ATTACHMENT 3

Flood Impact Assessment

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Norsearch Pty Ltd
c/- Newton Denny Chapelle
PO Box 1138,
Lismore, NSW, 2480

ATT: Damian Chapelle

RE: CRAWFORD SITE FLOOD IMPACT ASSESSMENT – STAGE 1

Dear Damian,

We are pleased to provide this letter report on the preliminary *regional* Wilsons River and *local* Minaltrie Creek flood impact assessment of the proposed development at the Crawford Site, Lismore. The aim of the assessment is to determine a preliminary maximum site filling line, based on both regional and local flood flows. An attachment to this letter report also presents a local drainage assessment of the existing waterways on the site, which should be considered in conjunction with this report.

The site is located on the eastern side of Minaltrie Creek, with a short length of the creek running through the south western corner of the site, as shown on Figure 1. A tributary also flows from east to west across the site, draining into Minaltrie Creek. Figure 1 also shows a thematic surface representing the existing 2m contour information, which was the only source of terrain information available for this assessment.

Regional Flood Impact Assessment (100yr ARI Design Flood)

Minaltrie Creek acts as a backwater storage area for regional flood flows moving down the Wilsons River. Council's 2D model does not incorporate Minaltrie Creek in the model network, however, extending the peak 100 year ARI flood level of 11.05m AHD up Minaltrie Creek as a backwater results in the inundation extent shown on Figure 2.

Acting as a backwater area, velocities in Minaltrie Creek in the vicinity of the site would be negligible, with the main impact on flood levels of filling the site being the loss in flood storage.

Figure 3 shows the regional 100yr design flood behaviour of the Wilsons River at the confluence with Minaltrie Creek. This indicates that the site is initially inundated at a relative time of approximately 32.25hrs, with the flood peak being at a relative time of 41.75 hrs.

The overall reduction in storage capacity as a result of full filling of the site is approximately 170,000m^3. During the time at which filling of the site would affect regional floodwaters (from initial inundation to flood peak), approximately 169,000,000m^3 of flood waters would flow past Minaltrie Creek. The loss in storage represents 0.1% of the total flow volume and would, therefore, have a negligible impact on regional flood levels, both in the vicinity of the site and throughout the floodplain.

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Regional Flood Impact Assessment (10yr ARI Design Flood)

Minaltrie Creek acts as a backwater storage area for regional flood flows moving down the Wilsons River. Council's 2D model does not incorporate Minaltrie Creek in the model network, however, extending the peak 10 year ARI flood level of 9.72m AHD up Minaltrie Creek as a backwater results in the inundation extent shown on Figure 4.

Similarly to the 100yr design flood, with Minaltrie Creek acting as a backwater area, velocities in the vicinity of the site would be negligible, with the main impact on flood levels of filling the site being the loss in flood storage.

Figure 5 shows the regional 10yr design flood behaviour of the Wilsons River at the confluence with Minaltrie Creek. This indicates that the site is initially inundated at a relative time of approximately 32.5hrs, with the flood peak being at a relative time of 38.25 hrs.

The overall reduction in storage capacity as a result of full filling of the site is approximately 66,000m^3. During the time at which filling of the site would affect regional floodwaters (from initial inundation to flood peak), approximately 71,800,000m^3 of flood waters would flow past Minaltrie Creek. The loss in storage represents 0.1% of the total flow volume and would, therefore, have a negligible impact on regional flood levels, both in the vicinity of the site and throughout the floodplain.

Local Flow Impact: Minaltrie Creek 10yr Design Flows

Minaltrie Creek flows through the south western corner of the site and has a local catchment of approximately 4.8km^2. The catchment is a mixture of what would be classified as rural and urban land use. Indicative peak 10yr local inflows at the southern end of the site, determined using the *Northern Rivers Storm water Design Manual (2006)* and the rational method, are approximately 38m^3/s.

Normal depth calculations using Manning's equation indicate approximate peak flood levels of 8.53m AHD at the southern end of the site using a bed slope of 0.005 and Manning's 'n' of 0.04. Complete filling of the site, without maintaining any conveyance through the site, would result in an increase of approximately 0.05m in peak flood levels for the 10yr ARI Minaltrie Creek catchment.

Based on these simplified calculations, maintaining the natural topography up to approximately 8.53m AHD would be sufficient to ensure negligible impacts on flood behaviour on surrounding properties for the 10yr local design event. Alternatively, a constructed channel could be sized to convey the local Minaltrie Creek flows which is likely to increase the amount of land that can be filled. However, this is beyond the scope of this project. Accordingly, an indicative "no fill" zone is shown on Figure 6.

Given the relatively small flows down Minaltrie Creek, the peak levels are heavily dependent on the accuracy of the elevation model (in this case, the 2m contours) in determining flow cross sections and bed slopes. With more accurate elevation information, and more detailed modelling, the above preliminary information could be further refined/confirmed and a "best case" filling scenario determined.

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Conclusion: Indicative Maximum Fill Line

Filling the site above the regional 100yr ARI design flood level does not have a significant impact in regional flood levels. Therefore, the largest impact on flood levels will be the impact of filling on local creek flows.

The preliminary analysis shows that complete filling of the site is likely to raise local Minaltrie Creek 10yr flood levels by approximately 0.05m. Ensuring conveyance of these flows by leaving the south west corner of the site unfilled results in the indicative 'no fill' line shown in Figure 6. This figure should be considered in conjunction with the *local drainage assessment of existing creeks on the site*, which accompanies this letter report.

A refined maximum fill line could be calculated using more detailed terrain information and more detailed local site modelling, including the potential for conveying these flows through engineered channels.

We trust that this report addresses your requirements.

Yours faithfully
WorleyParsons

Cameron Druery
Principal Engineer

Review / Verification by Date

19.04.11

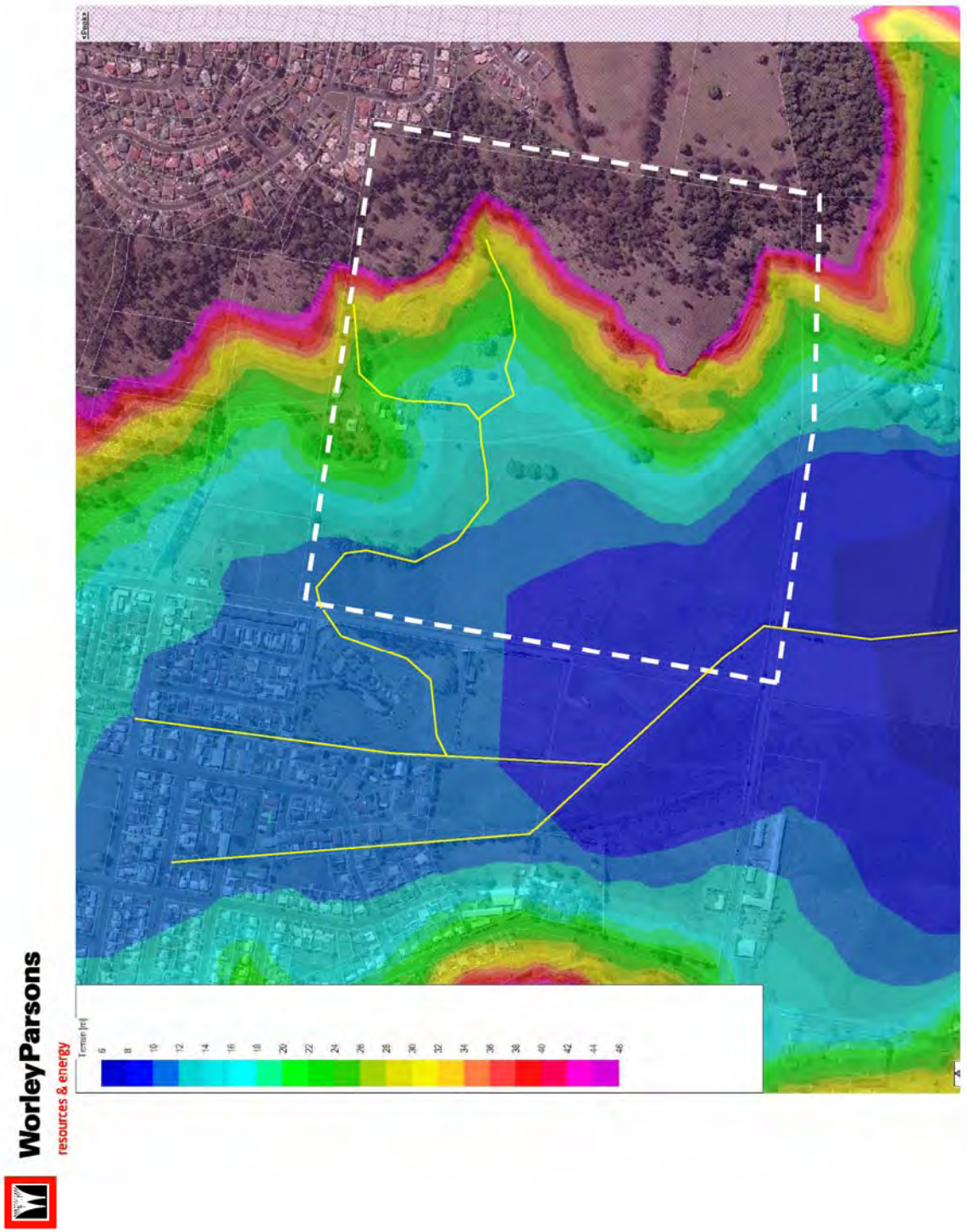

Figure 1 - Site Layout showing Minaltrie Creek and tributaries with 2m Contour Elevation Surface.

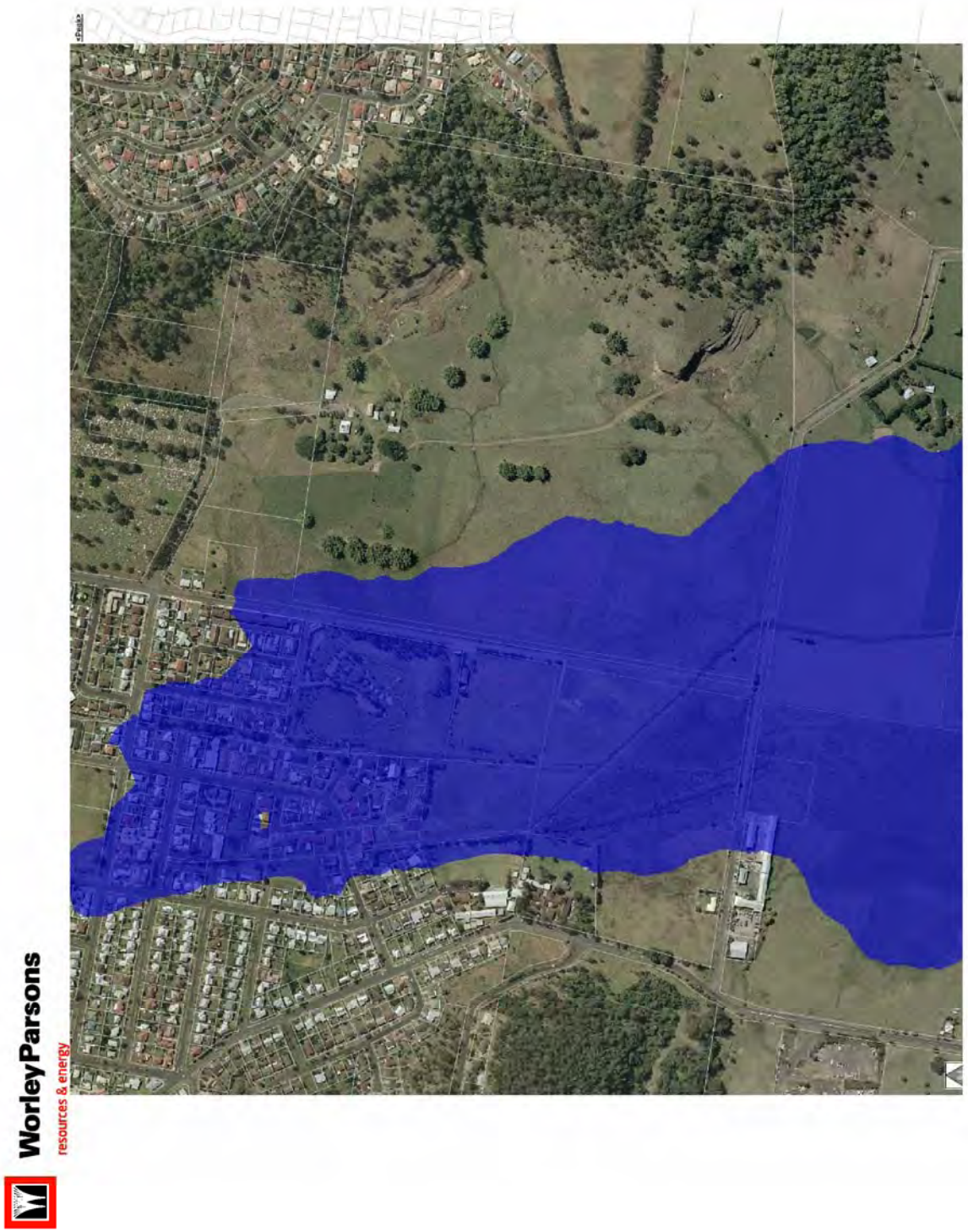

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Figure 2 – Indicative Regional 100yr Flood Extent based on 2m contours.

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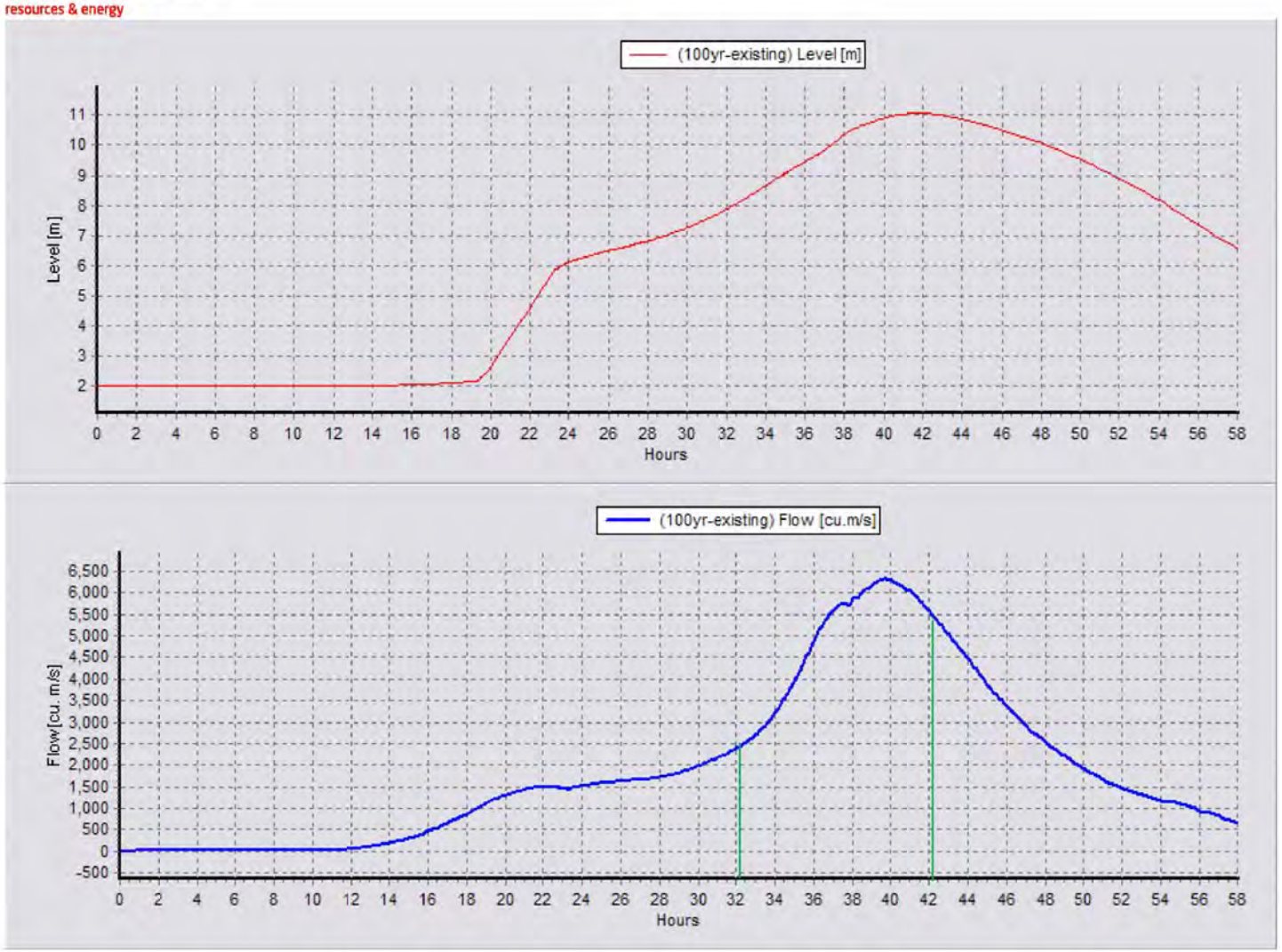

Figure 3 – Regional Flood Behaviour in the Wilsons River at the confluence with Minaltrie Creek – 100yr ARI Design Flood.

Figure 4 – Indicative Regional 10yr Flood Extent based on 2m contours.

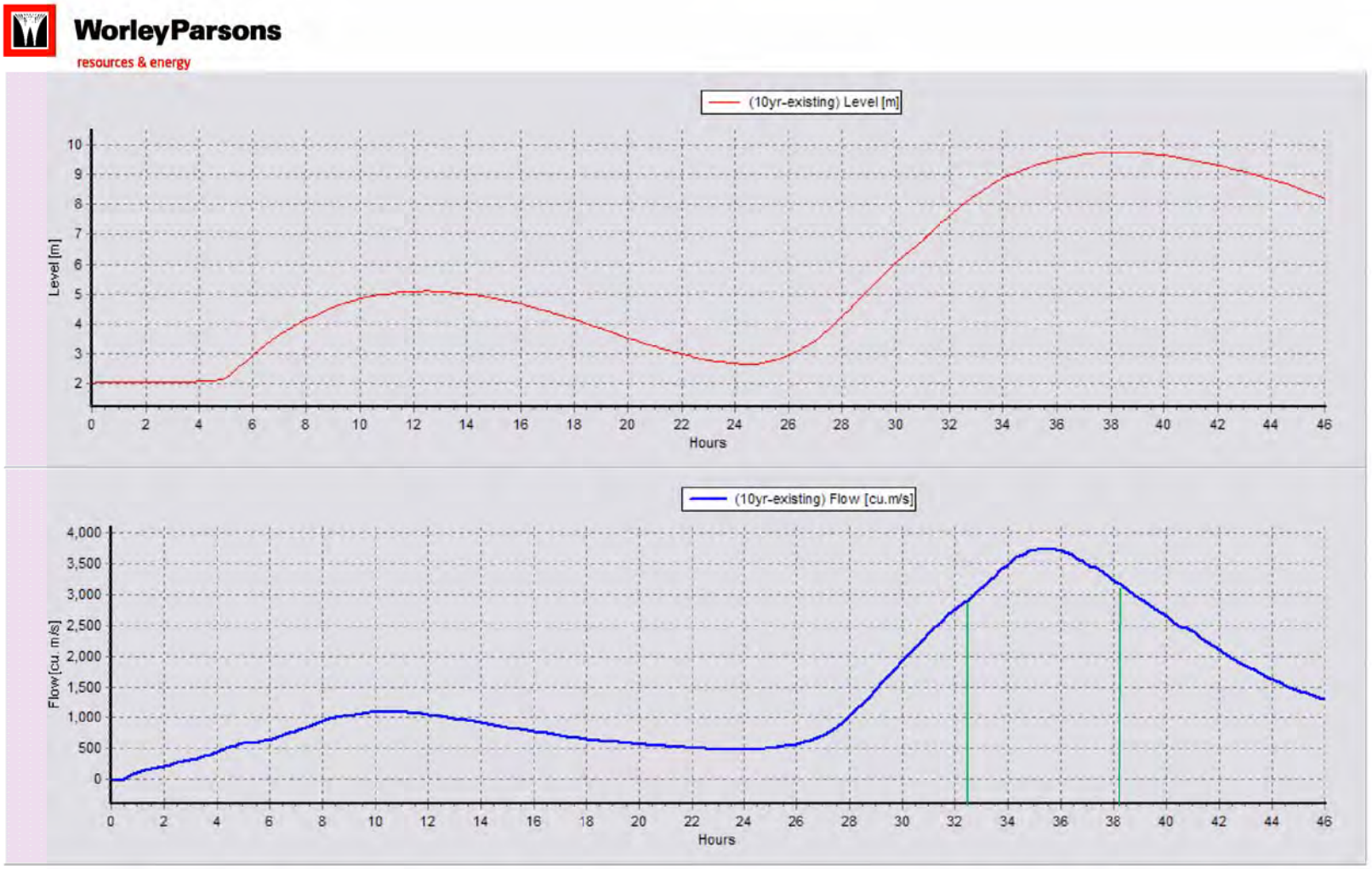

Figure 5 – Regional Flood Behaviour in the Wilsons River at the confluence with Minaltrie Creek – 10yr ARI Design Flood.

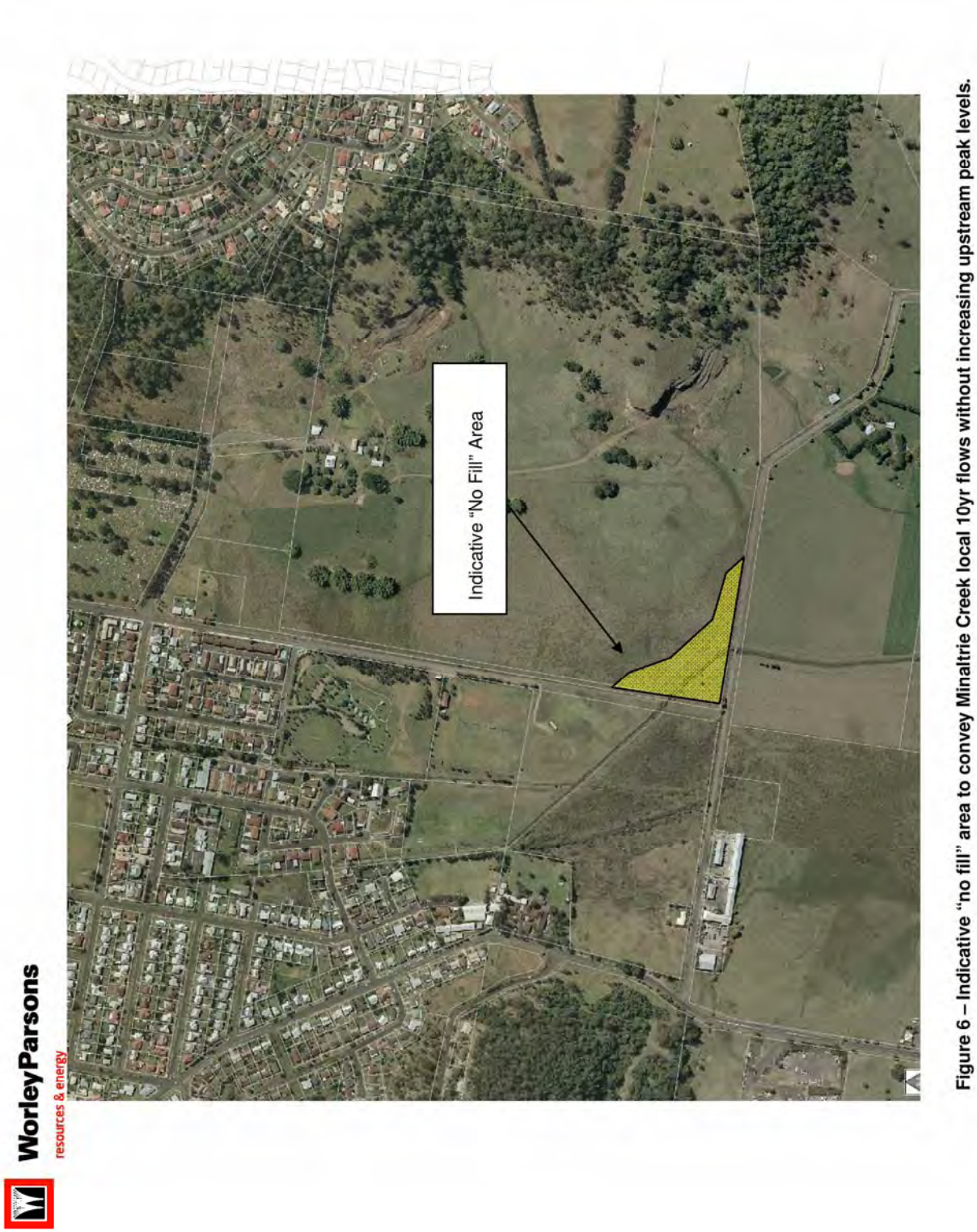

Figure 6 – Indicative "no fill" area to convey Minaltrie Creek local 10yr flows without increasing upstream peak levels.

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13 April 2011

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Norsearch Pty Ltd
c/- Newton Denny Chapelle
PO Box 1138 Lismore NSW 2480
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Attention Damian Chapelle

Dear Damian,

CRAWFORD SITE, EAST LISMORE - LOCAL DRAINAGE ASSESSMENT OF EXISTING WATER COURSES

Introduction

Further to your communications with Cameron Druery, we are pleased to provide this letter report on the preliminary local drainage assessment of existing water courses traversing the Crawford Site. The preliminary assessment has been undertaken to estimate peak flow rates and to provide preliminary dimensions for open channels required to drain external and local catchments.

The Crawford Site is bound by Crawford Road to the north, urban development and forested areas to the east, Skyline Road to the south and Military Road to the west. The site covers an area of approximately 60 hectares and contains three tributary overland flow paths that drain in an westerly direction towards Minaltrie Creek. A site locality plan is shown on **Diagram 1**.

Diagram 1 Site Locality Plan

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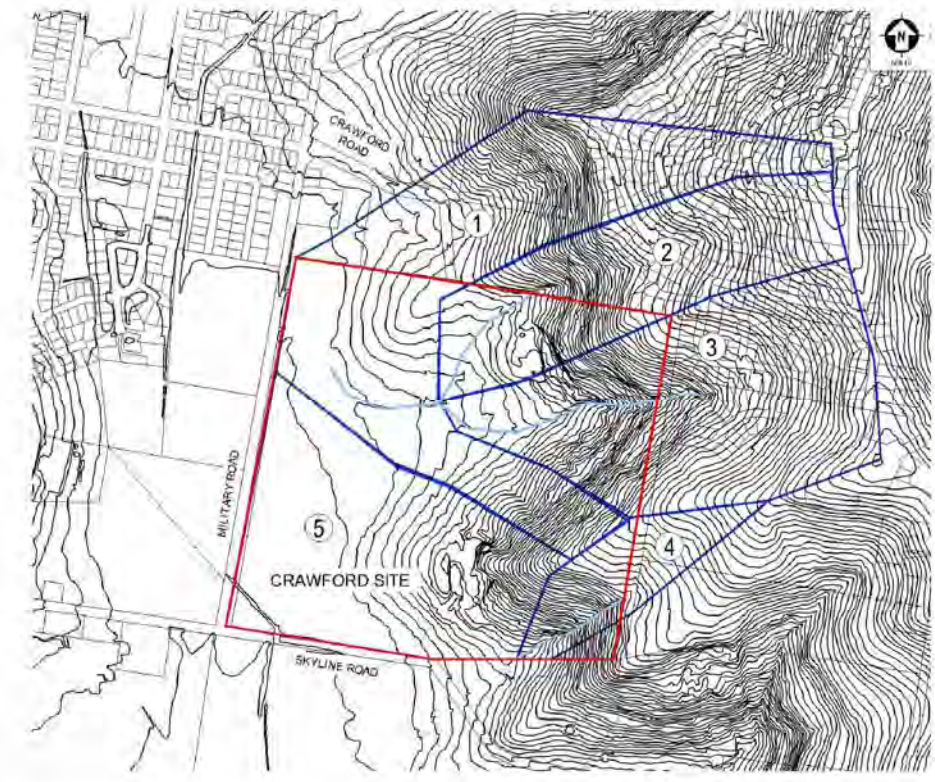
Catchment Characteristics

In order to estimate peak flow rates through the Crawford Site catchments were delineated based on 2.0 m ALS contours and watershed boundaries. In total five catchments were identified. In some instances catchment boundaries extended beyond the site boundary. Catchment parameters are included below in **Table 1** and shown on **Diagram 2**.

Table 1 Catchment Parameters

Catchment Name	Area (hectares)	Catchment Slope (%)	Percentage Impervious* (%)
1	34.0	7	50
2	19.0	14	50
3	28.8	13	50
4	6.6	17	50
5	23.9	11	50

Diagram 2 Catchment Boundaries



* Percentage impervious has been nominated for a post-development scenario

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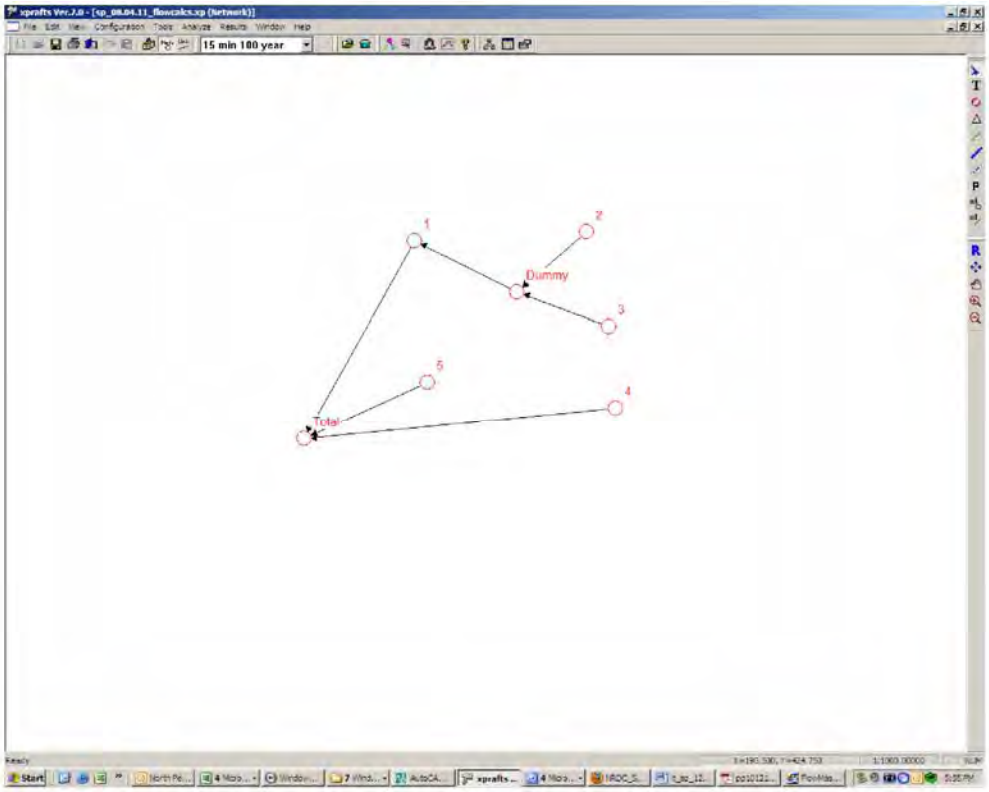
Hydrology

In order to estimate the proposed 5 year and 100 year Average Recurrence Interval (*ARI*) peak flows, a hydrologic model was created using XP-RAFTS.

The XP-RAFTS model was created to reflect the catchment parameters nominated in **Table 1** and used the recommended intensity-frequency-duration parameters for the Lismore area as set out in the '*Northern Rivers Local Government Handbook of Stormwater Drainage Design*', Version 1, 2007.

The XP-RAFTS network is shown below in **Diagram 3**.

Diagram 3 XP-RAFTS Network



Peak flow estimates for each of the 5 catchments are provided in **Table 2**.

Table 2 Peak Flow Estimates

Catchment	5 Year ARI Peak Flow (m^3/s)	100 Year ARI Peak Flow (m^3/s)
1	27	43
2	6	10
3	10	17
4	3	4
5	9	14

Hydraulics

Well defined overland flow paths are present in Catchments 1, 2, 3 and 4. Based on ALS contours and a current aerial photograph there does not appear to be evidence of an existing overland flow path in Catchment 5.

Preliminary 1-Dimensional hydraulic calculations have been undertaken using Manning's equation to estimate the channel geometry that would be required to accommodate the 100 year ARI peak flow rate through the proposed development. The required channel geometry will be dependant on the depth of flow, adopted channel slope and a Manning's "n" roughness coefficient.

For the purpose of this assessment, conservative (*i.e., less steep*) channel grades were adopted and a Manning's "n" coefficient of 0.03 (*representing a grass lined channel*) was used. These assumptions will need to be confirmed as appropriate by the consent authority. A series of potential channel geometries for the four existing creek lines is provided below in **Table 3**.

Table 3 Potential Channel Geometries

		Channel Width (rectangular channel)			
Catchment	Adopted Channel Slope	Channel Depth of 0.5 m	Channel Depth of 1.0 m	Channel Depth of 1.5 m	Channel Depth of 2.0 m
1	7%	16.1 m	5.9 m	3.7 m	2.8 m
2	5%	4.8 m	2.1 m	1.4 m	1.1 m
3	8%	6.3 m	2.6 m	1.8 m	1.4 m
4	10%	1.7 m	0.9 m	0.6 m	0.5 m

In addition to establishing the required channel geometries to convey the 100 year ARI flow, preliminary hydraulic calculations were undertaken to estimate the pipe diameter that would be required to drain the 5 year ARI flow that would discharge along the alignment of the existing overland flow path located in Catchment 2. Based on preliminary hydraulic calculations it is estimated that a 900 mm diameter pipe would be required.

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Conclusion

Preliminary hydrologic and hydraulic calculations have been undertaken to assist in the preparation of development application documentation for the Crawford Site. The advice provided is preliminary only and will need to be refined during the approval process to the satisfaction of the consent authorities.

Should you have any questions or require any additional information please do not hesitate to contact myself or Peter Tow on 8456 7225.

Regards

Sean PORTER
Engineer

Reviewed By

DC per

David STONE
Senior Engineer

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