4 CATCHMENT MODELLING

4.1 Preamble

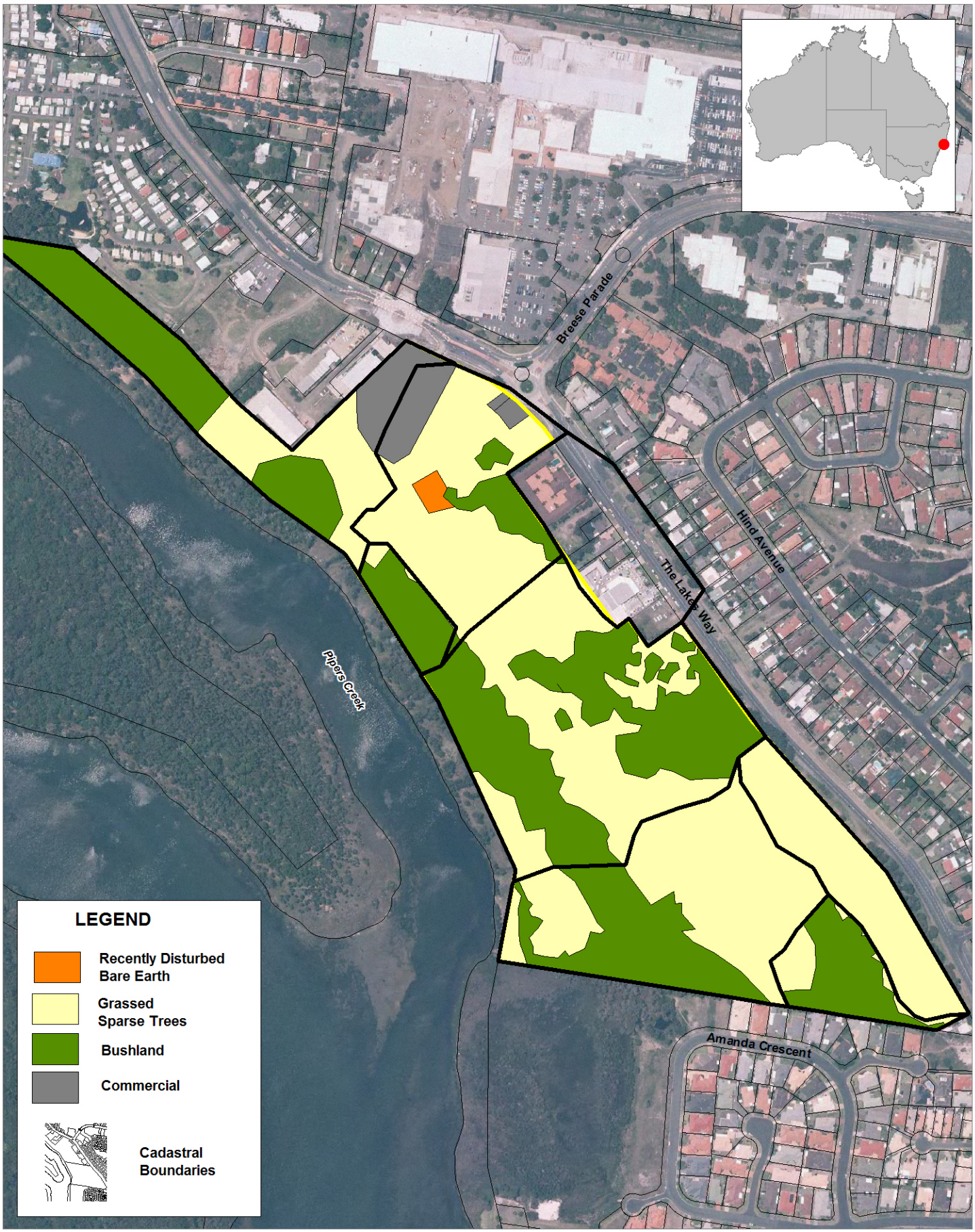
BMT WBM understands that Pipers Creek (the receiving waters for catchment runoff from the study area) has been identified as susceptible to impacts resulting from increased nutrient loading from development. Flushing of the Pipers Creek section of the lake can range up to 2-3 months, particularly during dry periods. Development in the catchment draining to Pipers Creek will only be permitted where it can be demonstrated that the water quality of Pipers Creek will not be degraded as a result of runoff from development within the creek catchment. Council has adopted an objective of a no-net-increase in nutrients and other pollutants from future development in the Pipers Creek catchment to achieve this objective.

4.2 Scope

A base scenario MUSIC model was prepared to estimate runoff volumes, and TSS, TP and TN loads for the existing site conditions. The approach undertaken to evaluate the existing catchment loads is summarised in the following sections.

4.3 Existing land use

Aerial photography was reviewed to estimate an appropriate land use / surface type distribution for the existing site configuration and this is shown in Figure 4-1. The land use distribution was applied to estimate catchment loads for the site.



Title:

Existing Landuse

Figure: 4-1

Rev: A

BMT WBM endeavours to ensure that the information provided in this map is correct at the time of publication. BMT WBM does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.

N

0 100 200m

Approx. Scale

BMT WBM

www.wbmpl.com.au

Filepath : C:\B17295.C.DCC\MAPPING\DRG\WQU_004_090426_Landuse.wor

The following areas for each land use were estimated:

- Bushland = 9.8 ha;
- Water storages/depressions (note that these are bare earth) = 3.4 ha;
- Commercial = 1.0 ha;
- Grass or lightly vegetated = 7.9 ha; and
- Recently disturbed = 2.3 ha.

All landuses apart from Commercial were assumed to be 100% pervious. Due to the presence of existing roofed buildings and compacted carparks on the site of the Lakeside Tavern and bottleshop, these were assumed to have a 50% perviousness. Figure 4-2 provides a recent photographic image of the Lakeside Tavern, Bottleshop and Carpark.

Figure 4-2 Lakeside Tavern, Bottleshop and Carpark

4.4 Rainfall-Runoff Parameters

The results of two studies were applied to estimate reasonable MUSIC rainfall-runoff parameters. One study undertaken by BMT WBM (2007) for 14 urban and non-urban catchments in NSW determined average rainfall-runoff parameters based on calibrated rainfall-runoff modelling using rainfall and stream flow data. A separate independent study by McLeod (2008) was undertaken to estimate rainfall-runoff parameters based on soil facets/characteristics. The rainfall-runoff parameters derived from these studies that are relevant to this site are summarised in Table 4-1.

Table 4-1MUSIC Rainfall-Runoff Parameters

Parameter	Existing Site	
	BMT WBM (2007) Parameters (hydrology)	McLeod (2008) Parameters (soil characteristics)
Impervious Area Parameters		
Rainfall threshold	1.0	1.0
Pervious Area Parameters		
Soil Storage capacity (mm)	175	215
Initial Storage (% of capacity)	30	30
Field Capacity (mm)	55	140
Infiltration Capacity Coefficient – a	215	250
Infiltration Capacity Exponent - b	2.4	1.3
Groundwater Properties		
Initial depth (mm)	10	10
Daily Recharge Rate (%)	55	60
Daily Baseflow Rate (%)	10	45
Daily Deep Seepage Rate (%)	0	0

The parameters in Table 4-1 were input to MUSIC and the models run to assess the suitability of each parameter set for the Site. The modelling results for the existing site hydrology are presented in Table 4-2.

Table 4-2 Existing site hydrology - MUSIC modelling results

Parameter	Existing Site Hydrology			
	BMT WBM (2007) Parameters (hydrology)		McLeod (2008) Parameters (soil type)	
	ML/yr	Water balance	ML/yr	Water balance
Rainfall	254	100%	254	100%
Surface Runoff	11	4%	11	4%
Base Flow	94	37%	47	19%
Evapotranspiration	149	59%	196	77%

The MUSIC modelling results for hydrology were then compared with estimates based on long-term regional hydrologic characteristics available from the Bureau of Meteorology (BoM) and the outcomes of a MUSIC model calibration study undertaken by BMT WBM (2007). The regional Average Annual Areal Actual Evapotranspiration maps published by BoM indicate that the long-term average evapotranspiration would be approximately 750mm for this site (refer Figure 4-3).

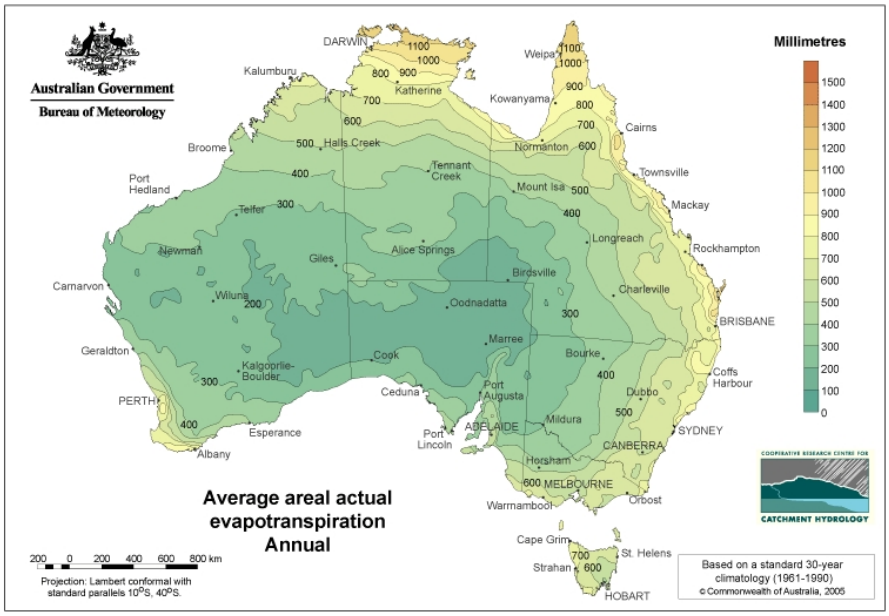


Figure 4-3 Average Areal Actual Annual ET (BoM, 2005)

The average annual rainfall (MAR) for the site is approximately 1150mm. Therefore, for a typical site in Forster approximately 65% (750/1150) of average annual rainfall would return to the atmosphere as evapotranspiration and approximately 35% of rainfall would become runoff (surface runoff and baseflow). In addition, based on the relationships shown in Figure 4-4, it is estimated that for a catchment with an average annual rainfall of 1150mm and effective imperviousness less than 5%, typically 32% of rainfall would become runoff (surface runoff + base flow).

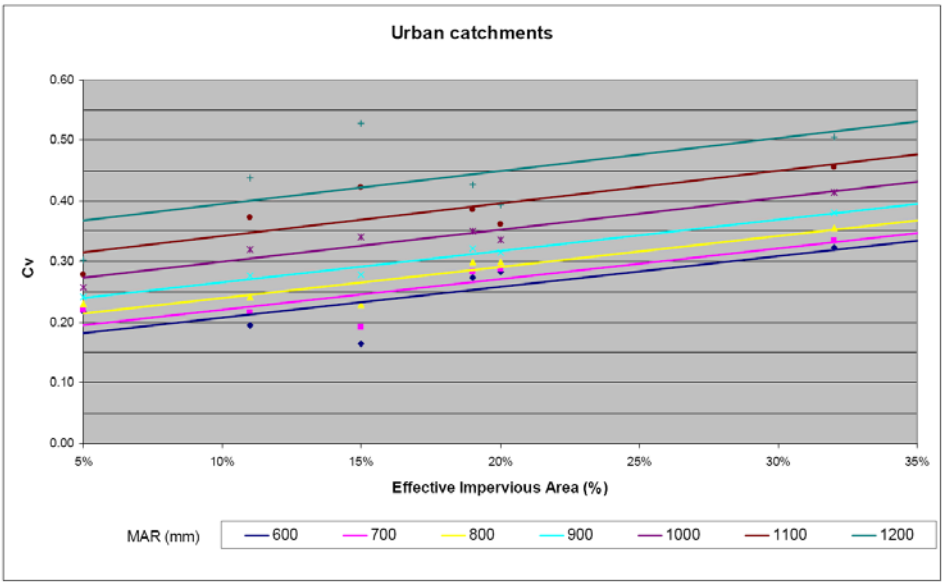


Figure 4-4 Typical Volumetric Runoff Coefficients (BMT WBM, 2007)

Based on the estimates of long-term hydrologic characteristics for the site it is estimated that the water balance distribution estimated applying the BMT WBM parameters provides a reasonable

representation of the typical distribution within Forster. These parameters were adopted for estimating the existing catchment loads.

4.5 Catchment Loads

There are limited water quality data available for runoff quality within the Great Lakes Council LGA. For this site, typical base flow and storm flow concentrations for common stormwater pollutants were adopted from a recent NSW wide study undertaken by the former Co-operative Research Centre for Catchment Hydrology (CRCCH) on behalf of the NSW Department of Environment and Climate Change. The mean adopted pollutant concentrations (normalised) are summarised in Table 4-3. MUSIC requires the concentrations to be input as log_{10} concentrations and these inputs for TSS, TP and TN are summarised in Table 4-4 and Table 4-5.

Table 4-3 Mean Adopted Concentration Parameters (mg/L)

	Stormflow			Baseflow		
	TSS	TP	TN	TSS	TP	TN
Land use/zoning						
Urban residential	140	0.25	2.0	16	0.14	1.3
Commercial	140	0.25	2.0	16	0.14	1.3
Rural	90	0.22	2.0	14	0.06	0.9
Agricultural	140	0.60	3.0	20	0.09	1.1
Forest	40	0.08	0.9	6	0.03	0.3
Surface type						
Roofs	20	0.13	2.0	16	0.14	1.3
Sealed roads	270	0.50	2.2	16	0.14	1.3
Unsealed roads	1000	0.50	2.2	16	0.14	1.3

Table 4-4 Base Flow Concentration Parameters for NSW (Fletcher et al, 2004)

Concentration (mg/L-log_{10})						
	TSS		TP		TN	
	mean	std. dev	mean	std. dev	Mean	std. dev
Land use/zoning						
Urban residential	1.20	0.17	-0.85	0.19	0.11	0.12
Commercial	1.20	0.17	-0.85	0.19	0.11	0.12
Rural	1.15	0.17	-1.22	0.19	-0.05	0.12
Agricultural	1.30	0.13	-1.05	0.13	0.04	0.13
Forest	0.78	0.13	-1.52	0.13	-0.52	0.13
Surface type						
Roofs	1.20	0.17	-0.85	0.19	0.11	0.12
Sealed roads	1.20	0.17	-0.85	0.19	0.11	0.12
Unsealed roads[1]	1.20	0.17	-0.85	0.19	0.11	0.12

Table 4-5 Storm Flow Concentration Parameters for NSW (Fletcher et al, 2004)

Concentration (mg/L-log$_{10}$)						
	TSS		TP		TN	
	mean	std. dev	mean	std. dev	Mean	std. dev
Land use/zoning						
Urban residential	2.15	0.32	-0.60	0.25	0.30	0.19
Commercial	2.15	0.32	-0.60	0.25	0.30	0.19
Rural	1.95	0.32	-0.66	0.25	0.30	0.19
Agricultural	2.15	0.31	-0.22	0.30	0.48	0.26
Forest	1.60	0.20	-1.10	0.22	-0.05	0.24
Surface type						
Roofs	1.30	0.32	-0.89	0.25	0.30	0.19
Sealed roads	2.43	0.32	-0.30	0.25	0.34	0.19
Unsealed roads[1]	3.00	0.32	-0.30	0.25	0.34	0.19

1. Additional surface type not included in Fletcher et al (2004).

Considering the existing land use/surface characteristics shown in Figure 4-1, the following parameters were adopted based on the land use zonings in Table 4-4 and Table 4-5.

- Bushland – adopt FOREST parameters;
- Commercial – adopt COMMERCIAL parameters;
- Grass or lightly vegetated – adopt RURAL parameters; and
- Recently disturbed (large stockpile) – adopt AGRICULTURAL parameters.

Although the presence of water storages has been noted on site, conservatively, this storage has not been modeled within MUSIC, as the storage appears to be an informal sediment type basin, potentially built to capture sediment laden stormwater from land disturbing activities. It is unlikely that this site feature will remain in future site development scenarios. This assumption is conservative in the sense that the site generates very low overland flow runoff volumes and it will over tend to slightly overestimate the pollutant export.

4.6 Model Results

A MUSIC model was prepared adopting the existing land use/surface characteristics presented in Figure 4-1, rainfall-runoff parameters outlined in Table 4-1 and applicable runoff concentration parameters in Table 4-4 and Table 4-5.

The estimated catchment loads for the existing site are-:

- Flow = 102 ML/yr;
- TSS = 2,440 kg/yr;
- TP = 7.45 kg/yr; and
- TN = 83.1 kg/yr.

4.7 Indicative Approach to Management of Stormwater from Future Development

Stormwater management approaches for any planned development will feature in the Stage 2 report for the site.

Approaches to stormwater management will need to be cognisant of the likely changes in runoff volumes and quality from the site, particularly if the proposed development contains a large percentage of hardstand area, such as roof and or carpark.

In the event of portions of the site being converted to essentially hardstand, the general stormwater management response would be to capture and reuse as much runoff as possible, primarily by the harvesting of roof water for reuse in such things as toilet flushing, cooling towers and landscape irrigation. Overflow from the harvesting tank(s) could be infiltrated into the groundwater to further reduce discharge quality and quantity.

Stormwater quality and quantity can be effectively managed by collection and treatment in distributed treatment systems such as bio-retention systems and infiltration systems.

If issues are noted with trying to achieve a non-worsening of pollutant discharges from the site, alternatives may need to be considered in conjunction with Council, such as offsets. The offset approach would require the developer to treatment stormwater from external catchments at locations on their site (such as stormwater runoff from the Lakes Way which presently discharges to the site). The offset approach provides Council the result they desire (i.e. net reductions in pollutant loads to creeks) and a practical alternative outcome for the developer.

5 REFERENCES

BMT WBM (2007) Rainfall Runoff Modelling Project, Prepared for NSW Department of Environment and Climate Change, BMT WBM Water and Environment - Newcastle, June 2007.

Bureau of Meteorology (2005), Climatic Atlas of Australia.

Campbell, B. (2009), Conics, Pers. Comm.

Coffey Geotechnics Pty Ltd (2008) Bulky Goods Store Lakes Way Forster. Report prepared for Woolworths Ltd.

DECC (2009), Draft Sea Level Rise Policy Statement.

DLWC (1998), Forster/Tuncurry Floodplain Management Study. Report prepared for Great Lakes Council.

Great Lakes Council (2008), Minutes of Ordinary Meeting, Section 16, October 2008. Accessed on Council's Website.

McLeod (2008,) Music Calibration Based on Soil Condition.

APPENDIX A: FLOOD LEVEL CERTIFICATE

Great Lakes COUNCIL

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PO Box 450 Forster NSW 2428
DX 7110 Forster
phone 02 6591 7222
fax 02 6591 7200
email council@greatlakes.nsw.gov.au

Cert. No 9 / 09

FLOOD LEVEL CERTIFICATE

Applicant

MARIAN HIGGINS TPG NSW PTY LTD
PO Box 1612
NORTH SYDNEY NSW 2059

Receipt No. : 748464
Date of Issue : 15 April 2009
Ref :

Property Key : 26012

Property Description

91 The Lakes Way, FORSTER NSW 2428
Lot 37 DP 1023220

Owner (as recorded by Council):

BOMBALA INVESTMENTS PTY LTD
33 The Lakes Way
FORSTER NSW 2428

FLOOD LEVEL DETAILS

The information available to council indicates that the property described in this certificate is flood affected to the estimated 1:100 year recurrence interval flood level (1% flood) of **RL 2.28 AHD.**

Notes:
This flood level certificate is limited to providing flood information that Council has in its procession in relation to flood studies or historical information and does not take into consideration Council's planning controls or policies. Should you require this information a copy of Council's Flood Management Policy can be provided or an application can be made for Planning Certificates 149(2) or 149(5).

It should be noted that this certificate is only as accurate as at the date of the flood study that it relies upon, therefore any further work or development carried out in the locality since the flood study will not be reflected in the information contained in this certificate. Copies of Flood Studies, Historical information, Management Studies and Plans are available for viewing at Council or on Council's website www.greatlakes.nsw.gov.au.

The information is provided to you without warranty or guarantee as to its accuracy and you should not rely upon the information provided. Should you require to rely upon information of the type provided, you should employ the services of a suitably qualified Engineer who will assist you in interpreting the information on your behalf.

Definitions: **Australian Height Datum** (AHD) : a common national surface level datum approximately corresponding to mean sea level.

Reduced Level (RL) : the height of a point relative to a specific datum level.

For further information, please contact
Engineering Services on (02) 6591 7273

KEITH O'LEARY
GENERAL MANAGER
Per: S.A. Nicholas

www.greatlakes.nsw.gov.au

APPENDIX B: ADVICE FROM LIDBURY, SUMMERS AND WHITEMAN

LIDBURY, SUMMERS & WHITEMAN
Consulting Surveyors, Planners & Engineers
Incorporating Degotardi, Smith & Partners (Forster)

LS&W

The Institution of Surveyors Australia
Registered under Real Property and Mining Acts

The Institution of ENGINEERS AUSTRALIA

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Partners
B. A. LIDBURY & ASSOCIATES PTY. LTD.
M. J. SUMMERS & ASSOCIATES PTY. LTD.
S. P. WHITEMAN & ASSOCIATES PTY. LTD.

Registered Surveyors
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Civil Engineers
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Your Ref:
Our Ref: 1010/W
Document Ref: 1010WEmail220409
Date: 22 April 2009

BMT WBM
PO Box 7059
BALLINA NSW 2478

Att: Damian Cavanagh

EMAIL: dcavanagh@wbmpl.com.au

RE: LANI & WOOLWORTHS SITE, FORSTER

Dear Sir,

Further to your recent inquiry we confirm –

1) The control level for the detail survey over the Woolworths site was SSM48606 (SCIMS search level of 2.41m AHD)
2) Yesterday we undertook static GPS control checks on PM48465 (RL5.168 by SCIMS, RL5.154 by 20 minutes static GPS compared to RL5.431 by LIDAR Control) the easting and northing only differed between us and SCIMS by .021m E and .004m N.
3) We levelled between 48465, 484466 & 48467 and agreed with SCIMS levels
4) To undertake these readings we used an independent mark located in Pioneer Drive Forster (SCIMS RL21.400 PM 45817)
5) We then undertook a 5 minute static GPS on SSM 48606 at the front of the Tavern and find by SCIMS 2.410m AHD and by us 2.449m AHD (**Please note** that this was a short observation. Also note that the Easting and Northing difference by us and SCIMS was 0.004m and 0.010m respectively).

Hence we have faith in the values of the SCIMS network and not the LIDAR control.

Please continue to use the survey levels as provided over the site.

Yours faithfully

BRIAN. A. LIDBURY
Registered Surveyor/Managing Director
cc. Simon Carroll (simon@coastplan.com.au)
cc. Mike Smith (mike.smith@greatlakes.nsw.gov.au)
cc. Brendan Soustal (brendan.soustal@greatlakes.nsw.gov.au)
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