P WALMSELY AND J & L DICKINSON
INFRASTRUCTURE IMPACT ASSESSMENT

Proposed Residential Subdivision
Lot 1 DP 167380, Lot 2 DP 961928 & Lot 1 DP 134787
Walmsleys Road and Lot 5 DP 1117326 Stott Street
Bilambil Heights NSW

Revision Number: 7

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Date: **22 April 2009**

OPUS

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Civil Engineer

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1. INTRODUCTION

Peter Walmsley and Jim and Les Dickinson have commissioned blueLAND engineers (now Opus Qantec McWILLIAM) to prepare a report on the impacts of earthworks, traffic, drainage, water and wastewater for a residential subdivision development at Walmsleys Road and Stott Street, Bilambil Heights. This assessment forms part of a Part 3A Major Project Application and Environmental Assessment prepared by others and is to be read in conjunction with that documentation.

The assessment addresses the following issues:

- Earthworks impacts including erosion control.
- Traffic generation impacts.
- Stormwater drainage impacts.
- Water demand impacts.
- Wastewater generation impacts.

2. PROPERTY DESCRIPTION

The property description is Lot 1 DP 167380, Lot 2 DP 961928 & Lot 1 DP 134787 Walmsleys Road and Lot 5 DP 1117326, Stott Street, Bilambil Heights in the Parish of Terranora, County of Rous in the Shire of Tweed. The total size of the site is approximately 14.1 hectares.

The land is partially zoned 2(c) Urban Expansion and partially 7(d) Environmental Protection (Scenic Escarpment) under Tweed LEP 2000. The residential subdivision is entirely within the 2(c) zone. The locality and zoning is shown in Figure 1.0.

3. LOCATION

The subdivision site is located on the northern side of Walmsleys Road. The northern part of the site, Lot 5 DP 1117326, is situated predominantly on the western side of Stott Street and includes a smaller parcel of land to the east of Stott Street adjacent to an existing Aged Care facility.

The site is bound to the north by existing residential development, to the east by remnant vegetation and existing residential development and to the west by grazing farmland. The southern boundary runs parallel to Walmsleys Road which provides access to existing residential development to the south.

4. DESCRIPTION OF PROPOSAL

The overall proposal comprises 77 conventional residential allotments, 5 community title allotments, a park area and a connecting roadway. All development is within the area zoned 2(c) Urban Expansion. The proposal will provide residential allotments ranging from approximately 600m^2 to over 2500m^2. All proposed internal roads are to be accessed off Walmsleys Road and Stott Street. The layout of the proposed development is shown in Figure 1.0.

5. EXISTING FEATURES

The three southern lots are characterised by a ridge approximately 50m wide, running north to south from the end of Stott Street to Walmleys Road. The site has two aspects; the western aspect falling from the ridge towards the western boundary at a grade increasing from 10% to 30% approaching the western boundary and an easterly aspect with slopes ranging from 10% up to 30% closer to the boundary. Levels within the proposed development area range from RL 86m AHD in the southeastern corner adjacent to Walmsleys Road to RL 54m AHD in the east and RL 51m AHD in the west. Figure 2.0 illustrates the existing surface and features and Figure 3.0 indicates the existing surface grades across the site.

Approximately two thirds of the southern area of Lot 5 DP 1117326 to the west of Stott Street, is currently a passionfruit plantation. The parcel of land to the east of Stott Street is currently overgrown by tall grasses. The remainder of the site is generally cleared and grassed with a row of assorted trees along the northern boundary to Lot 2 DP 961928. Remnant vegetation is evident to the east and west of the site beyond the 2(c) residential zone.

Vehicular access to the site is obtained from Stott Street to the North and Walmsleys Road to the south.

6. EARTHWORKS AND EROSION CONTROL

6.1 EARTHWORKS

6.1.1 PROPOSED EARTHWORKS

Earthworks will be required to grade out local irregularities and to facilitate vertical and horizontal alignment of proposed roads and allotment gradients. No earthworks are proposed to occur outside of the proposed 2(c) zone line as specified by Tweed Shire Council.

Earthworks preliminary design has been carried out to conform to the criteria of Tweed Shire Council Development Control Plan 2007, Part A5–Subdivision Manual and Development Design Specification D6 – Site Regrading v1.3. In particular the natural landform has been generally preserved with site regarding being limited to the minimum required to provide suitable road grades and practical residential lots. Figure 4.0 indicates the site areas with cut or fill greater than 5m from existing levels. This area represents

approximately 3% of the site area and is less than the 10% required by Section A5 and D6. The longitudinal sections of the preliminary road design (Figures 8.0 to 13.0) and site cross sections (Figures 7.1 to 7.2) demonstrate the design generally corresponds with the existing landform with cut and fill operations. The majority of site boundaries have been preserved at pre-development levels with the perimeter boundary walls greater than 1.2m in height limited to Road 5 to allow practical access to community Lots. Pre-development drainage patterns have also generally been preserved.

Vegetation and site clearing should generally be limited to within five metres of the extent of earthwork lines as determined in the detailed engineering design. Unsuitable fill materials identified in geotechnical assessments may need to be removed from the site. Preliminary calculations indicate a cut to fill deficit, with fill volume of approximately 95,000m^3 and a cut volume of approximately 55,000m^3. Actual quantities will be determined at the detailed design stage. With a bulking factor of 20% approximately 48,000m^3 of clean imported fill will be required to achieve the proposed site levels. Figures 4.0 indicate the proposed depths of cut and fill operations.

6.1.2 SLOPE STABILITY ASSESSMENT

The site is characterised by relatively steeply sloping land towards the east and west of the central ridge. Slope Stability assessments have been carried out to identify existing areas of instability and restrictions for development on the site.

Maiden Geotechnics carried out a slope stability assessment of Lot 1 DP 167380, Lot 2 DP 961928 and Lot 1 DP 134787 Walmsleys Road in June/July, 2004 which identified a number of areas where geotechnical conditions require remediation measures or impose development constraints. The geotechnical constraints identified in the report are shown in Figure 5.0.

A slope stability assessment of Lot 5 DP 1117326 has been carried out by Maiden Geotechnics in December 2003/January 2004. Organic fill was identified along the western boundary. This would need to be removed and replaced with compacted clay fill.

Due to the sites sloping terrain and existing areas of instability the restrictions and precautions detailed in the above reports should be adhered to. Copies of these reports are appended in the Part 3A Major Project Application and Environmental Assessment. These restrictions have been incorporated into the proposed lot layout.

6.1.3 IMPACT OF EARTHWORKS

Earthworks will primarily involve cut to fill and importing of fill to achieve the design road and allotment levels. In addition any unsuitable materials encountered will be removed and replaced with compacted fill. The earthworks have the potential to impact on drainage and erosion. These impacts are addressed in detail under the relevant headings of this report.

In conclusion the existing landform will be reshaped sufficiently to enable both roads and allotment accesses to be constructed to the required standards taking into consideration areas of unsuitability. The final landform would have improved stability by carrying out subsurface improvements in accordance with geotechnical engineering advice.

6.1.4 EARTHWORKS TRAFFIC

Impacts on the local amenity as a result of the traffic generated by earthworks would be mitigated by the sites close proximity to the distributor road network (Scenic Drive and Piggabeen Road). It is recommended that earthworks traffic access the site via Scenic Drive and Walmsleys Road. To minimise the impacts on local amenity we recommend trucks operate from 7am to 5pm, 5 days/week. Contributions toward the impacts on pavement life as a result of importation of fill material would be levied from the proposed development under Section 94 Plan No. 4 of the Tweed Road Contribution Plan (TSC, 2004), TRCP S94. Based on approximately 40,000m^3 (solid volume) of fill material required to be imported, a bulking factor of 20% and a 20m^3 capacity truck, approximately 4800 vehicle trips (two-way) would be required. This is likely to extend over 10 weeks based on 6 deliveries/hour, 8 hours average operational time per day 5 days/week. The development also may be liable to a heavy haulage levy on any unsuitable material encountered during construction, payable under TRCP S94.

6.2 EROSION CONTROL

6.2.1 EXISTING SITE

The existing site has full grass cover. There is evidence of old slip sites at the western and south eastern boundaries.

The Soil Landscape Maps of the Murwillumbah Tweed Heads (Morand DT 1996), show the site to comprise of billinudgel “bi” soil landscapes. These have an erodibility k factor of 0.04.

6.2.2 PROPOSED EROSION CONTROL

The bi 1 and 2 soil types have a fines (soil particle size <0.02mm) fraction of 70-90% (Morand 1996). A number of measures or best management practices (BMP) should be implemented to reduce soil erosion and achieve discharge water quality in compliance with Tweed Shire Council’s Tweed Urban Stormwater Quality Management Plan.

These measures include hay bales, filter fences, cut-off drains, mulching of slopes and sediment/water quality control ponds which should be placed in accordance with the proposed management plan during both the construction and revegetation phases. Disturbed areas should generally be controlled to drain to these water features. Runoff from undisturbed areas should be diverted away from erosion control structures. A shakedown area would be required at the site entry / exit on Walmsleys Road and at the entry / exit from Stott Street in accordance with TSC Design Specification D7 (2004).

The management plan should be implemented according to the Landcom Manual "Managing Urban Stormwater, Soils and Construction" (2004). The soil type has a high fines content and type D and F sediment basins, as described in the manual are required.

Preliminary calculations (refer Appendix A) indicate a maximum potential sediment volume of approximately 315m^3, assuming application of wood chip mulch to disturbed areas at a rate of 16 tonnes per hectare and ground cover regeneration after three months. The sediment volume has been based on the Revised Universal Soil Loss Equation (RUSLE) with the majority of development area disturbed. This volume is approximate and dependent on the size of disturbed catchment. Trapped sediment should be recovered and redistributed over the site. The sediment basin settlement volume required would be 2823m^3 for the 9.86ha of disturbed area. A total basin volume of 3634m^3 would be required for the entire site. Due to the topography of the site we recommend a number of basins be provided at a rate of 369m^3/disturbed hectare. A minimum of six sediment basins are required and are illustrated in Figure 6.0.

Figure 6.0 indicates a general erosion control management concept plan. The detailed design will be determined and incorporated within the engineering design drawings required for a construction certificate.

6.2.3 IMPACT OF EROSION CONTROL

The implementation and maintenance of erosion control measures would result in manageable impacts on the downstream water system. The impact of transported sediment would be ameliorated by utilising the proposed sediment ponds and construction of a perimeter silt fence around the site. Specific storage requirements would be determined at the detailed design stage. However, management practices such as staging construction encouraging revegetation and undertaking regular desilting operations would reduce the required storage volumes.

6.3 SOIL CONTAMINATION

Soil contamination assessments of the site have been undertaken by Gilbert & Sutherland Pty Ltd. Based on the results of these assessments the site is considered to be uncontaminated. These reports dated September 2003 and October 2003 are provided by others.

On the Department of Land & Water Conservation Acid Sulfate Soils Risk Maps Edition II – Bilambil 9541-S1 the site is designated as "no known occurrences" and does not warrant a field investigation for the occurrence of acid sulfate soils.

7. TRAFFIC

7.1 EXISTING TRAFFIC ENVIRONMENT

The site has frontage to Walmsleys Road to the south and Stott Street to the north. Walmsleys Road is accessed via Scenic Drive, and Nabilla Street via Warringa Drive (Refer Figure 1.0). Walmsleys Road

contains a 7 metre wide bitumen seal with kerb and gutter to the boundary of the proposed development. From here to the proposed subdivision entrance the road changes to a 4-metre wide bitumen accessway. This accessway currently provides access to the two existing dwellings adjacent to the development.

Stott Street is joined by Skyline Drive to Piggabeen Road. Piggabeen Road intersects Kennedy Drive approximately 1km to the east of the site. Stott Street extends to the southern boundary of the Aged Care Facility adjacent to Lot 4 DP1054848. Stott Street currently terminates in a cul-de-sac approximately 20m north of Lot 1 DP134787. Stott Street has an 11m wide bitumen seal with kerb and channelling.

7.1.1 ROAD NETWORK AND HIERARCHY

To the south of the site; Walmsleys Road, Nabilla Street and Warringa Drive are Access Streets servicing approximately 130 allotments. Warringa Drive intersects with Scenic Drive a Distributor Road, forming an AUSTROADS Channelised intersection.

To the north of the site; Piggabeen Road is classified as a Neighbourhood Connector. Skyline Drive and Stott Street are classified as Access Streets. The Tweed Road Development Strategy (TRDS - Veitch Lister Consulting 1997) indicates that Piggabeen Road is to be upgraded to Distributor Road function in the future as part of the Proposed Scenic Drive Diversion. Figure 1.0 shows the road network.

Tweed Heads, coastal towns and the Pacific Highway are approximately 4 km east of the site, and are linked by Scenic Drive to the east and Piggabeen Road to the north. Both roads connect to Kennedy Drive at Cobaki Bridge. Scenic Drive also provides a connection to Bilambil Heights south west of the site.

Scenic Drive and Piggabeen Road have a designated speed of 60 kph. The residential areas of Walmsleys Road, Nabilla Street, Warringa Drive, Stott Street and Skyline Drive have a designated speed of 50 kph.

7.1.2 EXISTING ROAD GEOMETRY

The Scenic Drive / Warringa Drive intersection to the east of the site is an AUSTROADS Channelised intersection. It consists of double barrier lines and raised concrete protection islands providing protection for right turning traffic into Warringa Drive. Scenic Drive has a winding horizontal alignment and a rolling vertical alignment.

Nabilla Street and Warringa Drive both have a pavement width of 9.0m. Their intersection is the junction of two local access streets. Sight distances for the Nabilla Street/Warringa Drive intersection were measured by Martin Findlater and Associates Pty Ltd in 1998 for an existing Walmsleys Road Subdivision and are still considered accurate as there have since been no alterations to the surrounding road geometry. The distances for Approach Sight Distance (ASD) and Safe Intersection Sight Distance (SISD) were measured according to Figure 6.2 of Austroads Guide to Traffic Engineering Practice Part 5 – Intersections at Grade (2005) and are presented in Table 7.1.2.

Table 7.1.2 Sight Distances

NABILLA STREET TO WARRINGA DRIVE			
ITEM	**AVAILABLE (m)**		**REQUIRED (m)**
	LEFT	RIGHT	Urban, 50kph
Approach Sight Distance (ASD)	57	50	47
Safe Intersection Sight Distance (SISD)	100+	100	89

The minimum stopping distance required for a 50kph road with a 12% down hill grade is 54m and 41m uphill according to Austroads (2005). With 57m available on the downhill approach and 50m available on the uphill approach, there is adequate approach sight distance in both directions.

The access road to the proposed subdivision is located approximately 250m west of the Nabilla Street/Walmsleys Road intersection. Walmsleys Road is a 7m two-way road with kerb and gutter to the boundary of the proposed development. The remaining 140m to the west is a 4m wide bitumen seal with a 1m shoulder. Walmsleys Road terminates approximately 130m east of the Nabilla Street/Walmsleys Road intersection. Walmsleys Road has a straight horizontal alignment and a rolling vertical alignment.

Stott Street comprises of an 11.0m sealed pavement with kerb and channelling with cul-de-sac head approximately 20m from the Lot 1 DP 134787. It grades at up to approximately 8% in a northern direction. Skyline Drive comprises 11.0m sealed pavement with kerb and channelling. It grades at up to approximately 16% in a north-easterly direction.

We conclude that sight distance requirements are met by all intersections applicable to the proposed subdivision.

7.1.3 EXISTING TRAFFIC VOLUMES

The following comparative traffic volumes presented in Table 7.1.3 were obtained from TRDS (1997), Banora Point and Tweed Road Development Strategy Review (2004), by personal communication with Tweed Shire Council (TSC) officers or calculated from the number of residential lots using design traffic generation of 9 vehicles per day/lot from Guide to Traffic Generating Developments (RTA, 2002).

Table 7.1.3 – Existing Traffic Volumes

Road	TRDS Existing 1995	TSC (Year)	RTA Design Generation	TRDS Review (2004) Ultimate
Walmsleys Road			477	
Nabilla Street			522	
Warringa Drive			1,485	
Scenic Drive	2,122	7,668 (2003) 7,325 (2006) 7,364 (2008)		4,788
Stott Street			531	
Skyline Drive			567	
Piggabeen Road	1,024	4,325 (2004) 4,154 (2006) 4,170 (2008)		2,260
Kennedy Drive	15,123	16,223 (2001) 16,241 (2006)		9,846

7.2 PROPOSED TRAFFIC ENVIRONMENT

7.2.1 INTERNAL ROAD HIERARCHY

The development is to be serviced by an internal road network of local access streets with geometry as follows in Table 7.2.1. The proposed road layout is shown in Figure 7.0.

Table 7.2.1 – Proposed Road Hierarchy and Geometry

ROAD NO.	ROAD TYPE	PAVEMENT WIDTH	RESERVE WIDTH	CARRIAGEWAY WIDTH
1	Neighbourhood Connector	11m	20m	11m
2	Access Street	7.5m	16m	7.5m
3	Access Street	7.5m	16m	7.5m
4	Access Street	7.5m	16m	7.5m
5	Access Street	7.5m	16m	7.5m

7.2.2 ACCESS

The proposed subdivision has two points of access. One access to the development is proposed off Walmsleys Road via a T-junction. The other will be provided from the southern end of Stott Street.

The access from Walmsleys Road provides a sight distance in excess of 100m eastbound of the access. Walmsleys Road in front of the site will require widening to match the existing 7m wide road as well as providing kerb and channeling along the site frontage.

The northern end of Road 1 is to link directly into existing Stott Street, thus providing a through route from Walmsleys Road to Stott Street. We conclude that the proposed development can provide suitable access for both the short and long term.

7.2.3 PEDESTRIAN AND CYCLIST ACCESS

According to Tweed Shire Council Design Specification – D1 Road Design (2004) a 1.2m wide concrete footpath would be required on one side of each access road proposed in the development. Considering the terrain both surrounding and within the proposed development it is considered unlikely that bicycles would be a significant mode of transport. Provision is provided for cyclists on proposed Road 1 by means of a shared footpath in accordance with Design Specification D1.

7.2.4 PUBLIC TRANSPORT

The site is in close proximity to the current public transport system. Surfside Buslines runs a regular service along Scenic Drive to central Tweed Heads 7 days per week. The recent approval for the extension of Stott Street required an 11m road pavement and the proposed continuation of this road to connect to Walmsleys Road is 11m wide. The 11m pavement width is suitable for provision of a public bus route if required, however the existing grades of 16% along Stott Street exceed maximum grade requirements of a neighbourhood collector road according to Tweed Shire Council Design Specification – D1 Road Design (2004).

7.2.5 TRAFFIC GENERATION

Veitch Lister Consulting's Tweed Road Development Strategy (TRDS 1997) and Tweed Shire Council's Tweed Road Contribution Plan (TRCP) provide quantitative data for traffic generation from Detached Housing Units on a regional basis. Guide to Traffic Generating Developments (RTA 1993) provides design generation rates for localised impacts. The traffic generations based on these rates were calculated as shown in Table 7.2.5 below.

Table 7.2.5 – Proposed Traffic Generation

Impact	Number of Dwellings	Daily Trip Rate Per Dwelling	Estimated Daily Trips
Localised	82	9.0	**738**
Regional		6.5	**533**

It is estimated that there will be a 50/50 split of traffic from the development travelling via Walmsleys Road to Scenic Drive and via Stott Street to Piggabeen Road. It is estimated that there will be a 90/10 percent split at the Warringa Drive intersection with Scenic Drive of traffic travelling towards Bilambil and traffic travelling towards Tweed Heads. There will be a similar split for traffic exiting Skyline Drive to Piggabeen Road.

The proposed connection of Stott Street to Walmsleys Road provides a neighbourhood connection between Piggabeen Road and Scenic Drive. It is assumed that on average traffic generated by outside developments will utilise the connection in equal proportions. Piggabeen Road is a slightly shorter route to Cobaki Bridge and Scenic Drive provides a quicker route to Bilambil, local shops and the primary school.

7.2.6 CONSTRUCTION TRAFFIC

During the construction phase, heavy vehicle traffic would be expected. This would comprise of earthmoving equipment, construction plant and builder's vehicles. Earthworks traffic is covered in section 6.1.4.

7.3 TRAFFIC IMPACTS AND MITIGATING MEASURES

7.3.1 ROAD LAYOUT IMPACTS

The proposed road layouts and formation widths generally comply with the requirements of the Tweed Shire Council Design Specification D1 – Road Design (2004). Longitudinal sections and typical cross sections of internal roads are given in Figures 9.0 to 13.0. For an indicative maximum traffic volume of up to 3000 vehicles/day, the street reserve minimum width of 14.5m to 16m and carriageway width of 7m to 11m is satisfied.

Design Specification D1 - Road Design states that cul-de-sacs shall not serve more than 20 dwellings and have a maximum length of 100m. These two criteria are satisfied by this development.

The Nabilla Street and Warringa Drive Intersections to the south and the Stott Street and Skyline Drive intersections to the north of the development satisfactorily meet the sight distance requirements of Austroads Part 5 – Intersections at Grade. The ASD and SISD requirements are satisfied at all intersection points. Therefore the existing road geometry provides suitable sight distances for the proposed development.

The existing local access streets Walmsleys Road, Nabilla Street, Warringa Drive, Stott Street and Skyline Drive, neighbour and distributor roads Scenic Drive and Piggabeen Road would be utilized for this development with moderate impacts.

7.3.2 LOCALISED TRAFFIC GENERATION IMPACTS

It is estimated that approximately 369 vehicles/day would access the proposed development by travelling westbound along Kennedy Drive, to Scenic Drive, right into Warringa Drive, right into Nabilla Street and left into Walmsleys (refer to section 7.2.5 for traffic generation calculations). The remaining 369 vehicles/day generated by the proposed development would access the development from Kennedy Drive, right into Piggabeen Road, left into Skyline Drive and left into Stott Street. The resulting impacts on roads providing access to the development are given in Table 7.3.2.

Table 7.3.2 – Localised Traffic Impacts

Road	Proposed Traffic Volume (vpd)	Percent Increase (%)	Capacity
Walmsleys Road	846	77	3,000
Nabilla Street	891	71	3,000
Warringa Drive	1,854	25	3,000
Stott Street	900	70	3,000
Skyline Drive	936	65	3,000

The increased volumes on Walmsleys Road, Nabilla Street, Warringa Drive, Stott Street, and Skyline Drive would be within their functional capacity of 3,000 vpd. As all local streets would remain within their functional capacity following implementation of the proposed development, we do not consider that there would be significant impact on local amenity and a detailed acoustic report would not be necessary. We conclude that these access streets would not require any additional works to provide for the proposal.

7.3.3 REGIONAL TRAFFIC GENERATION IMPACTS

Based on an assumed 50/50 split of traffic generated by the development, 267 vehicles per day would be accessing both Scenic Drive and Piggabeen Road and a total of 533 vehicles per day would be generated on Kennedy Drive. The resulting traffic volumes on these roads are presented in Table 7.3.3.

Table 7.3.3 – Regional Traffic Impacts

Road	Proposed Traffic Volume (vpd)	Percent Increase (%)	Capacity
Scenic Drive	7,592	3.6	15,000
Piggabeen Road	4,421	6.4	10,000
Kennedy Drive	16,508	1.6	22,000*

* At a Level of Service E (Refer Austroads Part 2 1998)

7.3.4 SCENIC DRIVE VIA WALMSLEYS ROAD, NABILLA STREET AND WARRINGA DRIVE

Scenic Drive is classified and functions as a distributor road. The ultimate forecast (TRDS Review 2004) of daily traffic volumes along Scenic Drive with the Scenic Drive Diversion, Cobaki Parkway and Tugun Bypass in place is approximately 4,790 vehicles/day. The ultimate daily traffic volume without construction of the Cobaki Parkway can be estimated from the 1997 report to be 9,317 vehicles/day. These ultimate figures include traffic generated by fully developed allotments within the contributing catchment. The most recent (2006) daily traffic volume in Scenic Drive is approximately 7,325 vehicles/day. The proposed development would increase traffic volumes on Scenic Drive to approximately 7,592 vehicles/day (assuming a 50/50 split from the development). The proposed increase is less than the ultimate traffic volume of 9,315 vehicles/day estimated before the construction of the Scenic Drive Diversion/Cobaki Parkway and the maximum functional capacity from Design Specification D1. We conclude that Scenic Drive would not require any works to increase capacity as a result of this development.

7.3.5 PIGGABEEN ROAD VIA STOTT STREET AND SKYLINE DRIVE

Piggabeen Road is classified and functions as a distributor road. The ultimate forecast (TRDS Review 2004) of daily traffic volumes along Piggabeen Road is approximately 2,260 vehicles/day. These ultimate figures include traffic generated by fully developed allotments within the contributing catchment. The most recent (2006) daily traffic volume in Piggabeen Road west of Gollan Drive is approximately 4,154 vehicles/day. The proposed development would increase traffic volumes in Piggabeen Road to approximately 4,421 vehicles/day (assuming a 50/50 split from the development). The proposed increase is less than the functional capacity from Design Specification D1. The expected impact from the proposed development on Piggabeen Road is in the range of 2,400 vehicles/day to 4,800 vehicles/day for a level of service B according to Austroads Guide to Traffic Engineering Practice Part 2 – Roadway Capacity (1988). The Piggabeen Road Bypass is currently under construction and is likely to be completed before issue of a

subdivision certificate for the development. We conclude that Piggabeen Road would not require any additional works to increase capacity as a result of this development.

7.3.6 KENNEDY DRIVE VIA SCENIC DRIVE AND PIGGABEEN ROAD

Tweed Shire Council at its meeting on 19 June 2007 resolved that the current remaining spare traffic capacity of 1506 vehicle trips per day on Kennedy Drive and Cobaki Bridge be allocated to future development west of Cobaki Bridge on a first in/first served basis. This major project application generates approximately 540 vehicle trips per day, and assuming that 90% travel east to Kennedy Drive (i.e. 486 trips) and based on advice provided by Council officers (i.e. 1378.6 trips per day available at 24 October 2007) at the time of preparing this assessment there is sufficient capacity on Kennedy Drive. We understand allocation has been reserved for this application.

It is noted that ultimate forecasts (TRDS Review 2004) of daily traffic volumes along Kennedy Drive assume Cobaki Parkway open. The maximum daily traffic volume for a two lane two-way road of this kind is estimated to be 22,000 vehicles/day at a level of service E. The proposed increase represents less than 2% of the most recent survey in Kennedy Drive. It is a small component and can be considered a component of ultimate growth.

Council has levied headworks contributions from the approved and constructed developments under Tweed Road Contribution Plan, which covers the cost of upgrading and maintaining the distributor road network. Further contributions would be levied on the proposed development and we consider that these contributions are adequate to alleviate and offset the potential impact of the proposed traffic generation on the bridge.

7.3.7 EXTERNAL TRAFFIC IMPACTS

It is noted that the connection of Walmsleys Road to Stott Street forms a connection between Scenic Drive and Piggabeen Road. Following construction of the Cobaki Parkway, the connection road through the proposed development is likely to be utilised by northbound traffic from the existing Malua Rainforest and Pacific Views Estate and the proposed Highfields Estate. We anticipate a 50-50 split of northbound / southbound traffic for these allotments, resulting in a potential increase of approximately 750 vehicles per day on the Walmsleys Road – Stott Street link. The external traffic impact would not exceed the capacity of the proposed road. We conclude that the existing and proposed road networks have the design capacity to cater for the proposed estate.

8. WATER CYCLE MANAGEMENT PLAN

8.1 STORMWATER DRAINAGE

8.1.1 EXISTING DRAINAGE

The site is vacant and grassed except for the existing passionfruit plantation in the southwest corner of Lot 4 DP 1054848. Drainage patterns in this area are well defined with a general fall away from the ridgeline of lot 1 DP 134787 towards the eastern and western boundaries of the site. High frequency storm runoff from eastern catchments drain onto an existing tree lined creek to the east. Runoff from catchments to the west of the ridge line drains overland to the west. Runoff from Stott Street flows into a field inlet pit at the end of the cul-de-sac. A 450 diameter pipe culvert carries runoff from the pit to a 3 metre wide open swale drain which runs east towards an existing creek. A concrete dish drain runs along the southern side of Walmsleys road for its frontage to the site. All site runoff drains ultimately through the SEPP14 Coastal Wetland to the north that forms a buffer to the Cobaki Broadwater. The flow path from the proposed development east and west of the ridgeline to the SEPP14 boundary is marginally greater than 1km in both directions. No site runoff flows directly to the Terranora Broadwater but ultimately flows into the Terranora Broadwater via the Cobaki Broadwater. The flow distance from where site runoff enters Cobaki Broadwater to Terranora Broadwater is approximately 5.2km.

The existing stormwater catchment has been divided into ten subcatchments as shown in Figure 14.0. The catchments A, B, C, D, E, F and G are within the site. The E1, E2 and E3 catchments are external and contain the existing aged care facility.

8.1.2 PROPOSED DRAINAGE NETWORK

Where facilitated by the terrain, excess runoff will flow to grass or to the internal road system. Runoff from Road 1 will flow along kerb and gutter into inlet pits and along Road 2 to a treatment device before being discharged to the existing creek. Runoff from Road 3 and 4 will flow along the kerb and gutter to inlet pits. Road runoff will be treated via a treatment device before being discharged to the residual lot. Roof water from allotments will drain into inter-allotment drainage pits connecting into the stormwater drainage network where suitable. Roof water from allotments 33-56 in lot 2 DP 961928 will drain through the proposed IAD lines to level spreaders in the residual Lot. The proposed drainage network is shown in Figure 15.0.

8.1.3 DRAINAGE AND FLOODING IMPACT

Drainage calculations have been carried out using the Rational Method as recommended by Design Specification D5 Stormwater Drainage and described in Australian Rainfall & Runoff 1987. Analysis has been carried out for the existing undeveloped case and the proposed developed case. The resultant discharge from the internal and external site catchments for various return period storms is summarized as follows in Tables 8.1.3(a) and 8.1.3(b). Developed catchment calculations were determined using recommended values for Impervious Fraction and Time of Concentration from the Queensland Urban Drainage Manual (QUDM 1992).

Table 8.1.3(a) Existing undeveloped catchments

Storm	Catchment	Area	t_c (min)	I_y	C_y	Q
5 yr	A	3.15	16	126.46	0.665	0.736
	B	0.63	13	138.51		0.161
	C	2.03	12	143.29		0.537
	D	0.45	11	148.57		0.123
	E	0.86	12	143.29		0.228
	F	4.06	18	119.87		0.899
	G	0.05	10	154.43		0.014
	E1	0.72	10	154.43	0.817	0.252
	E2	0.40	8	168.44		0.153
	E3	0.08	13	138.51		0.025
100 yr	A	3.15	16	199.40	0.840	1.466
	B	0.63	13	217.40		0.320
	C	2.03	12	224.53		1.064
	D	0.45	11	232.37		0.244
	E	0.86	12	224.53		0.451
	F	4.06	18	189.52		1.795
	G	0.05	10	241.07		0.028
	E1	0.72	10	241.07	1.032	0.498
	E2	0.40	8	261.83		0.300
	E3	0.08	13	217.40		0.050

Table 8.1.3(b) Proposed developed catchments

Storm	Catchment	Area	t_c (min)	I_y	C_y	Q
5 yr	A	3.15	12	143.29	0.741	0.929
	B	0.63	10	154.43		0.200
	C	2.03	10	154.43		0.65
	D	0.45	7	176.99		0.164
	E	0.86	10	154.43		0.273
	F	4.06	10	154.43		1.291
	E1	0.72	10	154.43	0.817	0.252
	E2	0.40	8	168.44		0.153
	E3	0.08	13	138.51		0.025
100 yr	A	3.15	12	224.53	0.936	1.838
	B	0.63	10	241.07		0.390
	C	2.03	10	241.07		1.27
	D	0.45	7	274.44		0.321
	E	0.86	10	241.07		0.539
	F	4.06	10	241.07		2.545
	E1	0.72	10	241.07	1.032	0.498
	E2	0.40	8	261.83		0.300
	E3	0.08	13	217.40		0.050

8.1.4 STORMWATER DRAINAGE AND FLOODING SUMMARY

The proposed development impacts on stormwater runoff rates are given in Table 8.1.4(a).

Table 8.1.4(a) Development Impact on Flow Rates

Catchment	Minor ARI Increase (%)	Major ARI Increase (%)
A	11%	10%
B	17%	15%
C	21.%	20%
D	25%	24%
E	27%	27%
F	28%	27%
G	Included in Catchment F	Included in Catchment F

It can be seen from the values above that the proposed residential subdivision will have an impact on the peak runoff rates for the site. The catchments flowing to the west of the ridgeline demonstrate a 17-22% increase and those flowing to the east would have a 10-28% increase if no measures are applied to detain runoff.

Stormwater detention calculations were carried out using the Volumetric Procedure for Determining Storages and Pump Rates (AR&R 1987) on the basis of maintaining the existing runoff rates following development. A volumetric runoff coefficient of 0.85 was adopted for the calculations, indicating infiltration of 15% of rainfall. The storage requirement calculated for each catchment is presented in Table 8.1.4(b).

Table 8.1.4(b) Stormwater Storage Requirements

Catchment	Storage Requirement (m^3)	Number of Contributing Lots	Storage per Allotment (m^3)
A	193.5	28	6.9
B	105.2	4	26.3
C	48.5	19	2.5
D	10.4	2	5.2
E	63.9	3	21.3
F	302.9	30	10.1
G	Part of Catchment F	Part of Catchment F	Part of Catchment F

We have investigated the detention requirements for the total eastern and western catchments of the site. On a per lot basis, allotments flowing westward would require an average of 8.7m^3 of detention per lot and lots flowing eastward would require an average 12.3m^3 per lot. It should be noted that these per lot storage requirements would be further reduced by provision of detention structures within the public road reserve. The above volumes are based on detaining a significant amount of runoff from public road areas and as such, provision of some detention within the road reserve is considered justifiable. The storage capacity

required per lot is within the capacity of pre-fabricated residential rainwater tanks. We recommend provision of rainwater tanks with permanent storage available at the above volumes. The tank's outlet rates could be controlled to pre-development rates. The provision of stormwater detention would mitigate the potential impact of the development on stormwater runoff rates from the site. It should be noted however that due to the significant length of flow path to the Cobaki Broadwater (1km) and to the Terranora Broadwater (5.2km), the majority of flows contributing to the discharge into the waterways would be from properties owned by others that the developers of the subject site have no control over. The development would therefore not be likely to have a measurable impact on these receiving environments.

8.2 WATER QUALITY

8.2.1 EXISTING WATER QUALITY

Approximately two thirds of the southern area of Lot 4 DP 1054848 to the west of Stott Street, is currently a passionfruit plantation. The remainder of the site is predominately undeveloped and no stormwater pollution was evident during site visits.

8.2.2 WATER QUALITY IMPACTS

Development of the site is expected to increase the concentrations of suspended solids, nitrogen and phosphorous in stormwater runoff compared to the existing undeveloped catchment if untreated. Pollutants from residential areas generally comprise of gross pollutants (trash and sediments) biological pollutants (decaying vegetable matter and animal excreta) and nutrients (nitrogen and phosphorus). Road areas typically collect oil products and sediments from vehicles and drain rapidly to the stormwater system. As such, runoff from road areas should be treated prior to discharge from the site.

8.2.3 PROPOSED TREATMENT MEASURES

Roof water from allotments is to drain into Inter-Allotment Drainage (IAD) pits. IAD pits will connect directly into the stormwater drainage network as it is considered by TSC to be suitably clean water. The runoff from driveways and paved areas on the proposed allotments would flow across grassed areas following the natural drainage path to the IAD pits. Alternatively driveway runoff could flow back onto the road stormwater system. Road runoff would be collected and treated by proprietary Gross Pollutant Traps, such as a Humeceptor.

The deemed to comply requirements from Tweed Shire Council Design Specification D7 – Stormwater Quality are an $11m^3$ storage volume per impervious hectare for a Humeceptor or equivalent. This consists of $9m^3$ storage for sediments and $2m^3$ storage for oil and grease per impervious hectare. The required proprietary device sizings are given in Table 8.2.3.

Table 8.2.3 Proprietary Treatment Device Sizing

Catchment	Road Area (m^2)	Sediment Storage Requirement (m^3)	Oil Storage Requirement (m^3)	Suitable Humeceptor Model
A	3059	2.75	0.61	STC 5
B	0	-	-	N/A
C	0	-	-	N/A
D	0	-	-	N/A
E	1254	1.13	0.25	STC 2
F	7152	6.44	1.43	STC 9

The stormwater treatment measures are specified in accordance with Design Specification D7. The performance of the devices would achieve the performance criteria set by Tweed Shire Council, specified in the Tweed Urban Stormwater Quality Management Plan (2000).

It is noted that the development would result in the removal of the existing passionfruit plantation. This would result in a reduction in nitrogen, phosphorous and sediment runoff.

8.2.4 COBAKI BROADWATER MANAGEMENT PLAN

The Cobaki Broadwater Management Plan (1998) was developed due to the ecological significance of the Cobaki Broadwater in the Lower Tweed Catchment area. The objectives for the Cobaki Broadwater Management Plan are:

- To preserve and enhance valuable habitats within the Broadwater.
- To encourage a low level of recreational activities and environmental education that is sensitive to the local environment and its requirements.
- To conserve the valuable ecological assets of the Broadwater.

The Cobaki Broadwater Management Plan does not specifically address the area of the catchment that contains the subject site nor provide quantitative water quality guidelines. The stormwater runoff from the site is to be treated with measures that in Tweed Shire Council Design Specification D7 – Stormwater Quality (2004) are deemed to comply with the water quality objectives of the Tweed Urban Stormwater Management Plan (2000). Both of these documents were published after the Cobaki Broadwater Management Plan. We consider these measures to be in accordance with the objectives of the Cobaki Broadwater Management Plan.

8.2.5 WATER QUALITY CONCLUSION

In conclusion, implementing pollution control structures will mitigate the potential increase in pollution attributable to development of this site. Runoff from the site flowing toward the Cobaki Broadwater and Terranora Broadwater would be treated in accordance with Tweed Shire Council requirements. Furthermore, as a consequence of the remoteness of the site from these downstream environments, no measurable impacts on water quality are anticipated.

9. WATER RETICULATION

9.1 PROPOSED WATER DEMANDS

An existing 150mm diameter water main fed from the Marana Street reservoir (TWL at 156m AHD) runs along the northern side of Walmsleys Road and through lot 1 DP 1634787 of the proposed site. Figure 16.0 indicates the proposed and existing water reticulation network.

The proposed subdivision will result in the following demands (refer Design Specification D11 – Water Supply).

i) Peak Instantaneous Demand.

82 Houses @ 0.15 L/s = 12.3 L/s

ii) Peak Daily Demand.

82 Houses @ 2,720 L/d = 223.04 kL/d

Council officers (pers. comm.) have advised that the existing 150mm diameter main traversing the site can adequately provide water reticulation to the proposed development. Connection directly to this main would require installation of a Pressure Reducing Valve (PRV) to limit pressure to the desired maximum of 780kPa. The PRV should be located to provide adequate access for maintenance. A further alternative for supply would be a connection to the main downstream of the existing PRV located on the hill above the Stott Street cul-de-sac, negating the need for an additional PRV.

9.2 STAGING OF DEVELOPMENT

The location of the existing water mains does not result in any impacts or additional works required to provide for the staging of the proposed development. Each stage can be independently provided with water reticulation from the existing mains.

9.3 WATER SENSITIVE DESIGN MEASURES

The rolling nature of the terrain on the site results in longitudinal road grades of up to 12-16% on the proposed roads. Grades of this magnitude are not conducive to provision of grass swales in lieu of kerb and gutter due to high flow velocities resulting in scouring and erosion.

With the introduction of the BASIX model by the Department of Infrastructure, Planning and Natural Resources in July 2005, all single dwellings are required to meet particular water sensitive and energy efficient design criteria. A number of design measures are required to achieve criteria including the following:

- Eaves and shading to windows
- Native vegetation
- Wall, ceiling and floor insulation
- Gas appliances
- 3A rated toilet and showerhead
- Gas boosted solar hot water system
- Light coloured roof
- Rainwater tank connected to toilet and garden irrigation
- Grey water recycling

The BASIX model aims to achieve a 40% reduction in mains potable water consumption across the state. Dwellings constructed on the proposed allotments will be required to meet the BASIX criteria and water sensitive design measures will be incorporated. Adequate allotment sizes are proposed that allow for construction of a dwelling with sufficient area to provide a rainwater tank. The provision of this tank and other water sensitive urban design practices would be required to be implemented at the dwelling construction stage.

10. WASTEWATER

10.1 PROPOSED WASTEWATER GENERATION

Design Specification D12 Sewer System contains design generation rates for assessing developments in the Tweed Shire. These generation rates have been used with the methods given in NSW Department of Public Works Manual of Practice – Sewer Design (1984) (PWD). The proposed residential subdivision is estimated to create the following total wastewater demands presented in Table 11.1 (based on 3.2 persons per tenement).

Table 11.1 Proposed Development Demands

Dwelling Type	Number of Dwellings	Equivalent Tenements (PWD)
Single Dwelling	82	65.6
Flow Generation (L/s)		
Average Dry Weather Flow		0.722
Peak Dry Weather Flow		2.525
Peak Wet Weather Flow		7.281

10.2 STAGING OF DEVELOPMENT

The proposed development would be implemented in seven stages. Stages 1,2,3 and 4 could be supplied by the existing downstream gravity sewer networks. Due to the low levels of the allotments in Stages 5, 6 and 7, construction of either individual pumping systems for the lots or construction of a Council sewer pumping station would be necessary in order for connection to the council mains. If Council recommends construction of a public sewer pump station, the pump station and related upstream gravity and pressure mains would be required to be constructed before completion of either Stage 4 or Stage 5.

10.3 WASTEWATER IMPACTS AND MITIGATING MEASURES

The wastewater generated by the proposed development would be serviced by the existing pump stations in Bolwarra Place (Malua Estate) and Piggabeen Road. The proposed sewer system is shown in Figure 16.0. The 50 proposed allotments to the west of Stott Street would ultimately be served by the Piggabeen Road pump station via a pumped connection to the existing gravity main in Stott Street. These allotments could be serviced by either individual pump systems via a shared rising main or a single public sewer pumping station as shown in Figure 16.0. Due to the steep nature of the site and likely access difficulties to a Council pump station, we recommend provision of individual pumping systems. In either case, no access to the allotments downhill to the west of the site would be required for effluent disposal. Similarly the provision of this development would not prevent those allotments to the west of the site from providing their own effluent disposal as they have frontage to Piggabeen Road and Cobaki Road respectively. Allotments to the east of Stott Street would be serviced by a gravity fed connection to the Bolwarra Place pump station. Council officers (pers. comm.) have advised that the downstream pump stations in Bolwarra Place and Piggabeen Road are of sufficient capacity to cater for the proposed development.

11. PUBLIC SERVICES AND INFRASTRUCTURE

11.1 ELECTRICAL AND TELECOMMUNICATIONS

Electrical and telecommunications services are available from existing cables in the Stott Street and Walmsleys Road reserves. It is intended that these services be extended to provide service to the proposed allotments.

11.2 STAGING OF DEVELOPMENT

As Stage 1 of the development would involve construction of the link between Stott Street and Walmsleys Road, it is anticipated that electrical and telecommunications services would be extended along the new road. Each subsequent stage would be able to be individually provided with utility services without additional works being required.

11.3 SOLID WASTE DISPOSAL

The proposed roads within the development conform to the horizontal and vertical geometric requirements of Tweed Shire Council's Design Specification D1 – Road Design. The proposed roads are suitable for maneuvering of a garbage truck for solid waste collection. Solid waste collection services would be provided by Tweed Shire Council's solid waste contractor.

11.4 PUBLIC SERVICES AND INFRASTRUCTRE CONCLUSION

We conclude that existing services are available for electrical and telecommunications. The relevant authorities would advise on the scope of works required to supply the proposed development at the construction certificate stage.

12. CONCLUSIONS

The following conclusions are made.

a) The development would have a minor impact on local and regional traffic movements. The existing local road system is sufficient to cater for the residential subdivision. Contributions would be levied to mitigate existing regional deficiencies.

   We recommend imported fill deliveries be restricted to 5 days a week between the hours of 7am and 5pm to reduce the impact on local amenity. We further recommend all trucks access the site via Scenic Drive and Walmsley Road.

b) The development would not have any measurable impact on downstream stormwater capacity due to the on-site storage of stormwater runoff. The potential increase in stormwater pollutants attributable to the proposed development would be reduced by introduction of treatment devices in accordance with Tweed Shire Council requirements. The Cobaki Broadwater and Terranora Broadwater are remote to the site and no measurable impacts on stormwater runoff or quality are anticipated.

c) Water demand would increase under the proposed development. This additional demand is to be supplied by the existing water reticulation network and will have minor impact on the network. BASIX certificate requirements would reduce the demand by 40%.

d) The wastewater generated would enter the existing sewage network in Stott Street and Bolwarra Place. The existing downstream sewer system has sufficient capacity to cater for the development.

e) Electrical and telecommunications services would be supplied by connection to the existing utilities in Stott Street and Walmsleys Road. Solid waste collection services would be provided by Tweed Shire Council's waste contractor.

13. REFERENCES

AUSTROADS	(1988)	Guide to Traffic Engineering Practice Part 2 – Roadway Capacity
	(2005)	Guide to Traffic Engineering Practice Part 5 – Intersections at Grade
INSTITUTE OF ENGINEERS AUSTRALIA	(1987)	Australian Rainfall and Runoff – A Guide to Flood Estimation
LANDCOM	(2004)	Managing Urban Stormwater, Soils and Construction
LAND & WATER CONSERVATION	(1997)	Acid Sulfate Soils Risk Maps
MORAND D T	(1996)	Soil Landscapes of the Murwillumbah Tweed 1:100,000 Sheet
NEVILLE JONES AND ASSOCIATES PTY LTD AND AUSTRALIAN WATER ENGINEERING	(1992)	Queensland Urban Drainage Manual
NSW DEPARTMENT OF PUBLIC WORKS	(1984)	Manual of Practice – Sewer Design
ROAD AND TRAFFIC AUTHORITY OF NSW	(2005)	Guide to Traffic Generation
TWEED SHIRE COUNCIL	(2004)	Development Design Specification D1 – Road Design
		Development Design Specification D5 – Stormwater Drainage.

		Development Design Specification D7 – Stormwater Quality.
		Development Design Specification D11 – Water Supply.
		Development Design Specification D12 – Sewerage System
	(2004)	Section 94 Plan No. 4 - Tweed Road Contribution Plan.
TWEED SHIRE COUNCIL	(2000)	Tweed Local Environmental Plan 2000.
		Tweed Urban Stormwater Quality Management Plan
	(1998)	Cobaki Broadwater Management Plan
VEITCH LISTER CONSULTING PTY LTD	(1997)	Tweed Road Development Strategy
	(2004)	Banora Point and Tweed Road Development Strategy Review 2004

APPENDIX A

REVISED UNIVERSAL SOIL LOSS EQUATION CALCULATIONS

REVISED UNIVERSAL SOIL LOSS EQUATION

Refer to NSW Dept of Housing
Managing Urban Stormwater Soils and Construction
A. Appendix for RUSLE
Chapter 6 for Settling Zone Volume

JOB No: 203057
DESCRIPTION: Walmleys and Dickinson, residential development

SEDIMENT STORAGE ZONE VOLUME

A = R K LS P C

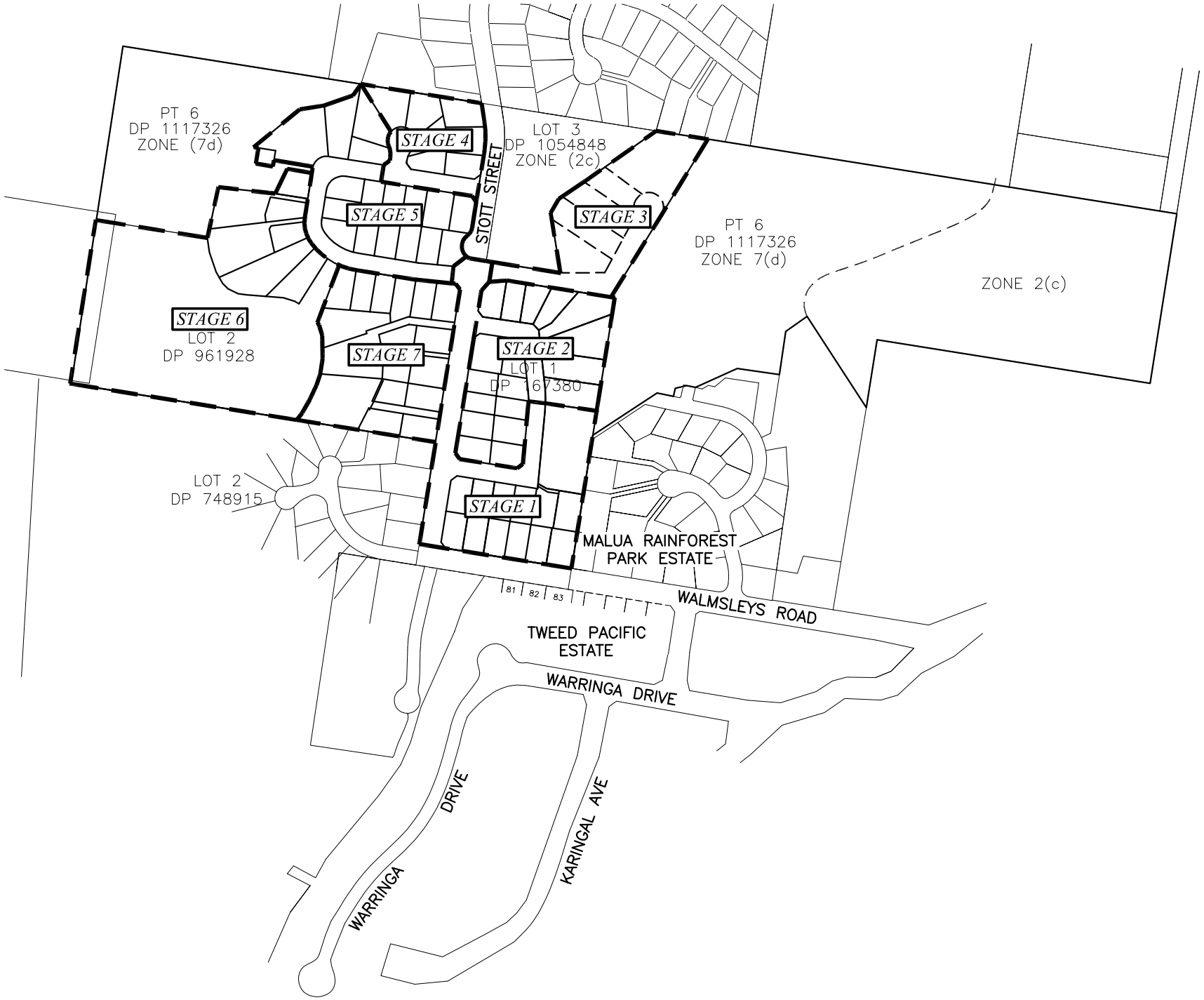
Where			Description		Value	
	A	=	**Computed soil loss (tonnes/ha/yr)**			
	R	=	**Rainfall Erosivity Factor**			
		=	164.74 (1.1177) ^{S} S $^{0.6444}$		**5833.618085**	
					INPUT	
			S = 2 Year ARI, 6 Hour Storm Event		16	mm/h
	K	=	**Soil Erodibility Factor**		0.04	From Soil Landscapes Manual
	LS	=	**Slope Length / Gradient Factor**		8.68	From Table A1
	P	=	**Erosion Control Practice Factor**		0.9	From Table A2
	C	=	**Ground Cover**		0.08	From Table A3
	A Soil Loss	=	**145.831**	**(tonnes/ha/year)**		
	V Volume	=	**113**	**(m^3/ha/year)**		
			Disturbed Surface Area (ha)		9.86	ha
			Computed soil loss		**1114.18**	m^3/year
			Sediment Storage Zone Volume		**279.00**	m^3 Assuming regeneration after
						3 Months

SEDIMENT BASIN VOLUME - Type F & D Soils

V	=	**10 Cv A R 75TH ile, 5 day (m^3)**			
10	=	Unit conversion Factor		**10**	
Cv	=	The volumetric runoff coefficient, defined as that portion of rainfall that runs off as stormwater		0.69	
A	=	Catchment Area of the Basin ha		9.86	ha
R (Y% ile, 5 day)	=	5 day rainfall depth not exceeded in y% of rainfall events. Refer Table 6.5 p 6-21		41.5	mm
V	=	**2823.411**	**m^3 Settling Zone Volume**		

TOTAL BASIN VOLUME	=	**Settling Zone Volume + Sediment Storage Zone Volume**		
	=	3102.41	m^3	
	=	**3103**	**m^3**	
BASIN VOLUME PER HECTARE	=	**315**	**m^3**	

FIGURES



SITE PLAN

0 50 100 150 200 m

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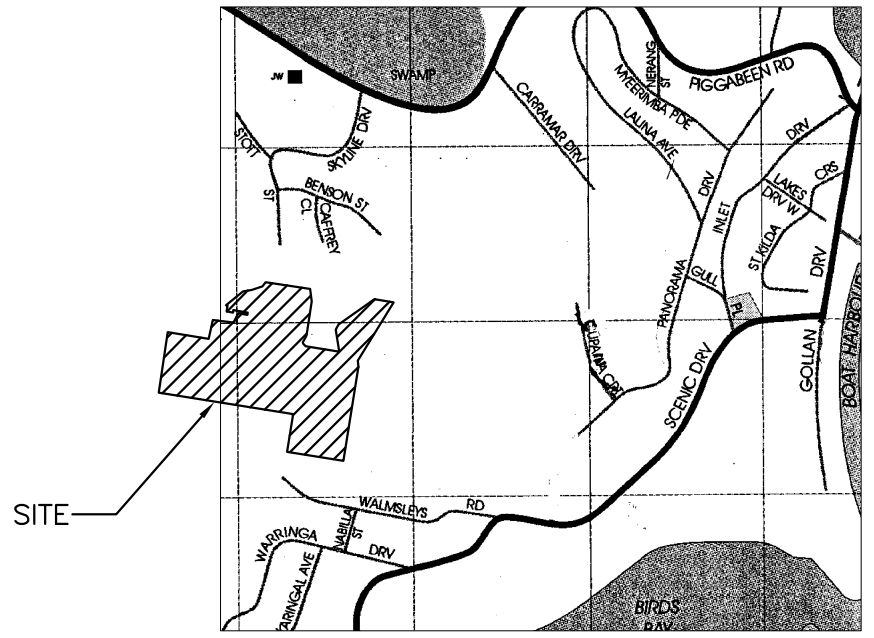

LOCALITY PLAN

NOT TO SCALE

PETER WALMSLEY, LES & JIM DICKINSON

PROPOSED RESIDENTIAL SUBDIVISION

WALMSLEYS ROAD & STOTT STREET
BILAMBIL HEIGHTS N.S.W.

FIGURE 1.0

LOCALITY AND SITE PLAN

DECEMBER, 2007
~~OCTOBER, 2007~~
~~OCTOBER, 2006~~
~~AUGUST, 2005~~
~~JULY, 2005~~
~~FEBRUARY, 2005~~

A3 203057

OPUS QANTEC McWILLIAM

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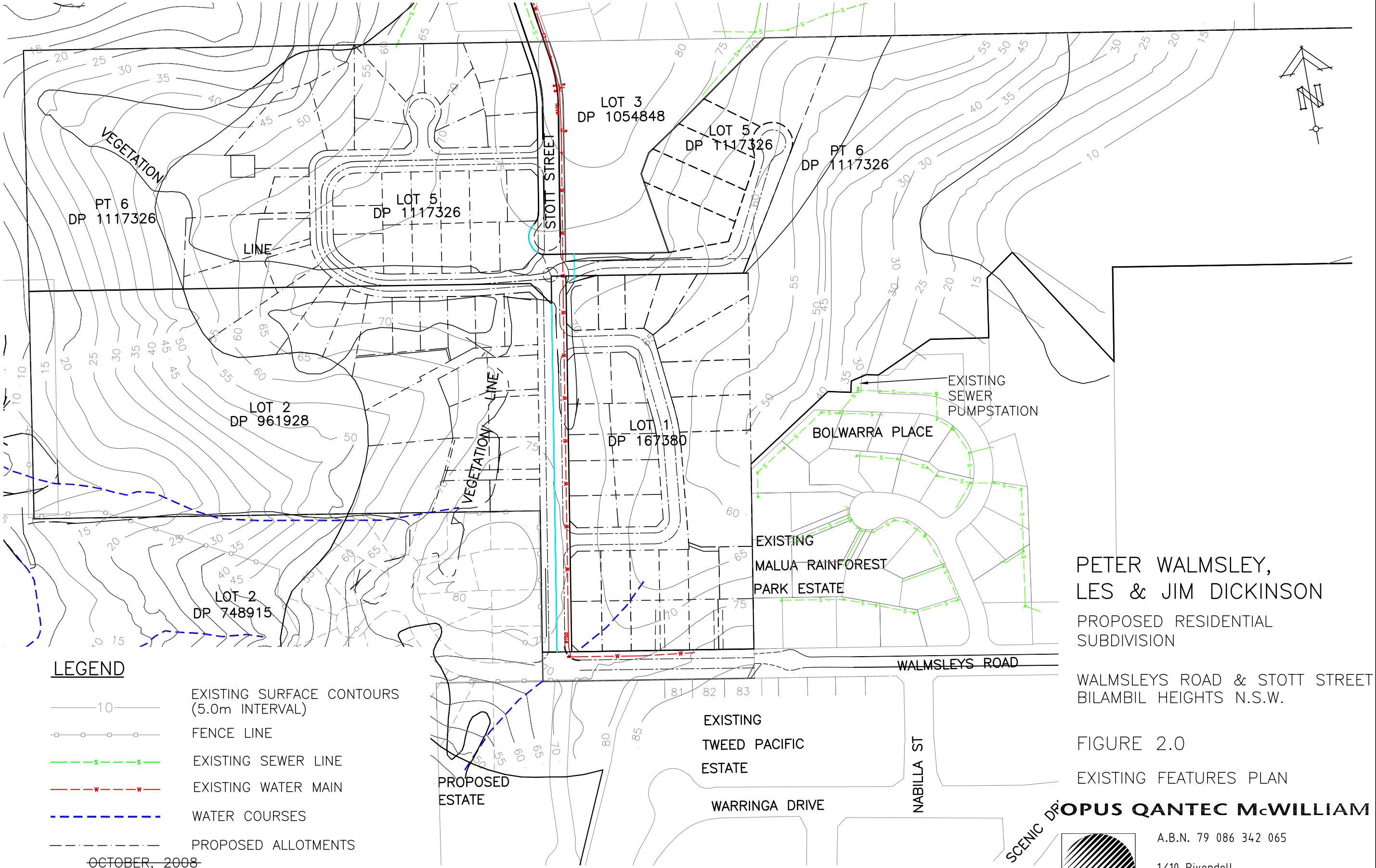
Telephone: (07) 5523 1755
Facsimile: (07) 5523 9664
E-Mail: tweedheads@opusqmcw.com.au



LEGEND

- EXISTING SURFACE CONTOURS (5.0m INTERVAL)
- FENCE LINE
- EXISTING SEWER LINE
- EXISTING WATER MAIN
- WATER COURSES
- PROPOSED ALLOTMENTS

~~OCTOBER, 2008~~
~~DECEMBER, 2007~~
~~OCTOBER, 2007~~
~~OCTOBER, 2006~~ APRIL, 2009
~~AUGUST, 2005~~
~~JULY, 2005~~
~~FEBRUARY, 2005~~

0 50 100 m
1:2,500 UNREDUCED

A3 203057

PETER WALMSLEY, LES & JIM DICKINSON

PROPOSED RESIDENTIAL SUBDIVISION

WALMSLEYS ROAD & STOTT STREET
BILAMBIL HEIGHTS N.S.W.

FIGURE 2.0

EXISTING FEATURES PLAN

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PT 6

DP 1117326

LOT 3

DP 1054848

PT 6

DP 1117326

STOTT STREET

ROAD NO.4

ROAD NO.3

ROAD NO.5 COMMUNITY PROPERTY

ROAD NO.2

ROAD NO.1

LOT 2

DP 961928

LOT 2

DP 748915

LOT 1

DP 167380

13 PUBLIC RESERVE

WALMSLEYS ROAD

LEGEND

- PROPOSED ALLOTMENTS
- 0% TO 5%
- 5% TO 10%
- 10% TO 15%
- 15% TO 20%
- 20% TO 33%
- GREATER THAN 33%

PETER WALMSLEY, LES & JIM DICKINSON

PROPOSED RESIDENTIAL SUBDIVISION

WALMSLEYS ROAD & STOTT STREET
BILAMBIL HEIGHTS N.S.W.

FIGURE 3.0

EXISTING GRADES ANALYSIS

~~OCTOBER, 2006~~
~~AUGUST, 2005~~
~~JULY, 2005~~
~~FEBRUARY, 2005~~

APRIL, 2009
~~OCTOBER, 2008~~
~~DECEMBER, 2007~~
~~OCTOBER, 2007~~

A3 203057

0 20 40 60 80m
1:2,000 UNREDUCED

OPUS QANTEC McWILLIAM

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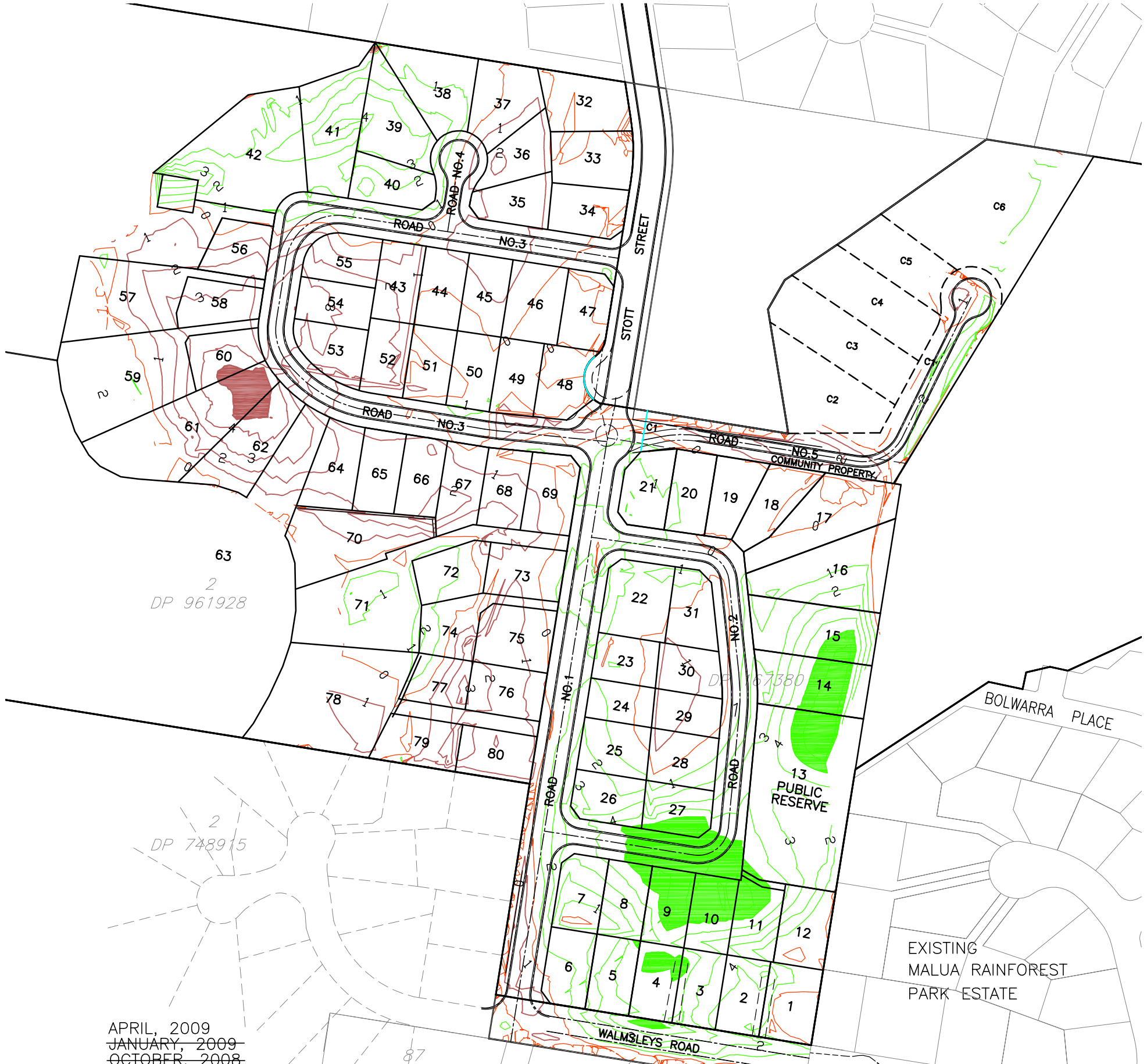

LEGEND

AREA OF CUT OVER 5m
427m² (0.3% OF SITE)

AREA OF FILL OVER 5m
3627m² (2.6% OF SITE)

PROPOSED CUT DEPTH CONTOUR
(1.0m INTERVAL)

PROPOSED FILL DEPTH CONTOUR
(1.0m INTERVAL)

PROPOSED EARTHWORKS
INTERFACE LINE

PETER WALMSLEY, LES & JIM DICKINSON

PROPOSED RESIDENTIAL SUBDIVISION

WALMSLEYS ROAD
BILAMBIL HEIGHTS

FIGURE 4.0

PROPOSED CUT AND FILL DEPTH CONTOURS

APRIL, 2009
~~JANUARY, 2009~~
~~OCTOBER, 2008~~
~~DECEMBER, 2007~~
~~OCTOBER, 2007~~
~~OCTOBER, 2006~~
~~AUGUST, 2005~~
~~JUNE, 2005~~

A3 203057

0 20 40 60 80m
1:2,000 UNREDUCED

OPUS QANTEC McWILLIAM

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STOTT STREET

BOLWARRA PLACE

WALMSLEY ROAD

DP 961928

DP 167380

DP 746915

DP 776309

LEGEND

- EASTERN DEPRESSION
- PREVIOUS DAM SITE
- DEEP GULLY
- FILL STOCKPILE AREAS

NOTE: GEOTECH CONSTRAINTS REFER TO MAIDEN GEOTECHNICS REPORT DATED JUNE/JULY 2004 ~~OCTOBER, 2007~~ ~~OCTOBER, 2006~~ ~~AUGUST, 2005~~ ~~JULY, 2005~~ APRIL, 2009 ~~OCTOBER, 2008~~

0 20 40 60 80m

1:2,000 UNREDUCED

A3 203057

JIM & LES DICKINSON AND PETER WALMSLEY

PROPOSED SUBDIVISION MASTERPLAN

LOT 2 DP 961928, LOT 1 DP 167380 AND LOT 1 DP 134787
WALMSLEY ROAD AND STOTT STREET
BILAMBIL HEIGHTS

FIGURE 5.0

GEOTECHNICAL CONSTRAINTS

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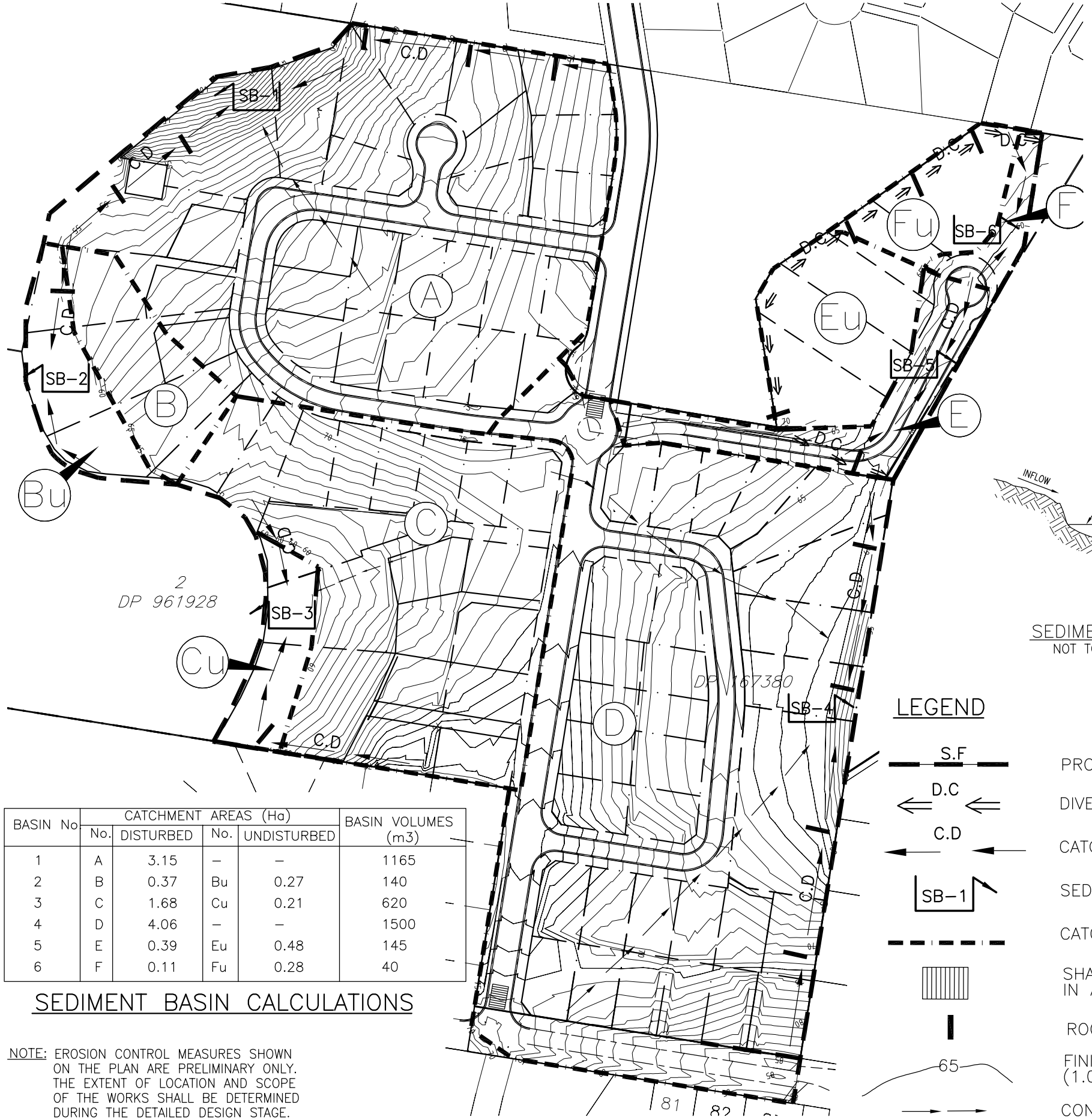
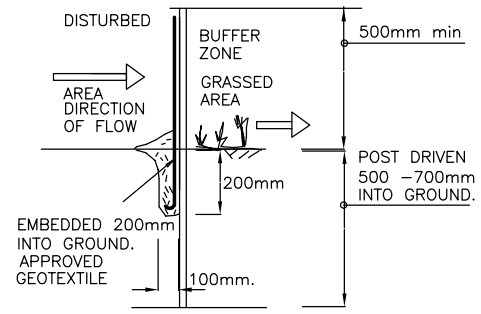
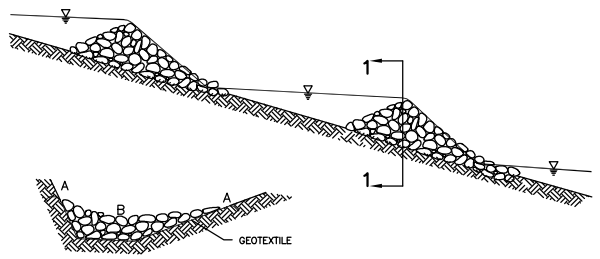


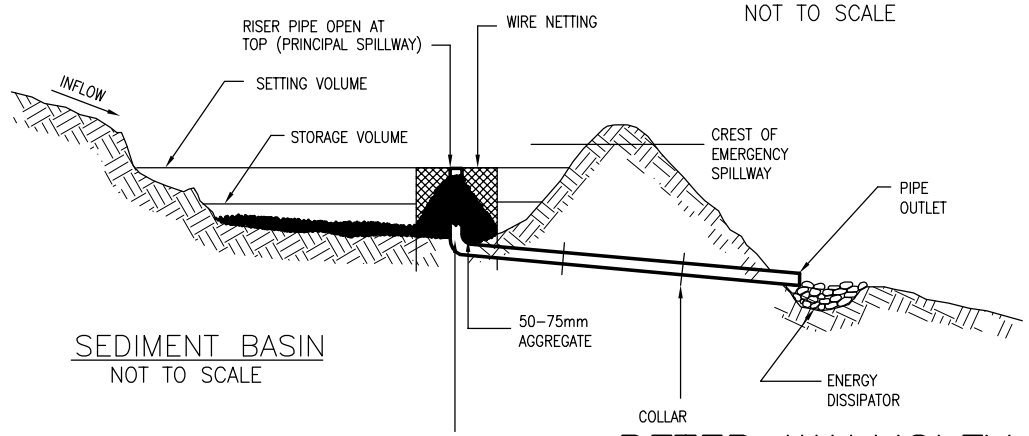


SILT FENCE
NOT TO SCALE



SECTION 1

CHECK DAM
NOT TO SCALE



SEDIMENT BASIN
NOT TO SCALE

BASIN No	CATCHMENT AREAS (Ha)				BASIN VOLUMES (m3)
	No.	DISTURBED	No.	UNDISTURBED	
1	A	3.15	–	–	1165
2	B	0.37	Bu	0.27	140
3	C	1.68	Cu	0.21	620
4	D	4.06	–	–	1500
5	E	0.39	Eu	0.48	145
6	F	0.11	Fu	0.28	40

SEDIMENT BASIN CALCULATIONS

NOTE: EROSION CONTROL MEASURES SHOWN ON THE PLAN ARE PRELIMINARY ONLY. THE EXTENT OF LOCATION AND SCOPE OF THE WORKS SHALL BE DETERMINED DURING THE DETAILED DESIGN STAGE.

~~OCTOBER, 2007~~
~~OCTOBER, 2006~~
~~AUGUST, 2005~~
~~FEBRUARY, 2005~~

APRIL, 2009
~~MARCH, 2009~~
~~JANUARY, 2009~~
~~OCTOBER, 2008~~

A3 203057

0 20 40 60 80m
1:2,000 UNREDUCED

LEGEND

S.F — PROPOSED SILT FENCE

D.C — DIVERSION CHANNEL

C.D — CATCH DRAIN

SB–1 — SEDIMENT BASIN

CATCHMENT BOUNDARY

SHAKEDOWN DEVICE IN ACCORDANCE WITH TSC D7

ROCK CHECK DAM

65 — FINISHED SURFACE CONTOURS (1.0m INTERVAL)

CONCENTRATED FLOW PATH

NOTE: SURVEY INFORMATION FROM MCLAUCHLAN SURVEYING DRAWING NUMBER 37401

PETER WALMSLEY, LES & JIM DICKINSON

PROPOSED RESIDENTIAL SUBDIVISION

WALMSLEYS ROAD
BILAMBIL HEIGHTS

FIGURE 6.0

EROSION & SEDIMENT CONTROL PLAN

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LEGEND

- FINISHED SURFACE CONTOURS (1.0m INTERVALS)
- PROPOSED RETAINING WALL
- APZ — ASSET PROTECTION ZONE
- PROPOSED BATTER

NOTE: REFER FIGURES 7.1 & 7.2 FOR SECTIONS.

PETER WALMSLEY, LES & JIM DICKINSON

PROPOSED RESIDENTIAL SUBDIVISION

WALMSLEYS ROAD & STOTT STREET
BILAMBIL HEIGHTS N.S.W.

FIGURE 7.0

ROAD LAYOUT PLAN

APRIL, 2009
~~MARCH, 2009~~
~~OCTOBER, 2008~~
~~OCTOBER, 2007~~
~~OCTOBER, 2006~~
~~AUGUST, 2005~~

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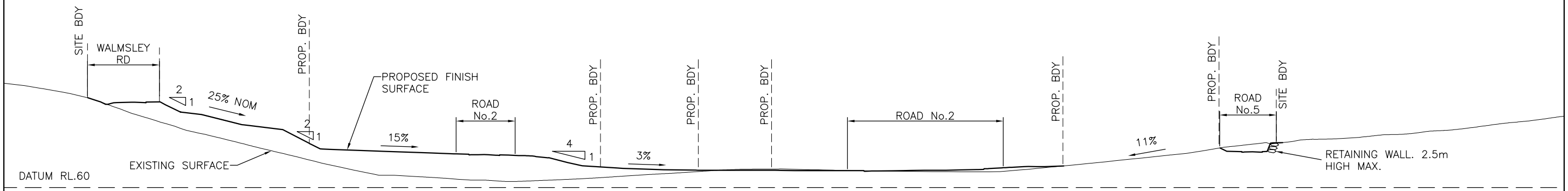
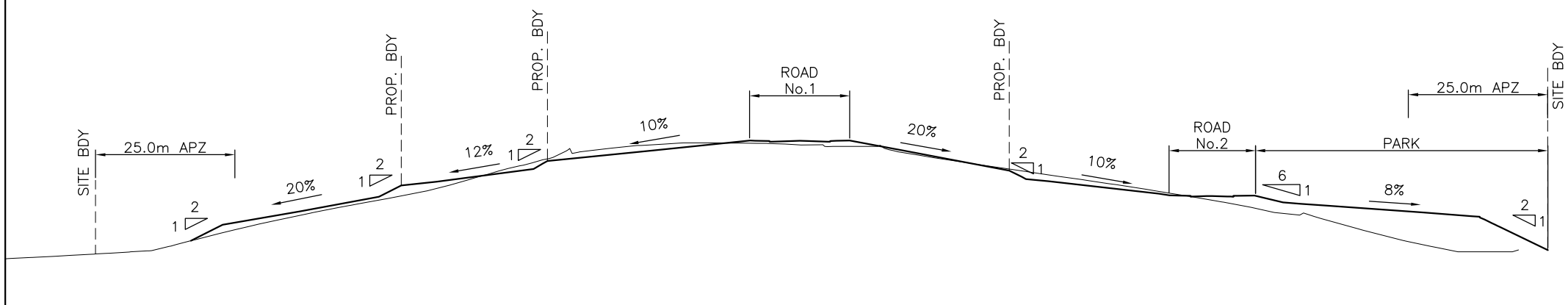
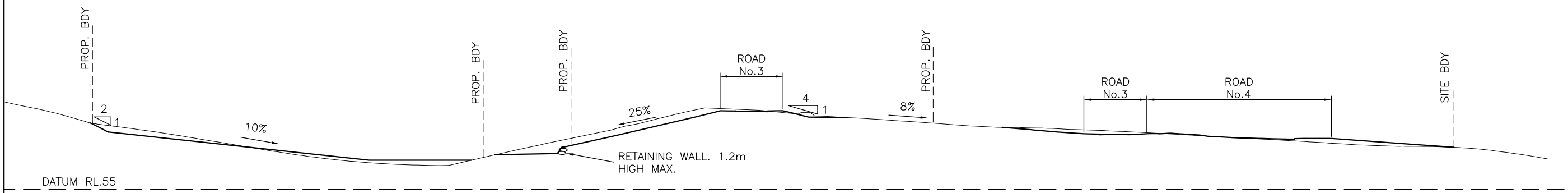


SECTION 1



SECTION 2



SECTION 3

LEGEND

8% →	NOMINAL SURFACE GRADE
2/1	SURFACE BATTER SLOPE
APZ	ASSET PROTECTION ZONE
PROP. BDY	PROPOSED PROPERTY BOUNDARY
SITE BDY	SITE BOUNDARY

0 10 20 30 40m
1:1,000 UNREDUCED

APRIL, 2009
~~MARCH, 2009~~
~~OCTOBER, 2008~~

A3 203057

PETER WALMSLEY, LES & JIM DICKINSON

PROPOSED RESIDENTIAL SUBDIVISION

WALMSLEYS ROAD & STOTT STREET
BILAMBIL HEIGHTS N.S.W.

FIGURE 7.1

SITE CROSS SECTIONS

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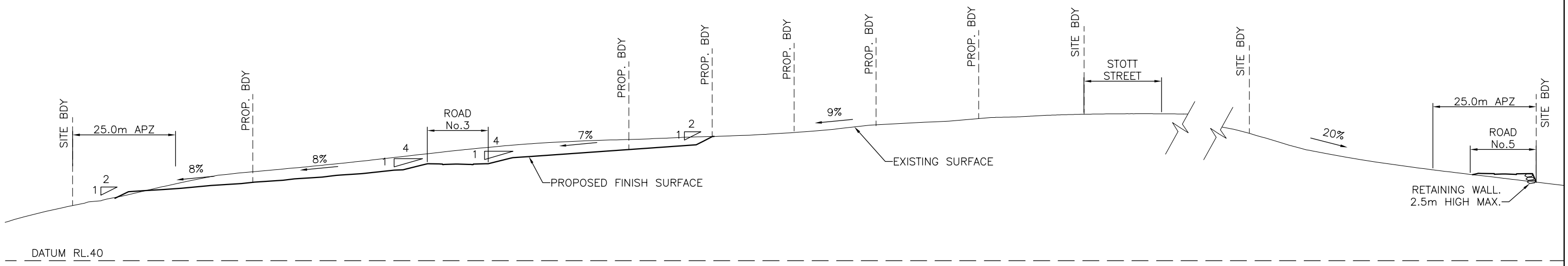
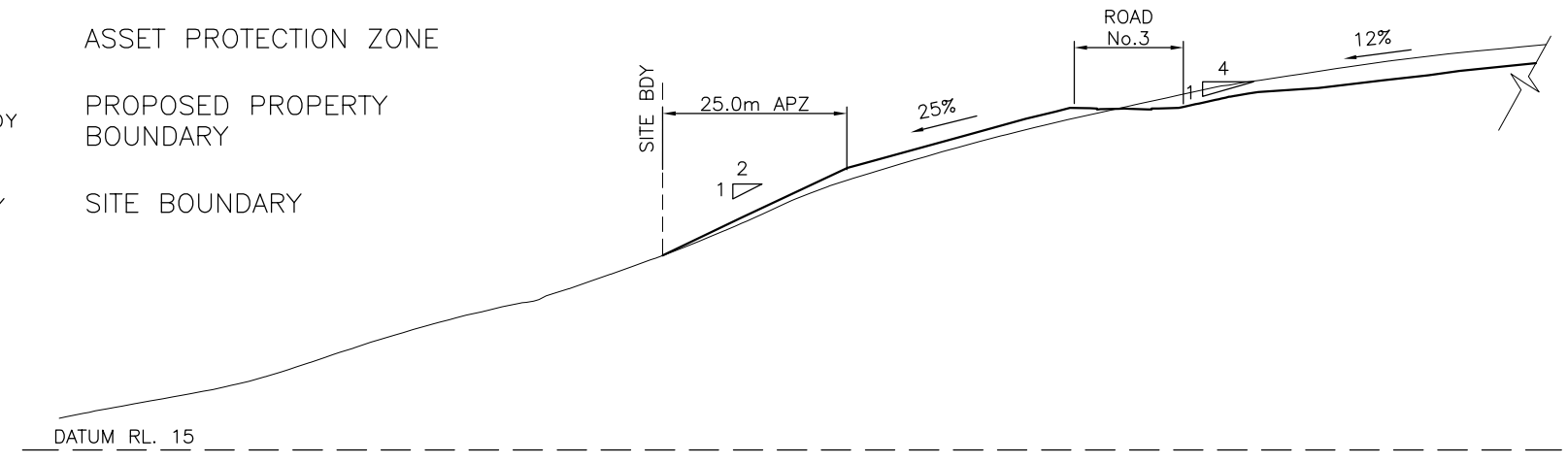


SECTION 4

LEGEND

8% →	NOMINAL SURFACE GRADE
2 / 1	SURFACE BATTER SLOPE
APZ	ASSET PROTECTION ZONE
PROP. BDY	PROPOSED PROPERTY BOUNDARY
SITE BDY	SITE BOUNDARY



SECTION 5

PETER WALMSLEY, LES & JIM DICKINSON

PROPOSED RESIDENTIAL SUBDIVISION

WALMSLEYS ROAD & STOTT STREET
BILAMBIL HEIGHTS N.S.W.

FIGURE 7.2

SITE CROSS SECTIONS

APRIL, 2009
~~MARCH, 2009~~
~~OCTOBER, 2008~~

A3 203057

0 10 20 30 40m
1:1,000 UNREDUCED

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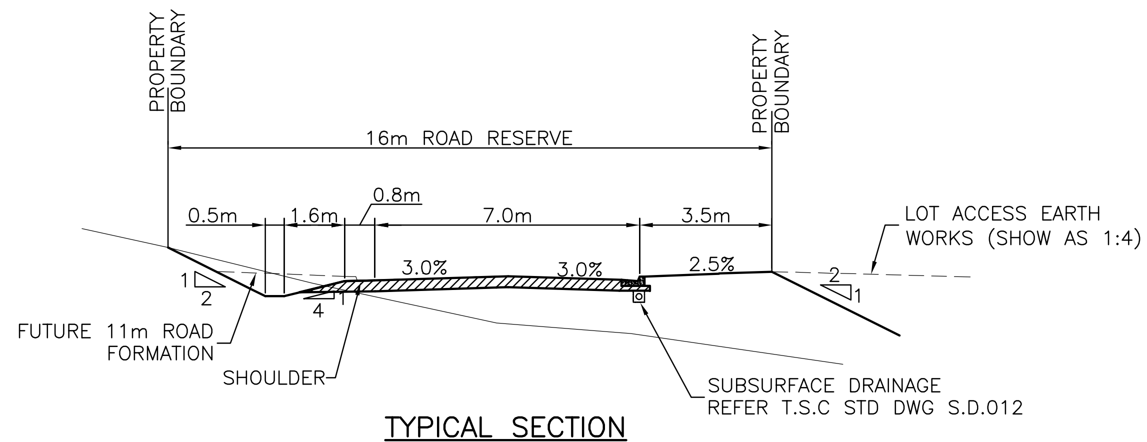
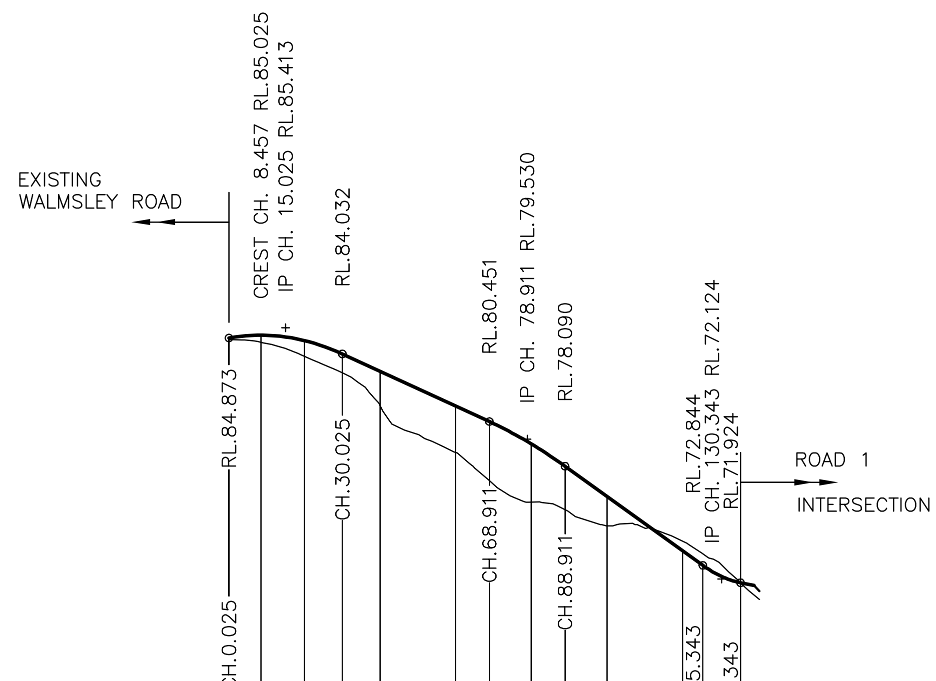


TYPICAL SECTION

0 2 4 6 8m
1:200 UNREDUCED



Horiz Curve Data

Vertical Geometry Grade (%): 3.6% | −9.208% | −14.4% | −4%
Vertical Grade Length (m): 15.025m | 63.886m | 51.431m | 8.555m

Vertical Curve Length (m): L 30 | L 20 | L 10
Vertical Curve Radius (m): R 234.222 | R 385.24 | R 96.154

DATUM R.L.51.000

CHAINAGE	DESIGN LEVELS ON ROAD CENTRELINE	NAT. SURFACE ON ROAD CENTRELINE	CUT / FILL DEPTH
0	84.873	84.780	−0.093
0.006	84.873	84.780	−0.093
0.025	84.873	84.780	−0.094
8.457	85.025	84.653	−0.372
20	84.741	83.909	−0.832
30.025	84.032	83.036	−0.997
40	83.114	81.293	−1.821
60	81.272	78.819	−2.452
68.911	80.451	77.317	−3.134
80	79.271	76.190	−3.081
88.911	78.090	75.796	−2.295
100	76.494	74.928	−1.566
120	73.614	74.122	0.508
125.343	72.844	73.455	0.610
135.343	71.924	71.929	0.004
140		71.090	
140.3		71.038	

LONGITUDINAL SECTION

0 10 20 30 40m
1:1,000 HORIZ. UNREDUCED

0 4 8 12 16 m
1:400 VERT. UNREDUCED

PETER WALMSLEY, LES & JIM DICKINSON

PROPOSED RESIDENTIAL SUBDIVISION

WALMSLEYS ROAD & STOTT STREET
BILAMBIL HEIGHTS N.S.W.

FIGURE 8.0

WALMSLEYS ROAD LONGITUDINAL SECTION AND TYPICAL CROSS SECTION

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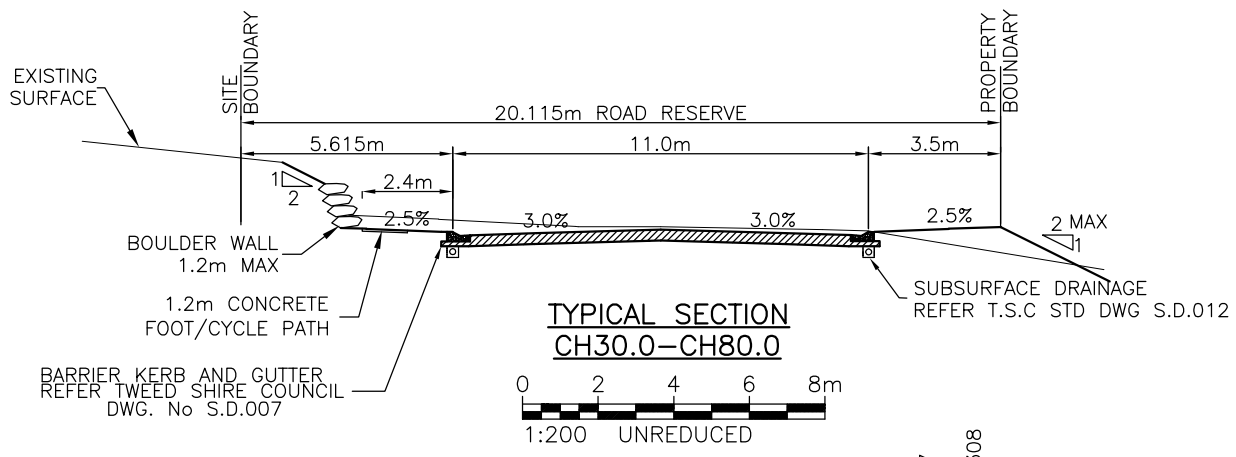
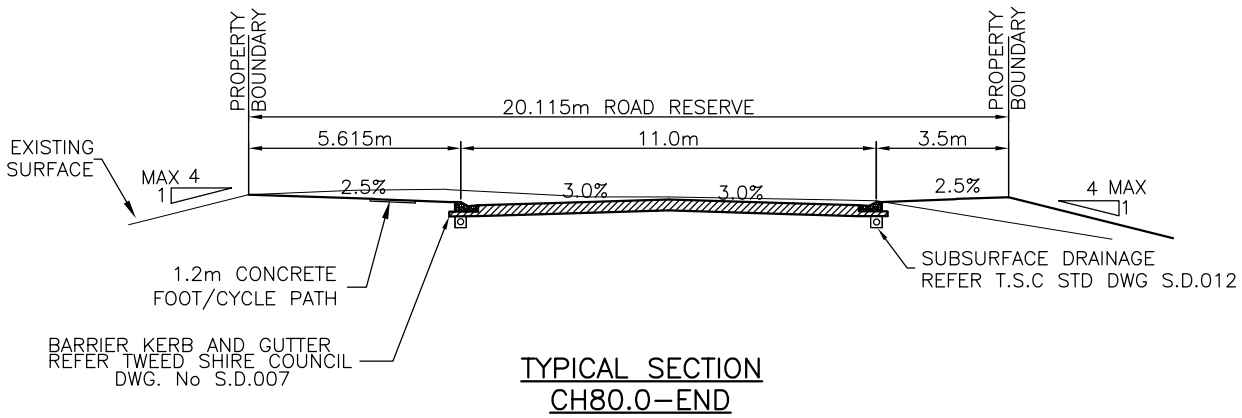
A3 203057 APRIL, 2009 ~~MARCH, 2009~~



TYPICAL SECTION CH30.0–CH80.0

0 2 4 6 8m

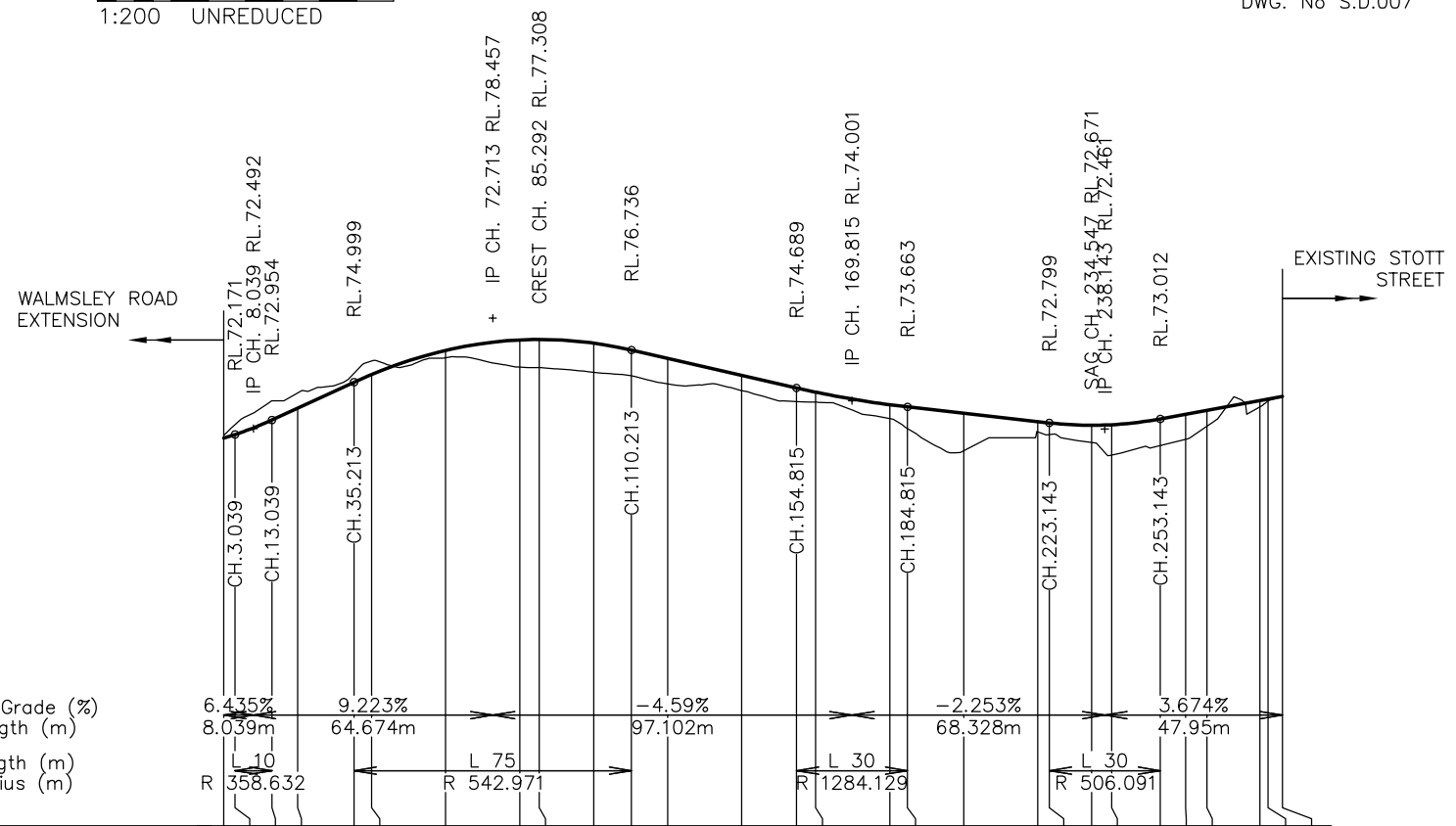
1:200 UNREDUCED



TYPICAL SECTION CH80.0–END

0 2 4 6 8m

1:200 UNREDUCED



Horiz Curve Data

Vertical Geometry Grade (%)	6.435%	9.223%	−4.59%	−2.253%	3.674%
Vertical Grade Length (m)	8.039m	64.674m	97.102m	68.328m	47.95m
Vertical Curve Length (m)	L 10	L 75		L 30	L 30
Vertical Curve Radius (m)	R 358.632	R 542.971		R 1284.129	R 506.091

DATUM R.L.51.000

DESIGN LEVELS ON ROAD CENTRELINE	71.975	72.171	72.954	73.596	74.999	75.419	76.719	77.282	77.308	77.109	76.736	76.287	75.369	74.689	74.462	73.780	73.663	73.321	72.870	72.799	72.671	72.700	73.012	73.264	73.475	73.999	74.082	74.223	
NAT. SURFACE ON ROAD CENTRELINE	72.136	72.701	74.000	74.422	75.477	76.139	76.322	75.814	75.786	75.530	75.340	74.908	74.542	73.957	73.919	73.035	72.493	71.302	72.317	72.165	71.747	71.050	71.575	71.919	72.619	73.663	73.984	74.223	
CUT / FILL DEPTH	0.161	0.531	1.046	0.826	0.479	0.720	−0.397	−1.469	−1.522	−1.579	−1.396	−1.379	−0.827	−0.733	−0.542	−0.745	−1.169	−2.019	−0.552	−0.634	−0.924	−1.649	−1.437	−1.345	−0.855	−0.336	−0.098	0.000	
CHAINAGE	0	3.039	13.039	20	35.213	40	60	80	85.292	100	110.213	120	140	154.815	160	180	184.815	200	220	223.143	234.547	240	253.143	260	265.727	280	282.261	286.093		

LONGITUDINAL SECTION

0 20 40 60 80m

1:2,000 HORIZ. UNREDUCED

0 4 8 12 16m

1:400 VERT. UNREDUCED

PETER WALMSLEY, LES & JIM DICKINSON

PROPOSED RESIDENTIAL SUBDIVISION

WALMSLEYS ROAD & STOTT STREET
BILAMBIL HEIGHTS N.S.W.

FIGURE 9.0

ROAD 1 LONGITUDINAL SECTION AND TYPICAL CROSS SECTION

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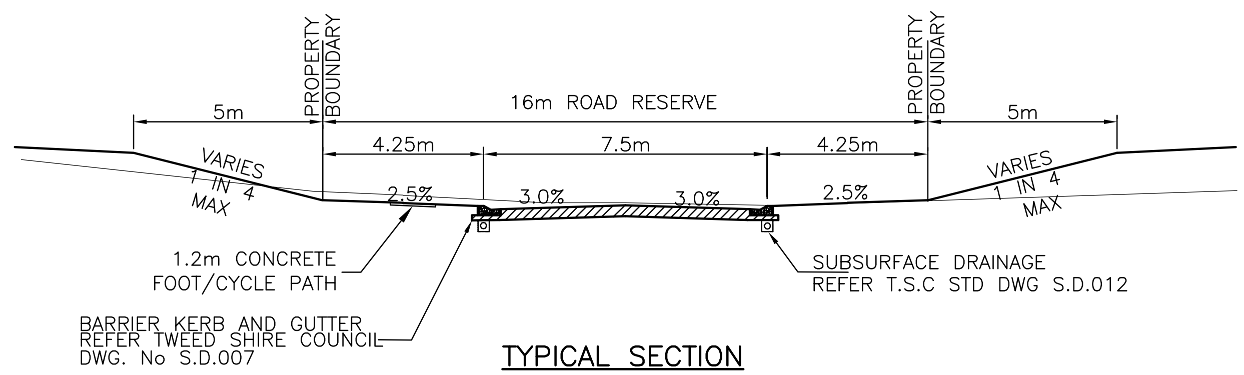
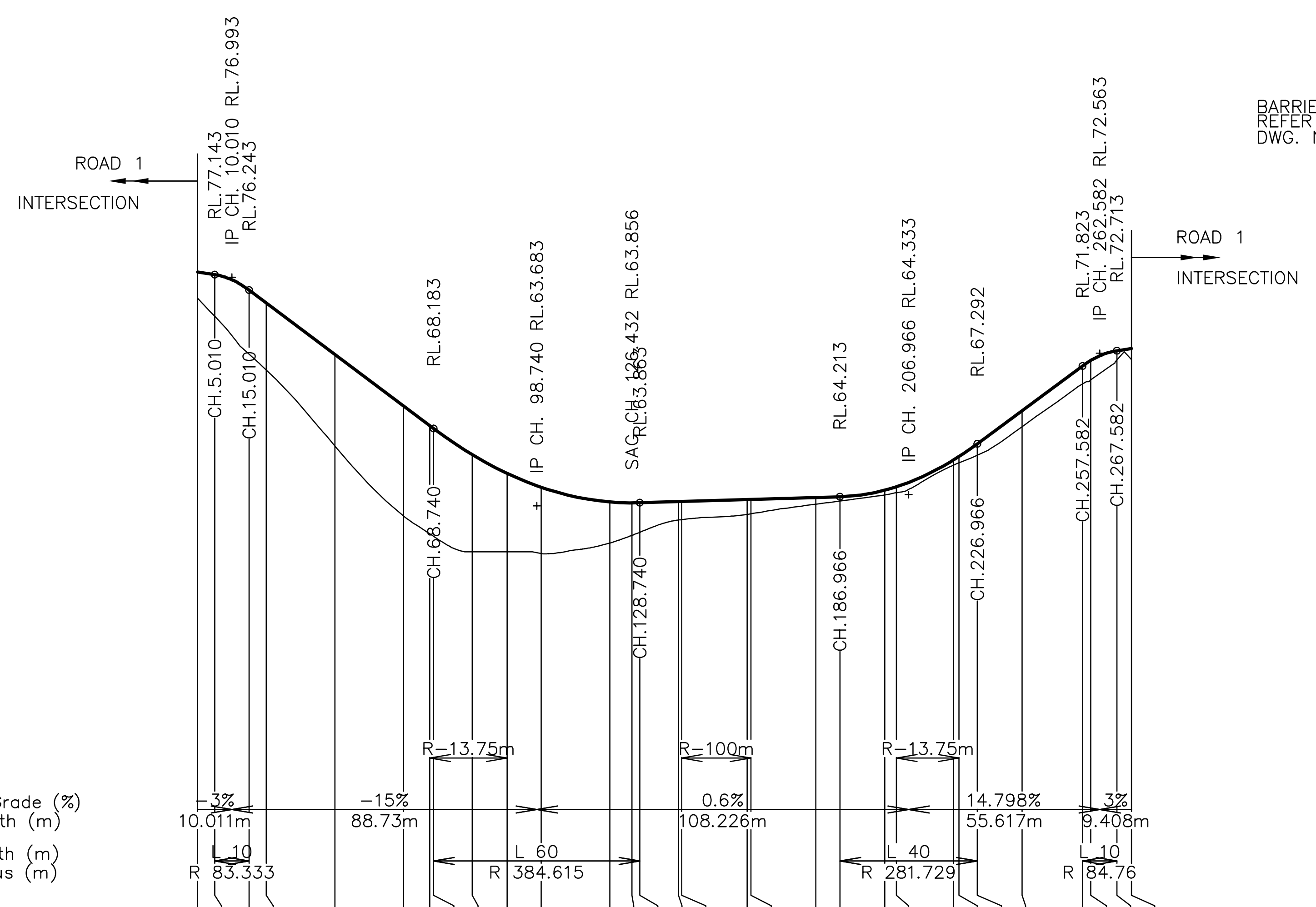
APRIL, 2009
~~MARCH, 2009~~
~~OCTOBER, 2008~~
~~OCTOBER, 2006~~

A3 203057 ~~JUNE, 2005~~



TYPICAL SECTION

0 2 4 6 8m
1:200 UNREDUCED



CHAINAGE	CUT / FILL DEPTH	NAT. SURFACE ON ROAD CENTRELINE	DESIGN LEVELS ON ROAD CENTRELINE
0	-1.519	75.774	77.293
5.01	-2.418	74.725	77.143
15.01	-3.730	72.513	76.243
20	-3.899	71.595	75.494
40	-5.329	67.165	72.494
60	-6.415	63.079	69.494
67.635	-6.295	62.053	68.349
68.74	-6.277	61.906	68.183
80	-5.659	61.000	66.659
90.099	-4.572	61.000	65.572
100	-3.855	60.910	64.765
120	-2.394	61.516	63.910
126.432	-1.895	61.961	63.856
128.74	-1.720	62.144	63.863
140	-1.075	62.856	63.931
140.894	-1.058	62.878	63.936
160	-0.873	63.177	64.051
161.058	-0.842	63.216	64.057
180	-0.393	63.778	64.171
186.966	-0.256	63.956	64.213
200	-0.273	64.319	64.592
203.414	-0.344	64.448	64.791
220	-0.300	66.047	66.348
221.597	-0.363	66.186	66.549
226.966	-0.657	66.635	67.292
240	-0.927	68.294	69.221
257.582	-1.052	70.771	71.823
260	-1.117	71.029	72.146
267.582	-0.536	72.177	72.713
271.863	-0.647	72.194	72.841

LONGITUDINAL SECTION

0 20 40 60 80m
1:2,000 HORIZ. UNREDUCED

0 4 8 12 16 m
1:400 VERT. UNREDUCED

PETER WALMSLEY, LES & JIM DICKINSON

PROPOSED RESIDENTIAL SUBDIVISION

WALMSLEYS ROAD & STOTT STREET
BILAMBIL HEIGHTS N.S.W.

FIGURE 10.0

ROAD 2 LONGITUDINAL SECTION AND TYPICAL CROSS SECTION

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APRIL, 2009
~~MARCH, 2009~~
~~JANUARY, 2009~~
~~OCTOBER, 2006~~
~~JUNE, 2005~~

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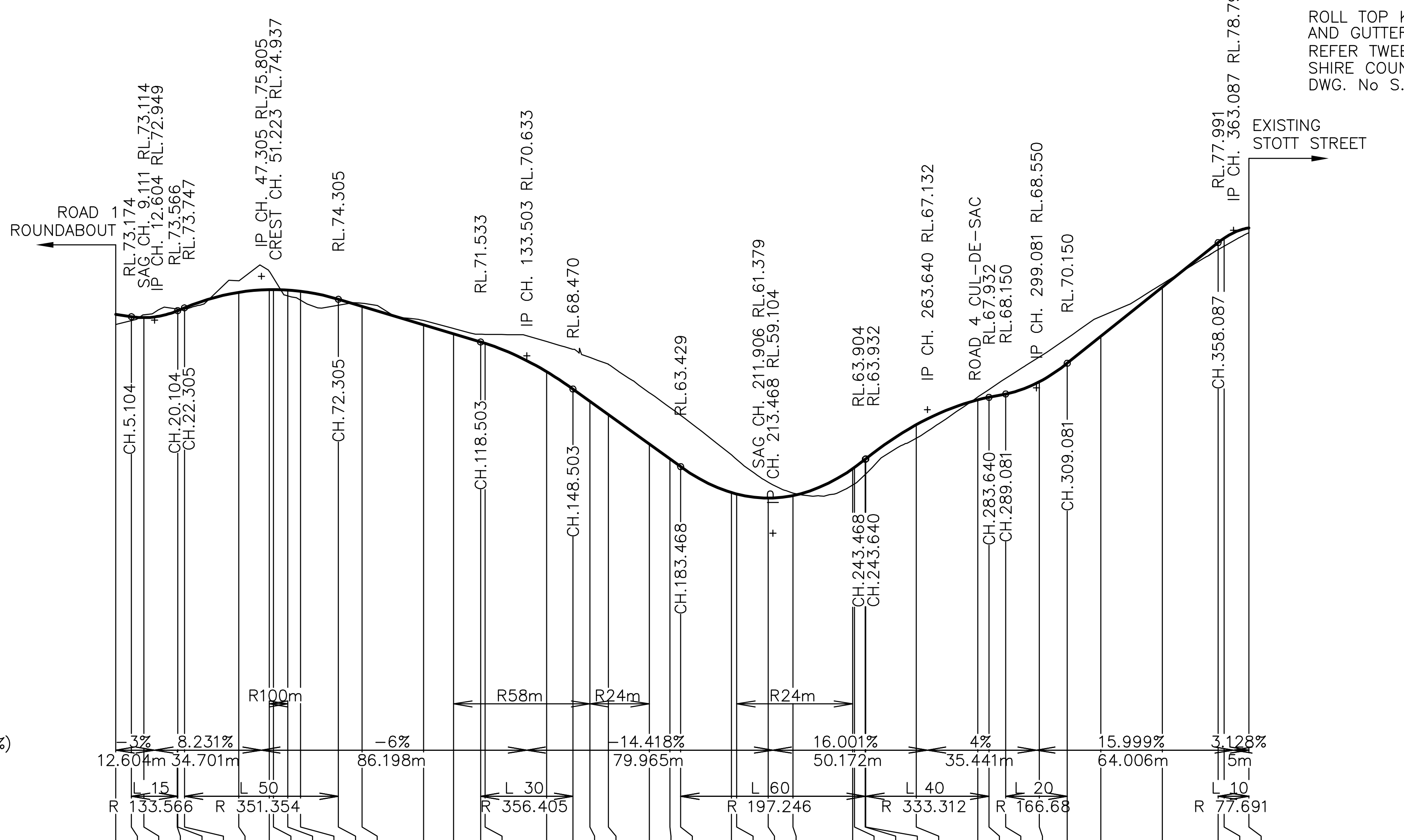
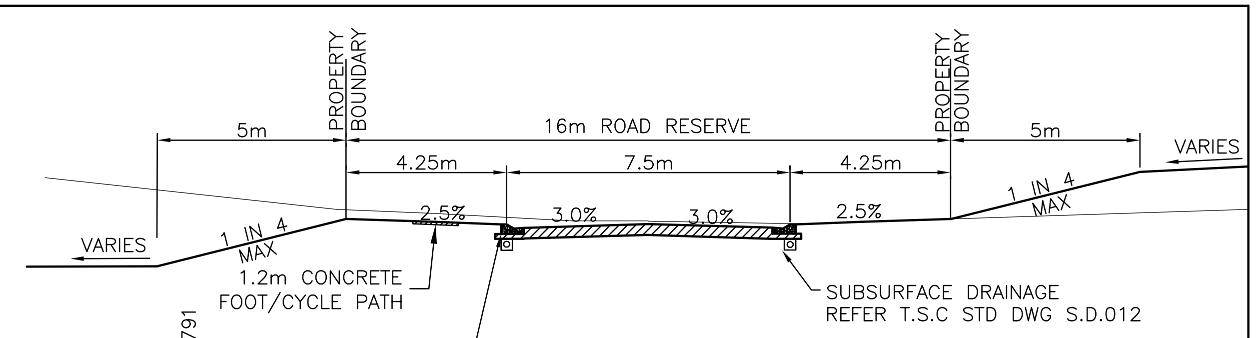


CHAINAGE	CUT / FILL DEPTH	NAT. SURFACE ON ROAD CENTRELINE	DESIGN LEVELS ON ROAD CENTRELINE
0	-0.667	72.660	73.327
5.104	-0.254	72.920	73.174
9.111	0.188	73.302	73.114
20	0.112	73.670	73.558
20.104	0.101	73.667	73.566
22.305	-0.072	73.676	73.747
40	0.746	75.505	74.758
49.899	1.181	76.116	74.935
51.223	0.754	75.691	74.937
55.858	-0.372	74.535	74.907
60	-0.580	74.248	74.828
72.305	-0.382	73.923	74.305
80	0.200	74.043	73.843
100	0.295	72.938	72.643
109.765	0.354	72.411	72.057
118.503	0.498	72.031	71.533
120	0.587	72.027	71.440
140	1.975	71.570	69.595
148.503	2.577	71.047	68.470
154.022	2.850	70.524	67.675
160	3.273	70.085	66.813
173.332	3.339	68.230	64.891
180	3.348	67.277	63.929
183.468	3.342	66.771	63.429
200	2.453	64.192	61.739
201.672	2.254	63.899	61.645
211.906	1.026	62.406	61.379
220	0.162	61.707	61.545
239.341	-1.054	62.233	63.287
240	-1.064	62.316	63.380
243.468	-0.983	62.921	63.904
243.64	-0.979	62.953	63.932
260	-0.872	65.276	66.148
280	0.185	67.951	67.767
283.64	0.499	68.431	67.932
289.081	1.015	69.165	68.150
300	1.610	70.554	68.944
309.081	1.623	71.773	70.150
320	1.295	73.192	71.897
340	0.218	75.315	75.097
358.087	-0.453	77.538	77.991
360	-0.517	77.757	78.273
368.087	-0.305	78.642	78.947

LONGITUDINAL SECTION

0 20 40 60 80m
1:2,000 HORIZ. UNREDUCED

0 4 8 12 16 m
1:400 VERT. UNREDUCED



TYPICAL SECTION

0 2 4 6 8m
1:200 UNREDUCED

PETER WALMSLEY, LES & JIM DICKINSON

PROPOSED RESIDENTIAL SUBDIVISION

WALMSLEYS ROAD & STOTT STREET
BILAMBIL HEIGHTS N.S.W.

FIGURE 11.0

ROAD 3 LONGITUDINAL SECTION AND TYPICAL CROSS SECTION

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~~MARCH, 2009~~
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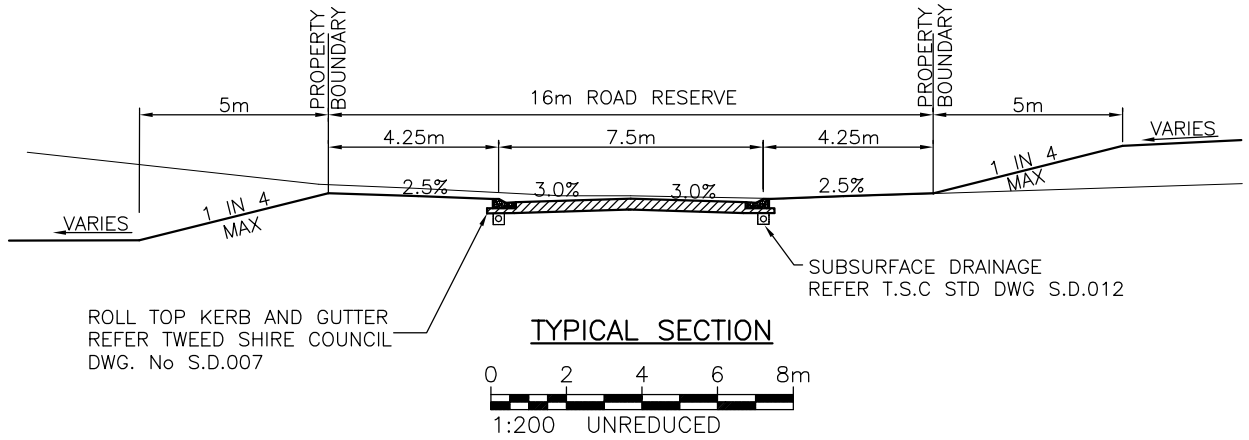
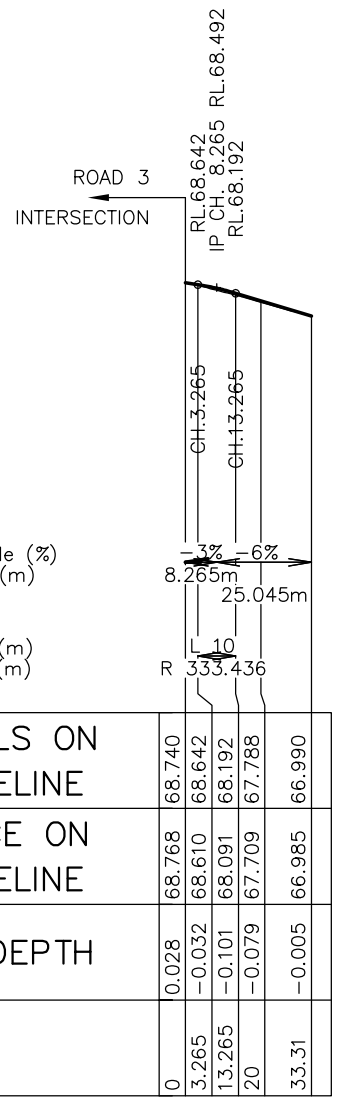
~~OCTOBER, 2006~~
~~AUGUST, 2005~~
A3 203057 ~~JUNE, 2005~~



TYPICAL SECTION

0 2 4 6 8m

1:200 UNREDUCED



DESIGN LEVELS ON ROAD CENTRELINE	68.740	68.642	68.192	67.788	66.990
NAT. SURFACE ON ROAD CENTRELINE	68.768	68.610	68.091	67.709	66.985
CUT / FILL DEPTH	0.028	−0.032	−0.101	−0.079	−0.005
CHAINAGE	0	3.265	13.265	20	33.31

LONGITUDINAL SECTION

0 20 40 60 80m

1:2,000 HORIZ. UNREDUCED

0 4 8 12 16m

1:400 VERT. UNREDUCED

APRIL, 2009
~~MARCH, 2009~~
~~JANUARY, 2009~~
~~OCTOBER, 2006~~
~~AUGUST, 2005~~
~~JUNE, 2005~~

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WALMSLEYS ROAD & STOTT STREET
BILAMBIL HEIGHTS N.S.W.

FIGURE 12.0

ROAD 4 LONGITUDINAL SECTION AND TYPICAL CROSS SECTION

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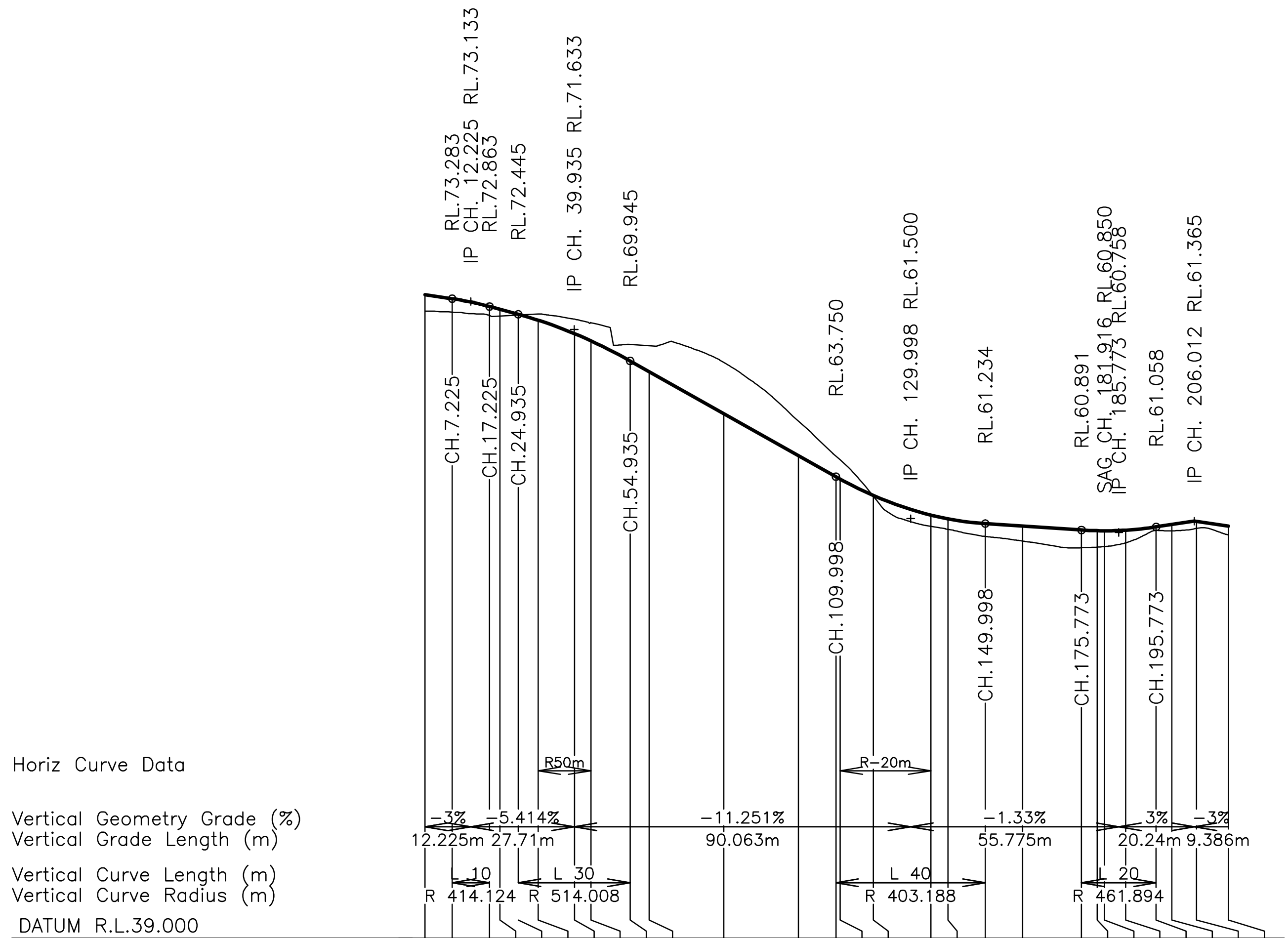
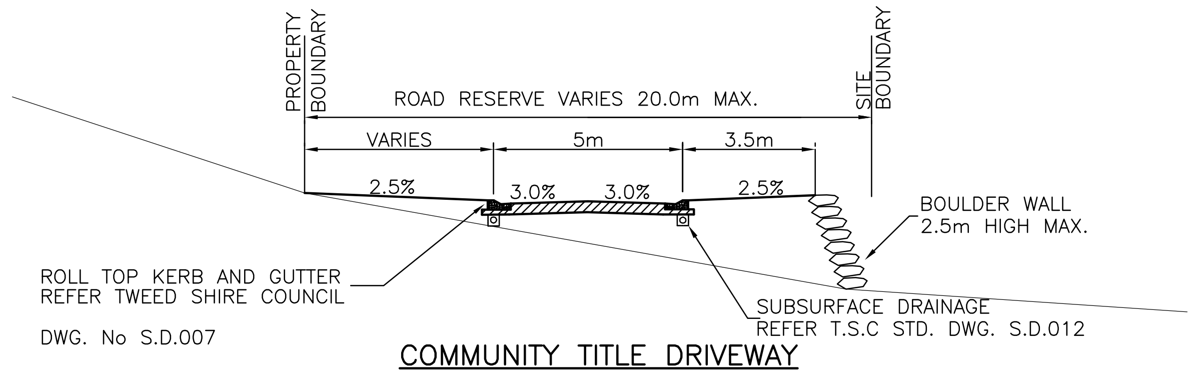


CHAINAGE	DESIGN LEVELS ON ROAD CENTRELINE	NAT. SURFACE ON ROAD CENTRELINE	CUT / FILL DEPTH
0	73.500	72.619	-0.881
7.225	73.283	72.558	-0.725
17.225	72.863	72.383	-0.480
20	72.712	72.355	-0.357
24.935	72.445	72.410	-0.035
30.234	72.131	72.468	0.337
40	71.409	72.184	0.776
44.413	71.021	71.997	0.975
54.935	69.945	70.837	0.891
60	69.375	70.764	1.389
80	67.125	69.868	2.743
100	64.875	66.721	1.846
109.998	63.750	64.849	1.099
111.118	63.626	64.652	1.026
120	62.749	62.713	-0.036
135.456	61.690	61.087	-0.603
140	61.491	60.932	-0.559
149.998	61.234	60.545	-0.689
160	61.101	60.303	-0.798
175.773	60.891	59.942	-0.949
180	60.854	59.977	-0.878
181.916	60.850	60.002	-0.848
187.56	60.885	60.201	-0.684
195.773	61.058	60.868	-0.190
200	61.185	60.851	-0.334
206.577	61.348	60.979	-0.370
215.127	61.092	60.624	-0.468

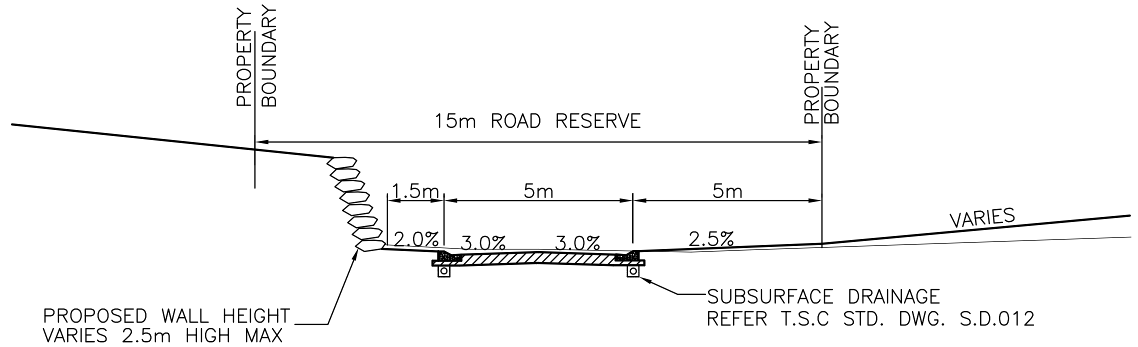
LONGITUDINAL SECTION

0 20 40 60 80m
1:2,000 HORIZ. UNREDUCED
0 4 8 12 16m
1:400 VERT. UNREDUCED



COMMUNITY TITLE DRIVEWAY
TYPICAL SECTION
CH120.0–END

0 2 4 6 8m
1:200 UNREDUCED



COMMUNITY TITLE DRIVEWAY
TYPICAL SECTION
CH0.0–CH120.0

0 2 4 6 8m
1:200 UNREDUCED

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FIGURE 13.0

ROAD 5 LONGITUDINAL SECTION
AND TYPICAL CROSS SECTION

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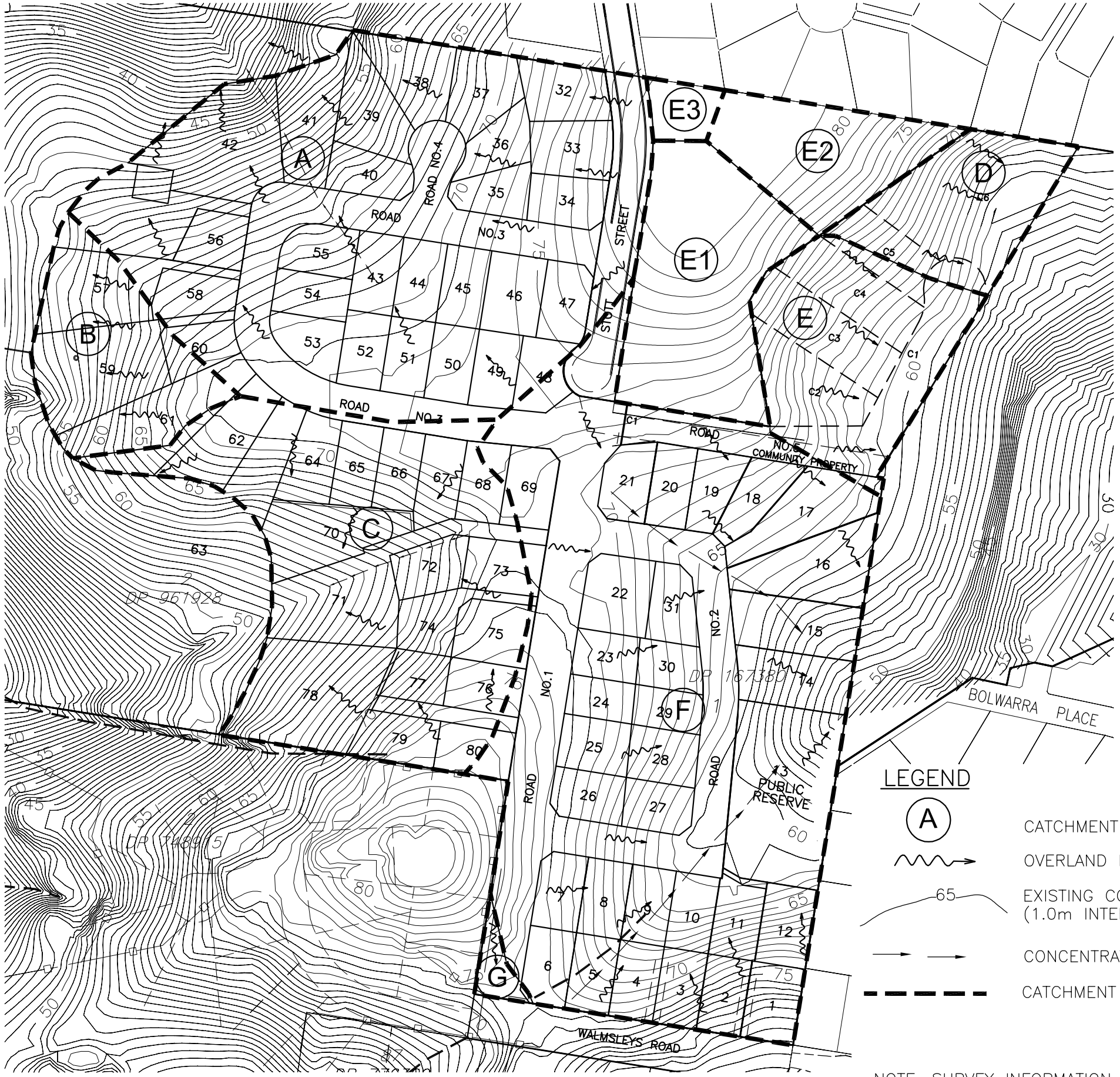

DRAINAGE CALCULATIONS

CATCHMENT	AREA (ha)	t_c (min)	I_5 (mm/hr)	c_5	Q_5 (m^3/s)	I_{100} (mm/hr)	C100	Q_{100} (m^3/s)
A	3.3	16	126.46	0.665	0.771	199.40	0.840	1.535
B	0.57	13	138.51	0.665	0.146	217.40	0.840	0.289
C	1.95	12	143.29	0.665	0.516	224.53	0.840	1.022
D	0.39	11	148.57	0.665	0.107	232.37	0.840	0.211
E	0.76	12	143.29	0.665	0.201	224.53	0.840	0.398
F	4.19	18	119.87	0.665	0.928	189.52	0.840	1.853
G	0.05	10	154.43	0.665	0.014	241.07	0.840	0.028
E1	0.72	10	154.43	0.817	0.252	241.07	1.032	0.498
E2	0.40	8	168.44	0.817	0.153	261.83	1.032	0.300
E3	0.08	13	138.51	0.817	0.025	217.40	1.032	0.050

LEGEND

- A — CATCHMENT NUMBER
- OVERLAND DRAINAGE DIRECTION
- 65 — EXISTING CONTOURS (1.0m INTERVAL)
- CONCENTRATED FLOW PATH
- CATCHMENT BOUNDARY

NOTE: SURVEY INFORMATION FROM MCLAUCHLAN SURVEYING DRAWING NUMBER 37401

APRIL, 2009
~~OCTOBER, 2008~~
~~OCTOBER, 2007~~
~~OCTOBER,2006~~
~~AUGUST, 2005~~
~~FEBRUARY, 2005~~

A3 203057

0 20 40 60 80m
1:2,000 UNREDUCED

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WALMSLEYS ROAD
BILAMBIL HEIGHTS

FIGURE 14.0

WATER CYCLE MANAGEMENT PLAN
PRE–DEVELOPMENT

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DRAINAGE CALCULATIONS

CATCHMENT	AREA (ha)	t_c (min)	I_5 (mm/hr)	C_5	Q_5 (m^3/s)	I_{100} (mm/hr)	C100	Q_{100} (m^3/s)
A	3.15	12	143.29	0.741	0.929	224.53	0.936	1.838
B	0.63	10	154.43	0.741	0.200	241.07	0.936	0.390
C	2.02	10	154.43	0.741	0.640	241.07	0.936	1.270
D	0.45	7	176.99	0.741	0.164	274.44	0.936	0.321
E	0.86	10	154.43	0.741	0.273	241.07	0.936	0.539
F	4.06	10	154.43	0.741	1.291	241.07	0.936	2.545
E1	0.72	10	154.43	0.817	0.252	241.07	1.032	0.498
E2	0.40	8	168.44	0.817	0.153	261.83	1.032	0.300
E3	0.08	13	138.51	0.817	0.025	217.40	1.032	0.050

LEGEND

A — CATCHMENT NUMBER

65 — DESIGN CONTOURS (1.0m INTERVAL)

SWD — PROPOSED STORMWATER DRAINAGE

CATCHMENT BOUNDARY

MAJOR OVERLAND FLOW PATH

0 20 40 60 80m
1:2,000 UNREDUCED

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WALMSLEYS ROAD
BILAMBIL HEIGHTS

FIGURE 15.0
WATER CYCLE MANAGEMENT PLAN
POST DEVELOPMENT

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~~OCTOBER, 2006~~
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~~JUNE, 2005~~
APRIL, 2009
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LEGEND

–65–	DESIGN CONTOURS
SRM	PROPOSED RISING SEWER MAIN
S	PROPOSED SEWER MAIN
W	PROPOSED WATER MAIN
— — — w —	EXISTING WATER MAIN FROM COUNCIL GIS PLANS
— — — s —	EXISTING SEWER MAIN FROM COUNCIL GIS PLANS TO REMAIN
— — — — —	APZ LINE

0 20 40 60 80m

1:2,000 UNREDUCED

APRIL, 2009
~~OCTOBER, 2008~~
~~OCTOBER, 2007~~
~~OCTOBER, 2006~~
~~AUGUST, 2005~~
~~JUNE, 2005~~
~~FEBRUARY, 2005~~

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PROPOSED RESIDENTIAL SUBDIVISION

WALMSLEYS ROAD & STOTT STREET
BILAMBIL HEIGHTS N.S.W.

FIGURE 16.0

SERVICES PLAN

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PT 6

DP 1117326

LOT 3

DP 1054848

PT 6

DP 1117326

STOTT STREET

ROAD NO.4

ROAD NO.3

ROAD NO.5 COMMUNITY PROPERTY

ROAD NO.2

ROAD NO.1

LOT 1

DP 167380

13 PUBLIC RESERVE

WALMSLEYS ROAD

LOT 2

DP 961928

LOT 2

DP 748915

C1 C2 C3 C4 C5 C6

LEGEND

- PROPOSED ALLOTMENTS
- 0% TO 5%
- 5% TO 10%
- 10% TO 15%
- 15% TO 20%
- 20% TO 33%
- GREATER THAN 33%

0 20 40 60 80m

1:2,000 UNREDUCED

A3 203057 MARCH, 2009

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WALMSLEYS ROAD & STOTT STREET
BILAMBIL HEIGHTS N.S.W.

FIGURE 17.0

PROPOSED GRADES ANALYSIS

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