Abstract

The Karloo-Wandina project is a joint initiative of the City of Greater Geraldton (CGG) and the Department of Housing (DoH) to provide affordable housing and trunk roads, drainage, water, sewer & power infrastructure to the growing Geraldton community. This significant undertaking is joint-funded by federal and state governments, an iron ore company and the CGG. Design & construction of the $28M infrastructure component of the project, including 2 new roundabouts and a bridge spanning the Southern Transport Road & Rail corridor (STC), is being managed exclusively by the CGG. Approximately 6 kilometres of new roads will connect the southern suburb of Wandina to the eastern suburb of Karloo, substantially reducing travel times. The trunk infrastructure will be established as a priority to facilitate subsequent land development activities, by both the CGG and the DoH, which will see in the order of 1,500 lots being ultimately developed. Though largely a greenfields project, significant challenges have been experienced that have required ‘exploring new territory’ thinking to resolve. These included how to finance $28M of trunk infrastructure works being a small regional local government and how to span a busy transport corridor with a road bridge and pass under transmission power lines in close proximity to meet all safe clearance requirements. The project is well underway and is planned to be completed prior to the end of March, 2014.

Key Words: Road, Bridge, Roundabouts, Joint Venture, Affordable Housing, Federal funding, Stakeholders, Main Roads, Rail, HV Power

Introduction

Growth infrastructure is becoming increasingly challenging to establish, whether it be from a developer financing capacity perspective, particularly in the current climate, or the deferral of government investment. Housing affordability is also under strain with rising development costs and demand for housing stock exceeding supply. This is certainly a growing concern in Midwest WA.

Geraldton is the regional centre of Midwest Western Australia (WA). A coastal city situated 430kms north of Perth in the heart of grain country. It has a population approaching 40,000 which has experienced 2.5% growth p.a. over the past decade and is expected to rise to between 60,000 and 80,000 over the next decade. The local economy enjoys sound diversity and is driven by the port through agriculture and mining industry export of grain, iron ore, gold, copper and zinc among other resources. Retail is also very strongly supported by the local community and health services too are a significant employer for Geraldton. The CGG is the largest WA regional centre north of Perth and the closest regional centre to the proposed Oakajee Port and Industrial Precinct. The current local authority, CGG, has experienced two voluntary amalgamations in the last five years.

The Geraldton urban area is not bypassed by the state highway network and as the Pilbara mining region in the Northwest relies on Fremantle port for imports and Perth for other manufacturing and services, Geraldton experiences significant heavy vehicle traffic. This in itself is a safety and amenity issue for the CGG, however this is compounded by the eastern suburbs suffering from the lack of a local distributor road. The current alternatives therefore are to use the state highway with its service level issues or “zig-zagging” through residential streets (an increasingly popular practice) for local north-south local travel.

Housing affordability is also a matter of concern for Geraldton. The forecast is for increased economic activity and consequent population growth, therefore Geraldton needs to take action to safeguard against unsustainable housing
scenarios that would adversely impact the community. A similar situation to the Pilbara where the median house price is approaching $1M and weekly rents are in the order of $2,000 needs to be desperately avoided. The 9th Annual Demographia Housing Affordability Survey rated the CGG as “Severely Unaffordable” under the median house price:median income ratio approach. Both the CGG and the state have significant strategic land holdings within 5kms of the City Centre that could offset the risk, but they suffer from a lack of trunk infrastructure affecting the viability of their development.

The CGG needs urban connectivity between its’ suburbs and the DoH needs trunk infrastructure to service the states’ land holdings in order to deliver affordable housing. Neither party could finance these fundamental requirements independently. The Federal Governments’ Building Better Regional Cities (BBRC) Program provided the suitable financial platform in which the needs of both parties could be achieved.

A consortium was formed between the CGG and DoH, a business case prepared and a joint application for funding was lodged. On the 30th June 2012, the Minister for Housing and Homelessness announced the successful funding of the Karloo-Wandina project under the BBRC Program. What has followed to date has been far from any routine local government capital works experience. This project and all those involved in it are certainly “exploring new territory”.

**Aim**

The aim of this paper is to profile the lateral thinking applied to this project; share lessons learned; and outline technical details of this significant local government project.

**The Site**

The project site is located south east of the City’s centre. Please refer to Appendix A which illustrates the project site in relation to the surrounding area and Appendix B which illustrates proposed land use.

The site is located predominantly in rolling terrain on cleared agricultural land, however there is some remnant vegetation to the north of the site.

The pink lines represent the proposed road reserves.

The northern extent of the site is bounded by the termination of the existing Abraham Street in Karloo and Highbury Street in Mt Tarcoola. The north-eastern extent of the site is bounded by the extent of DoHs’ land holding and in the south-east by the existing Scott Road reserve. The southern extent of the site is bounded by the Lot 9 (CGG-owned) boundary and the western extent is bounded by existing urban development in Wandina and Mt Tarcoola.

In terms of land use, the site falls within a variety of zones, namely; future urban, future industrial and service commercial. The land also has a diversity of ownership including the CGG, DoH and a private owner (Lot 21).

**The Scope**

The broad scope of the Karloo Wandina project is to provide Geraldton with affordable housing including provision of the necessary infrastructure to facilitate it.

The detailed scope includes the provision of Verita Road (approximately 4kms); North South Karloo Connector (NSKC) Road (approximately 1.6kms); a three-span (67.5m) bridge over the existing road and rail STC; Columbus Boulevard extension (approximately 850m), trunk water, wastewater and power supply, two roundabouts and one “T” intersection.

In terms of scope delivery of this essentially two-stage project, the CGG and the DoH came to an agreement regarding scope responsibility. The CGG would be responsible for the design and delivery of the preceding $28M trunk infrastructure works, whilst the DoH would be responsible for the planning, design and construction of the subdivisional development producing the affordable housing stock.

**The Constraints**

The project site possessed a number of significant physical and administrative constraints and most were identified during the project inception.

Avoiding impact on the STC, incorporating the Geraldton-Mt Magnet Road & the Midwest
Railway line) and the 132kV power transmission line, was one of the most complex challenges for the road and bridge design of the NSKC. Geraldton-Mt Magnet Road is under the jurisdiction of Main Roads Western Australia (MRWA), the rail is under lease from the state by Brookfield Rail and the power infrastructure is owned and operated by Western Power. These three stakeholders had various requirements that needed to be achieved in the design which will be addressed in more detail later in this paper.

The familiar presence of rock (coastal limestone) within the sites’ boundary is also a major constraint. Geotechnical investigations along Verita Road, NSKC and the Bridge site revealed rock depths and strength at various intervals along both corridors. The road designs have avoided rock wherever possible without compromising geometry. The presence of rock at the bridge site is anticipated to benefit construction in that only shallow bearing footings are required for bridge piers.

An existing DN600 AC water main (owned and operated by Watercorp) alignment conflicts with Verita Road, necessitating its’ relocation as part of the roadworks.

Fixed local road tie-ins are also a constraint for the project, particularly at Columbus Boulevard. The combination of the proposed roundabout location and the grade of the terrain added complexity.

An iron ore company (EHMP), proposed a dual DN500 slurry pipeline to the Geraldton Port using Verita Road. This provided some advantages to the project however their pipeline requirements were another constraint that was applied to the design.

A number of administrative issues also faced the project team including; a lean budget, a demanding delivery program, multiple funding and reporting bodies, a private landholder, a substantial key stakeholder list, absence of road reserve for full extent, requirement for clearing permits and absence of a structure plan.

The Financials
This project is financed by a number of government agencies, namely; Federal Government - Department of Families, Housing, Community Services & Indigenous Affairs ($9M), Midwest Development Commission ($13.97M) and CGG ($5M). The total trunk infrastructure budget is $27.97M.

The EHMP also contributed $2M towards bulk earthworks in return for co-locating their pipeline with Verita Road. An overview of the budget per infrastructure component is as follows:

<table>
<thead>
<tr>
<th>Infrastructure Component</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Verita Road</td>
<td>$8,500,000</td>
</tr>
<tr>
<td>Bridge</td>
<td>$7,770,000</td>
</tr>
<tr>
<td>North-South Karloo Connector</td>
<td>$2,410,000</td>
</tr>
<tr>
<td>Columbus Blvd Extension</td>
<td>$1,480,000</td>
</tr>
<tr>
<td>Water Supply</td>
<td>$3,120,000</td>
</tr>
<tr>
<td>Wastewater Supply</td>
<td>$2,990,000</td>
</tr>
<tr>
<td>Power Supply</td>
<td>$1,700,000</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>$27,970,000</strong></td>
</tr>
</tbody>
</table>

The People
The CGG is the lead agency on this project, with DoH being a consortium partner for the BBRC funding agreement.

As part of the CGGs’ project delivery framework, a project team structure was established for the detail design phase after the contract was awarded. The structure is illustrated in Appendix C which shows the relationship between the detail design consultants and the CGG.

A key role vital for successful delivery, is the CGGs’ project manager who is dedicated to this project. The expertise to manage this complex infrastructure project was not available internally.
and as such the CGG engaged a professional project manager. Equally as important is the consultants' dedicated project manager, who has provided ongoing prompt action.

As DoH has their own consultants commissioned to undertake the structure planning process on their landholdings and the fact that the CGG was undertaking detailed design simultaneously with its consultants, it was vital there was linkage between the two in the structure. This key function was provided by the Manager Town Planning Services.

My role in the project was to collaborate with the CGGs' project manager regarding decisions associated with detail civil design and transport planning.

There is also an extensive list of key stakeholders associated with this project including but not limited to Adjacent residents; Main Roads; DoH; Watercorp; Western Power; Brookfield Rail; Federal Government; Midwest Development Commission and Private Landholders.

### The Program

The federal government funding for the project was announced on 30th June 2012, which obligated the CGG to comply with several milestones. These milestones form the basis of the project program shown in the following table:

<table>
<thead>
<tr>
<th>Milestone</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milestone 1: Execution of Agreement</td>
<td>26/06/2012</td>
</tr>
<tr>
<td>Milestone 2: Completed Project Plan</td>
<td>31/07/2012</td>
</tr>
<tr>
<td>Milestone 3: Complete Infrastructure Works Design and Documentation</td>
<td>30/03/2013</td>
</tr>
<tr>
<td>Milestone 4: All Approvals obtained for Infrastructure Works commencement</td>
<td>3/06/2013</td>
</tr>
<tr>
<td>Milestone 5: Approvals for the commencement of the residential works obtained (DoH)</td>
<td>30/05/2013</td>
</tr>
<tr>
<td>Milestone 6: Calling of Tenders for the Construction of Infrastructure Works</td>
<td>13/04/2013</td>
</tr>
<tr>
<td>Milestone 7: Commencement of Infrastructure Works</td>
<td>26/06/2013</td>
</tr>
<tr>
<td>Milestone 8: Commencement of the Residential Works (DoH)</td>
<td>31/12/2013</td>
</tr>
<tr>
<td>Milestone 9: Completion of the Infrastructure Works</td>
<td>3/04/2014</td>
</tr>
<tr>
<td>Milestone 10: Completion of the Residential Works (DoH)</td>
<td>30/06/2016</td>
</tr>
</tbody>
</table>

Of particular interest within this program is the compressed design phase associated with Milestone 3. The public tender was advertised on the 7th December 2012 and closed on 10th January 2013. Note the final detail design & documentation needed to be completed by 30th March 2013. It goes without saying that consultants were not particularly impressed with the timing. Nevertheless there were no extensions granted. Tender evaluation was promptly conducted, however by the time a letter of intent was issued, the consultants had eight weeks to design and document the entire infrastructure project.

The design of Verita Road, after much refinement, was completed by the deadline however the North South Karloo Connector design was complicated by bridge approach grades and negotiations with the private owner of Lot 21. The design of NSKC and the bridge is now close to completion.

Milestone 4 was recently achieved (in part) with Native Vegetation Clearing Permit for Verita Road. The application was lodged on 21st March 2013 and took 2 months to obtain. Lodgement of the second clearing permit for the NSKC is currently pending consent of the owner of Lot 21.
The current construction strategy to achieve Milestone 7 includes letting two separate contracts for the project in two stages. The first contract will be for Verita Road construction and the second for construction of NSKC. The latter contract will have the added complexity of the bridge construction spanning the Midwest Rail line and STC.

At the time of writing this paper, the CGG had advanced to Milestone 6 and progress was essentially on schedule. It is critical the CGG does not delay infrastructure provision otherwise DoHs’ Milestone 8 will be adversely impacted.

**Transport Infrastructure**

Verita Road, incorporating the extension of Columbus Boulevard and Ackland Road possessed a number of issues that had to be addressed through design. Despite being a greenfields project, the first challenge was the absence of a road reserve for the full extent with part of the corridor passing through private property. Formalising the reserve will ultimately be dealt with through the structure planning and subdivision process however agreeing upon a road reserve width proved to be a challenge. The CGG required sufficient width to incorporate requirements of the cross section including the ultimate dual carriageway and a median to accommodate the dual DN500 dual slurry pipelines. A 50m road reserve was finally agreed upon. This project is only delivering the western carriageway of the ultimate separated dual carriageway to a rural cross section catering for on-road cycling. Over the next 20 years, traffic on the corridor is only expected to increase to approximately 14,000 vehicles/day and will only cater for as-of-right vehicles (up to 19m semi-trailer).

The design speed for the Verita corridor is 70 km/hr. The corridors’ relatively straight horizontal alignment did not pose a challenge however the vertical alignment was subject to ongoing revision to meet Austroads design requirements as well as achieving an earthworks balance and avoiding rock. The design levels avoid the modelled rock profile and the CGG is confident this will maximise efficiency during construction. The maximum depth of cut is 2.6m just south of Ackland and the maximum fill depth is 3.15m at the proposed Ackland roundabout. This is due to the roundabout being located in a depression in the terrain, which was unavoidable. Drainage will be directed to two new compensation basins.

The vertical alignment levels of Verita also had to meet tie-in requirements at Highbury Street, Ackland Road and Columbus Boulevard. Columbus proved to be the greatest challenge with Veritas’ relative proximity to it and the terrain falling into Lot 9 at approximately 7%. The geometry of the Columbus extension had to suit Verita requirements but also provide an access into Lot 9 suitable for future development to adjoin. By considering future development levels in the longsection, the designers were able to achieve a reasonable outcome.

Roundabouts were designed at Columbus and Ackland and a T intersection provided at Highbury. The traffic modelling recommended that Columbus and Ackland would benefit from roundabout control within a 20 year design horizon, particularly being crossroads. Whilst it is proposed in future to extend Verita further west through Highbury, at this stage it was decided to only provide a T intersection treatment at the Verita/Highbury intersection. The traffic volumes predicted here are relatively low until an extension is constructed.

The North South Karloo Connector Road had some challenging design aspects. No road reserve existed and only an indicative alignment was proposed in the business case. The alignment passed through the privately held Lot 21 and DoH land with each owner having specific requirements. DoH sought convenient geometry (i.e. rectangular) for their development and the owner of Lot 21 sought an appropriate access for their future development. Therefore substantial discussions were held regarding the final horizontal and vertical alignment of NSKC. The final agreed alignment is shown in Appendix D.

NSKC is designed as a single carriageway road of rural cross section catering for on-road cycling. The traffic forecast for the 20 year design horizon is in the order of 9,000 vehicles/day.
The final horizontal alignment of the NSKC was determined to suit the requirements of the DoH development (and the bridge location) and did not compromise the roads’ function. The location of the bridge was also subject to much debate. This however was only the beginning of a more complex problem-solving exercise as the bridge had to span the Midwest Rail line, four lanes (2 existing, 2 ultimate) of the highway and pass under high voltage transmission lines. Questions were raised as to where the most ideal position would be. The adopted location also had to result in a desirable development outcome for DoH on the adjacent land. After exploring two sites further to the east, it was decided the original proposal would be adopted, i.e. aligned with Abraham Street. It provided the most efficient alignment from a transport planning perspective but also was the most cost-effective as other options required similar earthworks but a greater length of road to service.

There was initially a proposal to construct the NSKC as an underpass of the STC. In my opinion, this proposal was never viable. The presence of limestone alone should have discredited it, without mentioning risk of interfering with the Midwest rail line that carries in the order of 25,000t of iron ore alone per day or the poor Crime Prevention Through Environmental Design (CPTED) outcome. The proposal was eventually discounted.

With regard to vertical geometry of the NSKC, the tie-in levels at each end were fixed by the existing Abraham Street and the Ackland roundabout design levels to satisfy Verita Road. The challenge was to then meet the clearance requirements of Main Roads, Brookfield Rail and Western Power whilst minimising earthworks and providing reasonable access to Lot 21. This road design was without a doubt an exercise in "threading the needle".

Main Roads required a 6.6m clearance to the underside of the bridge, Brookfield Rail required an 7.2m clearance from the underside of the bridge to the top of the rail and Western Power required 9m from a loaded power line to the road surface. In hot conditions, transmission power lines can sag up to 1m and Geraldton regularly experiences temperatures in excess of 40 degrees during summer months.

As the rail line is higher than the road, its clearance became the governing vertical control at the bridge. In more forgiving terrain, this design problem would have been more elementary to resolve. Unfortunately however, the existing terrain on the southern approach to the bridge falls away at 5%. With road design levels set to clear the rail, pass under the high voltage power and meet a 60km/hr design speed, a substantial earthworks problem resulted on the southern approach. The first alignment trials proposed a fill embankment of up to 13m, which was simply unacceptable and unaffordable. Many subsequent design iterations were processed. The optimal solution arrived at was 3 simply-supported raked bridge spans to minimise embankment height. Nevertheless, the fill required for the design NSKC bridge embankments, even with the aid of mechanically stabilised earth (MSE) walls is in the order of 60,000m$^3$, with a maximum height of fill 8.3m.

The project site is fortunate however to possess high quality subgrades with soaked CBRs in excess of CBR 25 across the site. Given the other challenges of this project, an economical pavement design was most welcomed.

**Exploring New Territory**

During the design phase of this project a great deal of lateral thinking was needed. What has been achieved in the final design is the result of many hours of “optioneering” by the design team but the project inception phase also saw some creative thinking.

Pursuing the partnership with DoH itself was enterprising. Without the channel to produce affordable housing, the application had no chance of success and expansion of the local road network would have taken many more years.

Negotiating an agreement with EHMP which included a contribution towards bulk-earthworks on the Verita Road alignment provided an offset to the project budget.

The CGG is funding its’ contribution to this project from the proceeds of a residential
development of a gifted land parcel. This minimises any undue increase in rates. An example of the CGGs’ land development activity can be found at: 

During the design phase, reconfiguring the bridge decks to be raked significantly reduced the ‘fill from stockpile’ earthworks volume and ultimately will conserve the projects’ budget. Designing fill batters that encroach into CGG-owned land and providing MSE walls adjacent DoH land both reduced costs and maximised DoHs’ developable area.

A significant amount of imported fill is required for the bridge approaches. Coincidentally, the CGG is excavating a third cell at Meru, the CGGs’ waste facility that will satisfy the fill requirement for the bridge approaches.

The CGG recognised that a parcel of land owned by DoH to the immediate south-east of the bridge would become isolated. It would be bound by the bridge approach to the west, the transport corridor to the north and industrial & service commercial land to the east. The CGG suggested a “land-swap”, effectively re-zoning this parcel to industrial under the CGGs’ control and DoH developing the equivalent amount of allotments in the southwest of Lot 9.

On the Verita design it was important to achieve an earthworks balance. Given the other geometrical constraints, the CGG decided not to construct to formation levels of the ultimate dual carriageway cross section in areas of fill. This minimised earthworks and reduced costs.

Lessons Learned

The single most important learning from this project is the absolute necessity to carry out an adequate due diligence investigation for any project that carries risk. This project should really have had a conceptual design and budget estimate prepared prior to submission. Whilst the detail design process, despite having its challenges, has been successfully completed, the CGG is now experiencing a new challenge in delivering the infrastructure scope for the agreed budget. Broad unit rate cost estimation for low-risk projects with reasonable certainty is generally satisfactory for high level budgeting, however this approach should not be applied to large scale, higher risk projects, especially those with some degree of uncertainty.

Local governments should shift some emphasis away from delivery to planning and conceptual design. Whilst construction is where the big money is spent, planning is where the large risks are identified and the big money is saved. How many local governments do you know that have say two years’ worth of shovel-ready capital works, designed and costed ‘on the shelf’ and accurately informing forward years’ budgets?

A whole of life cost assessment should have also been conducted on this project. Local authorities are asset-intensive businesses, so depreciation factors heavily upon a councils’ operating bottom line. Without disputing the immediate benefits this project will have upon the community, the longer term affordability should have appraised and processed through the long-term financial plan. Whilst higher levels of government have provided the majority of the upfront capital, this represents only about 20% of the whole of life costs of the asset. The CGG will ultimately inherit the ongoing maintenance of the road infrastructure and will now need to budget for in the order of an additional $1M/year for depreciation if it intends to maintain the same level of service.

If the CGG were to undertake a similar project in future, it would design the roadworks in house. The CGG has no grievance with its design consultants, however due to the multitude of geometrical refinements it most likely would have been more efficient to undertake internally. The issue for Geraldton in this regard is that it has no internal civil design staff and they would need to be seconded.

At the time, it was thought that tendering for design services would be most efficient and convenient. The successful tender was attractive being at around 4% of budget, and was the most desirable management scenario of all tenderers (i.e. all under one roof, expertise and dedicated project manager). The many changes, arguably due to insufficient planning, became difficult to manage and ultimately added expense. The
design tender and evaluation period also absorbed too much time in an already compressed program. For Geraldton, other procurement mechanisms, such as a design consultants panel, should be explored for rapid engagements in future.

The CGGs’ secondment of a freelance project manager, with the appropriate skills & experience to manage a project of this complexity and scale (who was also dedicated to this project) has proven to be a great success story. The CGG could not have managed this project effectively and maintained its momentum with existing resources. Portfolio managers need to pair the right project manager to the right project and if need be, import the expertise. Invest in people who have proven expertise and don’t get despondent about hourly rates (within reason). If they are proven performers, they will be more efficient than cheaper alternatives and ultimately will save you money.

Despite ultimately finding an ideal candidate, the CGG needed to engage the project manager much sooner. Five months were lost through appointment process due to procurement compliance issues and progress on the project was substantially inhibited. Due to the delay in the CGG appointing a project manager, DoH and their consultants showed some frustration towards CGG response times regarding their structure planning process and further pressure was applied to the program. A prequalified consultant panel or similar, as outlined earlier would minimise any delay in engagement.

A tendering lesson learned was that the bridge specification in the documents was far too explicit for what was known about the geometrics of the location and ultimately led to a design variation. Consultants designed precisely what was specified despite it clearly not being the optimal solution for the site, as it was called for in the specification. During contract administration, this was a point of dispute which could have been avoided.

The Way Forward
Whilst writing this paper, the CGG is approaching Milestone 7, Construction of Infrastructure Works. The lateral thinking continues as the CGG now considers assuming the Principal Contractor role and commencing construction under wet hire.

At the time of the conference, construction of Verita Road should be well underway.

Conclusion
The aim of this paper was to profile the lateral thinking applied to this project; share lessons learned; and outline technical details of this significant local government project.

All of these points have been explored and I trust the findings and opinions presented herein assist those who are in future presented with a similar capital works challenge.

Local authorities often urge higher levels of government to “build for growth”, however in the current economic climate and moving forward there is an increasing expectation for local authorities and the private sector to share the cost.

Through its commitment to this project, the CGG has put its faith in the future economic prosperity of the region. It has supported the development of affordable housing by facilitating this landmark project for Geraldton. The CGG has been decisive in taking advantage of this opportunity from the Federal Government to deliver the Karloo Wandina Project, as there will never be a better time than now. I am confident the construction phase will be a success and then I sincerely hope ‘they’ come.

References

Appendices
Appendix A – Project Site Plan
Appendix B – Land Use Plan
Appendix C – Project Team Structure
Appendix D - North South Karloo Connector Longsection
Biography

Mark Atkinson is a civil engineer with a broad range of industry experiences in both private and local government sectors. Commencing as a draftsman, he moved into civil design, project management and ultimately into professional engineering and management.

Mark is the Manager of Infrastructure Planning & Design at the CGG, responsible for development assessment, capital works planning & design and asset management. He has 17 years’ experience in the industry with the majority of that time spent in South East Queensland roles.

He has Civil Engineering Masters and Business Management qualifications and is a Member of the Institute of Engineers Australia.
Disclaimer: Whilst all care has been taken in the preparation of this data, this information is provided as a guide only and no responsibility shall be taken for any omissions or errors in this documentation. The accuracy provided is not to be used for legal purposes, but reference made to original documentation, which includes Certificate of Titles, Survey Diagrams and legal versions of the Town Planning Schemes.
<table>
<thead>
<tr>
<th>Station (m)</th>
<th>Elev. (m)</th>
<th>V.P.I.</th>
<th>Grade (%)</th>
<th>Length (m)</th>
</tr>
</thead>
<tbody>
<tr>
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<tr>
<td>120</td>
<td>31.70</td>
<td></td>
<td>-5.00</td>
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**Ground Level Difference**

**Design Level**

**Datum** = 10.00

**Elevation (ELE.)**

**Horizontal Geometry**

**Vertical Geometry**

**Superelevation**

---

**Notes:**

- Design to Ground Level Difference.
- Design Speed = 60km/hr (AUSTROADS).
- DATUM = 10.00.
- Design Level = 31.024.
- P = 1.98%.
- LVC = 200.
- V.P.I. No. 2 = 33.92.
- L = 81.22.
- E = 3.00%.
- V.P.I. No. 3 = 33.53.
- L = 120.00.
- E = 3.00%.
- V.P.I. No. 4 = 31.05.
- L = 77.25.
- E = 3.30%.
- LVC = 200.
- P = 1.80%.
- L = 267.13.
- V.P.I. No. 2 = 33.92.
- L = 120.00.
- E = 3.00%.
- V.P.I. No. 3 = 33.53.
- L = 120.00.
- E = 3.30%.
- V.P.I. No. 4 = 31.05.
- L = 77.25.
- E = 3.30%.
- V.P.I. No. 2 = 33.92.
- L = 120.00.
- E = 3.00%.
- V.P.I. No. 3 = 33.53.
- L = 120.00.
- E = 3.30%.
- V.P.I. No. 4 = 31.05.
- L = 77.25.
- E = 3.30%.

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**Scale:** 1:2000 / 1:250 AT FULL SIZE

**Date:** 20/05/13

**Design Speed:** 60km/hr (AUSTROADS)