – from Queensland Trial of TSD (Weligamage et al)

Repeatability studies carried out without delay at different vehicle speeds show that deflection results can vary slightly at speeds over 30-40 kph, but for practical purposes may be considered similar.

However, at speeds under 30 kph, deflections tend to be higher, sometimes increasing by a factor of up to 2 or more, as speeds diminish towards 0 kph. This characteristic is well known and has been observed in Benkelman Beam studies. The greatest differences are on soft cohesive subgrades. As standard procedure is to collect all TSD data at not less than 30 kph, this characteristic (which should be considered carefully for intersection design) is not discussed further.

In order to determine what factor may apply between any two runs, the most convenient representation is to plot the deflection axis at a log scale, as shown below.





Figure 2.4-2: Two examples comparison of TSD runs (2015 - 2016) with FWD data

When comparing TSD data on NZ state highways in successive years (2015 and 2016), the *general trend* is reasonably strong.

However, as can be clearly seen in the following example, both TSD sets seem to be generally underestimating the FWD deflection (as expected, given differences between the contact area configurations of the two devices), but the TSD distributions also show differences between successive years.



Figure 2.4-3: Cumulative distribution comparisons of TSD runs (2015 – 2016) with FWD data

The entire 2015 and 2016 RAMM TSD data sets were collated into one file and filtered down so that the road id, lane, start_m and end_m matched across the row for both sets allowing a direct comparison from 2015 to 2016 for each 10 m section.

Of the 684,978 matching records, 666,269 (97.2%) and 651,843 (95.2%) records had values for load and raw d0 (i.e. were not blank or zero) for the 2015 and 2016 sets respectively.

The 2016 raw TSD deflections are on average about 15% smaller than the previous year (that is without standardising the deflections using the applied load). Another anomalous observation is that the applied load (from the strain gauge readings) is recorded to have gone *up* approx. 8% from 2015 to 2016, which compounds the standardised deflection error to a 25% drop between the years.



Figure 2.4-4: Cumulative distribution comparisons of the RAMM TSD data sets (2015 – 2016)



Figure 2.4-5: Comparison of Raw TSD central deflections (2015 – 2016)

Some of the difference may be due to preceding rainfall, humidity and temperature effects, and further studies can be carried out readily for any particular case of interest by comparing

the changes in respective layer moduli in relation to climate data, materials and water table fluctuations. Vehicle wander is obviously another factor which may account for differences in successive years, which would be more likely where there are wide lanes and sharp bends.

Deflections on bridges are not reported in the dataset. Assuming that information would be collected automatically, deleting it has drawbacks in that it discounts the use of this data as regular checks for repeatability, bearing in mind that seasonal effects are likely to cause minimal change to deflection in concrete structures. Access to unfiltered data files would be advantageous.

Fluctuations of deflections or strains may often be in the range of 10%, and therefore when using the Austroads subgrade strain criterion (which relates pavement life inversely to the 7th power of subgrade strain), a 10% difference in strain translates to a factor of 2 in pavement life. This is significant, but not unduly so when it is noted that in practice, most "homogeneous" treatment lengths on rural highways tend to exhibit an order of magnitude range in pavement life e.g. 2 to 20 years or say 10⁶ to 10⁷ ESA.

3 Transformation of TSD to FWD-equivalent

3.1 Introduction

This section summarises alternative methods that may be used to transform Traffic Speed Deflectometer (TSD) deflections to Falling Weight Deflectometer (FWD) deflections. A spreadsheet can be provided that can be used to calculate the transformed bowls.

3.2 Methods

3.2.1 Application of Transfer Function generated from TSD vs FWD relationship – Route Station Specific

This method was originally developed in search of a national transformation, but case histories soon demonstrated that it is best used for more localised applications after calibration for a set of roads where both FWD data and TSD data exist.

A simple transfer function is generated comparing the distribution of FWD deflections (d_x) at any given offset position (ranging from 0 to 1500 mm) from the centre of the load (x) with the corresponding distribution of deflections under TSD. This result is a plot of FWD d_x against TSD d_x for the specific Route Station (RS), but the same concept could potentially be applied to an entire network.

The transfer function is generated in the form:

$$FWD(TSD d_x) = A * TSD d_x^2 + B * TSD d_x$$

This function is applied to the raw TSD data at the corresponding geophone offset d_x . The function for the example case below is illustrated by the dashed trend line below:



Figure 3.2-1: Example case plot of FWD d0 vs TSD d0 comparison

The FWD d_0 vs TSD d_0 example plot shows that TSD deflections appear to be underestimates when compared to the FWD deflections.

For the example case above that was analysed, a goodness of fit value of 0.886 was determined across the entire distribution of d_0 prior to transformation, which upgraded to a value of 0.981 following transformation. The FWD data were compared to the transformed TSD data as a cumulative distribution to quantify the effectiveness of the relationship, as illustrated below.



Figure 3.2-2: Example plot of cumulative distribution of FWD and 2015 TSD compared for the same route station before and after transformation

This plot illustrates a significantly improved TSD deflection distribution post-transformation when comparing to the FWD deflection distribution.

Plotting the same data against chainage shows that the transformation has largely modified the data in the right direction, and relative to the magnitude of the original deflection.

However, there are still a few sections where the FWD and TSD still do not correlate well (e.g. 1.7 - 1.8 and 2.9 - 3.0 km on the following plot).



Figure 3.2-3: Chainage plot of FWD and 2015 TSD compared for the same route station before and after transformation



The same transfer function was then applied to the following year's TSD data to conclude if reliability exists between data sets for the 2015 versus 2016 TSD runs.



The comparison between TSD datasets from 2015 and 2016 shows a significant shift from year to year. This suggests that the transfer function generated from one year's data for a specific Route Station (RS) cannot be applied directly to historic or future data with a high degree of confidence, although relativity between chainages is still likely to be consistent.



Figure 3.2-5: Example plot of cumulative distribution of FWD and 2016 TSD compared for the same route station before and after transformation, and showing equivalent 2015 function

The same level of confidence can be significantly less when applying the above generated transfer function to a different RS. This is illustrated below where the transfer function generated from the example case is applied to a different route station. This results in the transformed TSD distribution showing a less accurate representation of the FWD distribution across the length of the route station. The differences are relatively less at higher deflections - hence, critical points are less influenced in this case, but all the same, caution is required with any network-wide transformation.



Figure 3.2-6: Example plot of cumulative distribution of FWD and TSD for 01S-0569 compared using the transformation from 045-0081

To use this method with any confidence, a transfer function should be generated from within each route station, and for each deflection offset.

3.2.2 QMR (Queensland Main Roads) Method

This method was developed to be used across the entire Queensland network, but when it was applied in practice to NZ situations, was found to be limited. The technique has been evolving, and the latest nominal relationship for Queensland just received⁸ (yet unpublished) is shown in Equation 3.

Note: The unit for deflection used in this method is microns.

$$d_{0}(FWD) = \frac{40.129 + d_{0TSD}}{0.9845}$$
$$d_{x}(FWD) = d_{0}(FWD)e^{(-\frac{x}{k_{2,x}})}$$

Where the $k_{2,x}$ values are provided by the method to be:

$k_{2,200} = 590, k_{2,300} = 460, k_{2,450} = 444, k_{2,600} = 463 \text{ and } k_{2,900} = 527$

An example of this method is shown in Appendix D, Figure D2 showing the cumulative distribution of FWD d_0 against the raw and transformed TSD d_0 distribution for the same Route Station. The Queensland calibrated factors were applied to an example road in New Zealand to show the degree of applicability of this transformation to other regions.

A significant limitation of this method is that it transforms only d_0 (discarding the rest of the bowl) and then generates the remainder of the bowl using a characteristic bowl shape derived for the network. Discarding most of the collected data in this fashion is contrary to the goals of the NZ study. It is, however, reported here in case future versions do become more appropriate, as it is the only other attempt worldwide to address this issue from enquiries to date.

Owing to the above limitations, this method is only detailed further in Appendix D as the methodology presently used is not considered ideal. A suggested modification of this method to improve the reliability for New Zealand sites is also contained in Appendix D.

3.2.3 Application of Transfer Function generated from TSD vs FWD relationship – Network Specific Individual Offset Method

This method has been developed to be used across an entire network. The nominal relationships derived from FWD comparisons are shown below in Equation Set 4.

The transfer functions modify the composite moduli directly. Firstly, the TSD deflections (for the given offsets below) are converted into their corresponding composite moduli (CM_x). Next, the transfer functions below are applied producing transformed composite moduli (CM'_x) which are then converted back into an FWD-equivalent deflection bowl. The deflections for the remaining offsets (200, 450, 750 and 1200 mm) are interpolated.

(3)

⁸ Gary Chai, pers. comm.

$$CM'_{0} = (0.0225 * LN(CM_{0}) + 0.778) * CM_{0}$$

$$CM'_{300} = (-0.06 * LN(CM_{300}) + 1.071) * CM_{300}$$

$$CM'_{600} = (-0.11 * LN(CM_{600}) + 1.267) * CM_{600}$$

$$CM'_{900} = (1.119 * \frac{CM_{600}}{CM'_{600}}) * CM_{900}$$

$$CM'_{1500} = (-0.925 * LN(\frac{CM_{1500}}{CM_{900}}) + 1.239) * CM_{1500}$$
(4)



Figure 3.2-7: Transformation for d0 using Individual Offset Method showing a good correlation (0.98)



Figure 3.2-8: Transformation for d0 showing only a marginally improved correlation (0.83)

In this case, the critical points (with highest deflection) have relatively smaller differences, but it does need to be appreciated that any correlations applied across networks can have limited reliability in some situations.

3.3 Conclusions

Several methods for transforming New Zealand TSD deflection bowls (d_x) into equivalent FWD deflection bowls have been examined and are (order of preference):

- (i) Network Specific Individual Offset Method
- (ii) Route Station Specific Method
- (iii) QMR Method

The most favourable method outlined is the Network Specific Individual Offset Method, which provides a strong transformation from TSD recorded deflection to an equivalent FWD deflection for the given offsets unlike the QMR method which only <u>calculates</u> an equivalent FWD deflection for d_0 , d_{200} , d_{300} , d_{450} , d_{600} and d_{900} . The Route Station Specific Method does have the ability to be applied across the entire range of offsets but requires a direct calibration at each offset. Using this method produces good accuracy, but the calibration stage is case specific and therefore time consuming.

The current QMR methodology was determined to be unreliable when applied to the New Zealand road network. Using only the central deflection from the TSD dataset and then generating a deflection bowl from only this point gives significant uncertainty on the reliability of the method, particularly as the offset distance increases.

A workbook with all the evaluated methods, including the recommended Network Specific Individual Offset Method, is available.

4 Structural Treatment Length Sectioning

Sub-sectioning of any road where TSD data have been evaluated uses the same principles as FWD. However, because there are so many data points, in order to establish the start and end points of each structural treatment length, it is more convenient to use auto-sectioning techniques. Typically, this is done with a CUSUM-like method which examines the results of the analysis to delineate intervals where the remaining life is relatively uniform. Any sections which are in a terminal condition, are sub-sectioned further into intervals where similar thicknesses of treatments are required.

The outputs for each structural treatment length (remaining life, generic remedial treatment options and critical parameters) can then be provided in common formats, such as spreadsheets and Google Earth KMZ files, as well as RAMM fields and dTIMS output sheets. Case history examples from the New Zealand data are provided in an accompanying presentation.

5 Reality Check: Review of TSD Interpretation

As a reality check on how useful the TSD data could be in practice, 50 km pilot sections of state highways (one North Island and one South Island) were nominated so that both the basic empirical data and the more detailed mechanistic analyses could be subject to the scrutiny of NZTA RAPT⁹ engineers that had close familiarity with the historic long term performance and current condition of the specific roads. This was carried out in two passes. The 50 km pilot sections are displayed in appendices E and F.

The first pass was an interpretation of the TSD data by an analyst with no familiarity with the networks and no incorporation of any RAMM information except the current traffic loading. The empirical design parameter was the Austroads Simplified remaining life method (which uses only the equivalent standard central deflection from the TSD, and the nominal granular overlay thickness).

The mechanistic analyses (without other RAMM information) were used to generate the corresponding parameters (remaining structural life and granular overlay). Presentation of this information revealed that the TSD outputs did correctly identify some of the treatment lengths planned for treatment in the next year or two, but there were also examples where interpretation of the TSD data identified treatment lengths in the medium term (3-7) years that were not on the current FWP. The issue then becomes which of the two predictions will eventuate, and while this will be established in due course, in the meantime it is clearly necessary to focus on the short to medium term, i.e. next 1-2 (or possibly 3) year plan for TSD reality checks¹⁰.

From historic performance and visual inspections, NZTA's RAPT managers have identified the following rehabilitation treatment lengths:

South Island Sites (Appendix E)	Year for Rehabilitation
• SH 1 RP 583/ 310-900	16/17
 SH 1 RP 583/ 900-1700 	17/18
 SH 1 RP 583/ 14970-15500 	18/19
• SH 1 RP 651/156-800	16/17
 SH 1 RP 651/5700-6200 	15/16
• SH 1 RP 683/ 7160-9200	15/16
North Island Sites (Appendix F)	Year for Rehabilitation
• SH 2 RP 544/ 5080-5190	16/17
• SH 2 RP 707/ 13040-13114	16/17

⁹ The Transport Agency's Review and Prioritisation Team

¹⁰ The findings were sufficiently encouraging, for the RAP Team to recommend that the next step should be for the analyst to now incorporate the relevant RAMM data and establish a local link to the Roadrunner software to determine whether a closer calibration could then be achieved to the short term. This work is in progress.

6 Strain Gauge Modification

A review of TSD data has highlighted some areas of concern with regards to the strain gauges. Presented below is each successive year of TSD data for the left strain gauges on SH01N-0557. The two graphs below present the observed differences in the left strain gauge over the four years of TSD testing, uncorrected and corrected.

Using SH01N-0557 shift functions were developed for the TSD strain_gauge_left readings for each year (to map 2016, 2017 and 2018 onto 2015). The *modified* strain gauge_left reading to convert the mass into the average load applied by the dual wheels for each 10 m interval. Generally, the more concave upward the pavement is over any given 10 m, then the greater will be the average load applied by the moving wheels (and vice versa). The strain gauge corrections are critical when correlating FWD and TSD. However when calculating remaining life, because the static axle load of the TSD used to date in New Zealand has reportedly been constant, the most simple approach for determining remaining life is to make the assumption that all heavy axles will have similar dynamic components to their loads as exhibited by the TSD. Hence for analysis and design adopt the TSD load as its static value and the TSD deflections as their dynamic values (without any strain gauge correction. If shape correction is being adopted this will no longer apply.)

ARRB report that issues with the strain gauges have been referred to the manufacturer, and should be addressed in future.

Transfer functions:

2015 = *x**0.00981 2016 = (*x**0.899+261)*0.00981 2017 = (*x**1.018+4)*0.00981 *2018* = (*x**1.035+1930)*0.00981



Figure 6.1 – Strain Gauge Left, uncorrected. Raw Percentile values.



6.2 – Strain Gauge Left, corrected.

7 Applicability

This report has been prepared for the benefit of NZTA with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose without our prior review and agreement.

Report prepared by:

Mike Plunket Graduate Engineer Gina Schmitz Graduate Civil Engineer

Reviewed for GeoSolve Ltd by:

.....

Dave Stevens Pavements Team Leader

Authorised for GeoSolve Ltd by:

Graham Salt

.....

Graham Salt Technical Director

Appendix A

SH8 RS169 L1 comparing 2015 and 2016 TSD datasets



Figure A1: Standard Central Deflection plot comparing TSD data for 2015 and 2016 for SH8 RS169



Figure A2: Curvature d0s – d300s plot comparing TSD data for 2015 and 2016 for SH8 RS169



Figure A3: Deflection Slope at 600 mm offset plot comparing TSD data for 2015 and 2016 for SH8 RS169



Figure A4: Deflection Slope at 900 mm offset plot comparing TSD data for 2015 and 2016 for SH8 RS169

Appendix B

SH90 RS35 L1 comparing 2015 and 2016 TSD datasets



Figure B1: Standard Central Deflection plot comparing TSD data for 2015 and 2016 for SH90 RS35



Figure B2: Curvature d0s – d300s plot comparing TSD data for 2015 and 2016 for SH90 RS35



Figure B3: Deflection Slope at 600 mm Offset plot comparing TSD data for 2015 and 2016 for SH90 RS35



Figure B4: Deflection Slope at 900 mm Offset plot comparing TSD data for 2015 and 2016 for SH90 RS35

Appendix C

Example applications of TSD Data



Figure C1: Transfer function generated from 2015 TSD/FWD data applied to 2015 and 2016 data



Figure C2: Transfer function generated from 2015 TSD/FWD data RS569 applied to RS583



Figure C3: Transfer function generated from RS569 d0 applied to RS569 d200

Appendix D

QMR Method (Additional Notes)

The transfer at D_0 proves to be somewhat effective for this specific case as shown in Figure D2, but due to the method generating deflections for offsets based solely on the central deflection, the method does not hold as the deflection offset increases.

Figure D3 shows the QMR method transformation at D_{600} using the set "k" factor - this proves to be a very ineffective transformation from TSD to an equivalent FWD deflection. To improve the transformation at D_{600} , the "k" factor was calibrated to the specific Route Station. A linear trend was generated for the input "k" factor, this allowed an increasing "k" factor to be applied across the Route station as the deflection reading increased. This addition improves the ability to fit the transformed TSD deflections to an equivalent FWD deflection.

The trendline generated for the calibration is shown in Figure D1, where the resulting calibrated transformation using the increasing value for "k" is shown in Figure D4. This proves effective but requires too specific calibration (each route station) and therefore has been left out of the Network Specific Individual Offset Method.



Figure D1: Calibration for k value increase as deflection increases

Using the modified concept for the k_x factor the equation becomes:

$$D_{0}(FWD) = \frac{40.129 + D_{0 TSD}}{0.9845}$$
$$D_{x}(FWD) = D_{0}(FWD)e^{(-\frac{x}{slope_{x}*D_{0}}(FWD) + intercept_{x})}$$



Figure D2: QMR method, transformation for central deflection, d0



Figure D3: Uncalibrated QMR method, provided k value



Figure D4: Calibrated QMR method, with k value increasing with deflection

Appendix E

Coastal Otago 50 km Pilot Sections 01S RS569 & SH90 RS0 – Both Lanes
Summary Plot: 01S – 0569 L1 FWD

Granular Overlay and Remaining Life



LUATION: 015-0569 Lane L1 (14/08/2014)				
01S – 0569 L1 ioscale		╺┽────			
FW/D					
		~			
2 Standard Central Deflection (mm)	·/				
Curvature Function (mm)					
1 RPP Critical Layer					
300 Granular Overlay (mm) - NZ RPP Fatigue Model					
²⁵ Life (Years) - RPP Structural Fatigue (Governing)					
²³ Life (Years) - RPP Surfacing Fatigue (Governing) 0					
²³ Life (Years) - RPP Structural (Governing Deterministic) 0					
²⁵ Life (Years) - RPP Structural (Aggregate Rutting) 0					
²⁵ Life (Years) - RPP Structural (Shallow Shear) 0					
²² Life (Years) - RPP Structural (Subgrade Rutting) 0					
²³ Life (Years) - RPP Structural (Subgrade Shear) 0					
²³ Life (Years) - RPP Structural (Seal Deformation) 0					
²⁵ Life (Years) - RPP Surfacing Flexure 0					
²⁵ Life (Years) - RPP Cemented Base Cracking 0					
23 Life (Years) - RPP Structural Economic 0					
³³ Life (Years) - RPP Surfacing Economic o					
²⁵ Life (Years) - RPP Aggregate Instability 0					
⁵ Priority (Local) for Drainage			┌└────││└┟───		
 Granular Overlay (mm) - Austroads (GMP-Rigorous) All Layers 					
300 Granular Overlay (mm) - Austroads 2011 (Part 5) 0					
³³ Life (Years) - Austroads (GMP-Rigorous) 6					
Elfe (Years) - Austroads 2011 (Part 5) - Granular			8	10	12

MESA: 6.132 | Layer 1 Thickness: 160 | Depth to Subgrade: 265 to 580

Summary Plot: 01S – 0569 L1 TSD

Granular Overlay and Remaining Life



	LUATION: 015-0569 L1 (22/01/2015)								
01S – 0569 L1	noscale man and man	when when when when when when when when	month	hundre	human	monterna	mportamp	······································	mannen
TSD	Manman of the state of the stat	1.44 10 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	1 1 m 1 m 1 m	an and the second s	month	V T W WWWWWWW	where have been	with	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
	monthly photomally	whowmand	hitration	worth _	horning	reh marchadende	muchum	welly work would be a set of the	un home margan de
² Standard Central Deflection (mn	n) wMmmmmmmmmmmmmmmmmmmmmmmmmmmmmmmmmmmmm	mh.m.m.		manne	montin	mmmm	month	mmmmm	mmmmM
² Curvature Function (mm)									
1 RPP Critical Layer									
300 Granular Overlay (mm) - NZ RPP	Fat gue Model								
Life (Years) - RPP Structural Fatig	gue (Governing)	Π							
Life (Years) - RPP Surfacing Fatig	ue (Governing)								
Life (Years) - RPP Structural (Agg	rregate Rutting)								
Life (Years) - RPP Structural (Sha	llow Shear)		T						
Life (Years) - RPP Structural (Sub	grade Rutting)								
Life (Years) - RPP Structural (Sub	igrade Shear)								
Life (Years) - RPP Surfacing Flexu	ire								
Life (Years) - RPP Cemented Bas	e Cracking								
Life (Years) - RPP Structural Econ		معر وبالدال	i ws mir					C. C	
Life (Years) - RPP Surfacing Econ	omić,	1			m n	nr ¹ h h		a interes	
Life (Years) - RPP Aggregate Inst	ability	11							
Priority (Local) for Drainage	When and with the sure book	Manhuman	1.4		Chartrane Mon	M. Marcallan	allement	and my advanta	manus and a sub-
300 Granular Overlay (mm) - Austroa	ads (GMP-Rigorous) All Layers							MUNDER PAR 4 Hod . 0 . P	
° ³⁰⁰ Granular Overlay (mm) - Austroa	ads 2011 (Part 5)		IIIIII.	<u></u>					
Life (Years) - Austroads (GMP-Ri	gorous)								
Life (Years) - Austroads 2011 (Pa	rt 5) - Granular								
	2	4		6		8	10	12	
	o								

MESA: 6.132 | Layer 1 Thickness: 135 | Depth to Subgrade: 375 to 525

JIS – USOY KI arithmicscale				
FWD				
² Standard Central Deflection (mm)		 	 	
² Curvature Function (mm)				
a RPP Critical Layer				
Granular Overlay (mm) - NZ RPP Fatigue Model				
²⁵ Life (Years) - RPP Structural Fatigue (Governing)				
³⁵ Life (Years) - RPP Surfacing Fatigue (Governing)				
²⁵ Life (Years) - RPP Structural (Aggregate Rutting)				
²⁵ Life (Years) - RPP Structural (Shallow Shear)				
25 Life (Years) - RPP Structural (Subgrade Rutting)				
²⁵ Life (Years) - RPP Structural (Subgrade Shear)				
²⁵ Life (Years) - RPP Structural (Seal Deformation)				
25 Life (Years) - RPP Surfacing Flexure				
25 Life (Years) - RPP Cemented Base Cracking				
²³ Life (Years) - RPP Structural Economic				
25 Life (Years) - RPP Surfacing Economic				
25 Life (Years) - RPP Aggregate Instability				
Priority (Local) for Drainage				
300 Granular Overlay (mm) - Austroads (GMP-Rigorous) All Lay	/ers			
⁰ ³⁰⁰ Granular Overlay (mm) - Austroads 2011 (Part 5)				
o ²⁵ Life (Years) - Austroads (GMP-Rigorous)				
²⁵ Life (Years) - Austroads 2011 (Part 5) - Granular				

	LUATION: 015-0569 R1 (04/02/	2015)																		
01S – 0569 R1	aigocale	m	n	m		m	Jamer	-	sing	munoran		mum	- manual	ymme	m	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~			4mm	****
TSD	Je sa Mala a construction and a construction of the construction o	W	n ng hang		- www.	8-8-2-Mar	hrm	V V V	Ar-M	www.wa	J.		www.warden.com	᠂᠆ᠾ᠆ᡙᡘ᠆ᡀ	ᠰ᠆᠆᠆᠘ᠰ᠉᠂ᡎ	MIN		- WA	www	nrymi
-0.6			لسداكس			h			nuh	utumut.	A		al water may	minulu	Lenda	_^n		n	ոթու	u
² Stahdard Central Deflection (mm)	human	mmmm	1mm		monda.	manim	-A-Mart	hnem	quart	homen	m.	ma	mannam	and more	mmm				while	mhr
² Curvature Function (mm)									~~~~				~~~~~~~	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~			~~~~			<u>^</u> ^-
								U												
 ³⁰⁰ Granular Overlay (mm) - NZ RFP Fa o mm audu a dimension mm a shu 	atigue Model			Kalan I aan Kala		dd		hin.com.c.c.					m.h	Maarata				00		
Life (Years) - RPP Structural Fatigu	e (Governing)					Т, 1 р.	A Maria													
Life (Years) - RPP Surfading Fatigue	e (Governing)																			
Life (Years) - RPP Structural (Aggre	egate Rutting)														8					
Life (Years) - RPP Structural (Shallo	bw Sh⊵ar)																			
Life (Years) - RPP Structural (Subgr	ade Rutting)					1														
Life (Years) - RPP Structural (Subgr	ade Shear)																			
Life (Years) - RPP Sulfading Flekum	2																			
Life (Years) - RPP Cemented Base	Cracking																			
Life (Years) - RPP Structural Econo		With:	i it			1	in the second	G UTP	1. diffe	أألف ال	đ	in h	n inii		(appent)	hinaaa	1.3.3.	CE MIN		
Life (Years) - RPP Suffacing Econor	nic al (P II P)	11 115				14.16									110.43					
Life (Years) - RPP Aggregate Instat	pility																			
Priority (Local) for Drainage 	my my ham	~ Mu	4 rd	TW'IM	a 1, 111 1	⁰ A A		and the second second	Ply		yu			-h-lotte	Low by Level		1470	"Thy	ILn	
300 Granular Overlay (mm) - Austrbad o	s (GMP-Rigorous) All Layers	. iu . iu					Million					6	l			- N.			d in L	۸۸n
300 Granular Overlay (mm) - Austrbad o	s 2011 (Part 5)								IJ				ni	L. h. h. ll						
Life (Years) - Austroads (GMP-Rigo	prous)	.1			1 T	1			1	1										
Life (Years) - Austroads 2011 (Part	5) - Granular																			
	2		4				6			8				10			12			
MESA, 612211 aver 1 Thickness 1251 Donth to St	ubarada 200 to 405																			

Summary Plot: 090 – 0000 L1 FWD

Granular Overlay and Kernanning Life	Granular	Overlay	and	Remaining	Life
--------------------------------------	----------	---------	-----	-----------	------



AL EVALUATION: 090-0000 Lane L1 (21/08/2014)			
090 – 0000 L1 arithmic Scale			
¹ <u>Standard Central Deflection</u> (mm)			
² Curvature Function (mm)	L		
			الك ومحد وحدد ولا
300 Granular Overlay (mm) - NZ RPP Fatigue Model			
Life (Years) - RPP <mark>St</mark> ructural Fatigue (Governing)			
Life (Years) - RPP Surfacing Fatigue (Governing)			
Life (Years) - RPP Structural (Aggregate Rutting)			
Life (Years) - RPP <mark>St</mark> ructural (Shallow Shear)			
Life (Years) - RPP Structural (Subgrade Rutting)			
Life (Years) - RPP Structural (Subgrade Shear)			
²⁵ Life (Years) - RPP Structural (Seal Deformation)			
²⁵ Life (Years) - RPP Surfacing Flexure			
²⁵ Life (Years) - RPP Cemented Base Cracking			
²⁵ Life (Years) - RPP Structural Economic			
²⁵ Life (Years) - RPP Surfacing Economic			
²⁵ Life (Years) - RPP Aggregate Instability			
Priority (Local) for Drainage			
300 Granular Overlay (mm) - Austroads (GMP-Rigorous) All Layers			
³⁰⁰ Granular Overlay (mm) - Austroads 2011 (Part 5)			
²³ Life (Years) - Austroads (GMP-Rigorous)			
²³ Life (Years) - Austroads 2011 (Part 5) - Granular			
209 25 Year Traffic (MESA) - Logarithmic Scale			
2 4 6 8	10	12 14	16

MESA: 0.942 to 1.436 | Layer 1 Thickness: 130 to 140 | Depth to Subgrade: 290 to 595

Summary Plot: 090 – 0000 L1 TSD

Grandial Overlay and Kernalining Life	Granular	Overlay	and	Remain	ing Life	e
---------------------------------------	----------	---------	-----	--------	----------	---



ILUATION: 090-0000 L1 (28/	/01/2015)							
090 – 0000 L I aicseale	mon for a second	m	mmmmm	monum	mannen	and many	mannen	monterman
TSD	w. www.	and a second water and a	man man and	mmmmm	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	Man Mary Mary Mary	manystry	markament
a lot is the produce of monological and the	mucher moles	In May carmy	Anna A A Anna	h	relland in a .	when would a	du altra	
² Standard Central Deflection (mm)	man man	Man Minun	Man Marken	minint	man man han me	hummen	mann	Mayamanan
² Curvature Function (mm)	N		m marine	min anna		m man and	handreme Ma	M. mm ~~~
APP Critical Layer		******						
³⁰⁰ Granular Overlay (mm) - NZ RPP Fatigue Model	<u></u>							
Life (Years) - RPP Structural Fatigue (Governing)								
Life (Years) - RPP Surfacing Fatigue (Governing)								
Life (Years) - RPP Structural (Aggregate Rutting)								
Life (Years) - RPP Structural (Shallow Shear)								
Life (Years) - RPP Structural (Subgrade Rutting)								
u Life (Years) - RPP Structural (Subgrade Shear)								
o ²⁵ Life (Years) - RPP Surfacing Flexure								
o ²⁵ Life (Years) - RPP Cemented Base Cracking								
o ²⁵ Life (Years) - RPP Structural Economic					n n and <mark>a t</mark>	1 1 1		
o ²⁵ Life (Years) - RPP Surfacing Economic								
e ²⁵ Life (Years) - RPP Aggregate Instability								
Priority (Local) for Urainage			les la selle	III n.M.a				
ه مراجع المعالية من معالم المعالية (GMP-Right of the second second second second second second second second se معالية معالية (GMP-Right of the second se	<u></u>		<u> 1</u> ////////////////////////////////////	MALLE W WAL			W L. AMANAMAN	My and and and
			rhan in Viall	.		1		Radio and the second second
³⁰⁰ Granular Overlay (mm) - Austroads 2011 (Part 5)	., L	a iddiaaa	destin <mark>tion</mark> t	ha AAA.	الملقا للمالة ألماني ورار		unidakan da	a la line a dial
²⁵ Life (Years) - Austroads (GMP-Rigorous) 0	<u> </u>		T		TI YING DER KIN			
²⁵ Life (Years) - Austroads 2011 (Part 5) - Granular					NAM PER DIA 1			
2	4	6	8	10	12		14	16

MESA: 0.942 to 1.436 | Layer 1 Thickness: 135 | Depth to Subgrade: 405 to 515

$\frac{1 \text{ EVALUATION: 090-00}}{1000 - 000 - 000}$	000 Lane R1 (21/08/2014)					
FWD #	~~~~~					
		╶╌╻┯┯┯┲┚				
² Standard Central Deflection (mm)				~		╺───┥┎┟┍┝─╴
² Curvature Function (mm)						
1 RPP Critical Layer			┈┝┾╌┑╻┝┑╴			╶────┶┼╾┿╱┝╌╻
300 Granular Overlay (mm) - NZ RPP Fatigue Model						
²⁵ Life (Years) - RPP Structural Fatigue (Governing)						
²⁵ Life (Years) - RPP Surfacing Fatigue (Governing)						
²⁵ Life (Years) - RPP Structural (Aggregate Rutting)						
²⁵ Life (Years) - RPP Structural (Shallow Shear)						
²⁵ Life (Years) - RPP Structural (Subgrade Rutting) o						
²⁵ Life (Years) - RPP Structural (Subgrade Shear) o						
²⁵ Life (Years) - RPP Structural (Seal Deformation)						
²⁵ Life (Years) - RPP Surfacing Flexure o						
²⁵ Life (Years) - RPP Cemented Base Cracking 0						
²⁵ Life (Years) - RPP Structural Economic						
²⁵ Life (Years) - RPP Surfacing Economic o						
²⁵ Life (Years) - RPP Aggregate Instability o						
Priority (Local) for Drainage			~			
 Granular Overlay (mm) - Austroads (GMP-Rigorous 	s) All Layers					
300 Granular Overlay (mm) - Austroads 2011 (Part 5)						
²⁵ Life (Years) - Austrbads (GMP-Rigorous)						
²⁵ Life (Years) - Austrbads 2011 (Part 5) - Granular						
2	4 6	8	10	12	14	16

090 - 0000 RT 150000	- ~ may many market	mound	monorman	howwww	man man man man	mummer
TSD		mound	Murray M	and marked the second	and how we have a second second	Maria
35 min mar Have was man have born the	llmmmmmmmmmmmmmmmmmmmmmmmmmmmmmmmmmm	Mun min		man mark mark market	Uh unmm	
stadberd Central Deffection (mm)	Lautaman	Man Manhart	mumm	1 M. m. human	man harman	Munum
² Curvature Function (mm)	~	mmm	minum	man		Mark
oranular Overlay (mm) - NZ RPP Fatigue Model						
Life (Years) - RPP Structural Fatigue (Governing)						
Life (Years) - RPP Surfacing Fatigue (Governing)						
Life (Years) - RPP Structural (Aggregate Rutting)						
Life (Years) - RPP Structural (Shallow Shear)						
Life (Years) - RPP Structural (Subgrade Rutting)						
Life (Years) - RPP Structural (Subgrade Shear) 0						
²⁵ (Life (Years) - RPP Surfacing Flexure o						
²⁵ Life (Years) - RPP Cemented Base Cracking o						
²⁵ Life (Years) - RPP Structural Economic o						
²⁵ Life (Years) - RPP Surfacing Economic o						
²⁵ Life (Years) - RPP Aggrégate Instability o						
⁵ Priority (Local) for Drainage		un Mun	Mulan	ummente	while here m	M. W. manner
oranular Overlay (mm) - Austroads (GMP-Rigorous) All Layers	на ана н			i 		
³⁰⁰ Granular Overla <mark>r (mm) - Austroads 2011 (Part 5)</mark> ₀ 44	(i)	Jahr III Man I.	باسترجب بالمطيأ	a his mail in	المالية المراجعية المالي	
Life (Years) - Austroads (GMP-Rigorous)						
Life (Years) - Austrolads 2011 (Part 5) - Granular						
2 4	6	8	10	12	14	16

MESA: 0.942 to 1.436 | Layer 1 Thickness: 135 | Depth to Subgrade: 415 to 505

Summary Plot: 01S – 0583 L1 TSD









Visually, the above TSD identified site is comparable to programmed sites.

Summary Plot: 01S – 0583 08.36 L1 TSD







TSD identified site above, is structurally inferior to the programmed site. Unless other factors are involved, prioritisation may need to be re-considered.

Summary Plot: 01S – 0651 L1 TSD









Summary Plot: 01S – 0683 L1 TSD

	Granular	Overlay	and	Remaining	Life
--	----------	---------	-----	-----------	------





01S – 0683 L⁻ CH 8431

Appendix F

Hawke's Bay 50 km Pilot Sections SH2 RS483 & SH2 RS562 – Both Lanes

Summary Plot: 002 – 0562 L1 FWD

|--|



LUATION: 002-0562 Lane L1 (24/08/2015)	
FWD	
² Curvature Function (mm)	
1 RPP Critical Layer	
³⁰⁰ Granular Overlay (mm) - NZ RPP Fatigue Model	
²⁵ Life (Years) - RPP Structural Fatigue (Governing)	
²⁵ Life (Years) - RPP Surfacing Fatigue (Governing)	
²³ Life (Years) - RPP Structural (Aggregate Rutting)	
³ Life (Years) - RPP Structural (Shallow Shear)	
²⁵ Life (Years) - RPP Structural (Subgrade Rutting) 9	
³¹ Life (Years) - RPP Structural (Subgrade Shear)	
²³ Life (Years) - RPP Structural (Seal Deformation)	
²⁵ Life (Years) - RPP Surfacing Flexure	
²⁵ Life (Years) - RPP Cemented Base Cracking	
²⁵ Life (Years) - RPP Structural Economic	
²⁵ Life (Years) - RPP Surfacing Economic e	
²³ Life (Years) - RPP Structural (Governing Deterministic)	
³⁵ Life (Years) - RPP Aggregate Instability	
³³ Life (Years) - RPP Structural (Accumulated Deformation)	
^s Priority (Local) for Drainage	
³⁰⁰ Granular Overlay (mm) - Austroads (GMP-Rigorous) All Layers	
of Granular Overlay (mm) - Austroads 2011 (Part 5)	
Uife (Years) - Austroads (GMP-Rigorous)	
Life (Years) - Austroads 2011 (Part 5) - Granular	
	12 14

MESA: 1.891 | Layer 1 Thickness: 115 to 140 | Depth to Subgrade: 220 to 665

Summary Plot: 002 – 0562 L1 TSD

Granular Overlay and Remaining Life



	ECATION. 002-0302 E1 (10/03/2013)										
002 – 0562 L1	hie Seale		Misming	have	A A A A A A A A A A A A A A A A A A A	WWW-L-MAULT		er for the second	man	mm	an and a second
TSD		we have a second se	when the second	mun [for the second s	way		"Notramor	w Marin	and the state	have builded with
100		$M \sim M \sim$	Mar Mun	manul	and the second second				hole Wybur he	Immed	, M. A. MILMIN, M.
² Standard Central Deflection (mm)) 	M	mm	hour	my	man		white white	Mun	model-M	horman
² Curvature Function (mm)				1							
¹ RHA Critical Uaver		\ III _ I I									
300 Granular Overlay (mm) - NZ RPP F	atigue Model										
²⁵ Life (Years) - RPP Structural Fatigut o	ue (Governing)										
³³ Life (Years) - RPP Surfacing Fatigute 0	le (Governing)										
²³ Life (Years) - RPP Structural (Aggro o	egate Rutting)										
²⁵ Life (Years) - RPP Structural (Shall o	low Shear)										
Life (Years) - RPP Structural (Subgo)	grade Rutting)										
Life (Years) - RPP Structural (Subgo)	rade Shear)										
Life (Years) - RPP Cemented Base	Cracking										
Life (Years) - RPP Structural (Subb	pase Deformation)										
C Life (Years) - RPP Structural (Accu	mulated Deformation)								li i i		
Life (Years) - RPP Structural Econo	omic										
Life (Years) - RPP Surfacing Econo	mic								1	1. I	
Life (Years) - RPP Surfacing Flexur	re										
Life (Years) - RPP Aggregate Insta	bility										
⁵ Priority (Local) for Drainage					mult						
300 AC Overlay (mm) - Austroads (GM	IP-Rigorous)			1							
300 AC Overlay (mm) - Austroads 2013	1 (Part 5)	1.		line and a second se	Ш П.		1 228 開始開口口 第128 1 223 後期前期第3条第3		۸ <u>ا</u>		
Life (Years) - Austroads (GMP-Rig)	orous)		' T	PF							1
Life (Years) - Austroads 2011 (Part	t 5) - AC							1	1		
	2	4	6		8		10		12		14

MESA: 1.891 | Layer 1 Thickness: 135 | Depth to Subgrade: 320 to 630

Good consistency between FWD and TSD

'ALUATION: 002-0562 Lane R1 (24/08/2015)			
002 – 0562 R1			
2 Curvature Function (mm)			
1 RPP Critical Layer			
300 Granular Overlay (mm) - NZ RPP Fatigue Model 0			
²⁵ Life (Years) - RPP Structural Fatigue (Governing) 6			
²³ Life (Years) - RPP Surfacing Fatigue (Governing) a			
²³ Life (Years) - RPP Structural (Aggregate Rutting) 6			
²⁵ Life (Years) - RPP Structural (Shallow Shear) 6			
²⁵ Life (Years) - RPP Structural (Subgrade Rutting) 6			
²² Life (Years) - RPP Structural (Subgrade Shear)			
²³ Life (Years) - RPP Structural (Seal Deformation)			
8 Life (Years) - RPP Surfacing Flexure			
²⁷ Life (Years) - RPP Cemented Base Cracking			
Clife (Years) - RPP Structural Economic			
²² Life (Years) - RPP Surfacing Economic			
²³ Life (Years) - RPP Structural (Governing Deterministic) a			
²⁵ Life (Years) - RPP Aggregate Instability 6			
²⁵ Life (Years) - RPP Structural (Accumulated Deformation) 0			
Priority (Local) for Drainage			
³⁰⁰ Granular Overlay (mm) - Austroads (GMP-Rigorous) All Layers			
 Granular Overlay (mm) - Austroads 2011 (Part 5) 			
¹² Life (Years) - Austroads (GMP- <mark>Rigo</mark> rous) s			
Uife (Years) - Austroads 2011 (Part 5) - Granular			
2 4	6 8	10 12	14

MESA: 1.891 | Layer 1 Thickness: 140 | Depth to Subgrade: 245 to 665

002 - 0562 RT alestaller with and	many marches allowed and the state of the st
TSD March late with and and and and and and the second start and the sec	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
Apply the provide the property of the property	
² Standard Central Deflection (mm) Management Ma	- manun and and and all mark and
² Curvature Function (mm)	
	ערדענערעייביריייניערעייערעיניערעעערעערערעער
300 Granular Overlay (mm) - NZ RPP Fatigue Model	
Life (Years) - RPP Structural Fatigue (Governing)	
Life (Years) - RPP Surfacing Fatigue (Governing)	
Life (Years) - RPP Structural (Aggregate Rutting)	
Life (Years) - RPP Structural (Shallow Shear)	
Life (Years) - RPP Structural (Subgrade Rutting)	
Life (Years) - RPP Structural (Subgrade Shear)	
Life (Years) - RPP Cemented Base Cracking	
²³ Life (Years) - RPP Structural (Subbase Deformation)	
²⁵ Life (Years) - RPP Structural (Accumulated Deformation)	
²³ Life (Years) - RPP Structural Economic	n na sa
²⁵ Life (Years) - RPP Surfacing Economic	
¹ Life (Years) - RPP Surfacing Flexure	
¹ ²⁵ ²⁵ ²⁵ ²⁶ ²⁷ ²⁶ ²⁷ ²⁷ ²⁷ ²⁷ ²⁷ ²⁷ ²⁷ ²⁷	
Priority (Local) for Drainage	
AC Overlay (mm) - Austroads (GMP-Rigorous)	
AC Overlay (mm) - Austroads 2011 (Part 5)	
^o Life (Years) - Austroads (GMP-Rigorous)	
o 2 Life (Years) - Austroads 2011 (Part 5) - AC	
	8 10 12 <u>14</u>
MESA: 1.891 Layer 1 Thickness: 135 Depth to Subgrade: 425 to 570	

Good consistency between FWD and TSD

Summary Plot: 002 – 0592 L1 FWD





	LUATION: 002-0592 Lane L1 (25/08/2015)					
002 – 0592 L1	iescale					
F\//D				~_~~		~
2 Curvature Function (mm)						
6 Granular Overlay (mm) NIZ PPP E	atigua Madal					
o I jie (Vears) - RPP Structural Estim						
a Life (Years) - RPP Surfacing Eatigue	e (Governing)					
 Life (Years) - RPP Structural (Aggre 	vate Rutting)					
Life (Years) - RPP Structural (Shall	bw Shear)					
o ²³ Life (Years) - RPP Structural (Subgr	rade Rutting)					
²⁵ Life (Years) - RPP Structural (Subgringer)	rade Shear)					
5 Life (Years) - RPP Structural (Seal I	Deformation)					
c ²⁸ Life (Years) - RPP Surfacing Flexum	2					
²⁵ Life (Years) - RPP Cemented Base	Cracking					
Life (Years) - RPP Structural Econo	mic					
Life (Years) - RPP Surfacing Econor	nic					
Life (Years) - RPP Structural (Gove	rning Deterministic)					
²⁸ Life (Years) - RPP Aggregate Instab 1	ility					
¹⁵ Life (Years) - RPP Structural (Accur ⁶	nulated Deformation)					
³ Priority (Local) for Drainage						
³⁰⁰ Granular Overlay (mm) - Austroad	s (GMP-Rigorous) All Layers					
300 Granular Overlay (mm) - Austroad	s 2011 (Part 5)					
Life (Years) - Austroads (GMP-Rigo	prous)					
Life (Years) - Austroads 2011 (Part	5) - Granular					
	2 4	6	8	10	12	14

MESA: 2.932 to 3.02 | Layer 1 Thickness: 125 to 150 | Depth to Subgrade: 200 to 720

Summary Plot: 002 – 0592 L1 TSD

Granular Overlay and Remaining Life



	05/2015)								
002 – 0592 L1	month	munn	- waren	Mr. Mr.	M. Marth	Man man mush	way man have		- marine a company and
TSD	mann	my made	w.(m). √ 11 ⊂		Admin at a	the marine for the	ran was no		Man was a second was a second was a second was
Joseph March	man marken m	M_4MM	MANNAL		VMUMX,	1. M. Mur Mar Mar	I M M M		
Standard Central Deflection (mm)	mount	Mann	mamm		m	manny	mannan		Manufa management
Curvature Function (mm)									
				III		ļI			
o Utfo (Venera) - DDD Structural Estimus (Councilian)		and a life of a state of the st		There is an and the second sec		.			
Life (Years) - Ann Structural Patigue (Governing)									
Life (Years) - Arr Sunating Fatigue (Soverning)									
Life (Years) - Min Structural (Aggregate Nothing)									
Tife (Years) - RPP Structural (Subgrade Rutting)									
Life (Yeals) - RPP Structural (Subgrade Shear)				1					
Uife (Veals) - RPP Cemented Base Cracking									
Life (Years) - RPP Structural (Subbase Deformation)									
Life (Years) - RPP Structural (Accumulated Deformation)		- <mark>,</mark> ,		1					
u Life (Years) - RPP Structural Economic		1				n n			
Life (Years) - RPP Surfacing Economic									
Life (Years) - RPP Surfacing Flexure									
Life (Years) - RPP Aggregate Instability									
Priority (Local) for Drainage			1 . Augusta		Na was	l. n			
 AC Overlay (mm) - Austroads (GMP-Rigorous) 				J Wbl/L			U II Jul		
00 AC Overlay (mm) - Austroads 2011 (Part 5)	Constant Constant on a	nini il fill bladistraama							
Life (Years) - Austroads (GMP-Rigorous)									
Life (Yea's) - Austroads 2011 (Part 5) - AC		17 4							
2	4		6				10	12	14
5A: 2.932 to 3.02 Laver 1. Thickness: 135 Depth to Subgrade: 245 to 570									

Good consistency between FWD and TSD

LUATION: 002-0592 Lane R1	L (25/08/2015)						
002 – 0592 R1						┍┍╌╌╌╴╴	
FW/D					~~~~~		
f Standard Central Deflection (mm)							
² Curvature Function (mm)							
1 RPP Critical Layer							
300 Granular Overlay (mm) - NZ RPP Fatigue Model							
²⁵ Life (Years) - RPP Structural Fatigue (Governing)							
 Life (Years) - RPP Surfacing Fatigue (Governing) 							
²⁰ Life (Years) - RPP Structural (Aggregate Rutting)							
²⁵ Life (Years) - RPP Structural (Shallow Shear)							
²⁵ Life (Years) - RPP Structural (Subgrade Rutting)							
²³ Life (Years) - RPP Structural (Subgrade Shear) 6							
²⁵ Life (Years) - RPP Structural (Seal Deformation)							
²⁵ Life (Years) - RPP Surfacing Flexure							
²⁵ Life (Years) - RPP Cemented Base Cracking a							
Life (Years) - RPP Structural Economic o							
Life (Years) - RPP Surfacing Economic o							
³³ Life (Years) - RPP Structural (Governing Deterministic) 3							
¹⁵ Life (Years) - RPP Aggregate Instability o							
²⁵ Life (Years) - RPP Structural (Accumulated Deformation)							
⁵ Priority (Local) for Drainage							
³⁰⁰ Granular Overlay (mm) - Austroads (GMP-Rigorous) All Laye							
300 Granular Overlay (mm) - Austroads 2011 (Part 5)							
Life (Years) - Austroads (GMP-Rigorous)							
Life (Years) - Austroads 2011 (Part 5) - Granular							
2	4	6	8	10	12	14	

MESA: 2.932 to 3.02 | Layer 1 Thickness: 125 to 150 | Depth to Subgrade: 200 to 765

LUATION: 002-059	2 RI (26/03/2015)				
002 – 0592 R1 🔤	when which he had a second and the second	an an an	mon man and the	any marken	and the second s
TSD	A pro	en and a free work and an	eren hurren marger a strand	mound for the second	Marian management and the second
have here	M	han marin and	Mar Mar Mar Mar Mar	1_111 when the half w	Winder Margaret Margaret and and a second
² Standard Certifal Deflection (mm)	M-M-M-M-M-M-M-M-M-M-M-M-M-M-M-M-M-M-M-	······	mmmmula	month white	have many many way
² Curvature Function (mm)				·····	
	╜╴═╍╌╴┍┍╢╢┰┊╎╌╌╵┅╢╹┊╴╎╹╜╹╽╌┈╓╻╻╶╻╴┟┄┟╽╽╵				
³⁰⁰ Granular Overlay (mm) - NZ RPP Fatigue Model ⁰	n at a trainift and a faith				A h
Life (Years) - RPP Structural Fatigue (Governing)					
Life (Years) - RPP Surfacing Fatigue (Governing)					
Life (Years) - RPP Structural (Aggregate Rutting)					
Life (Years) - RPP Structural (Shallow Shear)					
Life (Years) - RPP Structural (Subgrade Rutting)					
Life (Years) - RPP Structural (Subgrade Shear)					
Life (Years) - RPP Cemented Base Cracking					
Life (Years) - RPP Structural (Subbase Deformation)					
Life (Years) - RPP Structural (Accumulated Deforma	ttion)				
Life (Years) - RPP Structural Economic					
Life (Years) - RPP Surfacing Economic					
Life (Years) - RPP Surfacing Flexure					
Life (Years) - RPP Aggregate Instability					
Priority (Local) for Drainage		rh		┟────┟──┟──┟──┟	
AC Dverlay (mm) - Austroads (GMP-Rigorous)	angang, polalice an a divide			Warman with the same stars the flight	
 AC Dverlay (mm) - Austroads 2011 (Part 5) AC Dverlay (mm) - Austroads 2011 (Part 5) 					at 1 at 101 be a statement with a state of a
Life (Years) - Austroads (GMP-Rigorous)					
Life (Vears) - Austroads 2011 (Part 5) - AC					
	4 6	8	10	12	14
SA: 2.932 to 3.02 Layer 1 Thickness: 110 to 135 Depth to Subgrad	de: 230 to 585				

Good consistency between FWD and TSD

Granular Overlay and Remaining Life





002 – 0544 L1 CH 1793 002 – 0544 L1 CH 5355

Visually, the above TSD identified site is comparable to programmed site.

Appendix G

Terminal Failure Site Investigation
← \uparrow → PAVEMENT STRUCTURAL EVALUATION: SH 02 RS 858 / 9.00	0 - 9.300 Lane R1 (17/08/2016)	Benchmark Site (Sterlised) Fai	ure			
Layer 1 Modulus (MPa) - Logarithmic Scale						
Subgrade CBR - Logarithmic Scale						
Subgrade Modulus Exponent				 		
Standard Central Deflection (mm)				 		·
Curvature Function (mm)						
RPP Critical Layer						
Granular Overlay (mm) - NZ RPP Fatigue Model						
Life (Years) - RPP Structural Fatigue (Governing)						
Life (Years) - RPP Surfacing Fatigue (Governing)						
Life (Years) - RPP Structural (Aggregate Rutting)						
Life (Years) - RPP Structural (Shallow Shear)						
Life (Years) - RPP Structural (Subgrade Rutting)						
Life (Years) - RPP Structural (Subgrade Shear)						
Life (Years) - RPP Surfacing Flexure					_	
Life (Years) - RPP Structural (Aggregate Degradation)						
Life (Years) - RPP Structural (Subbase Deformation)						
Life (Years) - RPP Structural (Subbase Instability)						
Load Damage Exponent for Basecourse (RPP Method)				 		۰ <u>ـــــ</u> ـــــ
Load Damage Exponent for Subgrade (RPP Method)						
Life (Years) - RPP Structural Economic						
Life (Years) - RPP Surfacing Economic						
Life (Years) - RPP Aggregate Instability						
Life (Years) - Rutting IAL (Uncalibrated)						
Life (Years) - Roughness IAL (Uncalibrated)						
Life (Years) - RPP Structural (Accumulated Deformation)						
Life (Years) - RPP Structural (Governing Deterministic)						
Life (Years) - RPP Structural (Governing Stochastic)						
Priority (Local) for Drainage						
Granular Overlay (mm) - Austroads (GMP-Rigorous) All Layers						
Granular Overlay (mm) - Austroads 2011 (Part 5)						
Life (Years) - Austroads (GMP-Rigorous)						
Life (Years) - Austroads 2011 (Part 5) - Granular						
Life (Years) - Austroads AC/OGPA Cracking						
0.05						

$\langle \uparrow \uparrow \rangle$ PAVEMENT STRUCTURAL EVALUATION: SH 02 RS 8587 9,000 - 9	.300 Lane L1 (17/08/2016) Benchmark Site (1	steriised) failure			
Layer 1 Modulus (MPa) - Logarithmic Scale					
Subgrade CBR - Logarithmic Scale					
Subgrade Modulus Exponent					
Standard Central Deflection (mm)					
Curvature Function (mm)					
RPP Critical Layer					¬
Granular Overlav (mm) - NZ RPP Fatigue Model					
Life (Years) - RPP Structural Fatigue (Governing)					
Life (Years) - RPP Surfacing Fatigue (Governing)					
Life (Years) - RPP Structural (Aggregate Rutting)					
Life (Years) - RPP Structural (Shallow Shear)					
Life (Years) - RPP Structural (Subgrade Rutting)					
Life (Years) - RPP Structural (Subgrade Shear)					
Life (Years) - RPP Surfacing Flexure					
Life (Years) - RPP Structural (Aggregate Degradation)					
Life (Years) - RPP Structural (Subbase Deformation)					
Life (Years) - RPP Structural (Subbase Instability)					
Load Damage Exponent for Basecourse (RPP Method)					
Load Damage Exponent for Subgrade (RPP Method)					
Life (Years) - RPP Structural Economic					
Life (Years) - RPP Surfacing Economic					
Life (Years) - RPP Aggregate Instability					
Life (Years) - Rutting IAL (Uncalibrated)					
Life (Years) - Roughness IAL (Uncalibrated)					
Life (Years) - RPP Structural (Accumulated Deformation)					
Life (Years) - RPP Structural (Governing Deterministic)					
Life (Years) - RPP Structural (G <mark>overning Stochast</mark> ic)					
Priority (Local) for Drainage					
Granular Overlay (mm) - Austroads (GMP-Rigorous) All Lovers					
Granular Overlay (mm) - Austroads 2011 (Part 5)					
Life (Years) - Austroads (GMP-Rigorous)					
Life (Years) - Austroads 2011 (Part 5) - Granular					
9.05	910	915	920	925	9.1

Appendix H

LTPP Site Coastal Otago FWD – TSD Comparison

		11.5 to 12.5						
Dig 2 d Dio Legistrate Cole <td>a Layer & Modulus (MPa) - Logarithmic Scale</td> <td></td> <td></td> <td></td> <td> </td> <td></td> <td></td> <td></td>	a Layer & Modulus (MPa) - Logarithmic Scale				 			
Signer McAusEponer	^o Subgrade CBR - Logarithmic Scale				 			
	Subgrade Modulus Exponent				 			
Structure Factory (ma) S	2 Standard Central Deflection (mm)				 			
	[°] ² Curvature Function (mm)							
32 2021 (Circle 1) milel 12 227 202 204 (dot 2000 2000 2000 2000 2000 2000 2000 2000 2000 2000 2000 2000 2000 2000 2000 2000 2000 2000 2000 2000 2000 2000 2000 2000 2000 2000 2000 2000 2000 2000 2000 2000 2000 2000 2000 2000 2000 2000 2000 2000 2000 2000 2000 2000 2000 2000 2000 2000 2000 2000 2000 2000 2000 2000 2000 2000 2000 2000 2000 2000 2000 2000 2000 2000 2000 2000 2000 2000 2000 2000 2000 2000 20000 2000 2000 2000 2000 2000 2000 2000 2000 2000 2000 2000 2000 2000 2000 2000 2000 2000 2000 2000 2000 2000 2000 2000 2000 2000	a RPP Critical Layer							
UP (Par) PP Student F Right (Sourchaig) Image: Sourchaig (Sourchaig) Image: Sourchaig) Image: Sourchaig) <td>° Granular Overlay (mm) - NZ RPP Fatigue Model</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td>	° Granular Overlay (mm) - NZ RPP Fatigue Model							
Ull (Yasc) - RPP Surface (Sharing)	^o ¹ Life (Years) - RPP Structural Fatigue (Governing)							
Life (vac) - APP Stockural (Aginegate Rutang) Life (vac) - APP Stockural (Subjede Rutang) Life (vac) - APP Stockural Stockural Stockural Life (vac) - APP Stockural Stockural Life (va	o ⁵ Life (Years) - RPP Surfacing Fatigue (Governing)		-					
U1 (2 (4 97) - RPP Structure (Skippede Ruting) IIII IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII	o ⁵ Life (Years) - RPP Structural (Aggregate Rutting)							
Life (versh) = PP Structural (Subgrade Shear) Life (versh) = PP Structural Stochaing Life (versh) = PP Structural	s ⁵ Life (Years) - RPP Structural (Shallow Shear)							
Life (Years) - RPP Structural (Subgrade Shear) Image: Structural (Subgrade Shear) Image: Structural Stru	s ⁵ Life (Years) - RPP Structural (Subgrade Rutting)							
Life (vers) - RPF Surfading Flexure Life (vers) - RPF Cemented Base Crucking Life (vers) - RPF Cemented Base Crucking Life (vers) - RPF Cemented Base Crucking Life (vers) - RPF Surfading Economic Life (vers) - RPF Aufrading Economic Life (vers) - Austradis (GMP- Rigorous)	s ⁵ Life (Years) - RPP Structural (Subgrade Shear)							
Ufe (Years) - RPP Commented Base Crashing Ufe (Years) - RPP Structural Economic Ufe (Years) - RPP Aggregate Instability Ufe (Years) - Austroads (OMP-Rigorous) All Learers Ufe (Years) - Austroads 2011 (Part S) Ufe (Years) - Austroads 2011 (Part S) Ufe (Years) - Austroads 2011 (Part S) - Granular Ufe (Years) - Austroads 2011 (Part S) - Granular	o Life (Years) - RPP Surfacing Flexure							
Ufe (Years) - RPP Structural Economic Ufe (Years) - RPP Aggregate Instability Ufe (Years) - RPP Aggregate Instability Ufe (Years) - Roughness IAL (Uncalibrated) Ufe (Years) - Austroads 2011 (Part 5) Ufe (Years) - Austroads 2011 (Part 5) - Granular 11.5 12.6	s ⁵ Life (Years) - RPP Cemented Base Cracking							
Ufe (Years) - RPP Surfacing Economic Ufe (Years) - RPP Aggregate Instability Ufe (Years) - RPP Aggregate Instability Ufe (Years) - Ruting IAL (Uncalibrated) Ufe (Years) - Roughness IAL (Uncalibrated) Ufe (Years) - Austroads (GMP-Rigorous) All Layers Ufe (Years) - Austroads 2011 (Part 5) Ufe (Years) - Austroads 2011 (Part 5) - Granular 116 118	9 ⁵ Life (Years) - RPP Structural Economic							
Life (Years) - RPP Aggregate Instability Life (Years) - Roughness IAL (Uncalibrated) Life (Years) - Roughness IAL (Uncalibrated) Priority (Local) for DraInage Granular Overlay (mm) - Austroads (CMP-Rigorous) All Layers Cranular Overlay (mm) - Austroads 2011 (Part 5) Life (Years) - Roughness IAL (Incalibrated)	⁹ ⁹ ¹							
Life (Years) - Rutting IAL (Uncalibrated) Life (Years) - Roughness IAL (Uncalibrated) Priority (Local) for Drainage (Granular Overlay (mm) - Austroads (GMP-Rigorous) All Layers Granular Overlay (mm) - Austroads 2011 (Part 5) Life (Years) - Rustroads 2011 (Part 5) - Granular 11.6 11.8 120	Uife (Years) - RPP Aggregate Instability							
Ufe (Years) - Roughness IAL (Uncalibrated) Priority (Local) for DraInage Granular Overlay (mm) - Austroads (GMP-Rigorous) All Layers Granular Overlay (mm) - Austroads 2011 (Part 5) Ufe (Years) - Austroads 2011 (Part 5) - Granular 11.6 11.6 11.8 12.0 12.0 12.0	Ife (Years) - Rutting AL (Uncalibrated)		-					
Priority (Local) for Drainage Granular Overlay (mm) - Austroads (GMP-Rigorous) All Layers Granular Overlay (mm) - Austroads 2011 (Part 5) Life (Years) - Austroads (GMP-Rigorous) Life (Years) - Austroads 2011 (Part 5) - Granular 11.6 11.8 12.0 12.2 12.4	Comment (Comment (Commen							
Granular Overlay (mm) - Austroads (GMP-Rigorous) All Layers Granular Overlay (mm) - Austroads 2011 (Part 5) Ufe (Years) - Austroads 2011 (Part 5) - Granular IIfe (Years) - Austroads 2011 (Part 5) - Granular IIfe (Years) - Austroads 2011 (Part 5) - Granular IIfe (Years) - Austroads 2011 (Part 5) - Granular IIfe (Years) - Austroads 2011 (Part 5) - Granular IIfe (Years) - Austroads 2011 (Part 5) - Granular IIfe (Years) - Austroads 2011 (Part 5) - Granular IIfe (Years) - Austroads 2011 (Part 5) - Granular IIfe (Years) - Austroads 2011 (Part 5) - Granular IIfe (Years) - Austroads 2011 (Part 5) - Granular IIfe (Years) - Austroads 2011 (Part 5) - Granular IIfe (Years) - Austroads 2011 (Part 5) - Granular IIfe (Years) - Austroads 2011 (Part 5) - Granular	Priority (I nesl) for Drainage							
Granular Overlay (mm) - Austroads 2011 (Part 5) Life (Years) - Austroads 2011 (Part 5) - Granular 11.6 11.8 12.0 12.2 12.4	Granular Overlav (mm) - Austroads (GMP-Rigorous) All Lavers							7
Ufe (Years) - Austroads 2011 (Part 5) - Granular 11.6 11.8 12.0 12.2	Cranitar Overlay (mm) - Austroads (0001 - Mgolods) An Layers					1		1
Life (Years) - Austroads 2011 (Part 5) - Granular 11.6 11.8 12.0	Oranital Overlay (IIII) - Austroads 2011 (Fart 3)							
11.6 11.8 12.0 12.2 12.4	Life (Years) - Austroads (SMP-Rigorous)							
<u>11.6</u> <u>11.8</u> <u>12.0</u> <u>12.2</u> <u>12.4</u>	Life (Years) - Austroads 2011 (Part 5) - Granular							
	11.6	11.8		12.0	12.2		12.4	

ar GeoSolve Ltd - Pavement Evaluation Grapher - [TSD N2-16.3/015-0729 L1/015-0729 L1/015	
	- 8
File Options Zoom Configuration Help Auto Section	
3.3x 2007 € h 2 AVENETT STRUCTURAL EVALUATION: 015-0729 L1 (23/01/2015)	
soo Tayer 1 Modulus (MPa) - Logerithmic Scale	
**/ Subgrade CBR - Logarithmic Scale	
1 Subgrade Modulus Exponent	
² Standard Central Deflection (mm)	
2 Curvature Function (mm)	
1 RPP Critical Layer	
orancial overlay (mm) - N2 APP haugue would	
Life (Years) - RPP Structural Fatigue (Governing)	
Life (Years) - RPP Surfacing Fatigue (Governing)	
Life (Years) - RPP Structural (Aggregate Rutting)	
life (Years) - RPP Structural (Shallow Shear)	
²³ Life (Years) - RPP Structural (Subgrade Rutting)	
¹⁵ Life (Years) - RPP Structural (Subgrade Shear)	
I Ifo (Vapra) - DDP Strifteding Elevation	
une (rears) "nrt sumacing readine	
Life (Years) - RPP Cemented Base Cracking	
a Life (Years) - RPP Structural Economic	
²³ Life (Years) - RPP Surfacing Economic	
²⁵ Life (Years) - RPP Aggregate Instability	
Princip (Incel) (for Dissipane	
300 Granular Overlay (mm) - Austroads (GMP-Rigorous) All Layers	
300 Granular Overlay (mm) - Austroads 2011 (Part 5)	<u> </u>
o 2 Title (Marco), Austroads (CMP Pigerous)	
²⁵ Life (Years) - Austroads 2011 (Part 5) - Granular	
	12.4