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PAVEMENT ASSESSMENT REPORT

COLLECTOR RD – BETWEEN FEDERAL HWY AND BARINA QUARRY

COLLECTOR

FOR

COLLECTOR RESOURCES

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1. INTRODUCTION

APS Aim Pavement Solutions Pty Ltd was engaged by Collector Resources to assess the existing pavement condition of Collector Rd, Collector, NSW, in order to:

- Assess the suitability of the existing pavement for immediate use by heavy vehicle traffic associated with the recommencement of the Barina Quarry.
- Develop a pavement maintenance strategy for the existing pavement prior to a road and pavement upgrade of Collector Rd.

An inspection of the road, between Barina Quarry entrance and the Federal Hwy was conducted, Dynamic Cone Penetrometer (DCP) testing was carried out at approximately 300m intervals to gain information for the analysis. The CIRCLY Pavement Design software was used to assess the remaining life of the pavement.

2. BACKGROUND INFORMATION

The section of pavement is 1.6Km long and consists of 2 traffic lanes. The shoulders are grassed, with table drains and culverts.

3. PROJECT DESIGN REQUIREMENTS

The assessment was completed to provide the following design requirements.

- Provide pavement maintenance options for an interim period of time to re-establish quarry operations and to carry the design traffic loadings.
- In the future, provide a pavement design for reconstruction of thee road to provide for a 20 year period.

4. PAVEMENT INVESTIGATION AND DESIGN OBJECTIVES

- Undertake DCP testing at the following chainages from the Federal Hwy.
  1. Chainage 20m
  2. Chainage 300m
  3. Chainage 680m
  4. Chainage 910m
  5. Chainage 1150m
  6. Chainage 1500m
- Formulate representative pavement parameters and design traffic to facilitate the pavement maintenance strategy, including the following elements;
  - Existing pavement layers and thicknesses
  - Existing pavement material strengths
  - Subgrade CBR values

The following information has been supplied by Collector Resources from a previous report:
MEMORANDUM
To: Collector Resources
From: Indesco
Date: 4 February 2023
Project Number: 9094
Project Name: Barina Quarry
Subject: Collector Road Existing Conditions Assessment

- AADT – 205 v/d
- Heavy Vehicles – 22%
- Cumulative Growth Factor – 0%
- Design life – Maintenance period
- Additional Quarry traffic to be added to these figures for design traffic purposes and maintenance design.

A copy of the Indesco Memorandum is attached to this report.

5 DCP INVESTIGATION

From the DCP testing, a design CBR value of 5% for the subgrade was calculated and shall be used for design purposes.

There are 2 layers of existing granular material of varying CBR values. The values use in the proposed design were the lowest results from the DCP testing which were as follows:

- Top 300mm – CBR 44
- Bottom 100mm – CBR 22

6 CHARACTERISATION OF EXISTING PAVEMENT

The existing pavement surface consists of various types of seals, some areas in reasonable condition, some poor condition. Apart from 3 poor areas, the remaining pavement is in reasonable condition, with some cracking, minor pot holes and some edge breaks. There is no pavement deformation, which suggests the existing base materials still have structural capacity.

The first failed area is at chainage 0m, just off the Highway.

This failure is mainly due to shear forces, braking and turning from heavy vehicles. There is no deformation and the base seems to have been stabilised, as there was refusal during DCP testing. There is an existing 20mm seal.

The second area is at chainage 300m.

This areas failure in mainly due to poor drainage. Over the years of traffic, silt has built up along the edge of the seal, making the shoulders higher than the pavement, causing water to remain on the pavement. The existing pavement is a 14mm seal which is badly cracked, pot holed with some deformation on the right hand edge, all caused by water.

The third area is the same as the second area at chainage 1150m.

Short term maintenance strategies will be discussed in the Maintenance Recommendations.

7 DESIGN TRAFFIC

Traffic has been calculated from existing data plus the proposed quarry traffic for a 1 year period to be 9.52E+3 ESA's. (Equivalent Standard Axles)

For short term design purposes, 1.62E+5 ESA's (Equivalent Standard Axles)

shall be used. This figure is based on the traffic counts from the above mentioned report plus required traffic to re-establish Barina Quarry over a 5 year period.

A rural presumptive Traffic Load Distribution (TLD) was adopted to calculate the design traffic for the CIRCLY runs. This is a constant figure in the CIRCLY software that is used when the Heavy Vehicle Axle Groups are unknown.

8 MAINTENANCE CONSTRUCTION RECOMMENDATIONS

For the second and third areas it is recommended that the following be carried out:

- Trim all areas from built up silt back to pavement level

- Remove the existing failed sealed areas and cold mixed pot holes
- Tyne the existing gravel base and add new DGB 20, regrade and compact
- Prime new gravel areas
- Seal the total area with a 14/10 seal.
- Regrade shoulders with a 3% cross fall away from the pavement towards the table drain and culverts
- Clear all table drains and culverts from overgrown grass and debris.

For the first area, remove the existing seal and cold mix, assess the existing base to assess whether new material needs to be added after tyning, regrade and compact, then reseal. A high stress seal should be designed for this area.

The analysis of pavement considered in Section 9 considers the design traffic for the existing and repaired pavements over a 5 year period. This gives ample time for the quarry to be re-established, pavement reconstruction designs and any Council issues to be resolved prior to any reconstruction work commencing while the existing pavement remains safe and trafficable. During this time the pavement should be maintained to a safe level.

9 CIRCLY Pavement Design Software RUN

CIRCLY is a nationally recognised pavement design tool used to determine appropriate layer thicknesses for roads to perform over their design life. It forms part of the Austroads – Pavement Design Guides framework and is widely used across Australia for road pavement design.

CIRCLY Pavement Check Explanation

This section explains what the CIRCLY output means for the specific run using the Austroads 2017 design method. The intent is to describe what CIRCLY is checking, what inputs were used in this run, and what the results mean in terms suitable approval (i.e. whether the pavement is predicted to have sufficient capacity for the nominated traffic loading).

Key inputs used in this run

- Software/version: CIRCLY Version 7.0 (23 April 2025)
- Design method: Austroads 2017
- Design traffic (NDT): 1.62E+05 cumulative heavy vehicle axle groups over the design period (i.e., about 162,000 axle-group load applications)
- Traffic load distribution: NSWPresumeRural – “NSW RMS Aug 2018 - Rural Presumptive (Table 18)”
- Average conversion to ESAs: ESA/HVAG = 1.068 (each heavy vehicle axle group is treated as ~1.068 standard axle equivalents on average)
- Load groups analysed: ESA750-Full (vertical force 92.1, radius 0.75) and SAST53 (vertical force 102.4, radius 0.80)
- Modelled pavement layers: 300 mm Gran_450 over 100 mm Gran_220 over Sub_CBR5 subgrade
- Reliability level: Austroads 95%

- Critical check reported: vertical strain at the top of subgrade (component EZZ)

What each part of the CIRCLY output means

Step 1 – Design method (Austroads 2017)

"Design Method: Austroads 2017" means CIRCLY will assess the pavement using Austroads' 2017 mechanistic design approach. CIRCLY first calculates how much the pavement "squashes and bends" under heavy vehicle wheel loads (using engineering equations for layered materials), then uses Austroads performance relationships to convert those calculated deformations into a prediction of whether the pavement has enough capacity for the nominated traffic.

Step 2 – Design traffic (NDT)

"NDT ... 1.62E+05" is the total number of heavy vehicle axle-group load applications the pavement is required to carry over the design period. For this run, NDT = 1.62×10^5, which is approximately 162,000 axle-group load applications. CIRCLY uses this value as the "how many times will trucks load the pavement?" input when it totals up damage over time.

Step 3 – Traffic load distribution (how heavy the axles are)

The Traffic Load Distribution (TLD) defines the mix of axle loads expected in service (i.e., not every axle is the same weight). This run uses NSWPresumeRural – "NSW RMS Aug 2018 - Rural Presumptive (Table 18)", which is a standard/rule-based rural axle-load spectrum. CIRCLY uses this distribution to analyse representative axle loads and then combine their effects.

"ESA/HVAG: 1.068" means that, for the selected spectrum, each *heavy vehicle axle group* is equivalent (on average) to about 1.068 standard axles (ESAs) in terms of pavement wear. This is a traffic conversion factor derived from the axle-load spectrum; it is not a measured strain, but it informs how the total traffic is represented for design purposes.

Step 4 – Load groups (the wheel loads CIRCLY applies)

Under Details of Load Groups, CIRCLY lists the wheel-load cases it will apply to the pavement model. In this run there are two load groups:

- Load group 1: ESA750-Full – applied as a vertical force of 92.1 with a circular contact radius of 0.75.
- Load group 2: SAST53 – applied as a vertical force of 102.4 with a circular contact radius of 0.80.

CIRCLY treats each tyre as pushing down on the pavement over a circular "footprint". The vertical force is the wheel load, and the radius controls how spread out the load is. CIRCLY converts wheel load and radius into an average contact pressure using the circle area (area = πr^2), then uses layered elastic theory to calculate the resulting stresses and strains through the pavement. Using more than one load group allows CIRCLY to represent a mix of axle weights rather than a single 'one-size-fits-all' truck.

Step 5 – Load locations (wheel spacing and axle spacing)

The Load Locations table lists where each wheel load is placed in the calculation. CIRCLY uses X and Y coordinates to represent wheel spacing (e.g., tyres side-by-side) and axle spacing (wheels/axles separated along the vehicle length). In this run, the ESA750-Full group is applied at X positions of -165, 165, 1635, and 1965 (with Y = 0), and the SAST53 group is applied at X positions of 0 and 2130 (with Y = 0).

The Scaling Factor = 1.00 means the loads are applied at their stated magnitudes (no adjustment), and Theta = 0.00 means the wheel pattern is not rotated. CIRCLY then adds up (superimposes) the effects from each wheel location to find the critical strain at the point being checked.

Step 6 – Layered system (what the pavement is made of)

CIRCLY models the pavement as a stack of layers, each with a thickness and stiffness. For this run, the structure is:

- Layer 1: 300 mm Gran_450 (granular layer with modulus shown as 4.50E+02)
- Layer 2: 100 mm Gran_220 (granular layer with modulus shown as 2.20E+02)
- Layer 3 (subgrade): Sub_CBR5 (modulus shown as 5.00E+01). The thickness is shown as 0.00 because the subgrade is treated as a very deep 'foundation' layer rather than a finite thickness layer.

Modulus is a measure of stiffness: higher modulus layers deform less under the same load. CIRCLY also lists Poisson's ratio (shown as 0.35 for the granular layers and 0.45 for the subgrade), which describes how a material tends to spread sideways when compressed. The output shows these materials as Aniso. (anisotropic), meaning CIRCLY allows stiffness to differ vertically versus horizontally for these unbound materials; the additional terms shown (e.g., Eh and vh) are the horizontal stiffness/shape parameters used internally in the calculations.

Step 7 – Performance relationship (how CIRCLY turns strain into "damage")

The Performance Relationships section tells CIRCLY what "failure mode" it is checking and which equation to use. The check shown is for the top of the subgrade (material Sub_CBR5) using the component EZZ, which is the vertical strain (vertical squeezing) at that location. Excessive vertical strain at the top of the subgrade is associated with long-term deformation (rutting).

The values Constant = 0.009150 and Exponent = 7.000 define a power-law relationship used by the Austroads method to estimate allowable load repetitions as a function of strain. The practical meaning is: the smaller the calculated vertical strain, the more traffic repetitions the pavement can carry. The exponent of 7 indicates that the predicted damage is highly sensitive to changes in strain (a modest increase in strain can significantly reduce allowable repetitions).

CIRCLY converts the calculated vertical strain at the top of the subgrade (component EZZ) into a prediction of allowable traffic for the Austroads rutting (subgrade deformation) criterion. CIRCLY applies the Austroads power-law parameters shown in the output (constant 0.009150 and exponent 7.000) to the calculated strain (reported later as SADT(80) = 1.206E-03) to determine how much of the pavement's deformation capacity is consumed by the design traffic; the result is then expressed as a CDF (Critical Damage Factor, reported later as Total CDF = 1.197E-01, i.e. 0.1197), where values below 1.0 indicate the rutting criterion is satisfied.

The Performance Relationships is where CIRCLY sets the rule for turning a calculated pavement response (a *strain*) into a prediction of how much traffic the pavement can tolerate before reaching the relevant Austroads performance limit. In other words, this step connects the engineering calculation (how much the pavement deforms under load) to the design outcome (how much "life" is used up by the nominated traffic).

CIRCLY is checking Layer 3 – top – Sub_CBR5, which means the critical location is the top of the subgrade (the natural foundation beneath the granular layers). The component EZZ is the vertical strain at that point (i.e., the amount the subgrade is squeezed in the vertical direction under heavy vehicle loading). This is the Austroads rutting (subgrade deformation) criterion: if vertical strain at the top of the subgrade is too high over repeated loading, the pavement is more likely to experience permanent deformation and rutting over its service life.

The strain reported later for the subgrade is SADT(80) = 1.206E-03. CIRCLY applies the above performance relationship to that strain across the nominated traffic spectrum and totals the effect into the reported CDF. The resulting Total CDF = 1.197E-01 indicates the design traffic uses only a small proportion of the allowable damage for this subgrade deformation criterion.

Step 8 – Reliability

The output states Project Reliability: Austroads 95%. The design check is carried out with a conservative allowance for variability in traffic, materials, and construction such that there is a high level of confidence in the outcome. The table shows a Reliability Factor of 1.00 for the subgrade check in this run (i.e., no additional adjustment beyond the selected Austroads 2017 reliability setting).

Step 9 – Sublayering (How CIRCLY Improves Calculation Accuracy Through the Depth)

"Austroads (2004) sublayering" for Layers 1 and 2 means CIRCLY internally splits the granular layers into thinner sublayers for the purpose of the mathematics. This helps it calculate how stresses and strains change with depth more accurately, while still reporting the layers in the practical thicknesses entered (300 mm and 100 mm) in the results summary.

Step 10 – Calculated Strain (What the Pavement Experiences Under Loading)

CIRCLY reports the critical strain value used for the Austroads subgrade deformation check. At the Sub_CBR5 subgrade, CIRCLY reports SADT(80): 1.206E-03. This is a unitless strain (a ratio of deformation to original dimension). Written out, 1.206E-03 = 0.001206, which corresponds to approximately 0.1206% vertical strain at the nominated critical location under the analysed loading spectrum.

Step 11 – Results (CDF: How Much of the Pavement's "Life" Is Used)

CIRCLY reports performance using CDF (Cumulative Damage Factor). CDF compares the design traffic demand to the pavement's predicted capacity for the selected failure mode.

- CDF ≤ 1.0: predicted to be acceptable for the nominated traffic (capacity is equal to or greater than demand).
- CDF > 1.0: predicted to be unacceptable (demand exceeds capacity).

The Sub_CBR5 subgrade has a reported Total CDF = 1.197E-01, i.e. 0.1197. This indicates that, for the stated inputs (NDT = 1.62E+05, NSWPresumeRural spectrum, layer thicknesses and stiffnesses, and 95% reliability), the pavement is predicted to have substantial remaining capacity against the subgrade vertical strain (rutting/deformation) criterion.

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CIRCLY  - Version 7.0 (23 April 2025)

Job Title: Collector Rd

Design Method: Austroads 2017

NDT (cumulative heavy vehicle axle groups over design period): 1.62E+05

Traffic Load Distribution:

   ID: NSWPresumeRural
   Name: NSW RMS Aug 2018 - Rural Presumptive (Table 18)
   ESA/HVAG: 1.068

Details of Load Groups:

   Load   Load                     Load                   Load
Radius    Pressure/    Exponent
   No.    ID                       Category               Type
Ref. stress
    1     ESA750-Full              ESA750-Full            Vertical Force
92.1    0.75          0.00
    2     SAST53                   SAST53                 Vertical Force
102.4    0.80          0.00

   Load Locations:
   Location    Load                    Gear          X           Y      Scaling
Theta
   No.         ID                      No.                              Factor
    1          ESA750-Full              1         -165.0         0.0
1.00E+00       0.00
    2          ESA750-Full              1          165.0         0.0
1.00E+00       0.00
    3          ESA750-Full              1         1635.0         0.0
1.00E+00       0.00
    4          ESA750-Full              1         1965.0         0.0
1.00E+00       0.00
    1          SAST53                   1            0.0         0.0
1.00E+00       0.00
    2          SAST53                   1         2130.0         0.0
1.00E+00       0.00

Details of Layered System:

   ID: Collector Rd 1 Title: Collector Rd 1 Year

   Layer  Lower    Material                  Isotropy   Modulus     P.Ratio
   No.    i/face   ID                                   (or Ev)     (or vvh)   F
Eh         vh
    1     rough    Gran_450                  Aniso.     4.50E+02    0.35
3.33E+02   2.25E+02   0.35
    2     rough    Gran_220                  Aniso.     2.20E+02    0.35
1.63E+02   1.10E+02   0.35
    3     rough    Sub_CBR5                  Aniso.     5.00E+01    0.45
3.45E+01   2.50E+01   0.45

   Performance Relationships:
   Layer  Location Material                  Component  Perform.    Perform.
Shift
```

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   No.              ID                                Constant    Exponent
Factor
    3      top      Sub_CBR5               EZZ          0.009150     7.000

   Reliability Factors:
   Project Reliability: Austroads 95%
   Layer  Reliability  Material
    No.   Factor        Type
    3      1.00        Subgrade (Austroads 2017)

   Details of Layers to be sublayered:
   Layer no.  1:  Austroads (2004) sublayering
   Layer no.  2:  Austroads (2004) sublayering

Strains:

   Layer  Thickness  Material                Axle      Unitless
   No.               ID                                Strain
    3        0.00    Sub_CBR5
                                             SADT(80): 1.206E-03

Results:

   Layer  Thickness  Material                Axle      CDF
   No.               ID                      Group
    1      300.00    Gran_450                               n/a

    2      100.00    Gran_220                               n/a

    3        0.00    Sub_CBR5                Total:    1.197E-01
```

FUTURE PAVEMENT RECONSTRUCTION

For the long-term upgrade of the road and pavement, i.e. for the life of the Quarry and beyond, the following guidance and recommendations are provided.

10 PROJECT DESIGN REQUIREMENTS

- Design new pavement to have 2 x 3.1m lane minimum width
- Carry out more intensive testing on existing pavement materials and subgrade
- Provide 20 year design life

11 DESIGN TRAFFIC

Based on existing traffic data, the following would apply

- AADT – 207 v/day
- Heavy Vehicles – 84%
- Cumulative Growth Factor – 3%

- Design Life – 20 years

This would give approximately 8.54E+05 N_{HV}

12 CONSTRUCTION RECOMMENDATIONS

For ease of construction and future maintenance considerations, a consistent pavement thickness throughout the whole new pavement area should be maintained.

Subgrades should be proof rolled, any soft points to be excavated deeper, on the advice of the on site engineer.

All subgrade and earthworks placed, should be carried out in accordance with the Councils standards, Transport for NSW Specifications and / or AustRoads Guides to Pavement Technology.

13 CLOSURE

If you have any questions, please don't hesitate to contact APS by email or phone.

Alan Morton

Director

Dip Civ Eng, MPavtTech, MIEAust

PREVIOUS SIMILAR PAVEMENT DESIGNS RECENTLY DONE:

- Beach Rd – Batehaven – Eurobodalla Shire Council
- George Bass Dr – Batemans Bay – Eurobodalla Shire Council
- Vesper St / Princes Hwy – Batemans Bay – Eurobodalla Shire Council / TfNSW
- Tarago Rd – Bungendore – Queanbeyan Palerang Regional Council
- Summerland Way – Kyogle – ACT Geotechs / TfNSW
- Kings Hwy – Batemans Bay - ACT Geotechs / TfNSW
- Commercial Development – South Jerrabomberra – ACT Geotechs / Queanbeyan Palerang Regional Council
- Industrial Development – Yass – Diverse Projects
- Edwin Land Pwy – Queanbeyan - Queanbeyan Palerang Regional Council
- Bungendore Rd – Bungendore - Queanbeyan Palerang Regional Council
- Cooma St – Queanbeyan - Queanbeyan Palerang Regional Council
- Araluen Rd – Braidwood - Queanbeyan Palerang Regional Council

ATTACHMENT: Indesco Memorandum 2 February 2023

MEMORANDUM

To:	**Collector Resources**
From:	Indesco
Date:	4 February 2023
Project Number:	9094
Project Name:	Barina Quarry
Subject:	**Collector Road Existing Conditions Assessment**

1 INTRODUCTION

This Project Memorandum presents the findings of Stage 1 engineering visual pavement assessment, carried out by Indesco Pty Ltd, for 1.6 km of Collector Road, Collector NSW (the site).

The assessment was commissioned by Collector Resources and carried out in general accordance with our fee proposal dated 2 February 2023.

The objective of this Stage 1 assessment was to carry out desktop review and a visual assessment of site and provide the following:

- A summary of our desktop review and site observations.
- Current surface condition of the existing roadway and immediate surrounds.
- Possible recommendations and management measures that could be employed to enable short-term use of the road for the current approved operations, from a geotechnical perspective.
- Recommendations of future geotechnical works, upgrades/standard to support long term use associated with future developments of the Barina Quarry Site.

2 DESKTOP REVIEW

2.1 SITE EXTENTS

The site extends from the intersection of the Federal Highway (Ch 0 m for the purpose of this Project Memorandum) and terminates at the Barina Quarry Site intersection (about Ch 1,600 m for the purpose of this Project Memorandum).

The site crosses the Local Government Area (LGA) boundary at about Ch 1,300, with Upper Lachlan Shire Council to the north, and Queanbeyan-Palerang Regional Council to the south.

2.2 PUBLISHED GEOLOGICAL INFORMATION

The Gunning 1:100,000 geological series sheet 8727, indicates the site is underlain by three main geological units:

- Quaternary Alluvium (Qa) comprising alluvial pebble to cobble sized gravel, sand, silt and clay.
- Quaternary Colluvium (Qc) comprising poorly sorted, para and orthoconglomerate, sand, silt and clay.
- Siluro-Devonian Covan Creek Formation (Smfo), comprising cream to buff to pale grey, thin to very thick bedded, very fine to very coarse grained, lithic-quartz to quartzose sandstone with interbedded, laminated, pale grey to biff siltstone and mudstone; very rare felsic volcanic rocks, sandstone typically contains fragments of dark chert and fine grained metasedimentary rock.

An extract of the NSW seamless geological map below presents the above geological units, with the approximate site extents shown in orange.

Figure 2-1 Extract of the NSW Seamless Geological Extent

Further, the site crosses Collector Creek at two locations, near the intersection of the Federal Highway, and the quarry entrance (shown in blue).

2.3 PUBLISHED TOPOGRAPHICAL INFORMATION

Published topographical information (shown in Figure 2-2 below), indicates the site follows locally lower terrain, with topographic highs to the northeast and west, beyond the site extents.

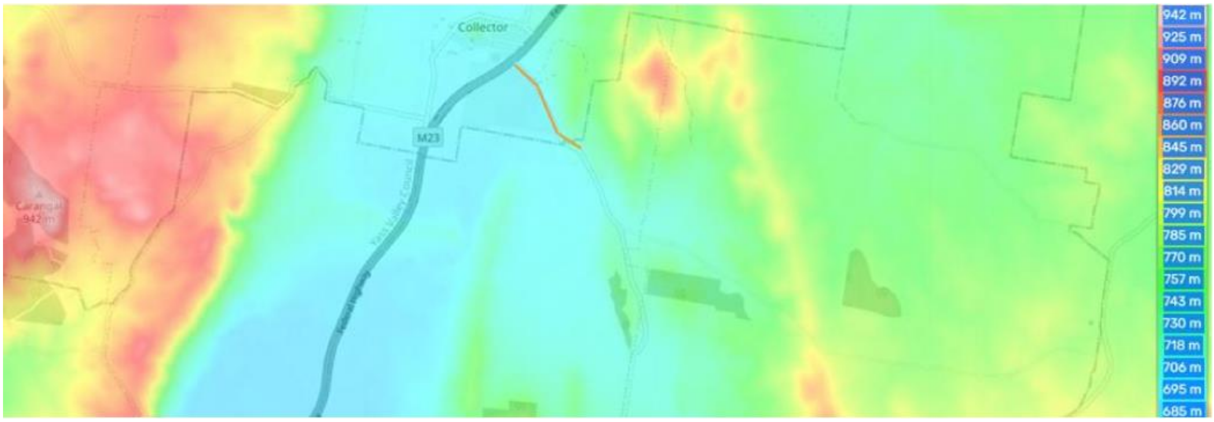


Figure 2-2 Extract of Published Topographic Information, with approximate site extents in orange

2.4 SITE USE

The site appears to service:

- Upper Lachlan Shire Council Collector Transfer Station (Ch 420 m).
- Local rural residential/farm properties, including one residence (Ch 1,230 m) within the site extents.
- Barina Quarry Site (1,600 m).

The existing traffic volumes are in the order of 205 AADT with 22% heavy vehicles. With the proposal for an increase in Quarry Operations following below potential traffic volumes, which may be considered as part of a future development application/approval.

Table 2-1 Collector Road Traffic Volumes Post Development

Future Traffic Volumes				
AM	**Light**	**Heavy**	**Total**	**HV%**
EB	2	13	15	87%
WB	9	8	17	47%
PM	**Light**	**Heavy**	**Total**	**HV%**
EB	13	11	24	46%
WB	8	9	17	53%
DAILY	**Light**	**Heavy**	**Total**	**HV%**
EB	75	120	195	62%
WB	85	85	170	50%
Total	**160**	**205**	**365**	**56%**

3 SITE OBSERVATIONS

As part of the Site Inspections and Investigations phase, an assessment of the existing conditions along the road corridor was conducted. The basis for this assessment of existing conditions was aerial imagery and a site visit.

3.1 ROAD OBSERVATIONS

It was found that the existing road corridor had a unposted speed limit of 100km/h.

The horizontal alignment of Collector Road is curvilinear in nature and comprises straights and curves of various radii over the section subject to this investigation. The vertical alignment of the corridor varies from less than 1% to 10% grade along the eastern section on approach to the Quarry access.

The typical cross section generally comprises two lanes of 3.1m width and is without sealed shoulders. The verge each side of the carriageway varies and appears to be as narrow as 0.5m in places.

The existing pavement surface has been resealed over the entire length of the project. The surface conditions of the pavement are noticeably worn and failing in places, and the line marking is in poor condition. The roadside environment is characterised by numerous sections of fill batters and a mixture of grass and tree lined verges.

The land beyond the road reserve is rural and agricultural in nature.

3.2 PAVEMENT OBSERVATIONS

The site can broadly be split into six distinct pavement areas, as summarised in below.

Pavement Zone Reference	Approximate Chainages (m)	Pavement Geometry and Immediate Surrounds	Pavement Surfacing and Defects	Possible Causes of Defects
A	0 – 143	▪ Two single lanes and layout area. ▪ Low embankment, possible culvert structure ▪ Eastbound sealed shoulder ▪ Limited westbound sealed shoulder ▪ Vegetated shoulders and mature trees	▪ Significant defects ▪ Multiple Chip Seals ▪ Patching ▪ Possible delamination ▪ Loss of aggregate and binder	▪ Load associated disintegration of the base. ▪ Poor quality base material ▪ Poor adhesion to underlying layers ▪ Dislodgment initiated by cracking ▪ Water seepage
B	143 – 425	▪ Low embankment, culvert structure ▪ Two single lanes ▪ No sealed shoulder ▪ Vegetated shoulder ▪ Culvert structure partially blocked.	▪ Significant defects ▪ Spray seal ▪ Edge break ▪ Edge drop off ▪ Potholes ▪ Patching ▪ Crocodile cracking ▪ Rutting ▪ Longitudinal cracking	▪ Water ingress ▪ Structural overloading of the pavement e.g. inadequate ▪ thickness or quality ▪ Poor construction control ▪ Poor drainage ▪ Pavement in terminal conditions
C	425 – 860	▪ See Zone B	▪ Some defects, see Zone B	▪ See Zone B
D	860 – 1,320	▪ Within a low cut to the east. ▪ Low embankment to the west. ▪ Two single lanes. ▪ No sealed shoulder ▪ Vegetated shoulder ▪ Partially blocked culvert	▪ Spray seal ▪ Significant defects ▪ Edge break ▪ Edge drop off ▪ Potholes ▪ Patching ▪ Crocodile cracking ▪ Rutting ▪ Longitudinal cracking	▪ Water ingress ▪ Structural overloading of the pavement e.g. inadequate ▪ thickness or quality ▪ Poor construction control ▪ Poor drainage ▪ Pavement in terminal condition
E	1,320 – 1,540	▪ Within a low cut to the east. ▪ Low embankment to the west. ▪ Possible culvert structure.	▪ Spray seal(s) ▪ Significant defects ▪ Edge break	▪ Water ingress ▪ Structural overloading of the pavement e.g. inadequate

Pavement Zone Reference	Approximate Chainages (m)	Pavement Geometry and Immediate Surrounds	Pavement Surfacing and Defects	Possible Causes of Defects
		▪ Two single lanes. ▪ No sealed shoulder ▪ Vegetated shoulder with mature trees. ▪ Pavement likely widened	▪ Edge drop off ▪ Potholes ▪ Patching ▪ Crocodile cracking ▪ Rutting ▪ Crescent shaped cracking in shoulder widening ▪ Worst defects outbound from the quarry, westbound	▪ thickness or quality ▪ Poor construction control ▪ Poor drainage ▪ High horizontal shear forces associated with turning and ▪ accelerating
F	1,540 – 1,600	▪ Broadly at existing grade	▪ Spray seal ▪ Pavement in good condition	-

Typical photographs of each section are enclosed with this Project Memorandum.

4 POSSIBLE SHORT TERM MEASURES

Whilst Indesco are not privy to the history of the road, due to the likely multiple stakeholder(s) with an interest in the road i.e. Upper Lachlan Shire Council, Queanbeyan-Palerang Regional Council and Barina Quarry, it is likely multiple and varying stages of remediation have been carried out along the alignment. As an example, several types of seals, and base course were noted throughout our drive/walkover. Broadly, the pavement appears to be at its terminal life for its current condition and use. For the purposes of this commentary, short term asset and road user management measures have been broadly defined as measures that are readily available, at low capital cost and likely requiring limited approvals or long construction timelines/cost i.e. maintenance, and considered from a geotechnical/pavement perspective.

Such measures may include, in order of likely expenditure:

- Implementing a reduced speed limit for all road users.
- Improvement of drainage through devegetation of the shoulders, and cutting in table drains where currently limited drainage is present.
- Conducting localised reconstruction/patching of sections affected by potholing and severe rutting. Potholing is likely due to poor seal performance (ageing and cracking) permitting water, and potentially base course material quality being limited or deteriorated. Rutting is more likely a result of thin pavement and poor subgrade materials and may be associated with groundwater shows and poor sideways drainage from the pavement. Such patching would not address the structural problems of the pavement, and would be a short term measure, but would allow for an improved surface and road user safety.
- Conducting a re-seal after patching and ensuring any seal deterioration or cracking is repaired expediently.

With the existing limited subsurface information at hand, the above measures are unlikely to particularly prolong the pavement life, but rather provide a safer and more trafficable roadway in the short term. Once implemented the speed limit reduction recommended above, may be reviewed.

5 FUTURE WORK RECOMMENDATIONS

From an engineering perspective, future works should comprise:

- Determination of future road use and traffic data.
- Non-intrusive investigation e.g., Benkelman Beam or Falling Weight Deflectometer Testing, to determine remaining pavement life (if any), and whether the cause of the defects are typically shallow or deep in the pavement structure e.g. poor base course, inadequate thickness, or poor subgrade conditions (or all three).
- Intrusive investigations e.g., boreholes or test pits to suitably log the existing pavement and in-situ subgrade conditions, and to obtain samples for laboratory testing. The intrusive investigation would be interpretated in conjunction with the non-intrusive works to assist with future pavement remediations/construction.
- Based on the results of the above, it is likely the following options would be suitable for the presented design traffic:
    - In-situ stabilisation of the subgrade, and placement of a granular flexible pavement (appropriate for future design traffic) and seal. Seal selection will be a function of traffic, grade, radii, and presence of intersections. For the heavy vehicle traffic it is

likely that a specialised spray seal with PMB would be required in areas away from high stress such as braking, acceleration, low speed turning and the like. More robust solutions would be required at intersections, such as asphalt.

  - In-situ stabilisation of the existing gravel course, likely topped up with imported material for the required structural thickness, and some subgrade and drainage improvements

- Road upgrade including widening of the carriageway in compliance with AUSTROADS and ULSC design specifications to cater for increased volumes of heavy traffic

6 CLOSING

We trust this memorandum meets your current needs. Should you have questions feel free to contact the undersigned on 0417 654 539.

For and on behalf of Indesco

Michael Merange

Principal Civil Engineer

Enclosed: Pavement Defect Photographs

Attachment A Pavement Defect Photographs

Pavement Defect Photograph Job No: C-1703.00
Office: Canberra

Client: Indesco Pty Ltd	Date: 6 February 2023
Principal:	By: MM
Project: Collector Road	Location: Zone A

Pavement Defect Photograph

Job No: 9094
Office: Canberra

Client: Indesco Pty Ltd	Date: 6 February 2023
Principal:	By: MM
Project: Collector Road	Location: Zone A

Pavement Defect Photograph Job No: 9094
Office: Canberra

Client: Indesco Pty Ltd	Date: 6 February 2023
Principal:	By: MM
Project: Collector Road	Location: Zone A

Pavement Defect Photograph Job No: 9094
Office: Canberra

Client: Indesco Pty Ltd	Date: 6 February 2023
Principal:	By: MM
Project: Collector Road	Location: Zone B

Pavement Defect Photograph

Job No: 9094
Office: Canberra

Client: Indesco Pty Ltd	Date: 6 February 2023
Principal:	By: MM
Project: Collector Road	Location: Zone B

Pavement Defect Photograph

Job No: 9094
Office: Canberra

Client: Indesco Pty Ltd	Date: 6 February 2023
Principal:	By: MM
Project: Collector Road	Location: Zone B

Pavement Defect Photograph Job No: 9094
Office: Canberra

Client: Indesco Pty Ltd	Date: 6 February 2023
Principal:	By: MM
Project: Collector Road	Location: Zone B

Pavement Defect Photograph

Job No: 9094
Office: Canberra

Client: Indesco Pty Ltd	Date: 6 February 2023
Principal:	By: MM
Project: Collector Road	Location: Zone B

Pavement Defect Photograph

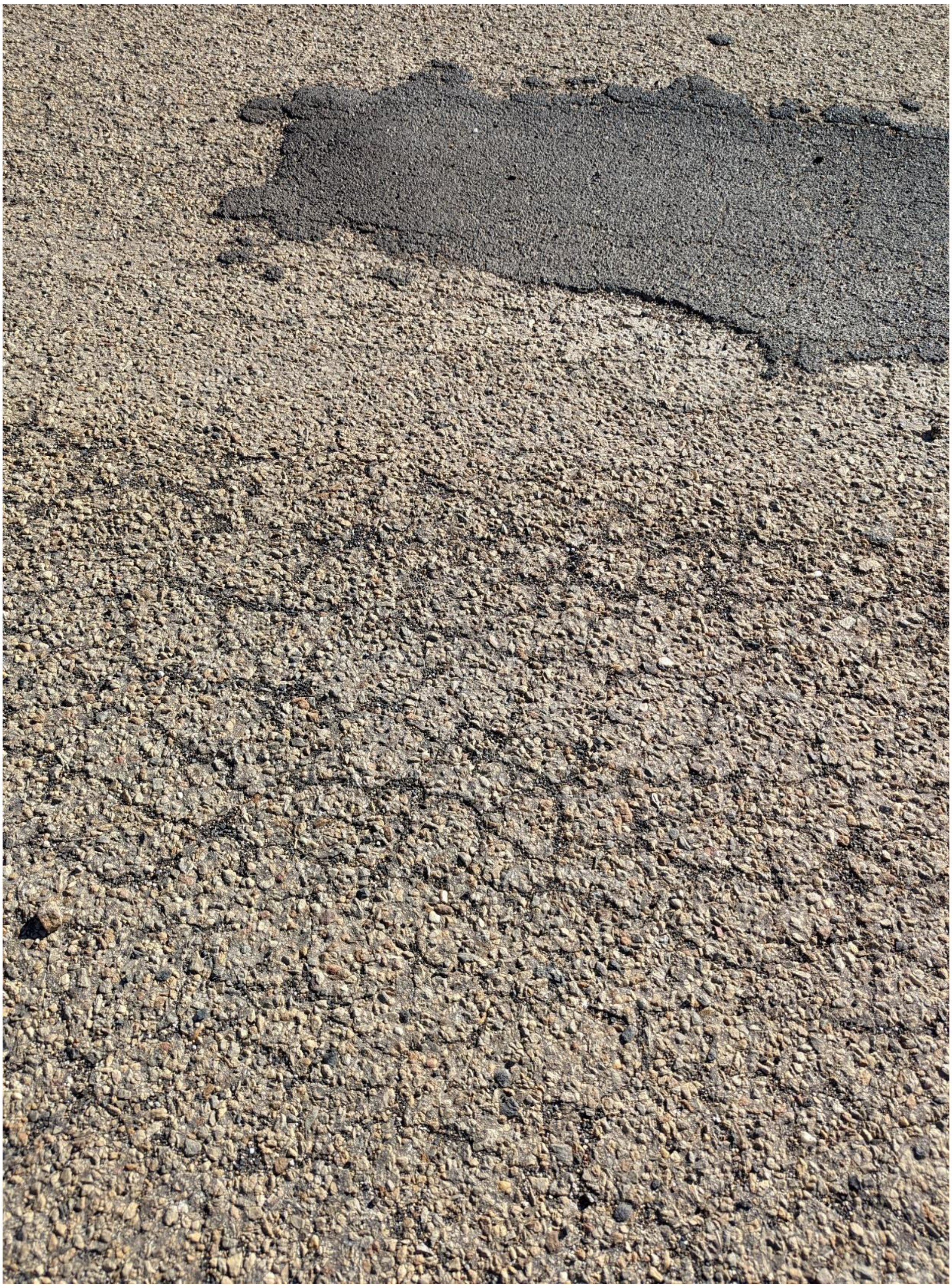
Job No: 9094
Office: Canberra

Client: Indesco Pty Ltd	Date: 6 February 2023
Principal:	By: MM
Project: Collector Road	Location: Zone B

Pavement Defect Photograph

Job No: 9094
Office: Canberra

Client: Indesco Pty Ltd	Date: 6 February 2023
Principal:	By: MM
Project: Collector Road	Location: Zone B



Pavement Defect Photograph Job No: 9094
Office: Canberra

Client: Indesco Pty Ltd	Date: 6 February 2023
Principal:	By: MM
Project: Collector Road	Location: Zone C

Pavement Defect Photograph

Job No: 9094
Office: Canberra

Client: Indesco Pty Ltd	Date: 6 February 2023
Principal:	By: MM
Project: Collector Road	Location: Zone C

Pavement Defect Photograph Job No: 9094
Office: Canberra

Client: Indesco Pty Ltd	Date: 6 February 2023
Principal:	By: MM
Project: Collector Road	Location: Zone D

Pavement Defect Photograph

Job No: 9094
Office: Canberra

Client: Indesco Pty Ltd	Date: 6 February 2023
Principal:	By: MM
Project: Collector Road	Location: Zone D

Pavement Defect Photograph

Job No: 9094
Office: Canberra

Client: Indesco Pty Ltd	Date: 6 February 2023
Principal:	By: MM
Project: Collector Road	Location: Zone D

Pavement Defect Photograph

Job No:9094

Office: Canberra

Client: Indesco Pty Ltd	Date: 6 February 2023
Principal:	By: MM
Project: Collector Road	Location: Zone E

Pavement Defect Photograph

Job No: 9094
Office: Canberra

Client: Indesco Pty Ltd	Date: 6 February 2023
Principal:	By: MM
Project: Collector Road	Location: Zone E

Pavement Defect Photograph

Job No: 9094
Office: Canberra

Client: Indesco Pty Ltd	Date: 6 February 2023
Principal:	By: MM
Project: Collector Road	Location: Zone E

Pavement Defect Photograph Job No: 9094
Office: Canberra

Client: Indesco Pty Ltd	Date: 6 February 2023
Principal:	By: MM
Project: Collector Road	Location: Zone F