Appendices

(Total No. of pages including blank pages = 76)

***Note: A copy of Appendices D, E & F are available on the Project CD**

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APPENDIX A

INSPECTION REPORT

(Total number of pages including blank pages = 4)

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INSPECTION REPORT

8/02/2012
Note: pavement and shoulder widths have been estimated due to variation over length of route
Traffic Impact Study – Road Data

CH Start (m)	CH Finish (m)	No. Of Lanes Each Direction (m)	Approx. Lane Width (m)	Approx. Sealed Shoulder Width (m)	Approx. Unsealed Shoulder Width (m)	Notes
Obley Road (Chainages commence at intersection of the Newell Highway)						
0	1.0	1	3.5	1		80km/hr zone, known tourist precinct, shared cycleway track to east, 9m seal width, central barrier line marking only, good delineation
0.6	0.6	1	3.5	1		Zoo intersection, channelised right turn into zoo, shared cycleway crossing with pedestrian island, finger island on zoo road, no street lighting
1	9.5	1	3.5	0.5		100km/hr speed limit, several share road with cyclists warning signs, pavement in average condition, speed advisory signs on curves OK, central barrier line marking only, good delineation
1.7	1.7	1	3.5	0.5		Box culvert under, headwalls approx. 1m of edge of seal.
3.2	3.2	1	3.5	0.5		Box culvert 0.5 m from edge of seal.
3.3	3.3	1	3.5	0.5		Camp Rd intersection
3.7	3.7	1	3.5	0.5		Tree within clear zone on outside of curve, (1.5m from seal)
4.8	4.8	1	3.5	0.5		Intersection Belowrie Rd, access Morris Park Speed Way, limited sight distance to south, no give way controls
5	5	1	3.5	0.5		Unnamed Rd with several mail boxes, limited sight distance to Nth, possible bus stop.
6.5	6.5	1	3.5	0		Concrete Bridge over Cumboogle Creek, 7m in width, substandard guardrail terminals, concrete wearing surface
6.6	6.6	1	3.5	0.5		4 way intersection with Cumboogle Rd (east) & Belmont Rd (west), good sight distance both directions, give way signs but no holding lines, relatively narrow approach seal widths, bus stop shelter adjacent
8.2	8.2	1	3.5	0.5		Disused rail crossing on curve, rail crosses at 45 - 35 degree angle, approach sight distance average to north, good to south, tracks have been removed, adjacent private access to west will require relocating when railway is reopened
9.3	9.3	1	3.5	0.5		Benolong Rd intersection on outside of curve, good sight distance, give way controls ok, left turn auxiliary and auxiliary right on Obley Rd, no break in centre line
9.5	16.9	1	3	0.25		No line marking, seal varies in width 7 - 7.5m, several culvert headwalls 1 to 0.5m from edge of seal, substandard horizontal and vertical alignment, grassed shoulders
12.5	12.5	1	3	0.25		Bellevue Rd intersection, minor unsealed road, no give way controls, no sight screen, limited sight distance to south.

CH Start (m)	CH Finish (m)	No. Of Lanes Each Direction (m)	Approx. Lane Width (m)	Approx. Sealed Shoulder Width (m)	Approx. Unsealed Shoulder Width (m)	Notes
14.4	14.4	1	3	0.25		Floodway, no approach warning signs, no depth marker
14.9	14.9	1	3	0.25		Disused rail crossing on curve & crest, tracks have been removed
15	15	1	3	0.25		Oakdene Rd Intersection, minor sealed road, no sight screen, no give way controls, sight distance limited to north, school bus stop opposite in close proximity to rail crossing
15.1	15.1	1	3	0		Causeway with box culvert, 7m width, No causeway warning sign on southern approach
15.2	15.2	1	3	0.25		Hyandra Rd Intersection, no sight screen, unsealed minor road, no give way controls.
15.5	15.5	1	3	0		Floodway, no floodway warning sign on northern approach, depth markers not at lowest point
16.9	17.2	1	3.5	0.5		Seal widens, central barrier line marking, pavement in average condition
17.2	21.8	1	3.5	0.5		Central barrier and edge line marking, sealed shoulder width varies from 0.5 to 1m, pavement fatigue evident, northbound road narrows warning sign is upside down
21.8	21.8	1	3.5	0.5		Intersection with Toongi Rd, sight screen low, holding line but no give way sign, limited sight distance to south, bus stop immediately north, private access opposite 25m to north.
Toongi Road (Chainages commence at intersection of Obley Road)						
0	0.4	1	2.25		1	4.5m seal width, no posted speed limit assume 100km/hr
0.2	0.2	1	2.25		1	Waste transfer station
0.3	0.3	1	2			Causeway with low flow pipes, excessive grade on both approaches, no warning sign on eastern approach, no passing possible on causeway or approaches
0.4	0.4	1	2.25		1	The Springs Rd intersection, small sight screen, no give way controls or line marking
0.4	1.6	1	2		1	Seal width reduces to 3 - 3.5m, no curve advisory signs
0.7	0.7	1	2		1	Proposed access to processing plant on curve
1.6	1.6	1	2		0.5	Disused rail crossing
1.6	1.6	1	2		1	Road becomes unsealed and ends at private driveways

APPENDIX B

DIRECTOR GENERAL REQUIREMENTS

(Total number of pages including blank pages = 4)

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Coverage of Specific Issues

Page 1 of 2

Government Agency	Paraphrased Requirement	Relevant Section(s)
TRAFFIC AND TRANSPORT		
NSW Department of Planning & Infra-structure	The EIS must include: • accurate predictions of the road and rail traffic generated by the Proposal;	2.6
	• an assessment of the capacity of the rail network to accommodate the transport of ore;	1.3.4
	• an assessment of potential traffic impacts on the safety and efficiency of the road network; and	2.8 3.1 – 3.7
	• a detailed description of the measures that would be implemented to maintain and/or improve the capacity, efficiency and safety of the road and rail networks in the surrounding area over the life of the Proposal;	4.1 – 4.4
Roads and Maritime Services	• A traffic study is to be undertaken which includes, but is not limited to origin-destination of vehicles, including staff, contractors, construction, and maintenance personnel during both the construction and operation phases of the development. The study should include vehicle types, volumes and times of peak travel and include existing, proposed, and projected figures for the life of the project. The traffic study should also address internal traffic movement and parking facilities. The traffic study is to address impacts on key intersections with the Newell Highway including Obley Road.	2.5 2.6 2.8 3 4.4
	• Intersection treatments and mitigation measures to cater for predicted traffic impacts. This is to include any required temporary or staged treatments and other measures. Treatments are to be provided for any proposed new junctions as well as any other temporary junctions or existing intersection upgrades. The intersections are to cater for all heavy and over dimensional vehicles that will be accessing the development. Concept plans for those improvements should be included in the study.	4 Appendix D and F
	• The traffic impact study and proposed intersection treatments are to include the cumulative impacts of any existing approved developments in the vicinity of the site.	1.2 1.4
	• Details of all railway level crossings that will be reinstated or affected by an increase in traffic associated with the development.	2.4 2.5.2
	• Details of any proposed crossings of classified roads for water, gas, or electricity lines. The relevant State classified roads in the Dubbo area are the Newell, Mitchell and Golden Highways.	1.4
	• The layout of the internal road network, parking facilities and infrastructure within the project boundary	4.4
	• Any proposed road facilities and intersection treatments are to be in accordance with the Austroads Guide 10 Road Design and RMS supplements.	1.2 Appendix D and F
	• Consideration of the impacts of construction traffic on the road network in the vicinity of the development and measures to minimise any identified impacts.	3 4

Coverage of Specific Issues (Cont'd)

Page 2 of 2

Government Agency	Paraphrased Requirement	Relevant Section(s)
Roads and Maritime Services	• Identify the necessary road network infrastructure upgrades that are required to maintain existing levels of service on both the local and classified road network. In this regard, preliminary concept drawings shall be submitted with the EA for any 'identified road infrastructure upgrades. However, it should be noted that any identified road infrastructure upgrades will need to be to the satisfaction of RMS and I or Council.	4, Appendix D and F
	• Intersection analysis (such as SIDRA) shall be submitted to determine the need for intersection and road capacity upgrades. The intersection analysis shall include (but not be limited to) the following: – Current traffic counts and 10 year traffic growth projections – With and without development scenarios considered – 95th percentile back of queue lengths – Delays and level of service on all legs for the relevant intersections – Electronic data for RMS review.	2.5 2.6 2.8
	It is recommended that the proponent discuss the Proposal with RMS prior to commencing preparation of the traffic and transport study. RMS will provide further comment on the subject Proposal on receipt of the required traffic and transport study and more detailed information referred as part of the Proposal application process.	1.4

APPENDIX C

TRAFFIC COUNT DATA

(Total number of pages including blank pages = 4)

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TABLE Forecast Background and Mine Operational Traffic

SITE	MEASURED BACKGROUND TRAFFIC			FORECAST BACKGROUND TRAFFIC						FORECAST PROJECT TRAFFIC		FORECAST BACKGROUND + PROJECT TRAFFIC		
	Data Year	AADT	% HV	AADT LV 2016	AADT HV 2016	AADT 2016	AADT LV 2036	AADT HV 2036	AADT 2036	OP LV	OP HV	AADT LV 2036	AADT HV 2036	AADT 2036
Obley Road (between Newell Hwy & Zoo entry)	2012	2,330	10.9	2,203	270	2,473	2,968	363	3,331	320	158	3,288	521	3,809
Obley Road, 100m East of Zoo entry	2012	1,257	11.2	1,185	149	1,334	1,596	201	1,797	320	158	2,117	359	2476
Obley Road (250m north of Dundullimal Homestead)	2012	1,201	18	1,046	229	1,275	1,408	309	1,717	320	158	1,728	467	2,195
Obley Road (100m north of Toongi Road)	2012	388	38	256	156	412	344	211	555	320	158	664	369	1,033
Toongi Road (Immediately east of Obley Road)	2012	91	17	81	16	97	108	22	130	320	158	428	180	608
Boothenba Road (Btwn Old Mendooran Rd & Golden Hwy	2008	408	32.5	310	149	459	417	201	618	0	98	417	297	714
Boothenba Road (East of Yarrandale Road)	2001	750	24.1	712	226	938	959	304	1,263	0	98	1,263	400	1,663
Boothenba Road (50m west of Saleyards entry)	2002	1,436	20.7	1,402	366	1,768	1,889	493	2,382	0	98	1,889	589	2,478
Yarrandale Road (200m north of Purvis Lane)	2010	2,701	39.3	1,793	1,161	2,953	2,415	1,563	3,978	0	98	2,415	1,659	4,074
Wingewarra Street (Between Chelmsford & Kokoda Streets)	2008	9,703	10											
Mitchell Highway (Cobra Street – Near Apex Oval)	2011	19,575	10											
Boundary Street (West of Wheeler's Lane)	2007	3,146	10											
Macquarie Street (Old Dubbo Road – North of Margaret Crescent)	2010	1,386	10											

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APPENDIX D

(I) CONCEPTUAL ALIGNMENT AND (II) BRIDGE DECK LEVELS

(Total number of pages including blank pages = 18)

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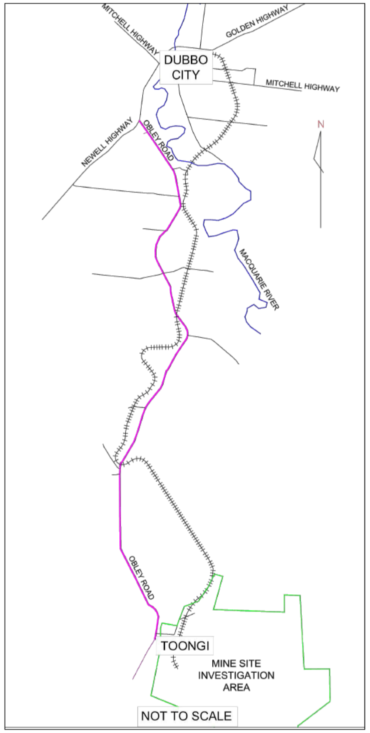
Appendix D(I) Conceptual Alignment of Obley Road

DUBBO ZIRCONIA PROJECT
OBLEY ROAD ALIGNMENT INVESTIGATION & INTERSECTION TREATMENT CONCEPT DESIGN



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201205-2	OVERVIEW PLAN OF ALIGNMENT
201205-3	EXISTING CONDITIONS & INTERSECTION PLAN CH 0 - CH 3900
201205-4	INTERSECTIONS 1 & 2 PROPOSED TREATMENTS DETAIL SHEET
201205-5	EXISTING CONDITIONS & INTERSECTION PLAN CH 3900 - CH 7800
201205-6	INTERSECTIONS 3 & 4 PROPOSED TREATMENTS DETAIL SHEET
201205-7	EXISTING CONDITIONS & INTERSECTION 5 PLAN CH 7800 - CH 10250
201205-8	EXISTING CONDITIONS & INTERSECTION PLAN CH 10000 - CH 16000
201205-9	INTERSECTION 6 PROPOSED TREATMENT DETAIL SHEET
201205-10	INTERSECTIONS 7 & 8 PROPOSED TREATMENTS DETAIL SHEET
201205-11	EXISTING CONDITIONS & INTERSECTION PLAN CH 16000 - CH 21300
201205-12	EXISTING CONDITIONS & INTERSECTION 9 TREATMENT PLAN CH 21300 - CH 21750

REVISIONS

REV.	DATE	BY	DESCRIPTION	CHK.
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A	04-09-2012	DB	ISSUED FOR REVIEW	

COVERSHEET & SHEET INDEX

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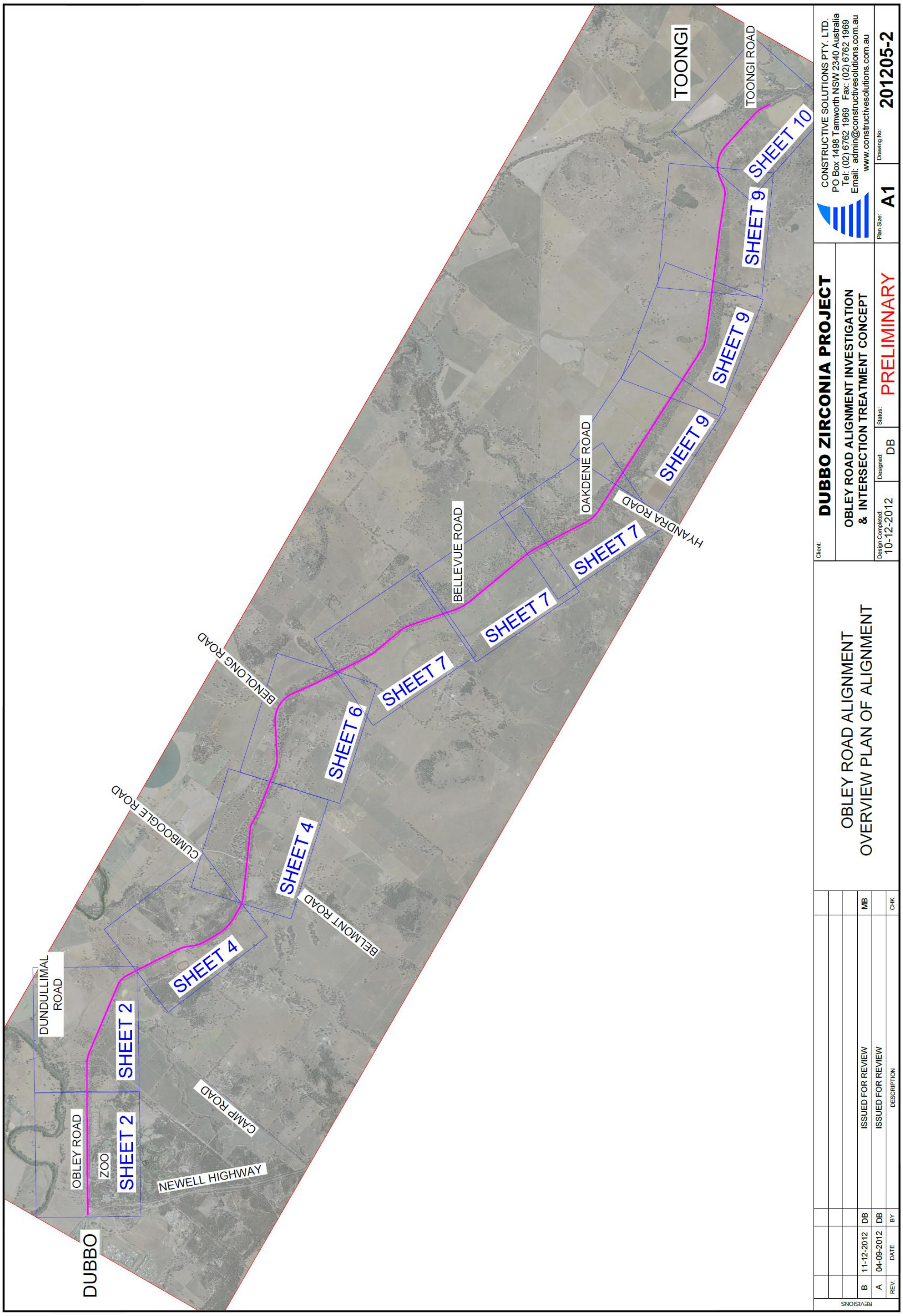
Plan Size: A1 | Drawing No: 201205-1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OBLEY ROAD
ZOO
NEWELL HIGHWAY
CAMP ROAD
DUNDULLIMAL ROAD
CUMBOOGLE ROAD
BELMONT ROAD
BENOLONG ROAD
BELLEVUE ROAD
OAKDENE ROAD
HYANDRA ROAD
TOONGI ROAD
SHEET 2
SHEET 2
SHEET 4
SHEET 4
SHEET 6
SHEET 7
SHEET 7
SHEET 7
SHEET 9
SHEET 9
SHEET 9
SHEET 10
OBLEY ROAD ALIGNMENT
OVERVIEW PLAN OF ALIGNMENT
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OBLEY ROAD ALIGNMENT INVESTIGATION
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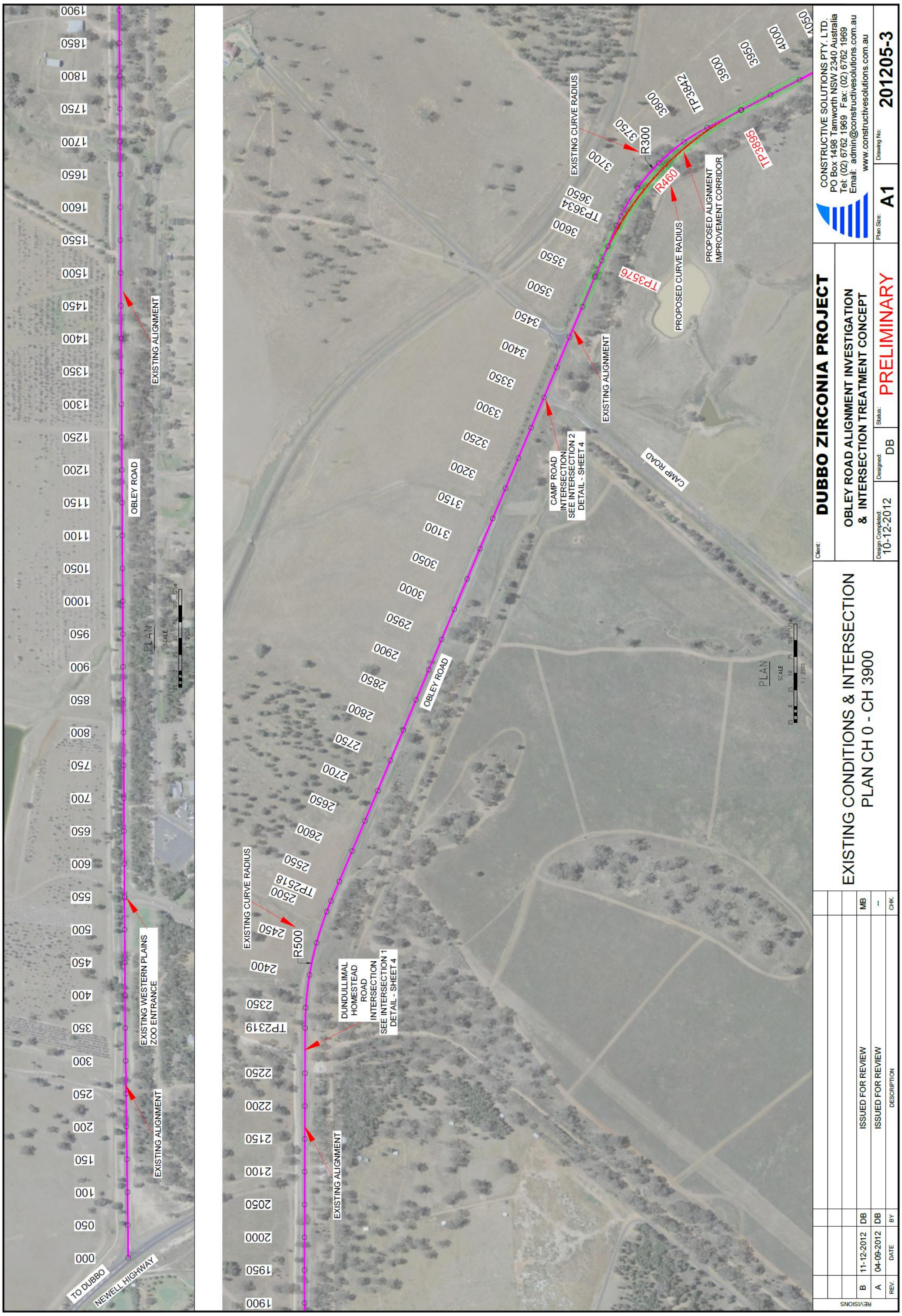
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OBLEY ROAD
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CAMP ROAD INTERSECTION SEE INTERSECTION 2 DETAIL - SHEET 4
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PROPOSED CURVE RADIUS
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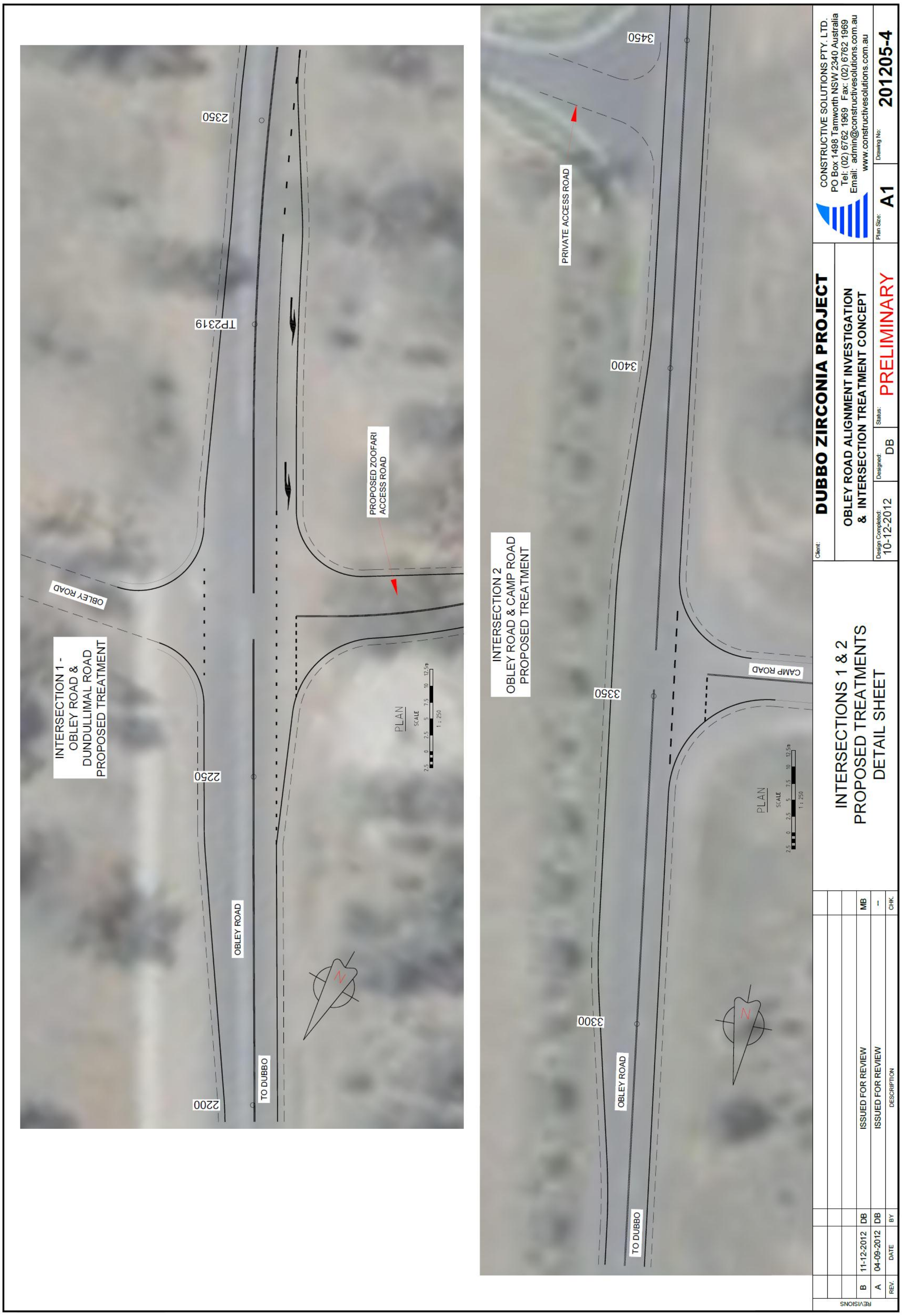
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2200
INTERSECTION 2 OBLEY ROAD & CAMP ROAD PROPOSED TREATMENT
PRIVATE ACCESS ROAD
CAMP ROAD
3450
3400
3350
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SCALE 1 : 250
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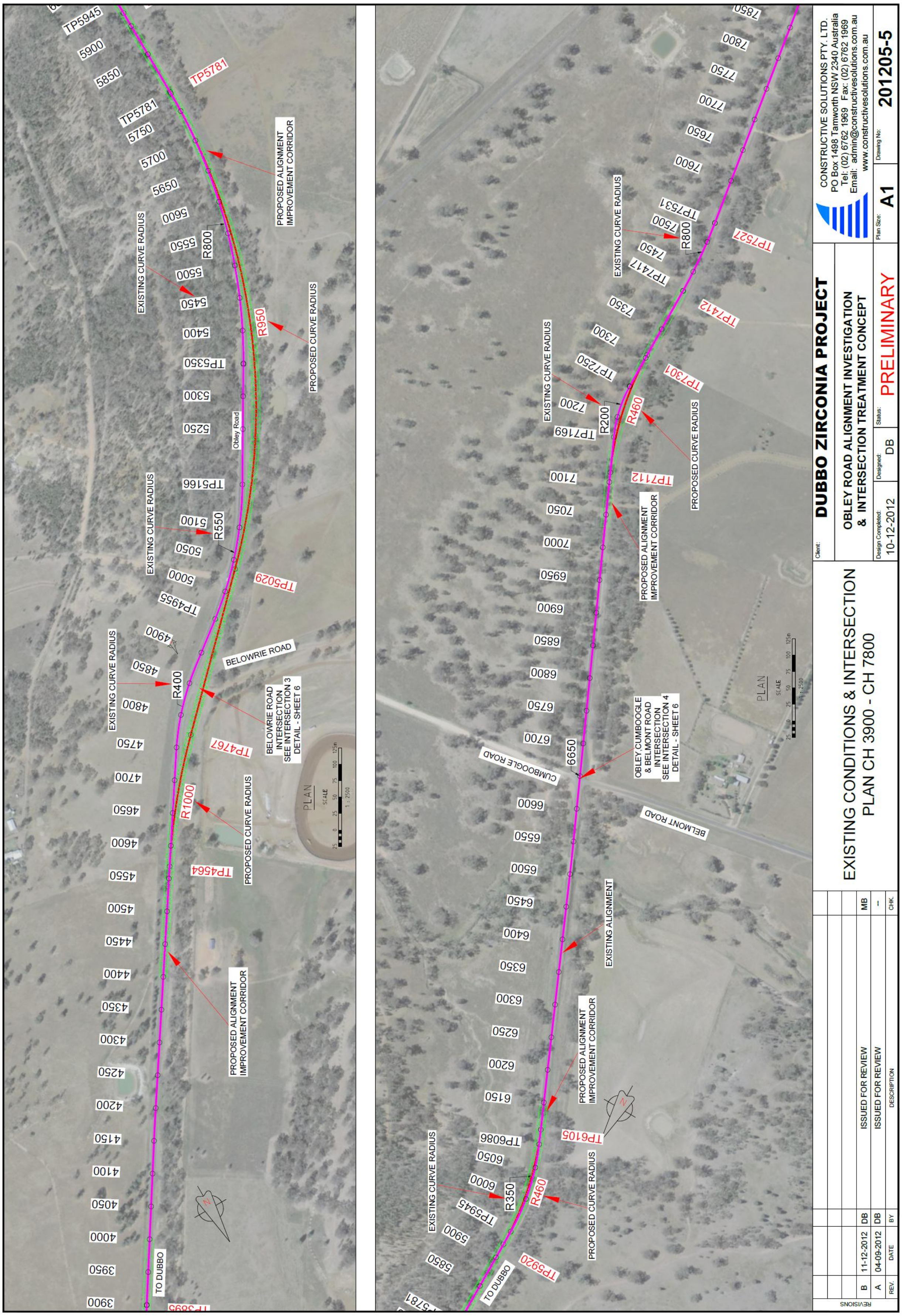
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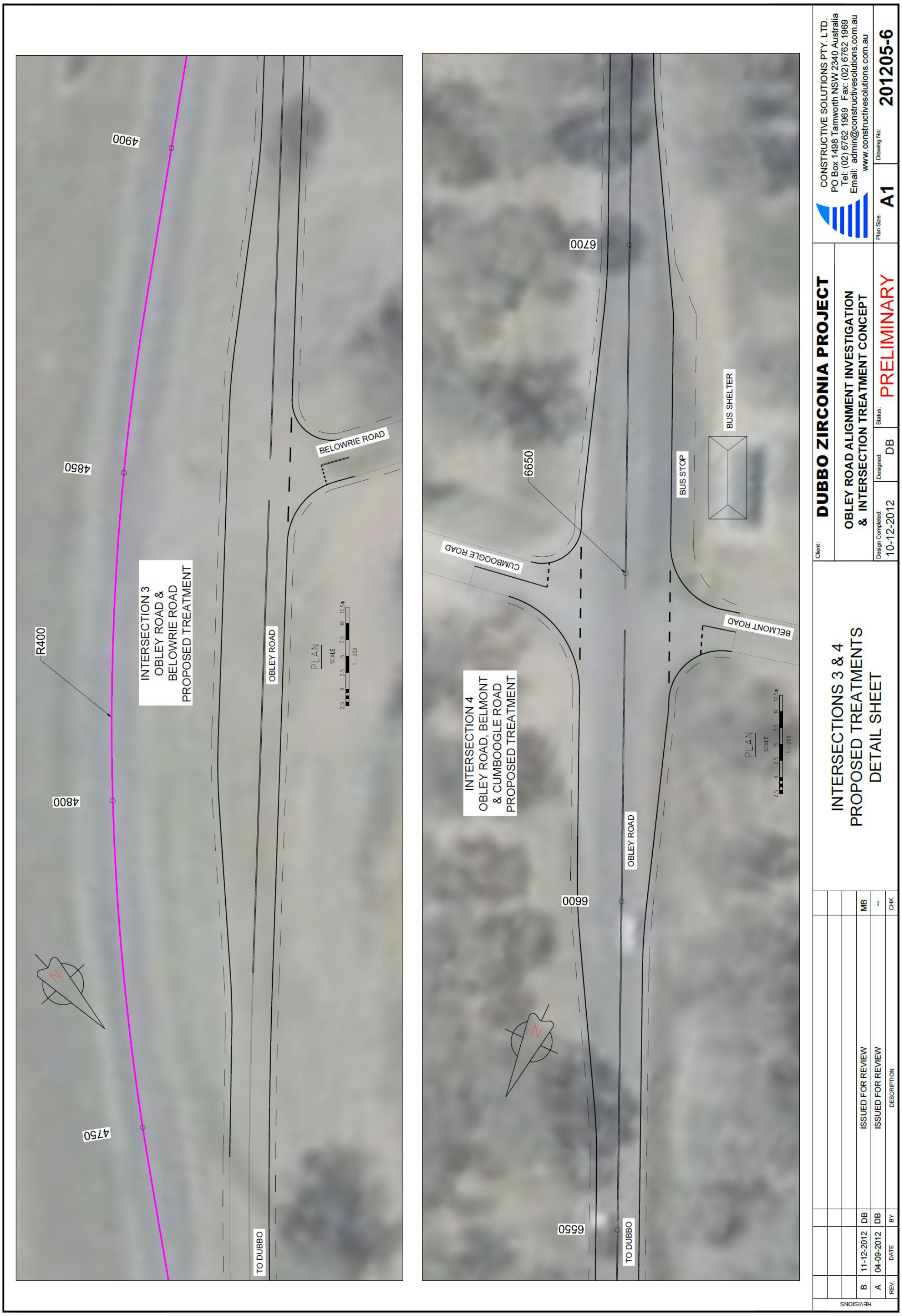
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& CUMBOOGLE ROAD
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TO DUBBO
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6650
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PLAN
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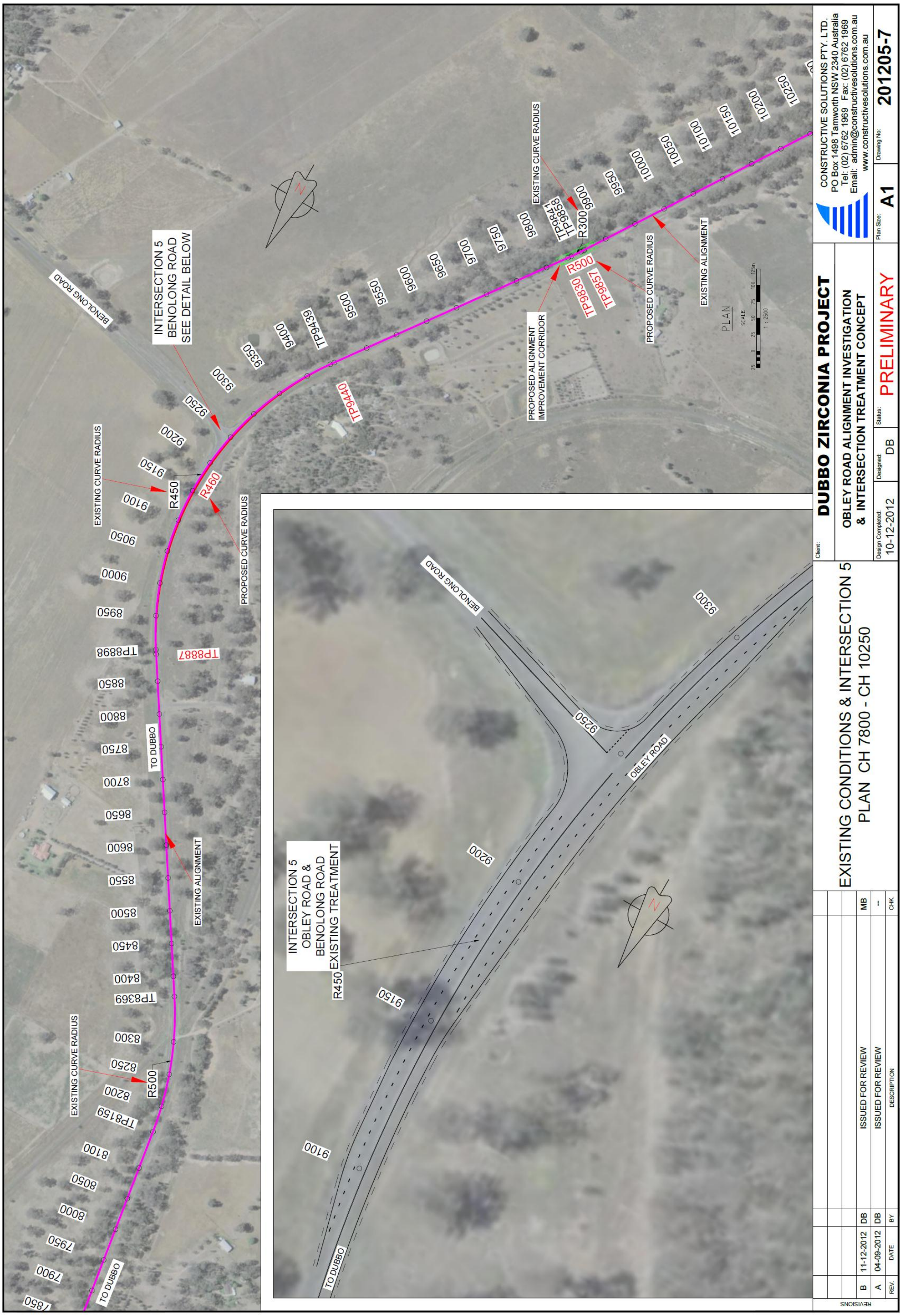

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INTERSECTION 5 OBLEY ROAD & BENOLONG ROAD EXISTING TREATMENT
BENOLONG ROAD
OBLEY ROAD
TO DUBBO
EXISTING CURVE RADIUS
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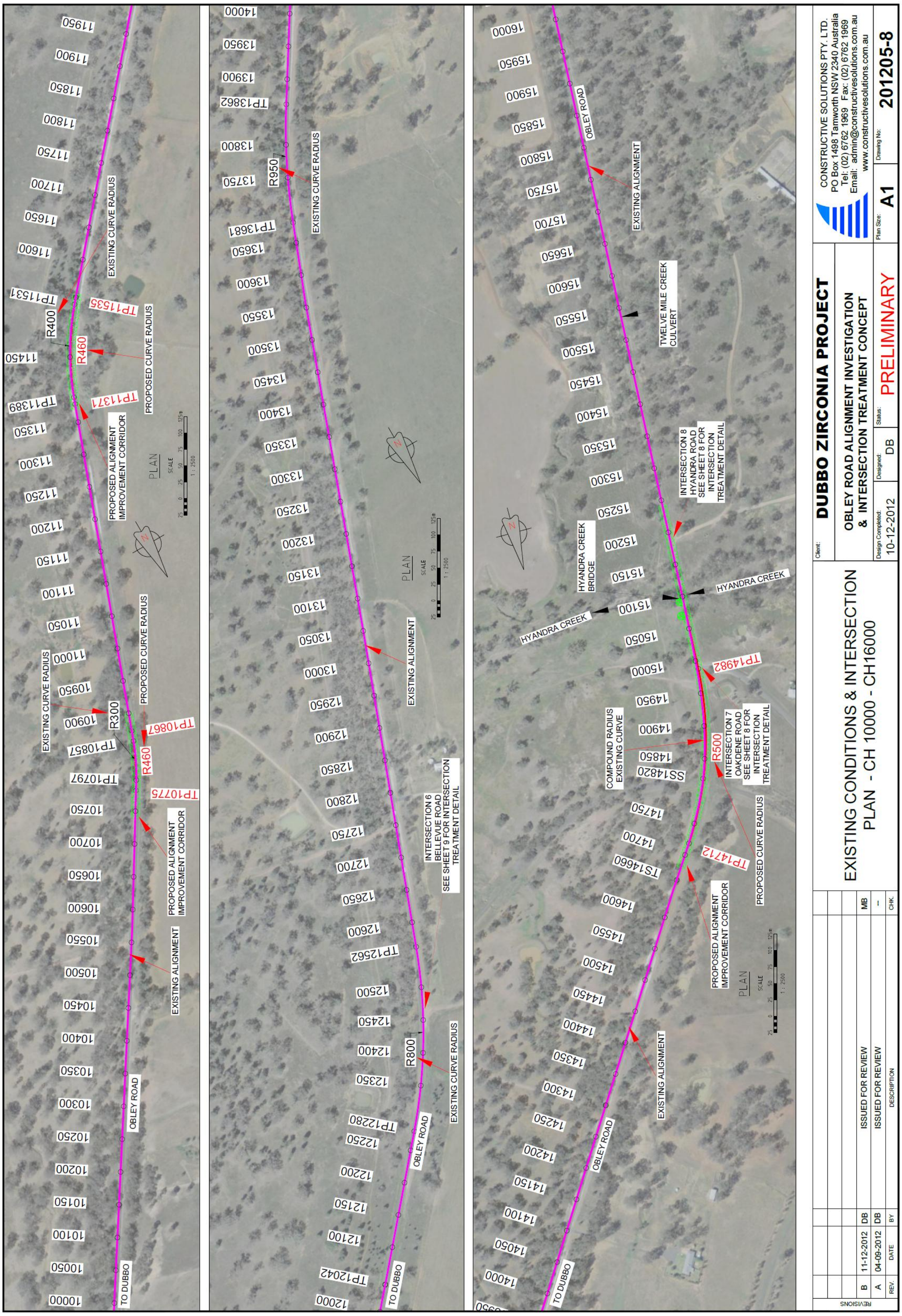

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BELLEVUE ROAD
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SCALE 1 : 250


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TO PROXIMITY TO HYANDRA CREEK BRIDGE
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BRIDGE
HYANDRA CREEK
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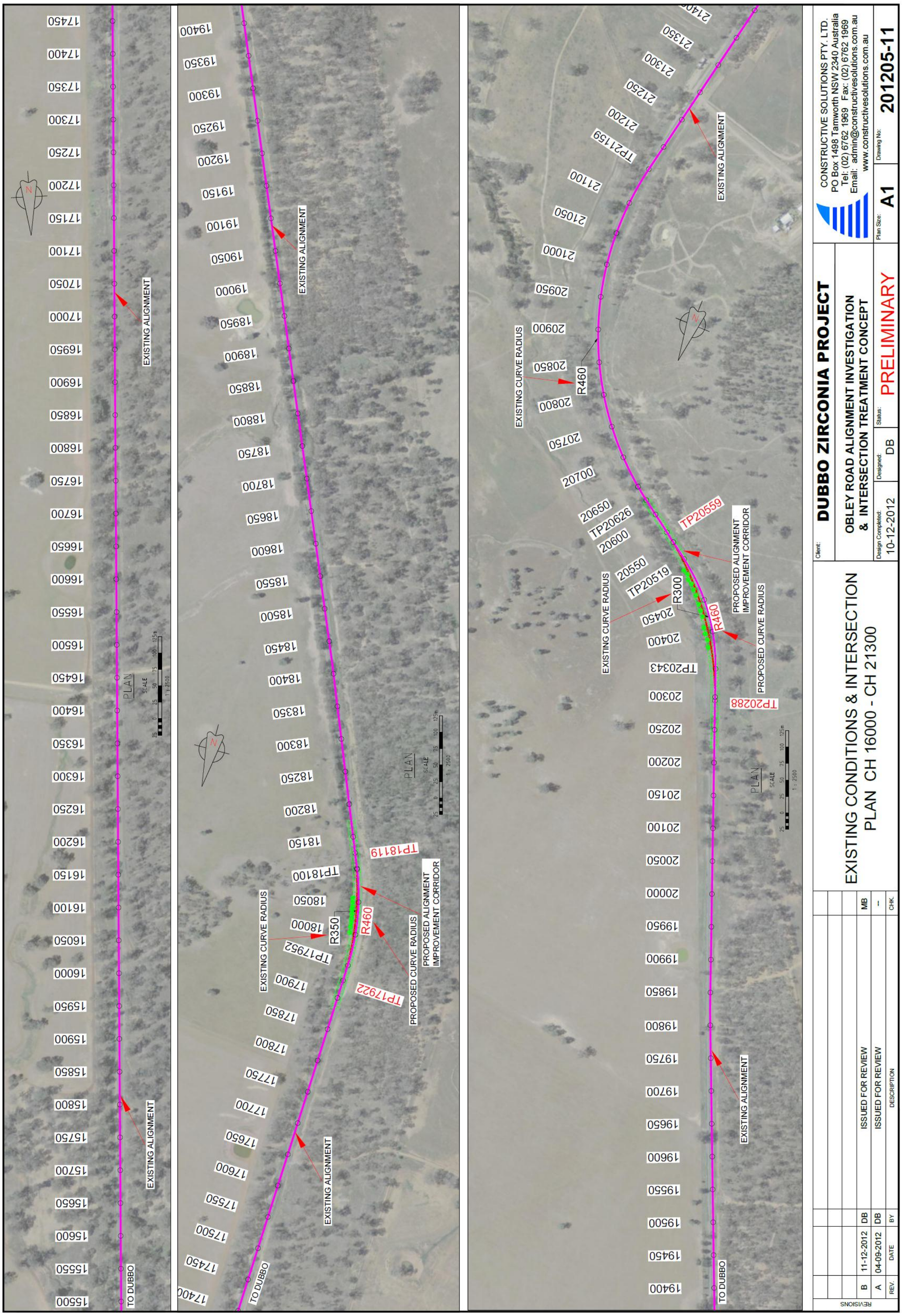
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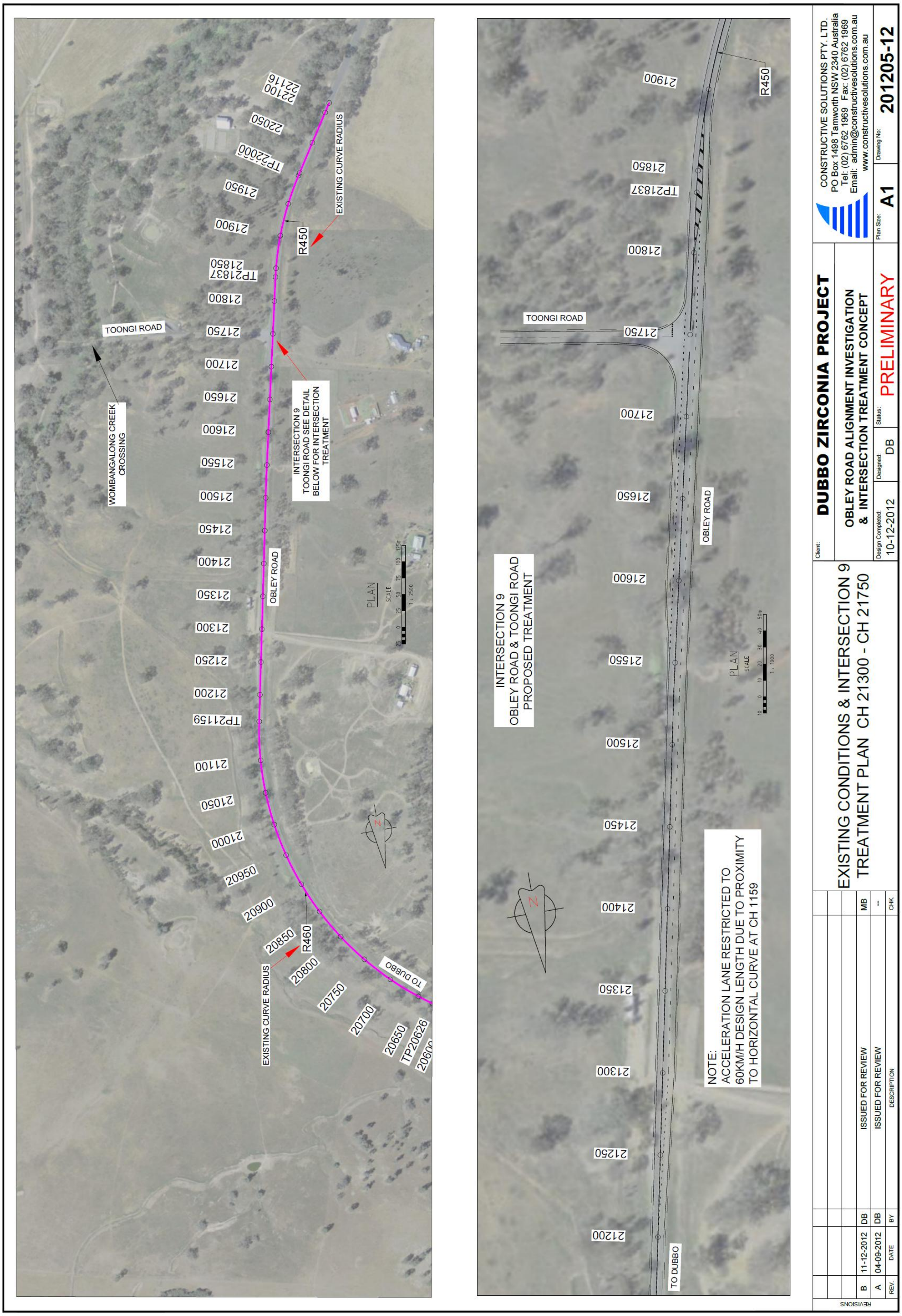
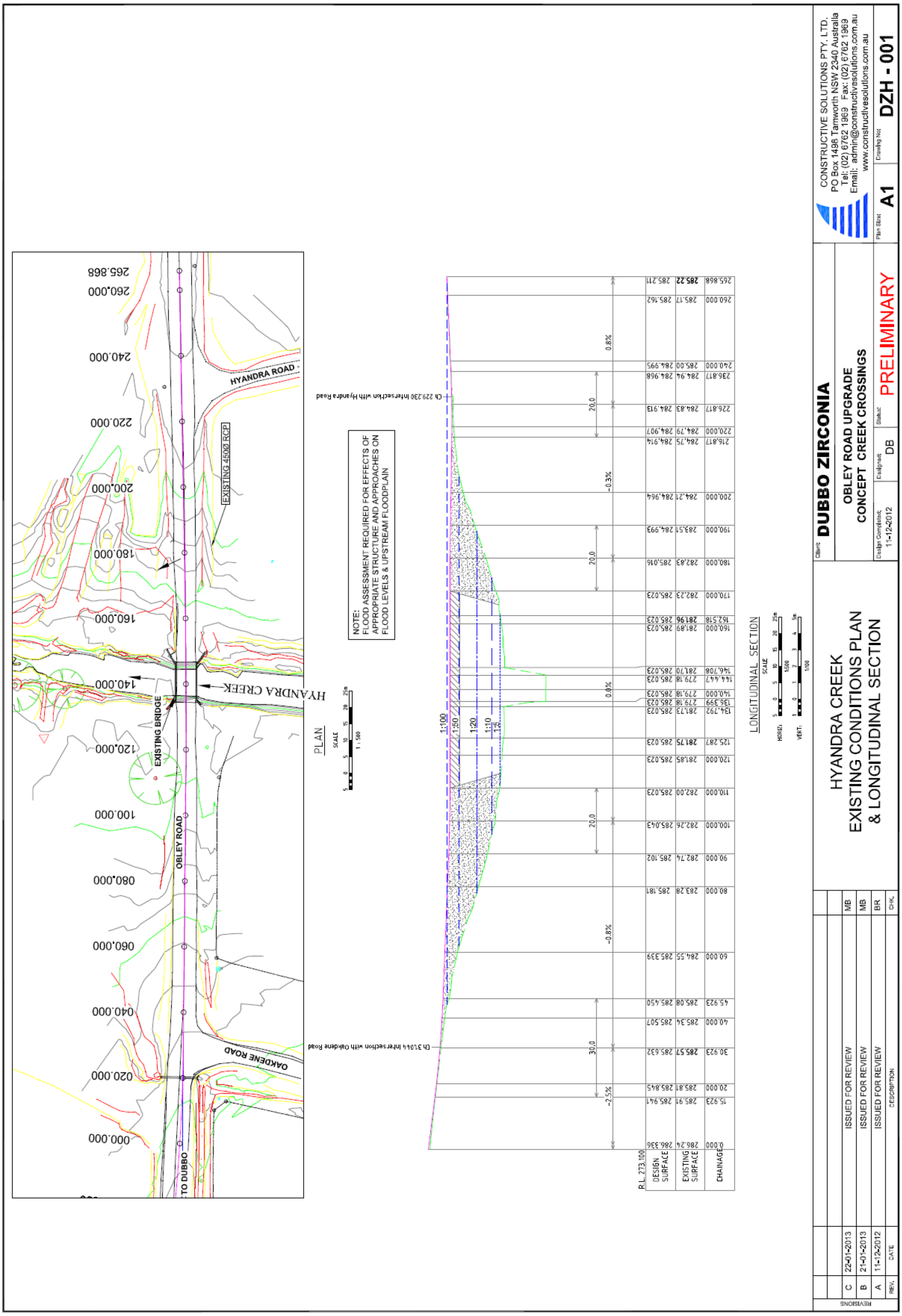


Appendix D(ii) Conceptual Bridge Deck Levels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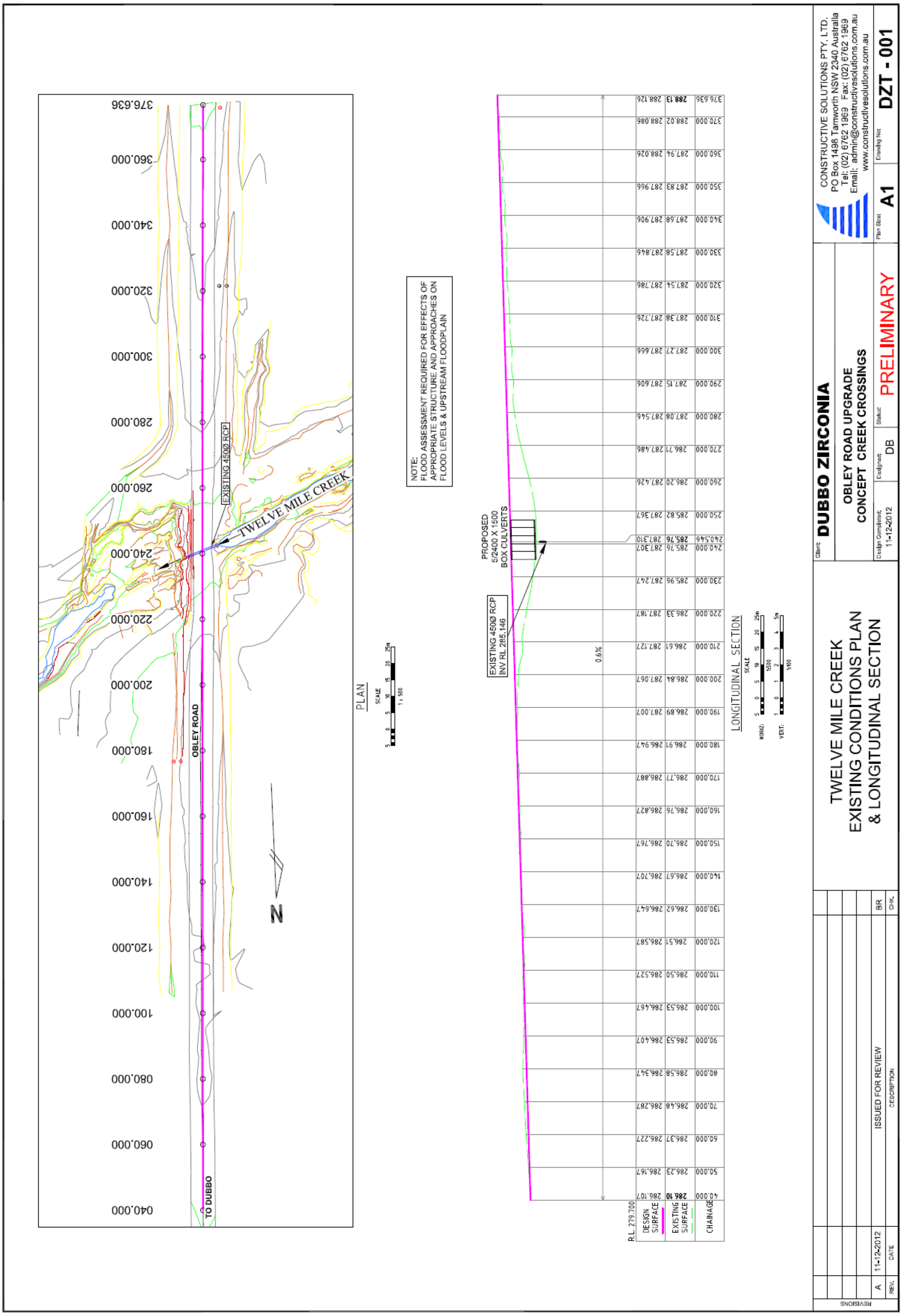
Tel: (02) 6762 1969 Fax: (02) 6762 1969
Email: admin@constructivesolutions.com.au
www.constructivesolutions.com.au
DUBBO ZIRCONIA
OBLEY ROAD UPGRADE
CONCEPT CREEK CROSSINGS
HYANDRA CREEK
EXISTING CONDITIONS PLAN
& LONGITUDINAL SECTION
PRELIMINARY
A1
DZH - 001
DB
11-12-2012
C 22-01-2013 ISSUED FOR REVIEW MB
B 21-01-2013 ISSUED FOR REVIEW MB
A 11-12-2012 ISSUED FOR REVIEW BR
NOTE:
FLOOD ASSESSMENT REQUIRED FOR EFFECTS OF
APPROPRIATE STRUCTURE AND APPROACHES ON
FLOOD LEVELS & UPSTREAM FLOODPLAIN
HYANDRA ROAD
HYANDRA CREEK
OBLEY ROAD
OAKDENE ROAD
EXISTING BRIDGE
EXISTING 450Ø RCP
TO DUBBO
PLAN
LONGITUDINAL SECTION
DESIGN SURFACE
EXISTING SURFACE
CHAINAGE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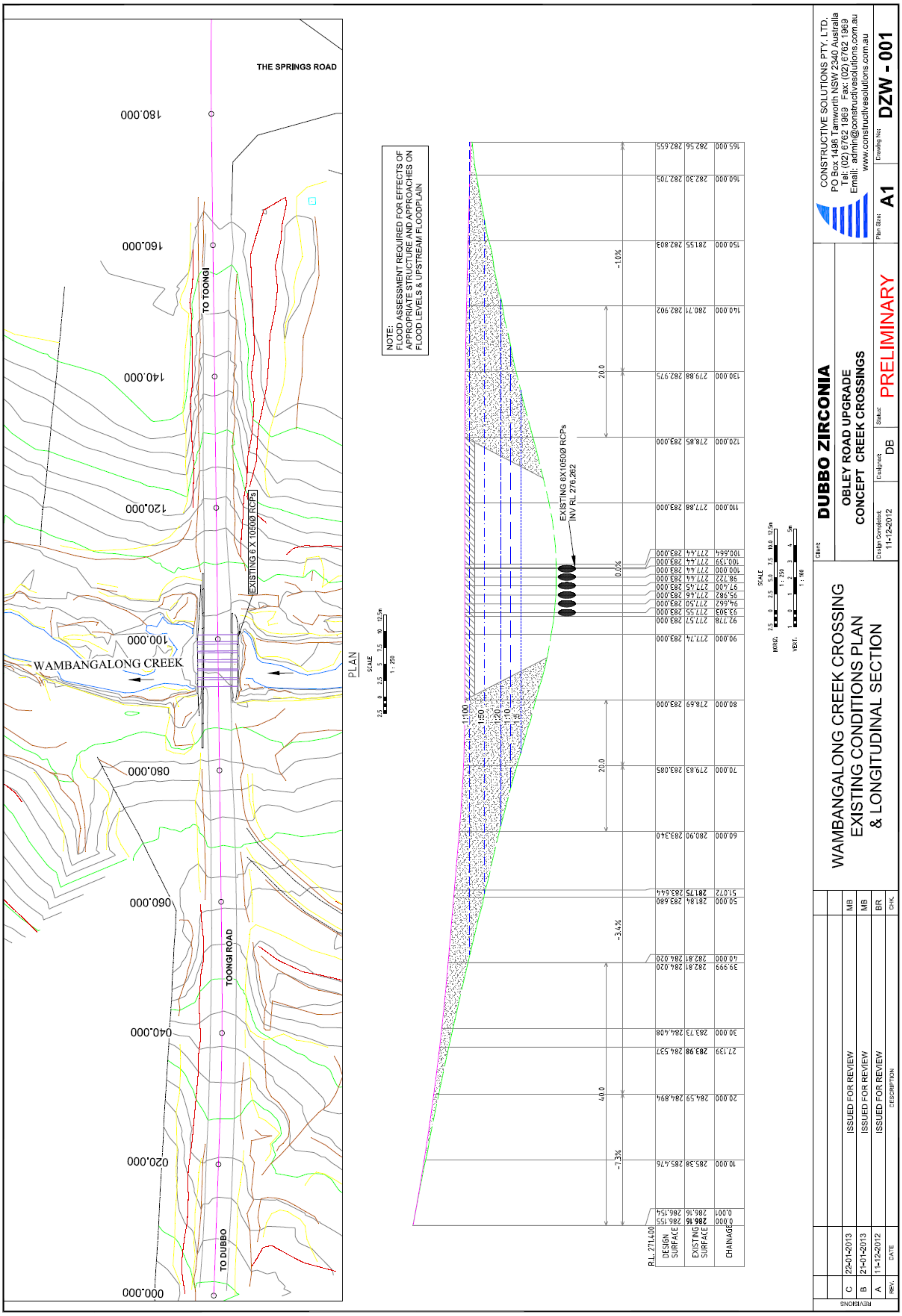
DUBBO ZIRCONIA
OBLEY ROAD UPGRADE
CONCEPT CREEK CROSSINGS
PRELIMINARY
A1
DZT - 001
TWELVE MILE CREEK
EXISTING CONDITIONS PLAN
& LONGITUDINAL SECTION
ISSUED FOR REVIEW
11-12-2012
NOTE:
FLOOD ASSESSMENT REQUIRED FOR EFFECTS OF
APPROPRIATE STRUCTURE AND APPROACHES ON
FLOOD LEVELS & UPSTREAM FLOODPLAIN
PROPOSED
5/2400 X 1500
BOX CULVERTS
EXISTING 450Ø RCP
INV RL 285.146
TWELVE MILE CREEK
OBLEY ROAD
TO DUBBO
PLAN
LONGITUDINAL SECTION
N


THE SPRINGS ROAD
TO TOONGI
WAMBANGALONG CREEK
EXISTING 6 X 1050Ø RCPs
TOONGI ROAD
TO DUBBO
PLAN
NOTE:
FLOOD ASSESSMENT REQUIRED FOR EFFECTS OF APPROPRIATE STRUCTURE AND APPROACHES ON FLOOD LEVELS & UPSTREAM FLOODPLAIN
EXISTING 6X1050Ø RCPs
INV RL 276.262
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DUBBO ZIRCONIA
OBLEY ROAD UPGRADE
CONCEPT CREEK CROSSINGS
PRELIMINARY
A1
DZW - 001
WAMBANGALONG CREEK CROSSING
EXISTING CONDITIONS PLAN
& LONGITUDINAL SECTION
ISSUED FOR REVIEW

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APPENDIX E

SIDRA ANALYSIS SUMMARIES

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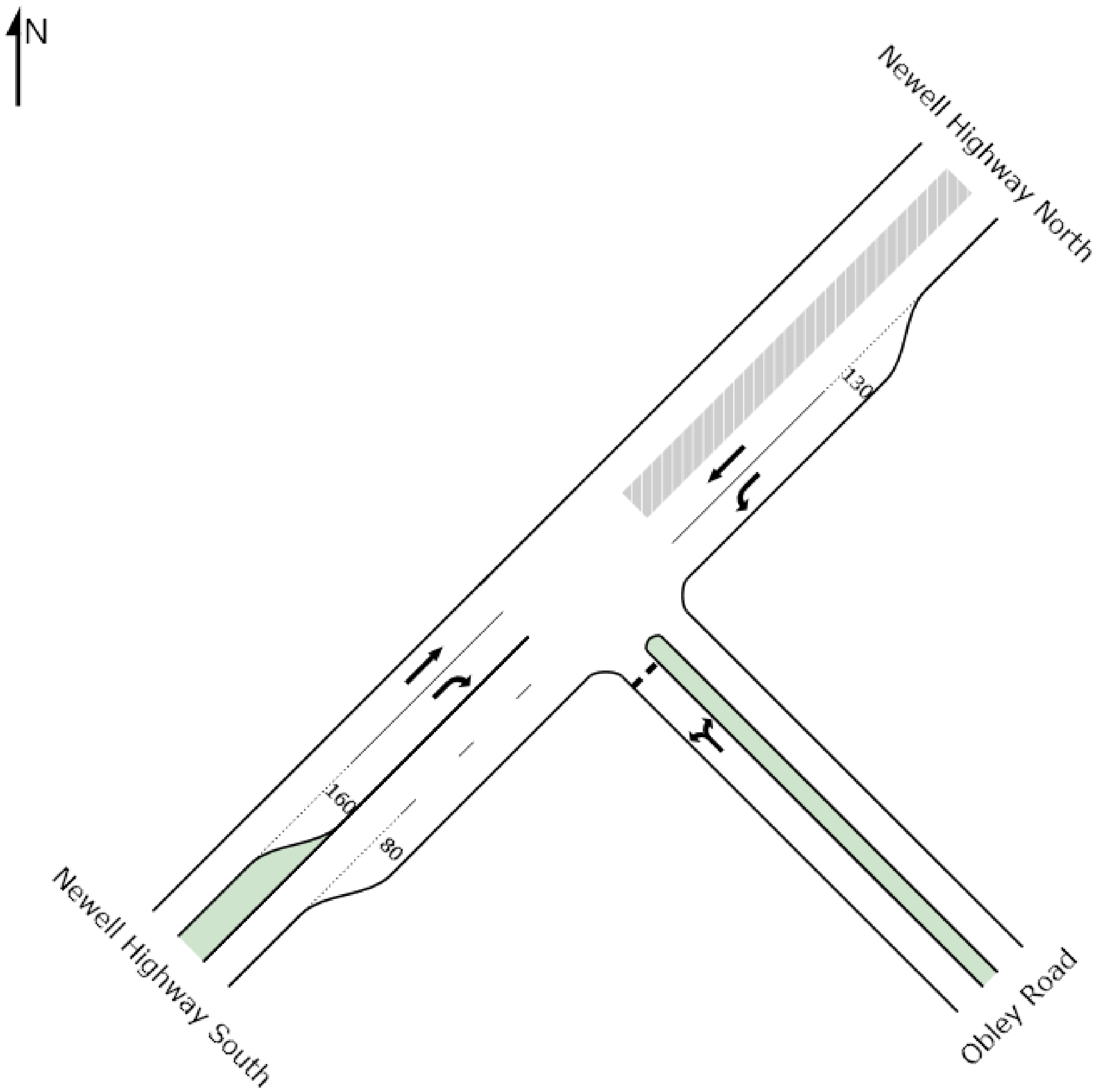
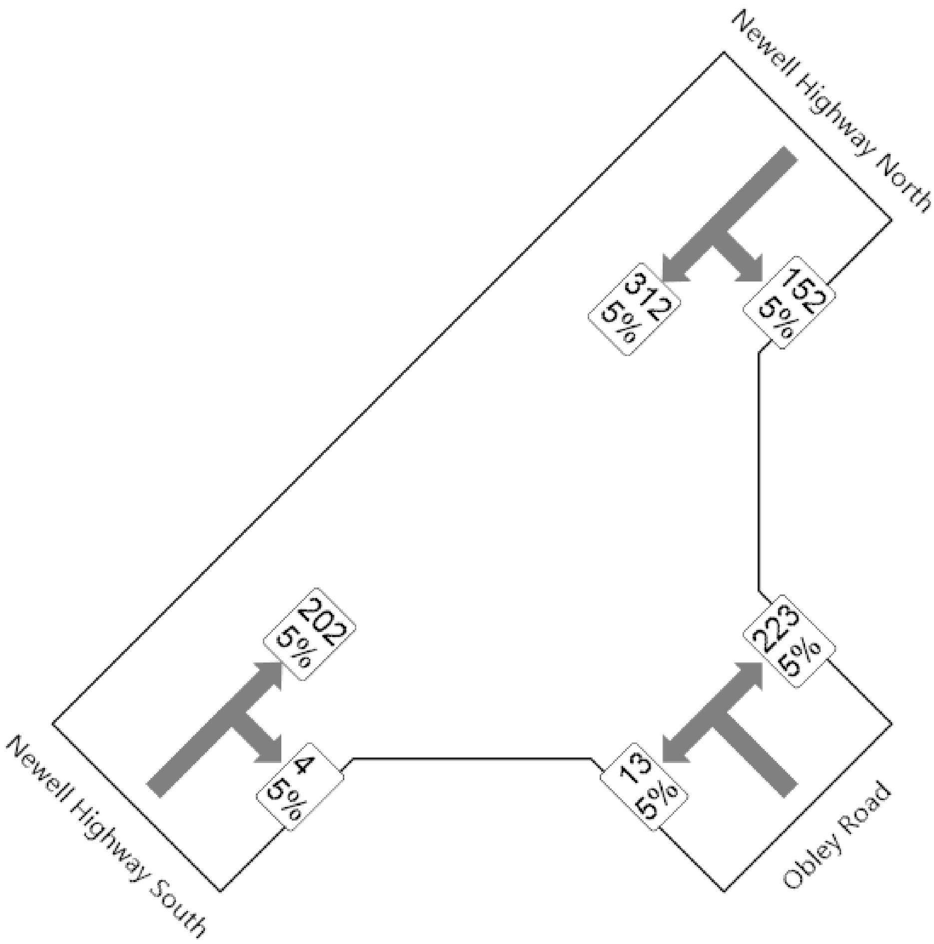

N
Newell Highway North
130
160
80
Newell Highway South
Obley Road

TOTAL FLOW WITH HEAVY VEHICLE %



INTERSECTION SUMMARY

Site: Obley Road Background Updated

Three-way intersection with 2-lane major road (Give-Way control)
Giveway / Yield (Two-Way)

Intersection Performance - Hourly Values

Performance Measure	Vehicles	Persons
Demand Flows (Total)	905 veh/h	1086 pers/h
Percent Heavy Vehicles	5.0 %	
Degree of Saturation	0.312	
Practical Spare Capacity	156.0 %	
Effective Intersection Capacity	2897 veh/h	
Control Delay (Total)	1.46 veh-h/h	1.76 pers-h/h
Control Delay (Average)	5.8 sec	5.8 sec
Control Delay (Worst Lane)	15.0 sec	
Control Delay (Worst Movement)	15.0 sec	15.0 sec
Geometric Delay (Average)	4.8 sec	
Stop-Line Delay (Average)	1.0 sec	
Intersection Level of Service (LOS)	NA	
95% Back of Queue - Vehicles (Worst Lane)	1.4 veh	
95% Back of Queue - Distance (Worst Lane)	10.3 m	
Total Effective Stops	326 veh/h	391 pers/h
Effective Stop Rate	0.36 per veh	0.36 per pers
Proportion Queued	0.15	0.15
Performance Index	11.6	11.6
Travel Distance (Total)	620.8 veh-km/h	745.0 pers-km/h
Travel Distance (Average)	686 m	686 m
Travel Time (Total)	9.2 veh-h/h	11.0 pers-h/h
Travel Time (Average)	36.6 sec	36.6 sec
Travel Speed	67.5 km/h	67.5 km/h
Cost (Total)	398.05 $/h	398.05 $/h
Fuel Consumption (Total)	83.6 L/h	
Carbon Dioxide (Total)	209.5 kg/h	
Hydrocarbons (Total)	0.281 kg/h	
Carbon Monoxide (Total)	14.46 kg/h	
NOx (Total)	0.597 kg/h	

Level of Service (LOS) Method: Delay (RTA NSW).

NA: Intersection LOS for Vehicles is Not Applicable for two-way sign control since the average intersection delay is not a good LOS measure due to zero delays associated with major road movements.

SIDRA Standard Delay Model used.

Intersection Performance - Annual Values

Performance Measure	Vehicles	Persons
Demand Flows (Total)	434,526 veh/y	521,432 pers/y
Delay	703 veh-h/y	844 pers-h/y
Effective Stops	156,313 veh/y	187,575 pers/y
Travel Distance	298,003 veh-km/y	357,603 pers-km/y
Travel Time	4,413 veh-h/y	5,296 pers-h/y
Cost	191,064 $/y	191,064 $/y
Fuel Consumption	40,143 L/y	
Carbon Dioxide	100,559 kg/y	
Hydrocarbons	135 kg/y	
Carbon Monoxide	6,942 kg/y	
NOx	287 kg/y	

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SIDRA INTERSECTION

MOVEMENT SUMMARY

Site: Obley Road Background Updated

Three-way intersection with 2-lane major road (Give-Way control)
Giveway / Yield (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South East: Obley Road											
1	L	13	5.0	0.312	15.0	LOS B	1.4	10.3	0.57	0.80	54.0
3	R	223	5.0	0.312	15.0	LOS B	1.4	10.3	0.57	0.91	54.0
Approach		236	5.0	0.312	15.0	LOS B	1.4	10.3	0.57	0.90	54.0
North East: Newell Highway North											
4	L	152	5.0	0.085	11.2	LOS A	0.0	0.0	0.00	0.73	58.9
5	T	312	5.0	0.165	0.0	LOS A	0.0	0.0	0.00	0.00	80.0
Approach		463	5.0	0.165	3.7	NA	0.0	0.0	0.00	0.24	71.7
South West: Newell Highway South											
11	T	202	5.0	0.107	0.0	LOS A	0.0	0.0	0.00	0.00	80.0
12	R	4	5.0	0.004	12.8	LOS A	0.0	0.1	0.46	0.64	56.4
Approach		206	5.0	0.107	0.3	NA	0.0	0.1	0.01	0.01	79.3
All Vehicles		905	5.0	0.312	5.8	NA	1.4	10.3	0.15	0.36	67.5

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model used.

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SIDRA INTERSECTION

LANE SUMMARY

Site: Obley Road Background Updated

Three-way intersection with 2-lane major road (Give-Way control)
Giveway / Yield (Two-Way)

Lane Use and Performance

	Demand Flows L veh/h	Demand Flows T veh/h	Demand Flows R veh/h	Total veh/h	HV %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Lane Length m	SL Type	Cap. Adj. %	Prob. Block. %
South East: Obley Road																
Lane 1	13	0	223	236	5.0	755	0.312	100	15.0	LOS B	1.4	10.3	500	–	0.0	0.0
Approach	13	0	223	236	5.0		0.312		15.0	LOS B	1.4	10.3				
North East: Newell Highway North																
Lane 1	152	0	0	152	5.0	1793	0.085	100	11.2	LOS A	0.0	0.0	130	Turn Bay	0.0	0.0
Lane 2	0	312	0	312	5.0	1889	0.165	100	0.0	LOS A	0.0	0.0	500	–	0.0	0.0
Approach	152	312	0	463	5.0		0.165		3.7	NA	0.0	0.0				
South West: Newell Highway South																
Lane 1	0	202	0	202	5.0	1889	0.107	100	0.0	LOS A	0.0	0.0	500	–	0.0	0.0
Lane 2	0	0	4	4	5.0	1163	0.004	100	12.8	LOS A	0.0	0.1	160	Turn Bay	0.0	0.0
Approach	0	202	4	206	5.0		0.107		0.3	NA	0.0	0.1				
Intersection				905	5.0		0.312		5.8	NA	1.4	10.3				

Level of Service (LOS) Method: Delay (RTA NSW).
Lane LOS values are based on average delay per lane.
Minor Road Approach LOS values are based on average delay for all lanes.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road lanes.
SIDRA Standard Delay Model used.

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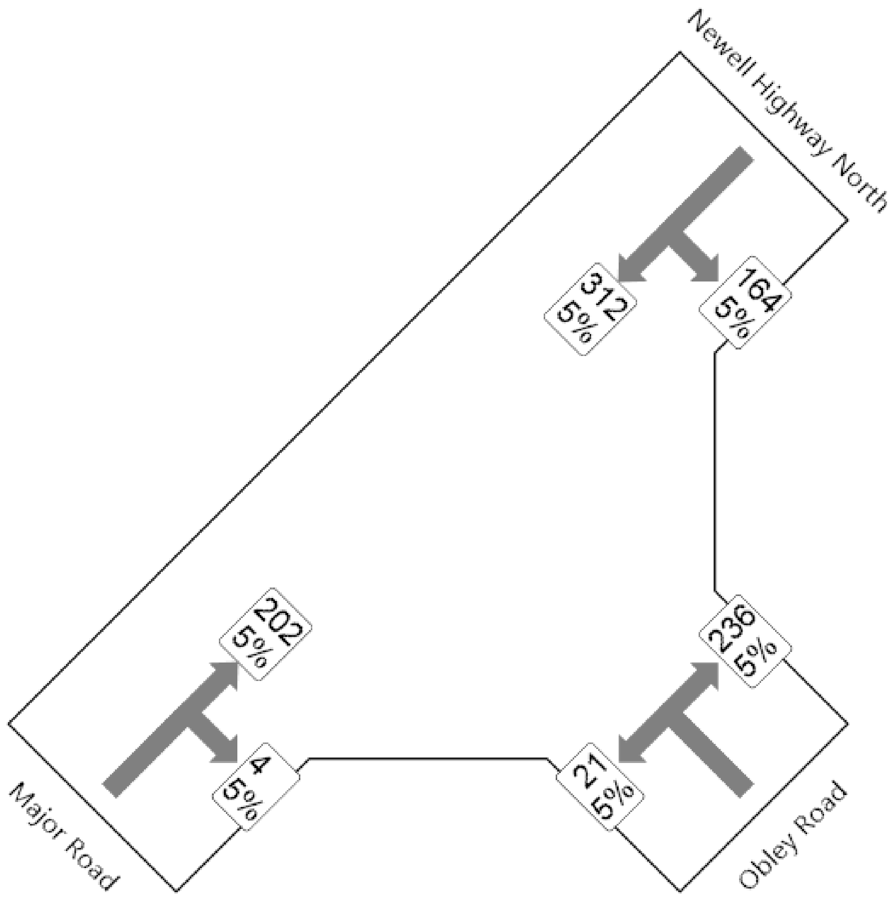
SIDRA INTERSECTION

TOTAL FLOW WITH HEAVY VEHICLE %



INTERSECTION SUMMARY

Site: Obley Road Background & Mine Updated

Three-way intersection with 2-lane major road (Give-Way control)
Giveway / Yield (Two-Way)

Intersection Performance - Hourly Values

Performance Measure	Vehicles	Persons
Demand Flows (Total)	939 veh/h	1127 pers/h
Percent Heavy Vehicles	5.0 %	
Degree of Saturation	0.339	
Practical Spare Capacity	135.9 %	
Effective Intersection Capacity	2768 veh/h	
Control Delay (Total)	1.60 veh-h/h	1.93 pers-h/h
Control Delay (Average)	6.2 sec	6.2 sec
Control Delay (Worst Lane)	15.1 sec	
Control Delay (Worst Movement)	15.1 sec	15.1 sec
Geometric Delay (Average)	5.1 sec	
Stop-Line Delay (Average)	1.1 sec	
Intersection Level of Service (LOS)	NA	
95% Back of Queue - Vehicles (Worst Lane)	1.6 veh	
95% Back of Queue - Distance (Worst Lane)	11.8 m	
Total Effective Stops	356 veh/h	427 pers/h
Effective Stop Rate	0.38 per veh	0.38 per pers
Proportion Queued	0.16	0.16
Performance Index	12.3	12.3
Travel Distance (Total)	643.6 veh-km/h	772.4 pers-km/h
Travel Distance (Average)	685 m	685 m
Travel Time (Total)	9.6 veh-h/h	11.5 pers-h/h
Travel Time (Average)	36.9 sec	36.9 sec
Travel Speed	66.9 km/h	66.9 km/h
Cost (Total)	416.81 $/h	416.81 $/h
Fuel Consumption (Total)	87.7 L/h	
Carbon Dioxide (Total)	219.6 kg/h	
Hydrocarbons (Total)	0.297 kg/h	
Carbon Monoxide (Total)	15.46 kg/h	
NOx (Total)	0.628 kg/h	

Level of Service (LOS) Method: Delay (RTA NSW).
NA: Intersection LOS for Vehicles is Not Applicable for two-way sign control since the average intersection delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model used.

Intersection Performance - Annual Values

Performance Measure	Vehicles	Persons
Demand Flows (Total)	450,695 veh/y	540,834 pers/y
Delay	770 veh-h/y	924 pers-h/y
Effective Stops	170,821 veh/y	204,985 pers/y
Travel Distance	308,948 veh-km/y	370,738 pers-km/y
Travel Time	4,616 veh-h/y	5,539 pers-h/y
Cost	200,068 $/y	200,068 $/y
Fuel Consumption	42,088 L/y	
Carbon Dioxide	105,431 kg/y	
Hydrocarbons	143 kg/y	
Carbon Monoxide	7,422 kg/y	
NOx	301 kg/y	

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MOVEMENT SUMMARY

Site: Obley Road Background & Mine Updated

Three-way intersection with 2-lane major road (Give-Way control)
Giveway / Yield (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South East: Obley Road											
1	L	21	5.0	0.339	15.1	LOS B	1.6	11.8	0.58	0.82	53.8
3	R	236	5.0	0.339	15.1	LOS B	1.6	11.8	0.58	0.92	53.8
Approach		257	5.0	0.339	15.1	LOS B	1.6	11.8	0.58	0.91	53.8
North East: Newell Highway North											
4	L	164	5.0	0.092	11.2	LOS A	0.0	0.0	0.00	0.73	58.9
5	T	312	5.0	0.165	0.0	LOS A	0.0	0.0	0.00	0.00	80.0
Approach		476	5.0	0.165	3.9	NA	0.0	0.0	0.00	0.25	71.3
South West: Major Road											
11	T	202	5.0	0.107	0.0	LOS A	0.0	0.0	0.00	0.00	80.0
12	R	4	5.0	0.004	12.8	LOS A	0.0	0.1	0.47	0.64	56.3
Approach		206	5.0	0.107	0.3	NA	0.0	0.1	0.01	0.01	79.3
All Vehicles		939	5.0	0.339	6.2	NA	1.6	11.8	0.16	0.38	66.9

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model used.

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SIDRA INTERSECTION

LANE SUMMARY

Site: Obley Road Background & Mine Updated

Three-way intersection with 2-lane major road (Give-Way control)
Giveway / Yield (Two-Way)

Lane Use and Performance

	Demand Flows L veh/h	Demand Flows T veh/h	Demand Flows R veh/h	Total veh/h	HV %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Lane Length m	SL Type	Cap. Adj. %	Prob. Block. %
South East: Obley Road																
Lane 1	21	0	236	257	5.0	757	0.339	100	15.1	LOS B	1.6	11.8	500	–	0.0	0.0
Approach	21	0	236	257	5.0		0.339		15.1	LOS B	1.6	11.8				
North East: Newell Highway North																
Lane 1	164	0	0	164	5.0	1793	0.092	100	11.2	LOS A	0.0	0.0	130	Turn Bay	0.0	0.0
Lane 2	0	312	0	312	5.0	1889	0.165	100	0.0	LOS A	0.0	0.0	500	–	0.0	0.0
Approach	164	312	0	476	5.0		0.165		3.9	NA	0.0	0.0				
South West: Major Road																
Lane 1	0	202	0	202	5.0	1889	0.107	100	0.0	LOS A	0.0	0.0	500	–	0.0	0.0
Lane 2	0	0	4	4	5.0	1148	0.004	100	12.8	LOS A	0.0	0.1	160	Turn Bay	0.0	0.0
Approach	0	202	4	206	5.0		0.107		0.3	NA	0.0	0.1				
Intersection				939	5.0		0.339		6.2	NA	1.6	11.8				

Level of Service (LOS) Method: Delay (RTA NSW).
Lane LOS values are based on average delay per lane.
Minor Road Approach LOS values are based on average delay for all lanes.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road lanes.
SIDRA Standard Delay Model used.

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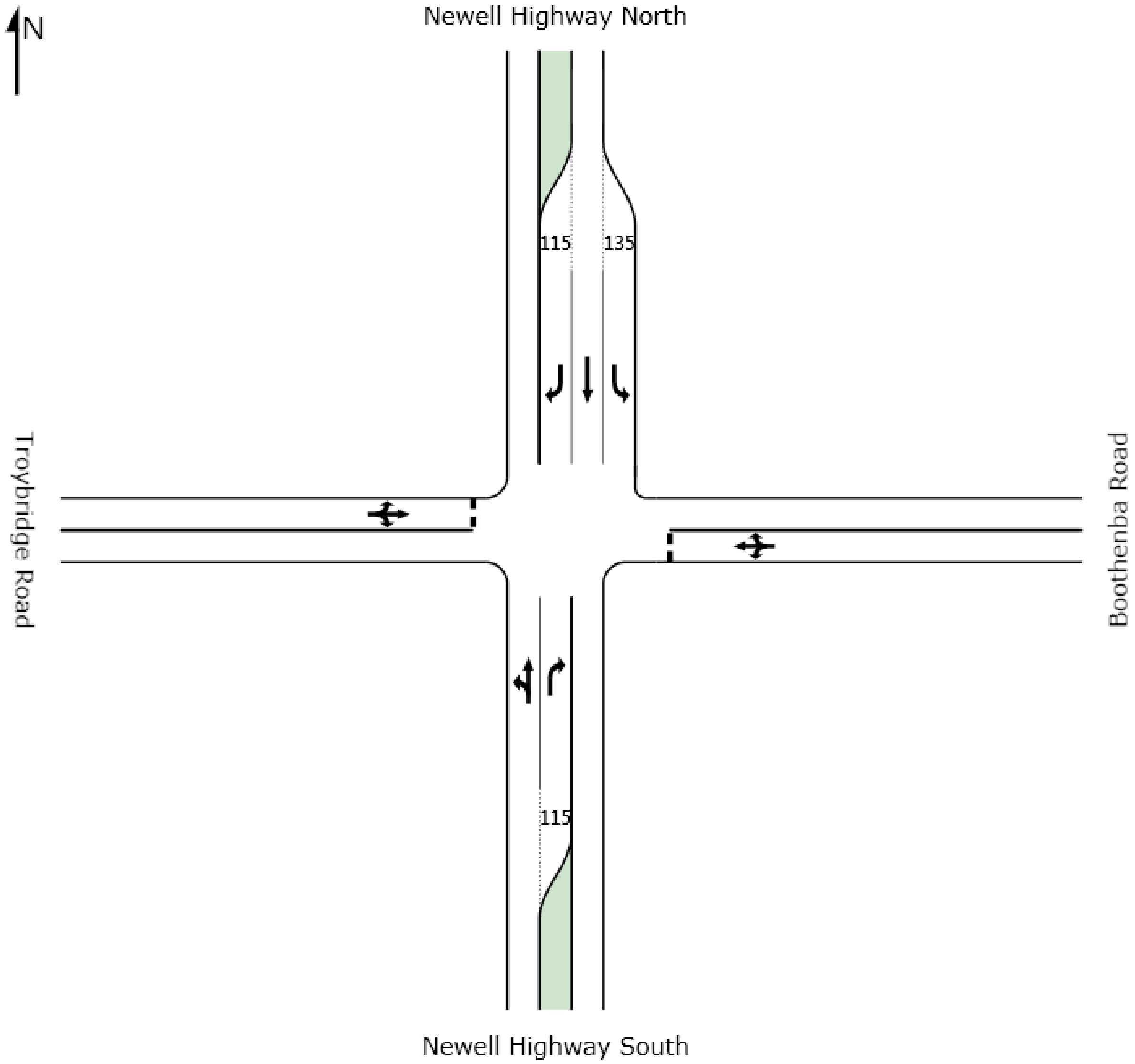
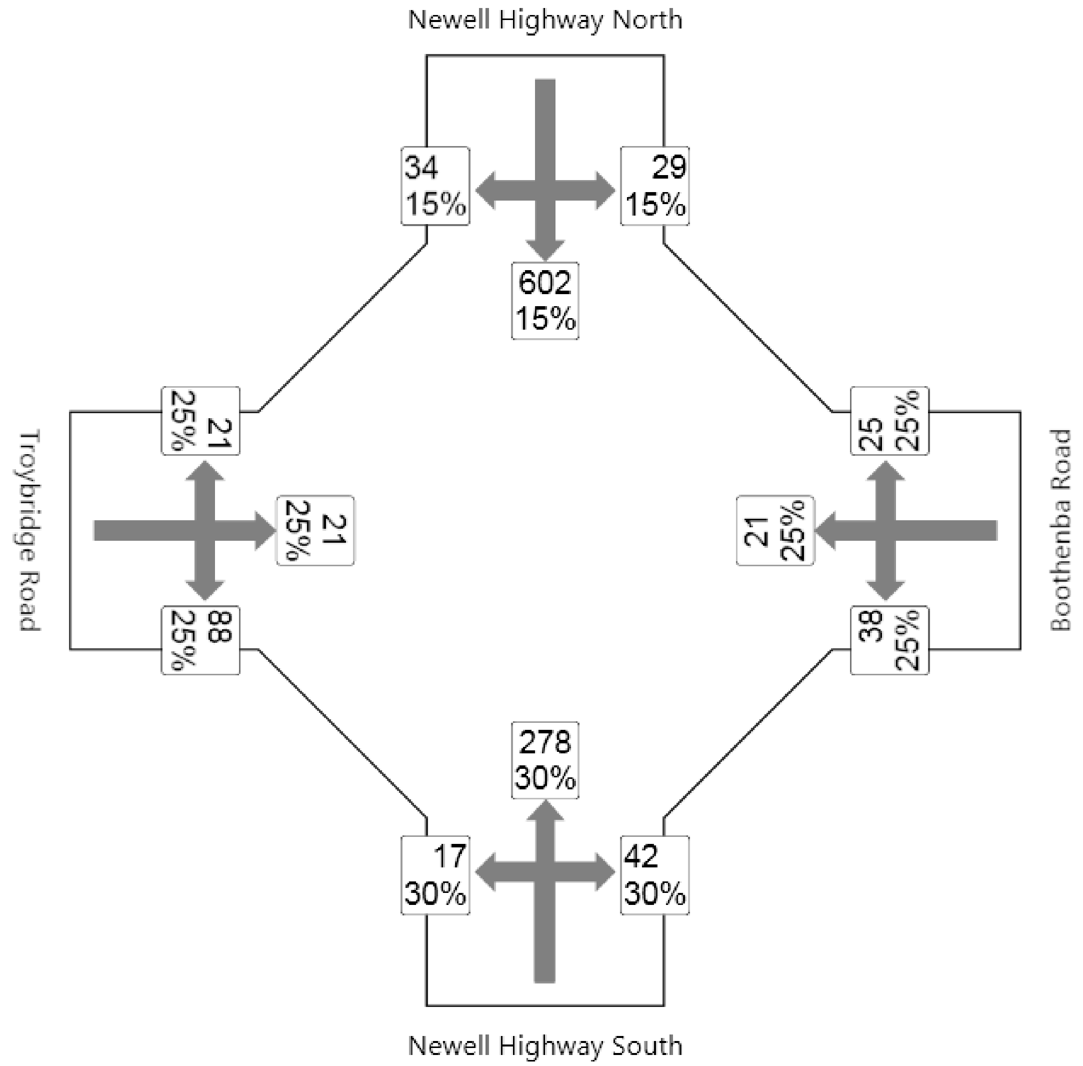

N
Newell Highway North
115
135
Troybridge Road
Boothenba Road
115
Newell Highway South

TOTAL FLOW WITH HEAVY VEHICLE %



INTERSECTION SUMMARY

Site: Boothenba/Troybridge Road
Background Updated

Four-way intersection with 2-lane major road (Give-Way control)

Giveway / Yield (Two-Way)

Intersection Performance - Hourly Values

Performance Measure	Vehicles	Persons
Demand Flows (Total)	1217 veh/h	1460 pers/h
Percent Heavy Vehicles	20.9 %	
Degree of Saturation	0.500	
Practical Spare Capacity	60.0 %	
Effective Intersection Capacity	2433 veh/h	
Control Delay (Total)	2.35 veh-h/h	2.82 pers-h/h
Control Delay (Average)	7.0 sec	7.0 sec
Control Delay (Worst Lane)	32.0 sec	
Control Delay (Worst Movement)	32.4 sec	32.4 sec
Geometric Delay (Average)	2.9 sec	
Stop-Line Delay (Average)	4.1 sec	
Intersection Level of Service (LOS)	NA	
95% Back of Queue - Vehicles (Worst Lane)	2.4 veh	
95% Back of Queue - Distance (Worst Lane)	20.6 m	
Total Effective Stops	339 veh/h	407 pers/h
Effective Stop Rate	0.28 per veh	0.28 per pers
Proportion Queued	0.18	0.18
Performance Index	16.9	16.9
Travel Distance (Total)	825.3 veh-km/h	990.3 pers-km/h
Travel Distance (Average)	678 m	678 m
Travel Time (Total)	13.1 veh-h/h	15.7 pers-h/h
Travel Time (Average)	38.7 sec	38.7 sec
Travel Speed	63.1 km/h	63.1 km/h
Cost (Total)	592.70 $/h	592.70 $/h
Fuel Consumption (Total)	126.5 L/h	
Carbon Dioxide (Total)	319.0 kg/h	
Hydrocarbons (Total)	0.353 kg/h	
Carbon Monoxide (Total)	14.55 kg/h	
NOx (Total)	0.655 kg/h	

Level of Service (LOS) Method: Delay (RTA NSW).
NA: Intersection LOS for Vehicles is Not Applicable for two-way sign control since the average intersection delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model used.

Intersection Performance - Annual Values

Performance Measure	Vehicles	Persons
Demand Flows (Total)	584,084 veh/y	700,901 pers/y
Delay	1,130 veh-h/y	1,355 pers-h/y
Effective Stops	162,878 veh/y	195,454 pers/y
Travel Distance	396,120 veh-km/y	475,344 pers-km/y
Travel Time	6,281 veh-h/y	7,538 pers-h/y
Cost	284,497 $/y	284,497 $/y
Fuel Consumption	60,717 L/y	
Carbon Dioxide	153,144 kg/y	
Hydrocarbons	169 kg/y	
Carbon Monoxide	6,982 kg/y	
NOx	314 kg/y	

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SIDRA INTERSECTION

MOVEMENT SUMMARY

Site: Boothenba/Troybridge Road
Background Updated

Four-way intersection with 2-lane major road (Give-Way control)

Giveway / Yield (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Newell Highway South											
1	L	17	30.0	0.181	11.4	LOS A	0.0	0.0	0.00	1.77	57.1
2	T	278	30.0	0.181	0.0	LOS A	0.0	0.0	0.00	0.00	80.0
3	R	42	30.0	0.127	20.2	LOS B	0.4	3.6	0.66	0.91	46.5
Approach		337	30.0	0.181	3.1	NA	0.4	3.6	0.08	0.20	72.9
East: Boothenba Road											
4	L	38	25.0	0.357	30.2	LOS C	1.5	12.4	0.84	1.03	36.2
5	T	21	25.0	0.357	27.7	LOS B	1.5	12.4	0.84	0.99	34.2
6	R	25	25.0	0.357	30.2	LOS C	1.5	12.4	0.84	1.02	36.1
Approach		84	25.0	0.357	29.6	LOS C	1.5	12.4	0.84	1.02	35.7
North: Newell Highway North											
7	L	29	15.0	0.018	10.7	LOS A	0.0	0.0	0.00	0.71	57.1
8	T	602	15.0	0.339	0.0	LOS A	0.0	0.0	0.00	0.00	80.0
9	R	34	15.0	0.051	13.4	LOS A	0.2	1.3	0.43	0.76	53.4
Approach		665	15.0	0.339	1.2	NA	0.2	1.3	0.02	0.07	77.1
West: Troybridge Road											
10	L	21	25.0	0.500	32.3	LOS C	2.4	20.6	0.84	1.01	35.0
11	T	21	25.0	0.500	29.8	LOS C	2.4	20.6	0.84	1.04	33.0
12	R	88	25.0	0.500	32.4	LOS C	2.4	20.6	0.84	1.08	35.0
Approach		131	25.0	0.500	32.0	LOS C	2.4	20.6	0.84	1.06	34.7
All Vehicles		1217	20.9	0.500	7.0	NA	2.4	20.6	0.18	0.28	63.1

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model used.

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SIDRA INTERSECTION

LANE SUMMARY

Site: Boothenba/Troybridge Road Background Updated

Four-way intersection with 2-lane major road (Give-Way control)

Giveway / Yield (Two-Way)

Lane Use and Performance

	Demand Flows L veh/h	Demand Flows T veh/h	Demand Flows R veh/h	Total veh/h	HV %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Lane Length m	SL Type	Cap. Adj. %	Prob. Block. %
South: Newell Highway South																
Lane 1	17	278	0	295	30.0	1626	0.181	100	0.7	LOS A	0.0	0.0	500	–	0.0	0.0
Lane 2	0	0	42	42	30.0	332	0.127	100	20.2	LOS B	0.4	3.6	115	Turn Bay	0.0	0.0
Approach	17	278	42	337	30.0		0.181		3.1	NA	0.4	3.6				
East: Boothenba Road																
Lane 1	38	21	25	84	25.0	236	0.357	100	29.6	LOS C	1.5	12.4	500	–	0.0	0.0
Approach	38	21	25	84	25.0		0.357		29.6	LOS C	1.5	12.4				
North: Newell Highway North																
Lane 1	29	0	0	29	15.0	1677	0.018	100	10.7	LOS A	0.0	0.0	135	Turn Bay	0.0	0.0
Lane 2	0	602	0	602	15.0	1777	0.339	100	0.0	LOS A	0.0	0.0	500	–	0.0	0.0
Lane 3	0	0	34	34	15.0	656	0.051	100	13.4	LOS A	0.2	1.3	115	Turn Bay	0.0	0.0
Approach	29	602	34	665	15.0		0.339		1.2	NA	0.2	1.3				
West: Troybridge Road																
Lane 1	21	21	88	131	25.0	261	0.500	100	32.0	LOS C	2.4	20.6	500	–	0.0	0.0
Approach	21	21	88	131	25.0		0.500		32.0	LOS C	2.4	20.6				
Intersection				1217	20.9		0.500		7.0	NA	2.4	20.6				

Level of Service (LOS) Method: Delay (RTA NSW).
Lane LOS values are based on average delay per lane.
Minor Road Approach LOS values are based on average delay for all lanes.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road lanes.
SIDRA Standard Delay Model used.

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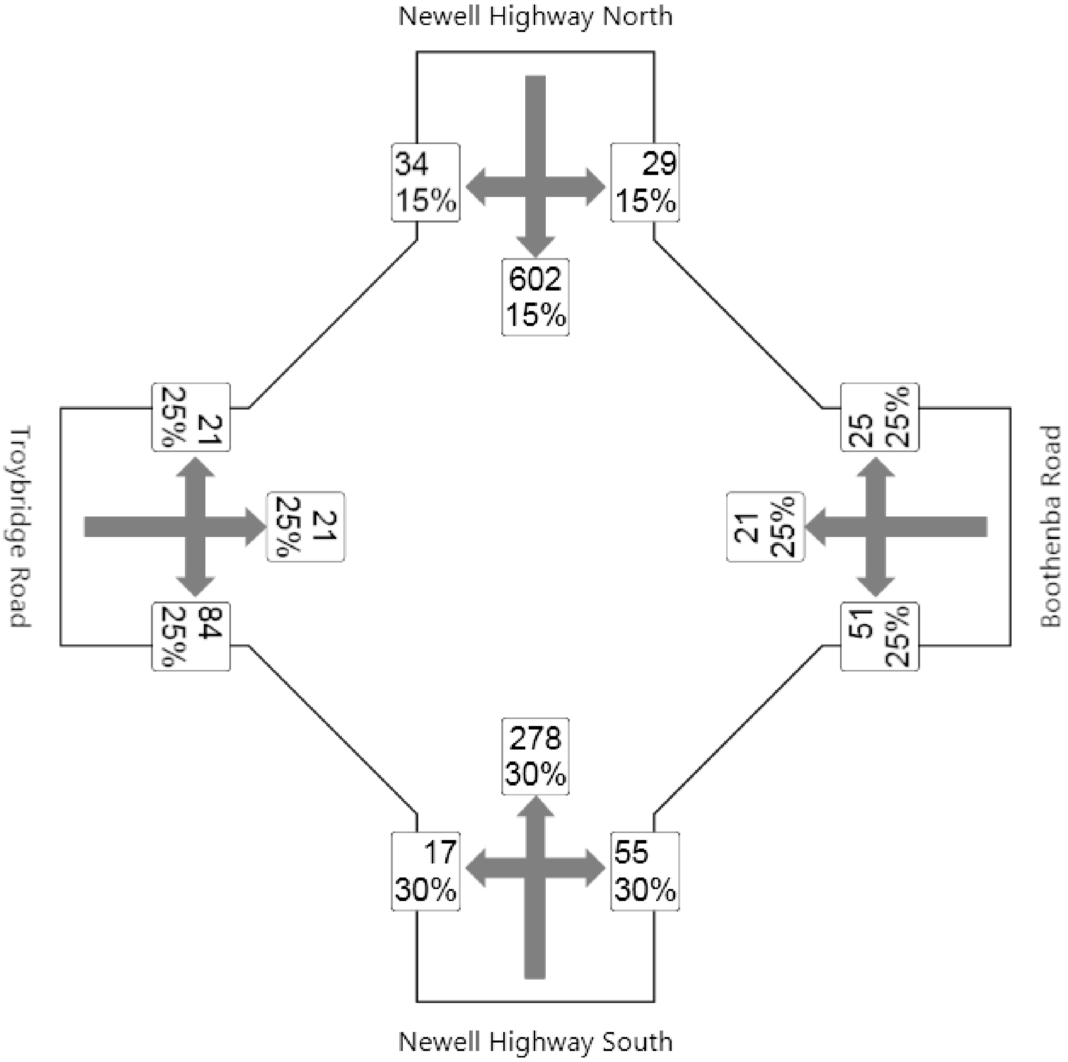
TOTAL FLOW WITH HEAVY VEHICLE %



INTERSECTION SUMMARY

Site: Boothenba/Troybridge Road Background & Mine Updated

Four-way intersection with 2-lane major road (Give-Way control)

Giveway / Yield (Two-Way)

Intersection Performance - Hourly Values		
Performance Measure	**Vehicles**	**Persons**
Demand Flows (Total)	1238 veh/h	1485 pers/h
Percent Heavy Vehicles	21.0 %	
Degree of Saturation	0.508	
Practical Spare Capacity	57.3 %	
Effective Intersection Capacity	2435 veh/h	
Control Delay (Total)	2.54 veh-h/h	3.05 pers-h/h
Control Delay (Average)	7.4 sec	7.4 sec
Control Delay (Worst Lane)	33.4 sec	
Control Delay (Worst Movement)	33.8 sec	33.8 sec
Geometric Delay (Average)	3.0 sec	
Stop-Line Delay (Average)	4.4 sec	
Intersection Level of Service (LOS)	NA	
95% Back of Queue - Vehicles (Worst Lane)	2.4 veh	
95% Back of Queue - Distance (Worst Lane)	20.8 m	
Total Effective Stops	361 veh/h	433 pers/h
Effective Stop Rate	0.29 per veh	0.29 per pers
Proportion Queued	0.19	0.19
Performance Index	17.6	17.6
Travel Distance (Total)	838.5 veh-km/h	1006.3 pers-km/h
Travel Distance (Average)	677 m	677 m
Travel Time (Total)	13.5 veh-h/h	16.1 pers-h/h
Travel Time (Average)	39.1 sec	39.1 sec
Travel Speed	62.3 km/h	62.3 km/h
Cost (Total)	608.96 $/h	608.96 $/h
Fuel Consumption (Total)	129.8 L/h	
Carbon Dioxide (Total)	327.5 kg/h	
Hydrocarbons (Total)	0.365 kg/h	
Carbon Monoxide (Total)	15.31 kg/h	
NOx (Total)	0.678 kg/h	

Level of Service (LOS) Method: Delay (RTA NSW).
NA: Intersection LOS for Vehicles is Not Applicable for two-way sign control since the average intersection delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model used.

Intersection Performance - Annual Values		
Performance Measure	**Vehicles**	**Persons**
Demand Flows (Total)	594,190 veh/y	713,027 pers/y
Delay	1,218 veh-h/y	1,462 pers-h/y
Effective Stops	173,382 veh/y	208,058 pers/y
Travel Distance	402,502 veh-km/y	483,002 pers-km/y
Travel Time	6,456 veh-h/y	7,748 pers-h/y
Cost	292,301 $/y	292,301 $/y
Fuel Consumption	62,324 L/y	
Carbon Dioxide	157,205 kg/y	
Hydrocarbons	175 kg/y	
Carbon Monoxide	7,351 kg/y	
NOx	325 kg/y	

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SIDRA INTERSECTION

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MOVEMENT SUMMARY

Site: Boothenba/Troybridge Road
Background & Mine Updated

Four-way intersection with 2-lane major road (Give-Way control)

Giveway / Yield (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Newell Highway South											
1	L	17	30.0	0.181	11.4	LOS A	0.0	0.0	0.00	1.77	57.1
2	T	278	30.0	0.181	0.0	LOS A	0.0	0.0	0.00	0.00	80.0
3	R	55	30.0	0.167	20.5	LOS B	0.5	4.8	0.68	0.92	46.1
Approach		349	30.0	0.181	3.8	NA	0.5	4.8	0.11	0.23	71.4
East: Boothenba Road											
4	L	51	25.0	0.388	29.8	LOS C	1.7	14.1	0.83	1.04	36.4
5	T	21	25.0	0.388	27.3	LOS B	1.7	14.1	0.83	1.00	34.4
6	R	25	25.0	0.388	29.8	LOS C	1.7	14.1	0.83	1.03	36.3
Approach		97	25.0	0.388	29.3	LOS C	1.7	14.1	0.83	1.03	35.9
North: Newell Highway North											
7	L	29	15.0	0.018	10.7	LOS A	0.0	0.0	0.00	0.71	57.1
8	T	602	15.0	0.339	0.0	LOS A	0.0	0.0	0.00	0.00	80.0
9	R	34	15.0	0.051	13.4	LOS A	0.2	1.3	0.43	0.76	53.4
Approach		665	15.0	0.339	1.2	NA	0.2	1.3	0.02	0.07	77.1
West: Troybridge Road											
10	L	21	25.0	0.508	33.8	LOS C	2.4	20.8	0.85	1.02	34.3
11	T	21	25.0	0.508	31.3	LOS C	2.4	20.8	0.85	1.05	32.3
12	R	84	25.0	0.508	33.8	LOS C	2.4	20.8	0.85	1.09	34.3
Approach		126	25.0	0.508	33.4	LOS C	2.4	20.8	0.85	1.07	34.0
All Vehicles		1238	21.0	0.508	7.4	NA	2.4	20.8	0.19	0.29	62.3

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model used.

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SIDRA INTERSECTION

LANE SUMMARY

Site: Boothenba/Troybridge Road Background & Mine Updated

Four-way intersection with 2-lane major road (Give-Way control)

Giveway / Yield (Two-Way)

Lane Use and Performance

	Demand Flows L veh/h	Demand Flows T veh/h	Demand Flows R veh/h	Total veh/h	HV %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Lane Length m	SL Type	Cap. Adj. %	Prob. Block. %
South: Newell Highway South																
Lane 1	17	278	0	295	30.0	1626	0.181	100	0.7	LOS A	0.0	0.0	500	–	0.0	0.0
Lane 2	0	0	55	55	30.0	328	0.167	100	20.5	LOS B	0.5	4.8	115	Turn Bay	0.0	0.0
Approach	17	278	55	349	30.0		0.181		3.8	NA	0.5	4.8				
East: Boothenba Road																
Lane 1	51	21	25	97	25.0	250	0.388	100	29.3	LOS C	1.7	14.1	500	–	0.0	0.0
Approach	51	21	25	97	25.0		0.388		29.3	LOS C	1.7	14.1				
North: Newell Highway North																
Lane 1	29	0	0	29	15.0	1677	0.018	100	10.7	LOS A	0.0	0.0	135	Turn Bay	0.0	0.0
Lane 2	0	602	0	602	15.0	1777	0.339	100	0.0	LOS A	0.0	0.0	500	–	0.0	0.0
Lane 3	0	0	34	34	15.0	656	0.051	100	13.4	LOS A	0.2	1.3	115	Turn Bay	0.0	0.0
Approach	29	602	34	665	15.0		0.339		1.2	NA	0.2	1.3				
West: Troybridge Road																
Lane 1	21	21	84	126	25.0	248	0.508	100	33.4	LOS C	2.4	20.8	500	–	0.0	0.0
Approach	21	21	84	126	25.0		0.508		33.4	LOS C	2.4	20.8				
Intersection				1238	21.0		0.508		7.4	NA	2.4	20.8				

Level of Service (LOS) Method: Delay (RTA NSW).
Lane LOS values are based on average delay per lane.
Minor Road Approach LOS values are based on average delay for all lanes.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road lanes.
SIDRA Standard Delay Model used.

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APPENDIX F

PAVEMENT INVESTIGATION

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Obley Road Upgrade and Associated Works – Pavement Thickness Design

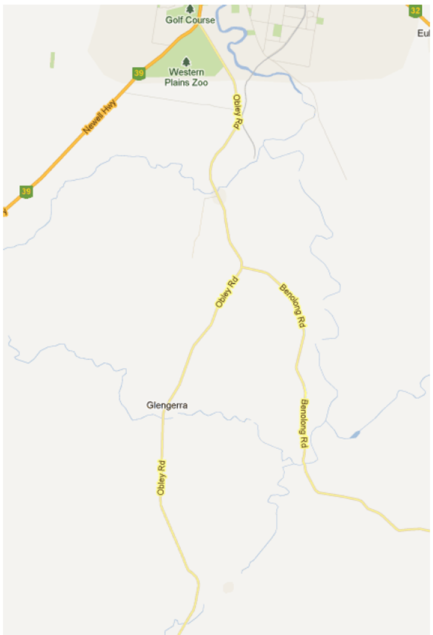
For Constructive Solutions Pty Ltd

Final

February 2013

Obley Road Upgrade and Associated Works – Pavement Thickness Design

For Constructive Solutions Pty Ltd



February 2013

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Executive Summary

Constructive Solutions were commissioned to determine road pavement upgrade requirements for the section of Obley Road between the Newell Highway and Toongi Road near Dubbo in New South Wales. GR Webb Consulting has undertaken detailed pavement thickness design for Constructive Solutions based on client provided data.

Projected traffic volumes for a twenty year design period for pavement thickness design are presented for two traffic loading scenarios, Option 1 and Option 2.

Option 1 provides for a scenario comprising both rail and road transport opportunities.

Option 2 provides for a scenario which only utilises road transport.

For pavement design purposes, the contribution of proportional consumption or damage to a pavement structure is expressed in terms of Equivalent Standard Axle loads (ESA's). The procedure for the determination of ESA's is described in Austroads (2012) Guide to Pavement Technology, Part 2: Pavement Structural Design.

The sums of the ESA's expected to be applied to the pavement during the design period (20 Years), in this report are expressed as "Design Equivalent Standard Axle's" (DESA). Input variables are presented in Section 2 - Traffic.

For Option 1 the calculated DESA = 9×10^6

For Option 2 the calculated DESA = 1.2×10^7

The findings presented in the *LOG-Zirconia-Rev3 5 November 2012.xls Geotechnical Investigation Summary* have informed the selection of typical subgrade support strength "Californian Bearing Ratio" (CBR) values used for new pavement thickness design calculations.

This report presents pavement thickness requirements based on the methods and procedures described in current Austroads pavement design guidelines.

Two methods for thickness determination have been utilised.

For the existing alignment and where practically feasible, overlay thicknesses have been deduced from Falling Weight Deflectometer (FWD) pavement deflection measurements.

For locations situated beyond the existing alignment, including both curve widening and new alignments, thicknesses have been calculated using the CIRCLY[1] analysis software for a range of subgrade (CBR) support strengths.

Table 3 of the report presents specific overlay and new pavement thickness requirements for specific locations along the entire route for each of the options. It is expected that some rationalisation of sections will be undertaken based on visual observation and other localised site constraints which will result in a more practical overall design option, however this report has attempted to capture all relevant information that will ultimately influence the final sectioning and assigned thicknesses.

It is recommended that the assumed subgrade CBR be proved (confirmed) at time of excavation for sections of curve widening and new alignment and, if found to be less than the assumed value, that an increase in the depth of excavation be undertaken and pavement layer thickness be increased in accordance with the configurations presented in the Tables and Figures included in the report.

The thickness designs presented herein assume that the pavement will be adequately drained and that moisture conditions under the pavement will remain relatively consistent.

1. CIRCLY 5, Mincad Systems Pty Ltd, Richmond South Victoria

Contents

Tables

Figures

Document Details

Project Title	Obley Road Upgrade and Associated Works – Pavement Thickness Design
Project Number	121202
Revision	(3) Final
Client	Constructive Solutions
Report Date	February 2013
Prepared By	GR Webb & PFB Williams

1. Pavement Project Locations

The pavement proposed for upgrade forms the first 21.75km (approx) of Obley Road, near Dubbo, N.S.W., beginning at the Newell Highway, and ending at Toongi Road. For this report, Chainage 00 is set at the Newell Highway. The direction in advancing chainage (i.e. Southbound) is referred to as the Prescribed Direction (PD), and the return direction as the Counter Direction (CD).

The first section, from Newell Highway to Benolong Road carries the major part of the general traffic. The upgrade assumes an intended mine haulage of up to 135 (on average) B-Doubles per day (2 way), loaded in the counter direction. The first 10 to 14 km of this section of Obley Road (from Newell Highway) is generally flat, with a small depression near a flood plain. The remaining section (towards Toongi) becomes gently undulating, with a slight rise to the South.

As part of the upgrade, it has been proposed that several curves be increased in radius to accommodate the heavy vehicles. In some parts this is to be achieved by a new alignment and in others, widening of the existing alignment. From the document *Obley Road Alignment Draft Rev A.pdf*, the following sections have been identified:

Realignment – Chainage from and to

1. 3500 to 4000
2. 4400 to 6100
3. 7000 to 7400
4. 14700 to 15200
5. 17900 to 18200
6. 20200 to 20600

Widening – Chainage from and to

1. 9800 to 9900
2. 10700 to 10900
3. 11350 to 11550

2. Traffic

Traffic was estimated for a 20 year design period, and expressed as Equivalent Standard Axles (ESA's). Determination of ESA's is described in Section 7 of Austroads APGT02.

Anticipated traffic loading was supplied as two components:-

1. Heavy haulage by B-Doubles of 135 vehicle per day (not HML)
2. A general traffic component.

The heavy haulage component (1.) has been considered in terms of two options, viz:-

- Option 1 assumes a portion of the haulage is undertaken by rail,
- Option 2 assumes no rail contribution.

Heavy Haulage

- AADT = 92 (Option 1) or 135 (Option 2) - via Excell Workbook *Road Rail Reagent Summary (25K HCl) November2012.xlsx*
- ESA per vehicle = 7.5 (deduced from *Truck Impact Chart_Appendix 4D HPV.pdf*)
- Annual Growth Rate = 1% (applied as "safety margin" – no growth rate was supplied)
- No directional or lane splitting required.

A heavy haulage contribution of 5.18 x 10^6 ESA (Option 1) or 8.2 x 10^6 ESA (Option 2) for 20 years was estimated.

General Traffic

Traffic counts were provided for both the Northern end (near Newell Highway), and the Southern end (near Toongi exit).

- AADT (Northern) = 1225
- AADT (Southern) = 373
- Heavy Vehicle content = 15%
- ESA per Heavy Vehicle = 4 (typical for location - see Table D1 of AGPT02)
- Annual Growth Rate = 3% (typical rate where no site specific data available)
- Directional factor = 0.5
- No lane splitting required.

It would appear that the sharp reduction in AADT between the Northern and Southern ends is due to greater than 800 vehicles per day departing Obley Road via Benolong Road (at approx. 9km from the Newell Highway).

General traffic contributions of 3.6 x 10^6 ESA (Northern end) and 1.2 x 10^6 ESA (Southern end) were estimated for the 20 year period.

Total Design Traffic

Given that the general traffic contributions are small compared to the heavy haulage component, the higher value (3.6×10^6) can be safely assumed, and design traffic (DESA) of 9×10^6 ESA (Option 1) or 1.2×10^7 ESA (Option 2) applied.

3. Geotechnical Information

Numerous pavement test pits were excavated for the purpose of acquiring relevant geotechnical information. The pits were sited at various locations along the existing pavement, both within the pavement (centre of pavement), and at the edge of the seal. In two cases, pits were located in the shoulder. No pits were located in sections where new alignment is planned. In most pits DCP (*Dynamic Cone Penetrometer*) measurement of the subgrade CBR were achieved. Also, at most of the sites, subgrade samples were taken, and laboratory (4 day soaked) CBR estimates made. The results are summarized in Table 1.

Pit	km	Location	Subgrade Description	DCP		Laboratory		
				CBR min	@mm	CBR	PI	@mm
TP19	0.4	Centre Pavement	yellow brown SAND with silt					
TP19	0.4	Edge of seal	yellow brown SAND with silt	25	950	19		300-500
TP18	1.7	Centre Pavement	light brown silty CLAY traces of sand and gravel	27.6	850	4		400-600
TP17	3.2	Centre Pavement	yellow brown silty sandy GRAVEL-imported					
TP17	3.2	Edge of seal	yellow brown silty sandy GRAVEL-imported fill					
TP16	4.4	Centre Pavement	light red clayey SAND					
TP16	4.4	Edge of seal	light red clayey SAND	25	650			
TP15	6.8	Centre Pavement	light red sandy CLAY ,with gravel					
TP15	6.8	Edge of seal	light red sandy CLAY with gravel	8	430	4		185-500
TP14	7.65	Centre Pavement	light red sandy CLAY,traces of gravel					
TP14	7.65	Edge of seal	light red sandy CLAY,traces of gravel	25	450	5		300-600
TP13	8.75	Centre Pavement	brown silty CLAY-high PI	15	650			
TP13	8.75	Edge of seal	brown silty CLAY-high PI	15	650	6	23	300-600
TP12	9.6	Centre Pavement	red sandy CLAY, traces of gravel					
TP12	9.6	Edge of seal	red sandy CLAY, traces of gravel	5.8	850	20		300-650
TP11	10.78	Centre Pavement	red sandy CLAY traces of gravel					
TP11	10.78	Edge of seal	red sandy CLAY, traces of gravel	22.5	650	6		380-600
TP10	13.05	Edge of seal		27.6	450	4		400-600
TP10	13.1	Centre Pavement	brown sandy CLAY					
TP09	13.75	Centre Pavement	red brown sandy CLAY, trace of gravel					
TP09	13.75	Edge of seal	red brown sandy CLAY trace of gravel	22.5	550	12		110-600
TP08	14.64	Centre Pavement	red brown silty CLAY					
TP08	14.64	Edge of seal	red brown silty CLAY	25	1050			
TP07	15.7	Centre Pavement	light brown/ red sandy CLAY with gravel					
TP07	15.7	Edge of seal	light brown/ red sandy CLAY with gravel	17.5	650	12		200-440
TP06	17.1	Pavement	light red silty CLAY	25	450			
TP05	18.31	Pavement	Yellow brown silty SAND	17.5	750	7		200-310
TP04	19.05	Shoulder	Red shaley GRAVEL (med PI) transitioning to	43.6	650			
TP03	20.15	Pavement	Red sandy CLAY, traces of gravel (med PI)	20	650	5		530-905
TP02	20.65	Shoulder	Grey silty CLAY, traces of gravel (High PI)	3.7	650	4.5		570-1000
TP01	21.25	Pavement	Red/brown silty CLAY, traces of sand,	5.8	650	2	42	550-580

Table 1 – Summary of Test Pits

No test pits were located within the areas identified for realignment. Further advice (e-mail from Owen Johns, 18 Dec. 2012) suggested which of the test pits would be representative of the major areas of realignment/widening. Of these, only 3 tests include laboratory tests. Of greater concern, for the major section involving new alignment (i.e. 3.5 to 6.1km, encompassing two sections of new alignment), only one DCP measurement is available, and no laboratory estimates. Given that the proposed realignment in this area involves significant offsets from the existing pavement, it is recommended that CBR strengths are confirmed by means of DCP testing at the time of initial excavation along the line of the proposed new alignment and pavement thickness requirements be adjusted accordingly.

Figure 1 displays the subgrade CBR estimates along the length of Obley Road which forms part of the haulage route. The blues dots and orange circles show the DCP (minimum) and laboratory values, respectively. In most cases, the 4-day soaked laboratory values are significantly lower than the DCP measurements, with two exceptions, at 9.6 km (TP12) and 20.65 (TP02). The latter, TP02 is only a minor discrepancy, and may reflect the *in situ* moisture content. For TP12, the minimum DCP value was located below the sample used for laboratory testing, and appears to represent only a thin band of weaker material.

Given the flooding potential of several sections of the road, the soaked (laboratory) values should be afforded high significance in the selection of subgrade CBR values for design purposes.

The dashed blue line (labelled "Representative") shows a suggested guide for selection of design values. The "blocking" of the data has been influences by deflection data, in particular the homogeneity within the maximum deflection values (see following section of this report).

The solid green and orange lines ("Realignment (a)" and "Realignment (b)") show the DCP and laboratory CBR's suggested by e-mail to be representative of the areas of realignment, as described above.

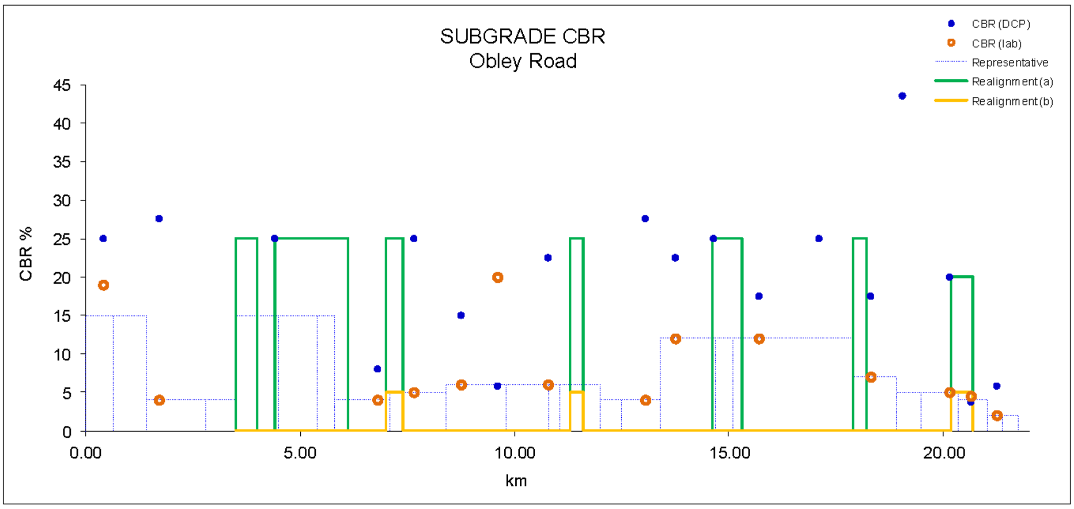

Figure 1 – Subgrade CBR values.

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4. Deflection

Falling Weight Deflectometer (FWD) data were taken at 100m intervals in both the prescribed (PD) and counter (CD) directions. These data were "standardized" (i.e. converted to Benkelman Beam equivalents), using a seasonal (climate) correction factor of 1.

No temperature correction was required, there being no structural asphalt present.

Homogeneous sections in Maximum Deflection (D0) were determined in each direction, and are shown as Characteristic Deflections (f = 2) in Figure 2 and Figure 3.

The 20 year design deflection, using DESA = 1.2×10^7 (see section 2), was estimated at 0.872mm, and appears as the dotted line in the figures. Note that, due to the sparsity of the deflection data (100m intervals), the characteristic deflection for many of the homogeneous sections are not statistically "correct" (i.e. involve too few data), and probably overestimate the true representative deflections of the sections.

Using the homogeneous sections and visual assessment of the deflection in both directions (combined), along with the geotechnical data, a crude sectioning was devised (see Figure 4). Each section of this scheme attempts to represent length of pavement/subgrade which may be considered as fairy uniform in terms of design/treatment requirements. Representative CBR's have been assigned to each section (see section 3). These should be considered as a rough guide only for selecting treatment options.

Based on the above design deflections, granular overlay thicknesses were calculated for sections of the road where the existing pavement is to be retained.

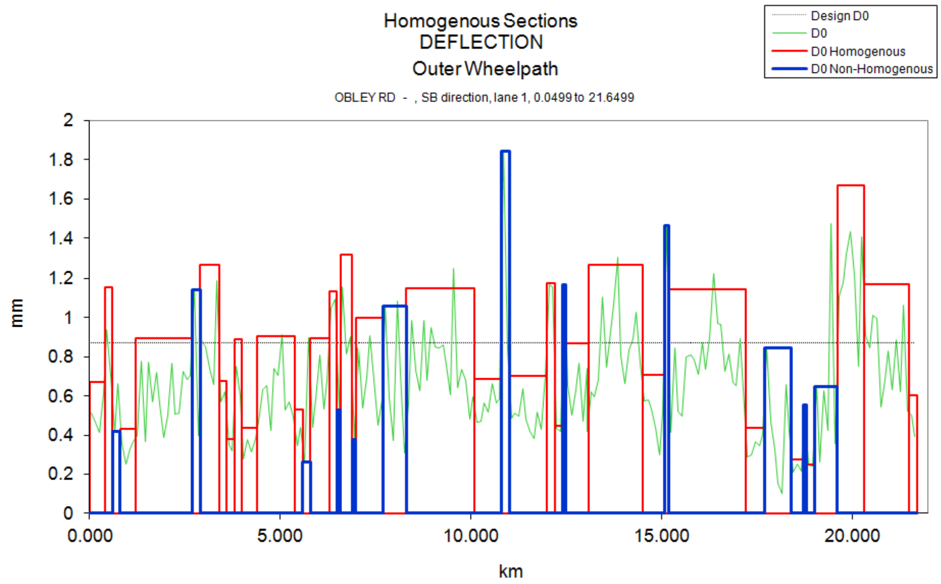

Figure 2 – Maximum Deflection, PD, showing Homogeneous Sections.

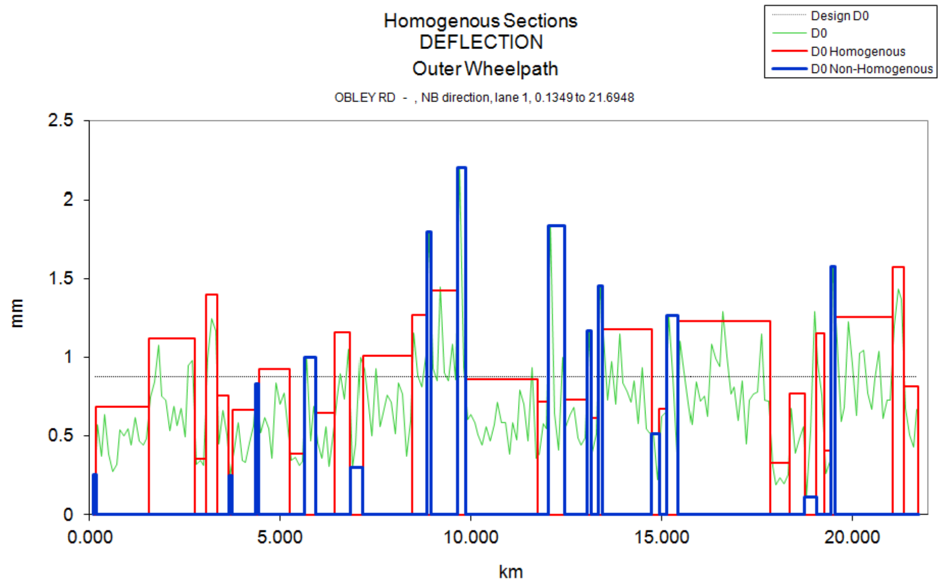

Figure 3 – Maximum Deflection, CD, showing Homogeneous Sections.

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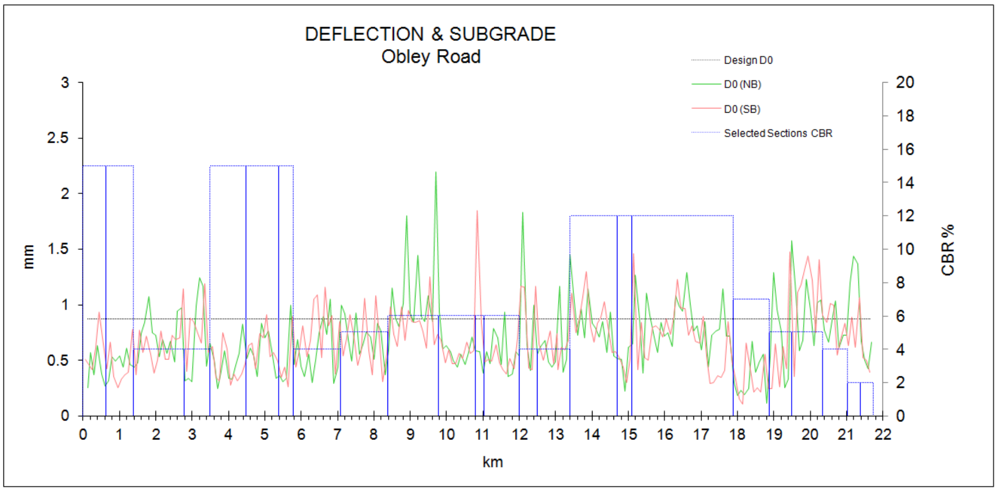

Figure 4 – Maximum Deflection in both PD and CD

5. Materials

All CIRCLY designs were for granular pavements, some including select fill. Granular base material was assumed to be good quality crushed rock, with a nominal Young's Modulus of 500MPa.

Select fill has been assumed, in accordance with Austroads guidance, to never exceed 100MPa in effective strength, and is automatically sub-layered by CIRCLY to reduce to the subgrade CBR at the bottom of the layer.

Figure 6 below, provides a means of selecting the appropriate thickness of select fill required for varying subgrades when CBR's less than 8% are encountered.

6. Mechanistic Design

Pavement designs for new construction (i.e. sections indicated for new alignment or widening) have been formulated using the CIRCLY program, as recommended by Austroads. For subgrades up to 8%, a 350mm granular base (good quality crushed rock) has been modelled on top of a select fill layer (Figure 5). The thickness of the select fill should be determined according to Figure 6.

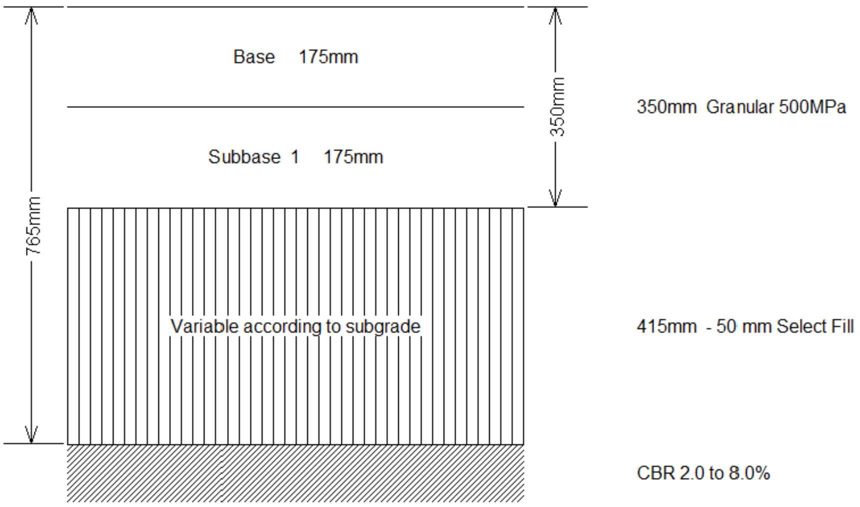

Figure 5 –Granular Design including variable Select Fill layer according to CBR.

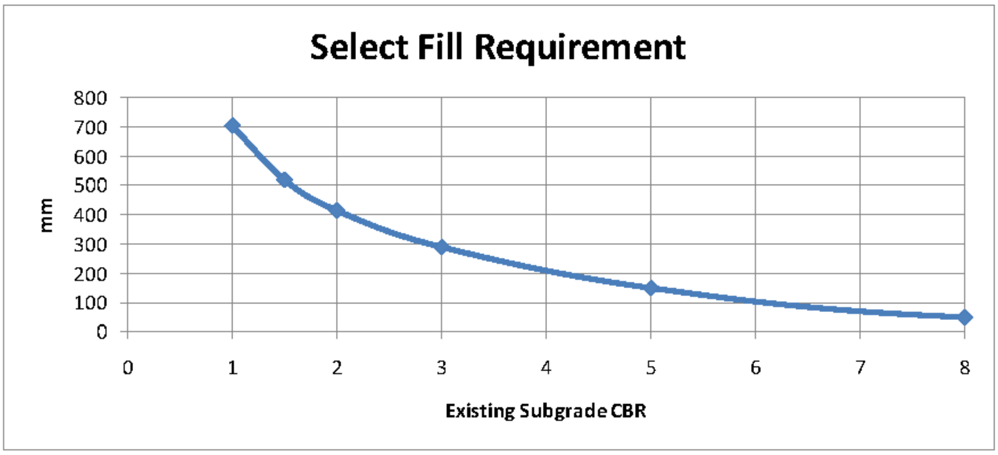

Figure 6 – Select Fill Requirement for Various Subgrades CBR's.

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For stronger subgrades (CBR's 12 and 15+%) full depth granular designs are shown in Figure 7.

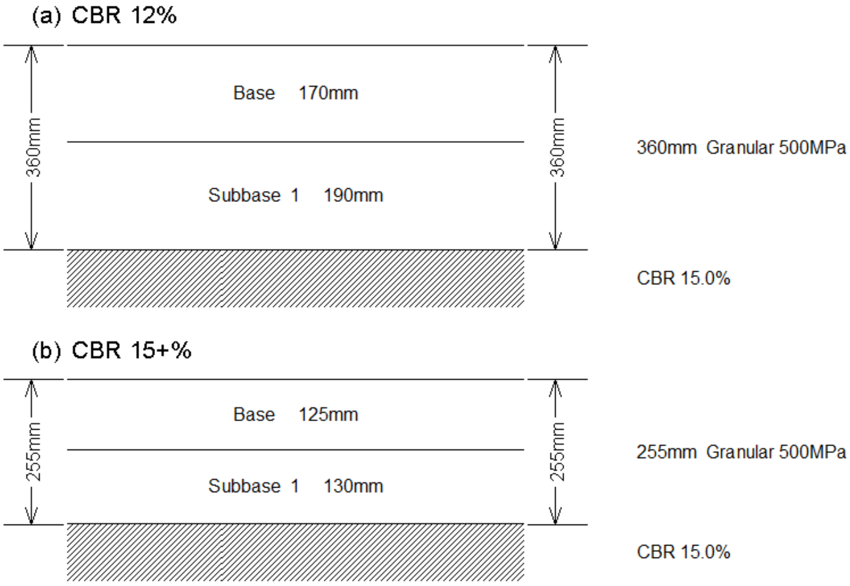

Figure 7 – Granular Designs for Subgrade CBR's 12% and 15+%

Tables 2 & 3 below, show the comparative thickness requirements for Option 1 with DESA of 9×10^6 and Option 2 with a DESA of 1.2×10^7.

The first row in each table shows the pavement thickness requirement based on Figure 8.4 of the Austroads Pavement Design Guide (AGPT02) for a range of CBR's between 2 and 15%. (Design Chart Thickness – Empirical Method)

The second row shows the pavement thickness requirement when calculated using the CIRCLY analysis software with assigned material properties over the same series of CBR's. (Mechanistic Method)

The third row shows the "Select Fill" thickness requirement over the various subgrade CBR's.

The tables show that there is only a relatively small difference in pavement layer thickness requirement between the two options.

DESA 9.00E+06

	CBR	2	3	5	8	12	15	%			
Fig 8.4	base	780	640	490	370	290	250	mm			
Circly	base	725	610	485	370	280	245	mm	500	Mpa	*good quality granular on subgrade*
Circly	fill	390	270	140	50	0	0	mm	500/100	MPa	*350 mm good quality granular on select fill*
	total	740	620	490	400	350	350	mm			

Table 2 – Summary of Design Thicknesses – Option 1

DESA 1.20E+07

	CBR	2	3	5	8	12	15	%			
Fig 8.4	base	800	660	500	380	295	255	mm			
Circly	base	745	652	495	385	290	250	mm	500	Mpa	*good quality granular on subgrade*
Circly	fill	415	290	150	50	0	0	mm	500/100	MPa	*350 mm good quality granular on select fill*
	total	765	640	500	400	350	350	mm			

Table 3 – Summary of Design Thicknesses – Option 2

7. Discussion and Recommendations

The proposed Obley Road upgrade includes a combination of treatments including retention of existing alignment and sections of new alignments and widening. Deflection testing has indicated that some sections of the existing alignment do not require strengthening, however for practical purposes and dependent upon specific site constraints, it may be appropriate to apply a minimum thickness overlay over the full length of the project and increase the depth at some locations as required.

In general terms, the pavement requires about a one hundred and fifty millimetre (150mm) overlay along the existing alignment to cater for the predicted future traffic loading. In addition, there are a few locations where, based on the available information, it appears that an increase in thickness would be required. The specific locations are shown in Table 3.

For sections of widening and new alignment, pavement thicknesses have been provided for a range of subgrade CBR's and it is recommended that the assumed CBR values be confirmed at the time of initial excavations and pavement layer thicknesses adjusted accordingly.

Analysis of the two traffic scenarios considered, Option 1 Road & Rail – DESA 9 x 106 and Option 2 Road Only – DESA 1.2 x 107, reveal only a relatively small difference in pavement thickness requirements as shown in Tables 2, 3 & 4 and Figures 8 & 9.

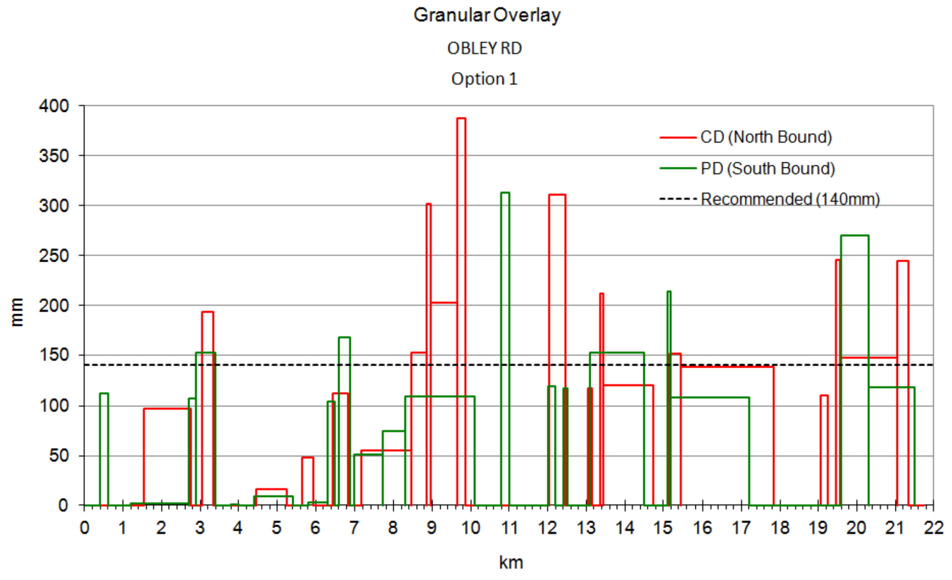

Figure 8 – Granular Overlay Thicknesses for Option 1

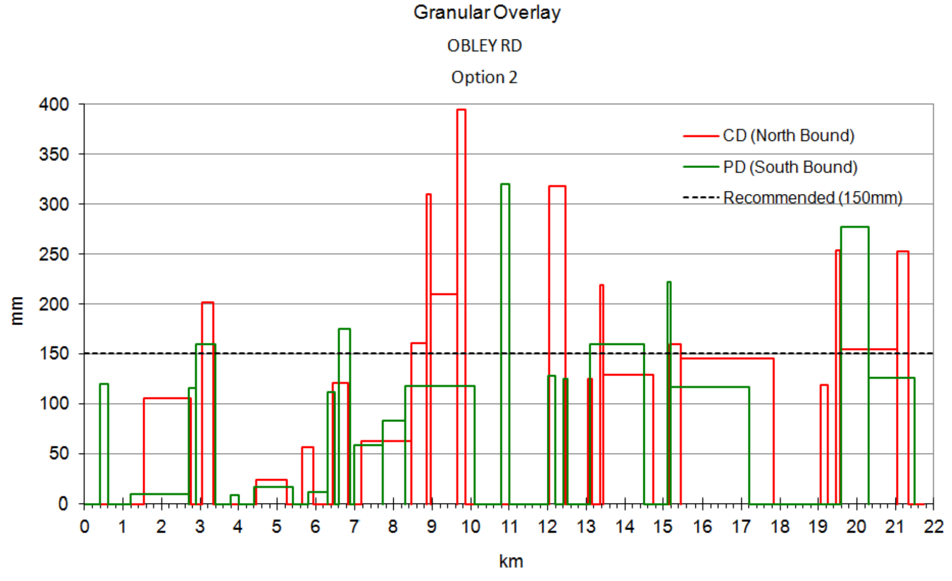

Figure 9 – Granular Overlay Thicknesses for Option 2

Chainage		Representative CBR %	Disposition	Treatment	Localized Repairs	Option 1			Option 2		
						Granular Overlay	Granular Construction		Granular Overlay	Granular Construction	
from	to						Base	Select Fill		Base	Select Fill
						mm	mm	mm	mm	mm	mm
0	1400	15	existing	retain	yes						
1400	2600	4	existing	retain	yes						
2600	3300	4	existing	overlay		190			200		
3300	3500	4	existing	retain	yes						
3500	4000	15	realign	construct			245	0		250	0
4000	4400	15	existing	retain	yes						
4400	5800	15	realign	construct			245	0		250	0
5800	6100	4	realign	construct			350	200		350	200
6100	7000	4	existing	retain	yes						
7000	7100	4	realign	construct			350	200		350	200
7100	7400	5	realign	construct			350	150		350	150
7400	8400	5	existing	retain	yes						
8400	9800	6	existing	overlay	yes[1]	200			210		
9800	9900	6	widen	partial construct			350	100	200	350	100
9900	10700	6	existing	retain							
10700	10800	6	widen	partial construct			350	100	0	350	100
10800	10900	6	widen	partial construct	yes[2]		350	100	0	350	100
10900	11350	6	existing	retain	yes						
11350	11550	6	widen	partial construct	yes		350	100	0	350	100
11550	12000	6	existing	retain							
12000	12500	4	existing	overlay		310			320		
12500	13100	4	existing	retain							
13100	13400	4	existing	overlay		150			160		
13400	14700	12	existing	overlay		150			160		
14700	15200	12	realign	construct			280	0		290	0
15200	17900	12	existing	overlay		140			150		
17900	18200	7	realign	construct			350	80		350	80
18200	18900	7	existing	retain							
18900	19500	5	existing	retain	yes[3]						
19500	20200	5	existing	overlay		270			280		
20200	20350	5	realign	construct			350	150		350	150
20350	20600	4	realign	construct			350	200		350	200
20600	21050	4	existing	overlay		150			150		
21050	21400	2	existing	overlay		240			250		
21400	21750	2	existing	overlay		150			150		

[1] Single point high deflection at 9700 requires further investigation
[2] Single point high deflection at 10850 requires further investigation
[3] Single point high deflection at 19000 requires further investigation

Table 4 – Site Specific Treatments

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8. Limitations and Qualifications

The analysis presented in this report has used the procedures described in the Austroads Guide to Pavement Structural Design, and the CIRCLY software analysis package. The results are predicated on and limited to the available input data provide in the referenced documents.

9. References

Austroads (2012) *Guide to Pavement Technology, Part 2: Pavement Structural Design.*

Austroads (2011) *Guide to Pavement Technology, Part 5: Pavement Evaluation and Treatment Design*

Truck Impact Chart_Appendix 4D HPV.pdf

LOG-Zircom-Rev3 5 November 2012.xls Geotechnical Investigation Summary

Excel Workbook *Road Rail Reagent Summary (25K HCl) November 2012.xlsx*

Obley Road Alignment Draft Rev A.pdf (2012)

Appendix A Extract from "Truck Impact Chart May 2009" (Australian Trucking Association)

AUSTRALIAN TRUCKING ASSOCIATION Truck Impact Chart May 2009 *

	GCM	Payload	Calculated ESA's 4th Power – Load Status 0%	50%	100%	No Trips per 1000 tonnes	ESA's per 1000 tonnes	Nom Fuel 100k
Two Axle Rigid GML	15.0	7.00	0.42	1.16	2.93	143	479	23
Two Axle Rigid Euro4	15.5	7.63	0.43	1.33	3.50	132	519	23
Three Axle Rigid GML	**22.5**	**13.12**	**0.51**	**1.27**	**3.58**	**77**	**316**	**28**
Three Axle Rigid Euro4	23.0	13.69	0.53	1.46	4.16	74	347	28
Six Axle Artic GML	42.5	24.13	1.14	2.03	4.96	42	257	47
Six Axle Artic HML (RFS)	45.5	27.13	1.14	2.03	4.96	37	226	50
Six Axle Artic CML (Non-RFS)	43.5	25.13	1.14	2.27	5.29	40	258	48
Six Axle Artic HML (Non- RFS)	45.5	27.13	1.14	2.18	6.05	37	267	50
Truck & Dog (6 Axle - NSW)	48.0	33.09	1.10	2.07	7.06	31	253	49
Truck & Dog (7 Axle)	50.0	34.19	1.10	1.89	5.57	30	201	51
B.double GML	62.5	38.93	1.15	2.24	6.34	26	195	62
B.double HML (RFS)	68.0	44.43	1.15	2.24	6.34	23	173	65
B.double CML (Non-RFS)	64.5	40.93	1.15	2.34	7.00	25	204	63
B.double HML (Non - RFS)	68.0	44.43	1.15	2.50	8.26	23	217	65
B-triple GML	82.5	52.44	1.16	2.51	7.72	20	178	68

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