

PROJECT
**HYDROLOGIC &
HYDRAULIC ASSESSMENT
ALTITUDE ASPIRE
TERRANORA ROAD
TERRANORA
NEW SOUTH WALES**

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SYNOPSIS This report describes the methodology and results of a hydrologic and hydraulic assessment undertaken to inform the preparation of the Preferred Project Report for the Altitude Aspire development at Terranora, New South Wales.

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SUMMARY

A hydrologic assessment was undertaken of the Altitude Aspire development site using the Rational Method and the Watershed Bounded Network Model (WBNM) to estimate peak flows within the catchment under existing and proposed developed conditions.

A 1D/2D hydraulic model was developed for the catchment using the Deltares modelling package, SOBEK, to quantify the impacts of the proposed development on flood levels, flows and velocities within the catchment and to design appropriate mitigation measures to ensure the development does not result in adverse impacts external to the site.

This report is a Hydrological and Hydraulic Assessment (HHA) report of the Altitude Aspire development site. It is a component of the Preferred Project Report for the development and describes:

- A hydrologic analysis of the catchment, pre- and post-development.
- Design of detention structures to meet flow requirements at the LPD.
- A hydraulic assessment to address flow velocities through the central drainage channel.

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1 Introduction

Newland Developers Pty Ltd commissioned Gilbert & Sutherland Pty Ltd (G&S) to prepare a Hydrologic & Hydraulic Assessment (HHA) in support of the Preferred Project Report (PPR) for the proposed residential subdivision, Altitude Aspire, located in Terranora, New South Wales (NSW).

1.1 Background

In November 2010, in response to the project's Director General's Environmental Assessment Requirements (DGRs), G&S prepared a report titled '*Conceptual Stormwater Assessment and Management Plan, Proposed Residential Development, Altitude Aspire Terranora, NSW*' (the CSWAMP). That report addressed peak flow management on a conceptual basis and provided general guidance on detention volumes required.

Following public exhibit of the project Environmental Assessment, the development layout was amended to consider State authority, Council and public submissions and to achieve consistency with Tweed Development Control Plan 2008, Section B24 – Area E Urban Release Development Code.

Then, in April 2012, G&S prepared a further report, '*Hydrologic and Hydraulic Assessment, Altitude Aspire, Terranora Road, Terranora*', expanding on the peak flow components of the CSWAMP, to address a revised layout and specific issues raised by Tweed Shire Council (TSC), NSW Department of Planning and Infrastructure (DOPI) and NSW Office of Water (NOW) following the exhibition process.

The HHA was submitted as a component of the draft PPR for the development and described:

- A hydrologic analysis of the catchment, pre- and post- development.
- Design of detention structures to meet flow requirements at the LPD.
- A hydraulic assessment to address flow velocities through the central drainage channel.

1.2 Revised Preferred Project Report

This report constitutes a revision of the HHA in response to comments received from TSC and (DOPI) regarding the Draft PPR, and is written in support of the Revised PPR application.

The items from the TSC and DOPI reviews of the Draft PPR relating to the HHA are reproduced below (in *italic* text), followed (in plain text) by references to additional information provided by this report in respect of each. This report demonstrates that the revised design satisfies each of the relevant conditions.

1.2.1 Tweed Shire Council issues

At the request of DOPI, TSC provided the proponent with a letter dated 20 July 2012 (ref: DA09/0701 LN35979) detailing 24 pages of feedback, including the following comments relevant to this report.

5. Lawful Point of Stormwater Discharge and Stormwater Management

The PPR concedes that the site does not currently have a lawful point of stormwater discharge, given that downstream land is within private ownership (Lot 227). Council is currently in negotiations with the applicant to prepare a VPA on various infrastructure matters, including stormwater drainage. The proposed approach is that prior to obtaining a subdivision certificate for the first stage of Altitude Aspire, Council will use its best endeavours to obtain a drainage easement over Lot 227 to provide a lawful point of discharge for the subject land and the rest of Area E. This will be at the applicant's expense. This process is subject to the successful finalisation and public exhibition of the VPA, including agreement on costs of the proposed works, as well as the success of the acquisition process for the easement. Refer to further discussion on the VPA below.

This is not the case. The site has a lawful point of discharge and this has been the focus of discussions with TSC. QUDM defines a lawful point of discharge as: "A point of discharge which is either under the control of a Local Authority or

Statutory Authority, or at which discharge rights have been granted by registered easement in favour of the Local Authority or Statutory Authority, and at which discharge from a development will not create a worse situation for downstream property owners than that which existed prior to development.”

The site contains a watercourse as defined by the New South Wales Office of Water (NOW) and therefore under its control. The proposed detention device ensures that discharge prior to and following development are sufficiently similar as to ensure no worsening for the downstream property.

Council's Development Engineer has reviewed the two revised stormwater management documents by Gilbert & Sutherland, being Stormwater Assessment & Management Plan (SWAMP), and Hydrologic & Hydraulic Assessment (HHA) both dated April 2012 and stated that the following design concepts and baseline parameters are raised for attention.

a. Relocate the detention storage area.

While the revised HHA removes the wetlands from the northern side of Broadwater Parkway, it now proffers a bunded detention area that covers approximately half of the 7(a) zoned land (that includes the SEPP14 EEC area). This is conceptually unsatisfactory as it conflicts with the objectives of the proposed conservation area and Vegetation Management and Rehabilitation Plan.

The bund is located on the perimeter of the mapped SEPP 14 Coastal Wetland and within the proposed 50m vegetated buffer, and would segregate this area from the rest of the 7(a) zoned land.

The bund would result in clearing and disturbance of the area, the impacts of which have not been considered by the JWA Ecological Assessment

There would also be a conflict with the Vegetation Management & Rehabilitation Plan, which nominates this area as a

'Conservation Area' with natural and assisted revegetation.

Any detention/storage requirements should be implemented on the south side of Broadwater Parkway. Water quality control is focused there, and water quantity control should be as well.

Following discussions with TSC, since the above conditions were issued, it has been agreed that conceptually, a bunded detention area downstream of Broadwater Parkway may be acceptable subject to ensuring it does not adversely impact on the hydrologic regime within the bunded area of the EEC. The results of the revised hydraulic assessment, presented within this report, demonstrate that the hydrologic regime of the wetland is significantly different post-development.

b. The HHA is missing:

i. "Section 5.3" which should have design information on the "detention device" as referenced on page 13.

Noted. This typographical error (referencing Section 5.3 instead of 5.2) has been rectified.

ii. Drawing 207 - which should have details on the stormwater channel road crossing, as referenced on page 15.

Noted. The typographical error (having labelled two different drawings with the same drawing number) has been rectified.

6. Potential Flood Hazard in Central Drainage Area

The revised subdivision and landforming plans remove most of the residential allotments and bulk filling from the central drainage area. Land allocated for townhouse development on the western side of the drain is retained, but is well elevated above likely flood levels. Detailed assessment of the PPR is required to ensure that risks of inundation and slope stability are properly addressed in this area, however this can generally be dealt with via consent conditions should the information in the PPR be insufficient.

Noted. The results of the hydraulic assessment contained herein demonstrate that all areas of the site proposed for development (including the area proposed for townhouse development) are free from inundation during all local storm events up to and including the 100 year ARI storm event.

1.2.2 New South Wales Department of Planning & Infrastructure issues

DOPI provided the proponent with a letter dated 4 December 2012 (ref: MP09_0166) detailing 17 pages of issues, including the following matters relevant to this report.

5. Ecological Considerations and the Conservation Area

a) Buffer to SEPP14 wetland – a 100 metre buffer is required (or provide justification if a smaller buffer is proposed), which does not include any infrastructure (including WSUD measures). This buffer should be clearly illustrated on the revised PPR plan with no infrastructure. Furthermore, the revised PPR must demonstrate/confirm that stormwater discharge onto Lot 227 (external to the site), which contains the SEPP 14 wetlands, is suitable in terms of water quality and quantity (owner's consent must be provided and implemented in the VPA documentation in the PPR).

The assessment described in the separate SWA report demonstrates that the proposed development meets all requirements with respect to water quality treatment of site runoff. All the proposed WSUD measures described within this report are located within the site and to the south of Broadwater Parkway, and thus outside the required buffer. All treatment devices flow to an appropriate LPD.

The assessment described in this report demonstrates that the proposed development results in no significant adverse impacts in terms of stormwater quantity and thus is suitable for discharge.

b) Wetland hydrology – there are no specific actions to maintain or mitigate changes to the wetland hydrology. Therefore

the revised PPR is required to consider potential impacts on wetland hydrology and vegetation communities to ensure impacts are avoided or minimized.

It is unclear what this reference specifically relates to. However, the proposal as described and assessed herein maintains the hydrology of the adjacent wetland by ensuring the flow regime from the site is regulated. Flow mixing, tidal exchange and flow characteristics in the low lying areas of the wetland have been considered in the modelling.

g) Infrastructure in the Conservation Area – the integrity of the conservation areas should not be compromised by infrastructure and other additional uses. The maintenance of this portion of the site has significant potential to compromise the ecological benefits obtained in this area. The effects of construction and maintenance of any infrastructure should be assessed and avoided where possible. In particular, the Coastal EEC and the remainder of the proposed conservation area will be potentially affected by the proposed stormwater flow mitigation bund and sewer mains as outlined in the Hydrological Report prepared by Gilbert and Sutherland dated April 2012 lodged with the Draft PPR. Furthermore, the Coastal wetland EEC will potentially be affected by the proposed transmission line.

Accordingly, this issue needs further consideration and the transmission easement and other infrastructure must be removed from the conservation area (Lot 1001) in the revised PPR.

Noted. With respect to the stormwater bund, please refer to our response to TSC item 5a above.

7. Infrastructure

a) Relocation of the proposed detention storage area/bund – The Hydrologic & Hydraulic Assessment prepared by Gilbert & Sutherland for the draft PPR dated April 2012 ('the HH Report') proposes a bunded

detention area within the 7(a) zoned land on the northern side of Broadwater Parkway and within the proposed conservation area containing the Freshwater Wetland EEC. The proposed bund covers approximately half of the 7(a) zoned land and is located on the perimeter of the mapped SEPP 14 Wetland, within the proposed vegetation buffer which would segregate this land from the remainder of the 7(a) land.

This location is not supported given it is contrary to the objectives of, and in direct conflict with, the conservation area and the Vegetation Management and Rehabilitation Plan (VMRP) in relation to the potential clearing and disturbance of the area. Detention and bunding (water quantity) on the southern side of Broadwater Parkway (with the water quality measures) is required. A revised layout in the revised PPR and the HH Report are required.

Noted. Please refer to our response to TSC item 5a above.

c) Errors/Mis-descriptions in the Hydrologic & Hydraulic Assessment Report – there are some aspects of the HH Report which requirement amendment, including the report missing ‘section 5.3’, which should have design information on the “detention device” as referenced on page 13 and Drawing 207 should have details on the stormwater channel road crossing as referenced on Page 15. These details need to be provided.

Noted. Please refer to our response to TSC item 5b above.

9. Hazards

b) Flooding – provide flood risk maps as per the Office of Environment and Heritage guidelines for both regional (Terranora Broadwater) and local catchment flooding and a combination of the two.

The NSW Office of Environment and Heritage’s Floodplain Development Manual (2005) states its primary objective (at ‘Foreward, at page i) as follows: “The primary objective of the NSW Government’s Flood Prone Land Policy is to reduce the impact of flooding and flood liability on individual owners and occupiers of flood prone property, and to reduce private and public losses resulting from floods.”

The Altitude Aspire site is located at the lower end of a catchment, adjacent to a wetland that is not occupied. Flooding behavior within the wetland external to the site is unchanged.

TSC has published flood risk maps applicable to the greater Tweed River catchment, including this site. There would appear to be little to gain from preparing further flood risk maps specific to the site.

1.3 Scope of this report

This hydrologic and hydraulic assessment is based on WBNM computer modelling to quantify discharge from the site and SOBEK 1D/2D modelling of the hydraulic behavior of the drainage channel.

2 Site description and proposal

2.1 Location

The site location is shown on Drawing No 10849-201 (provided in Appendix 1 of this report). The site has an approximate area of 36ha and is located off Fraser Drive and Terranora Road at Terranora, New South Wales.

Based on the revised layout, the proposed development consists of 251 residential allotments, a network of roads connecting the lots, open spaces and parks, a proposed community centre and designated environmental conservation areas.

2.2 Existing development

The majority of the site has been extensively cleared, drained and used for agricultural and or grazing purposes. There are four existing farm dams that have been constructed and are located within the central drainage corridor through the site. Additionally there are several dwellings and sheds located adjacent to the eastern and western site boundaries. The existing development is shown on Drawing No. 10849-202.

2.3 Proposed development

The proposed Altitude Aspire development involves the construction of a system of roads to provide access to 251 residential allotments.

Construction of a drainage channel through the centre of the site is proposed to convey runoff from the upstream catchment through the site. Additionally, a number of stormwater management measures would be constructed within the existing drainage corridor for treatment of site runoff and flow control purposes. The balance of the site would be dedicated to open space and land zoned environmental protection.

The proposed development, as shown on Drawing No. 10849-203, has a total area of approximately 36ha. The Altitude Aspire Subdivision Layout Plan

(prepared by B&P Surveys and included in Appendix 4) proposes the creation of a residential community that will form part of and be integrated into the Terranora Area E Urban Land Release.

The proposed development would comprise the construction and/or installation of the following components:

- site earthworks
- roads
- stormwater drains
- sewer reticulation mains
- water reticulation mains
- underground electricity distribution cables
- telecommunication cables
- other ancillary services
- dwellings
- landscaping.

Once the development has been completed, all disturbed portions of the site will be rehabilitated or covered by some form of improvement protecting the soils from erosion, hence minimising the transport of suspended solids from the site. These improvements will include structures, paved areas, lawns and landscaping.

2.4 Catchment description

The catchment within which the development is located occupies approximately 69ha, extending from a ridge defined by Terranora Road in the south to the fringe of the Terranora Broadwater floodplain in the north. The catchment ranges in elevation from 132mAHD in the south to 0mAHD in the north.

The upper part of the catchment is occupied by existing low-density residential development and drains to a central gully that directs flow into the site from the south.

The site occupies the lower portion (approximately half) of the catchment and drains to a well-defined central drainage corridor that also conveys discharge from the upstream catchment to the legal point of discharge (LPD) on the site's northern boundary.

The majority of the catchment is characterised by very steep slopes (>15%) which abruptly flatten out when they intersect with the floodplain at the northern end of the site.

The steep nature of the catchment causes specific challenges for management of flows and velocities throughout the site.

2.5 Receiving environment

Runoff from this development flows in a north-easterly or north-westerly direction towards a central ephemeral gully that traverses the site from south to north. Runoff from this gully discharges onto the SEPP 14 wetland area, which is essentially flat, semi-tidal and drained by a number of agricultural drains that discharge into the Terranora Broadwater. Terranora Broadwater adjoins the Tweed River, which discharges into the Pacific Ocean at Tweed Heads.

3 Hydrologic assessment method

A hydrologic assessment was undertaken to estimate peak flows upstream of, within and discharging from the site under a range of rainfall events and to generate inflow hydrographs for input into a hydraulic model of the central drainage channel. This assessment was carried out using the Watershed Bounded Network Model (WBNM) computer modelling software, with verification of the generated flows against the Rational Method.

3.1 Rational Method

The Rational Method (Section 4.03 QUDM¹) is flexible in its data requirements and is able to produce satisfactory estimates of peak discharges from a catchment with the following data input:

- local intensity – frequency – duration data
- catchment areas
- runoff coefficients.

Discharge using the Rational Method is calculated by:

$$Q = \frac{F_Y C_{10} I A}{360}$$

where: Q = Peak flow (m³/s)

F_Y = Frequency factor

C_{10} = Runoff coefficient (10yr)

I = Rainfall intensity (mm/hr)

A = Catchment area (ha)

Peak discharges at the site's Lawful Point of Discharge (LPD) were estimated for pre-developed conditions for events with average recurrence intervals (ARI) of between 1 and 100 years.

¹ Queensland Department of Natural Resources & Water, 2007, *Queensland Urban Drainage Manual*, Edn 2, Department of Natural Resources & Water, Brisbane.

3.1.1 Time of concentration

The time of concentration (t_c) for the catchment, with the site in a pre-developed state, was estimated using the Bransby Williams equation in accordance with the recommendations contained in QUDM. Details of the assumptions for these calculations are shown herein.

Bransby Williams Equation

$$t_c = \frac{92.7}{A^{0.1} S^{0.2}}$$

where: t_c = Time of concentration (min)

L = Longest flow path length (km)

A = Catchment area (ha)

S = Equal area slope (m/km)

The time of concentration for the catchment is shown in Table 3.1.1.

Table 3.1.1 Time of concentration by Bransby Williams Equation

Parameter	Value
L	1.61 km
A	68.61 ha
S	59.7 m/km
t_c	43 minutes

3.1.2 Rainfall intensity-frequency-duration data

Rainfall intensities for the simulation of design rainfall events were calculated using the polynomial factors obtained from the Bureau of Meteorology. The values for the factors used and resultant IFD Table are provided in Appendix 2. It is noted that these intensities are slightly higher than those provided in Table D5.1 of Tweed Shire Council's Development Design Specification D5 Stormwater Drainage Design (TSC D5), particularly for 100 year ARI events.

3.1.3 Runoff coefficients

The runoff coefficient for the 10 year (C_{10}) average recurrence interval (ARI) was estimated as per recommendations in Section 4.05 of QUDM 2007.

For the existing upstream development which is low density residential, a fraction impervious of

0.40 was selected from Table 4.05.1. This value when referenced in Table 4.05.3(a) provides a C_{10} value of 0.78.

For the proposed development site in its undeveloped state the fraction impervious is assumed to be zero. Table 4.05.3(b) then indicates that for a site with good grass cover and medium permeability, a value of 0.70 should be adopted for C_{10} .

The resultant runoff coefficient (C_{10}) for the catchment was calculated to be 0.74.

3.2 WBNM modelling

The Watershed Bounded Network Model (WBNM) is an event-based hydrologic model that calculates flood hydrographs from storm rainfall hyetographs. It can be used for modelling natural, partially developed and fully developed catchments.

For developed catchments, it calculates runoff from pervious and impervious surfaces and routes it through the major system of open watercourses.

WBNM does not model the details of piped drainage systems. It can be used to generate hydrographs from an actual storm event and or a design storm utilising Intensity – Frequency – Duration (IFD) data together with dimensionless storm temporal patterns.

The WBNM model is flexible in its data requirements and is able to produce satisfactory results with the following data input:

- local intensity frequency duration data
- design temporal patterns
- subcatchment areas
- impervious areas.

The modelled flows were verified against the Rational Method flows for the eastern catchment.

3.2.1 Storm data

The rainfall intensities described in Section 3.1.2 were adopted for the simulation of the design

rainfall events. The temporal patterns used were adopted from Book 2 of Australian Rainfall and Runoff 1998 (AR&R).

Losses used in the modelling were estimated in order to replicate the flows calculated using the Rational Method.

Losses were determined in conjunction with the recommendations contained in the XP-RAFTS reference manual and those published in Australian Rainfall and Runoff 1998, Book 2, Design Rainfall Considerations, Section 3.4. The losses adopted for this catchment are shown in Table 3.2.1.

Table 3.2.1 Model losses

Storm ARI (years)	Pervious Initial loss (mm)	Pervious Continuing loss (mm)	Impervious Initial loss (mm)
1	15	1.5	0.5
2	15	1.5	0.5
5	12	1.5	0.5
10	10	1.5	0.5
20	5	1.5	0.5
50	2.5	1.5	0.5
100	0	1.5	0.5

3.3 Peak flow site characteristics

The physical characteristics of the catchment are described in Section 2 of this report. In its current state (pre-development scenario), the site may be described as rural and an impervious fraction of zero has been adopted. This assumption is considered to be conservative as a few small buildings are currently located on the site.

Although rainwater storage tanks will be installed to collect runoff from roof areas, it has been assumed that the tanks may be full at the start of the critical storm and thus have not been included as part of the detention storage.

4 Hydrologic assessment results

4.1 Rational Method peak flows

The assumptions adopted to determine the peak flow rates discharging from the catchment with the site in its present state are listed below:

- Runoff coefficient C_{10} 0.74
- Time of concentration t_c 43 min
- Catchment area A 68.61 ha

The resultant peak flow rates over the standard ARI events are shown Table 4.1.1.

Table 4.1.1 Peak flows by Rational Method

ARI (yrs)	$C_Y = F_Y \cdot C_{10}$	I (mm/hr)	Q (m ³ /s)
1	0.50	49.6	4.7
2	0.60	63.3	7.2
5	0.68	79.7	10.4
10	0.74	89.0	12.6
20	0.79	101.6	15.4
50	0.87	118.0	19.5
100	0.95	130.3	23.6

4.2 WBNM modelling results

The sub-catchments and WBNM model layout for the site under existing conditions are shown on Drawing No. 10849-204.

4.2.1 Existing Case

The inputs and assumptions detailed above were incorporated into the WBNM model to generate hydrographs for the site. Peak catchment discharges were estimated for storms with durations ranging from 5 minutes to 6 hours for each standard ARI.

A lag parameter (C) value of 1.80 was adopted based on the recommended value in the WBNM documentation. A stream lag factor of 1.0 was used for routing along all flowpaths representing flow through a natural channel.

The peak flows of the generated hydrographs at the downstream boundary of the eastern catchment under a range of rainfall events are shown in Table 4.2.1 for verification against the Rational Method flows.

Table 4.2.1 WBNM modelled and Rational Method peak flow comparison at LPD

ARI (years)	Rational Method (m ³ /s)	WBNM existing (m ³ /s)
1	4.7	6.0
2	7.2	8.8
5	10.4	13.0
10	12.6	15.6
20	15.4	19.3
50	19.5	22.5
100	23.6	25.8

The WBNM modelling results are comparable to the Rational Method flows and thus, the modelled flows are considered acceptable.

4.2.2 Developed Case

The sub-catchments and WBNM model were then modified to reflect the proposed development as described Drawing No. 10849-203. The developed sub-catchments adopted in the modeling are shown on Drawing No. 10849-205.

The total catchment area contributing runoff to the site's LPD, under developed conditions is 69.71ha. The increase in catchment area, when compared to existing conditions, is due to the routing of runoff from all developed areas within the site to the central drainage channel for stormwater quality treatment, where a portion of the site discharges to the northwest under existing conditions.

To represent the proposed development within the model, a fraction impervious of 0.80 (for Low Density Residential development including roads) has been adopted across the site, with the exception of the central drainage corridor for which a zero fraction impervious as been adopted.

The modelled peak flows at the LPD including the proposed development are provided in Table 4.2.2 for comparison to the pre-developed flows.

Table 4.2.2 WBNM modelled developed peak flows at LPD

ARI (yrs)	Existing (m ³ /s)	Developed (m ³ /s)
1	6.0	8.9
2	8.8	12.3
5	13.0	16.7
10	15.6	19.2
20	19.3	22.9
50	22.5	26.3
100	25.8	29.7

The results indicate that the development leads to an increase in peak discharge at the LPD and thus flow mitigation measures will be required.

4.3 Detention storage design

It is intended to provide flow attenuation for the development using an online end-of-line surface detention basin between the northernmost proposed road (Broadwater Parkway) and the northern site boundary.

Due to the steep nature of the catchment and the influence this topography will have on flow conveyance through this site, the hydraulic model (developed to estimate velocities through the site) provides a better estimate of flow routing and peak site discharge than the hydrologic model (WBNM). Accordingly, the hydraulic model (described in Section 5) was employed for designing a detention device for the development. The design of this device is discussed in Section 5.2.5.

5 Hydraulic assessment

5.1 Overview

A hydraulic assessment was undertaken to further quantify the impact of the proposed development of peak site discharge and to estimate flow velocities through the central drainage channel to inform the design of suitable hydraulic management measures.

Flows currently enter the site via an open channel from the south and traverse north through a series of farm dams in a gradually widening ephemeral gully that discharges across the northern site boundary into the Terranora Broadwater floodplain. For the purposes of the modelling, a 'pre-development' scenario has been adopted assuming that the farm dams have not been constructed and thus do not alter flow conveyance through the channel.

Under the proposed developed conditions, the flowpath through the site will be formalised and confined to a central drainage channel, as shown on Drawing No. 10849-203. Two road crossings are proposed. 'Road 2' is adjacent to the southern site boundary where flows enter the site, and the Broadwater Parkway is located at the downstream extent of the development within the site.

Flow attenuation for the development will be catered for using a bunded online storage between the Broadwater Parkway and the site boundary. Design of hydraulic structures for each crossing and for flow mitigation is described in the following sections.

5.2 Approach

To analyse the proposed development in relation to flooding and flood impacts, a fully dynamic 1D/2D flood model was established using the Deltares (formerly the Delft Hydraulics Institute) flood modelling package, SOBEK.

The model was set up to consider both the pre-development and post-development scenarios. The analysis presented assesses the development as currently proposed and

incorporates the flow attenuation as outlined in Section 4.

The latest version of the modelling has been refined to incorporate a 2-dimensional component representing the lower portion of the site and the SEPP14 wetland area to the north of the site. This has allowed for a better representation of the hydraulic behaviour through this area (where no major flowpath is defined) and for better representation of the downstream boundary conditions for the model.

The model has been setup using a combined 1D/2D schematisation. The steeper portion of the site, to the south of Broadwater Parkway, where the flowpath can be easily defined, has been represented in the model by a one-dimensional channel. To the north of the Broadwater Parkway, where the topography flattens and there is no clearly defined drainage path, a two-dimensional grid has been adopted. The approach used in setting up the model is as follows.

5.2.1 Establish a Base Case model

Cross sectional profiles along the central drainage corridor (south of the Broadwater Parkway) were created using ground survey data for the site, undertaken by B & P Surveys.

Downstream of Broadwater Parkway, a two-dimensional grid has been setup representing the existing topography in this region. Beginning with TSC's Tweed Valley Regional Flood Model DEM, a 5m grid resolution was adopted for the 2D component of the G&S model. This resolution provides adequate detail for assessment of stormwater detention requirements.

A surface roughness, Mannings 'n' value of 0.05 was adopted for the site in the Base Case model, based on the recommendations contained within the HEC-RAS v4.1 Reference Manual (Table 3-1) and represents scattered brush with heavy weeds. Downstream of the site, the more dense vegetation in the SEPP14 Coastal Wetland has been represented by a surface roughness of 0.10.

The pre-developed SOBEK model layout is shown on Drawing No. 10849-206.

5.2.2 Determine boundary conditions

The site discharges into an area of the Terranora Broadwater floodplain that is contained behind tidal gates and thus not subject to the full tidal influence of the Broadwater itself. As the operating conditions of the tidal gates are not known, the Mean High Water Springs (MHWS) level of RL0.61mAHD in the broadwater, has been adopted as the tailwater condition for design purposes within the modelling. This assumption is considered appropriate as a low tailwater level:

- provides less hindrance to flow within the site and thus results in the highest velocities to consider in the design
- allows free-draining outlet from the proposed detention device to ensure the device adequately attenuates site discharge in the absence of a regional flood event.

Sensitivity testing of the final design has also been carried out using the regional 100 year ARI flood level of 2.9mAHD to estimate peak flood levels within the site, and is described in Section 5.2.7.

Although a substantial external catchment to the north-east of the site also drains to the SEPP14 Coastal Wetland included in the model domain downstream of the site, flows from this external catchment have been excluded from the modelling of local catchment discharge. This allows an assessment of the performance of the detention device with respect to site discharge in isolation, without ‘dampening’ any impacts against a large discharge from the adjacent catchment.

Coincident flooding with the external catchment runoff is considered to be included in the overall regional tailwater condition applied for sensitivity testing.

5.2.3 Hydraulic simulation

The base case model was run to establish existing velocities within and flows discharging from the site for a range of design storm events based on flow hydrographs from WBNM model for the ARI 1 to 100 year events.

In determining the flows entering the site, it has been assumed that the upstream catchment (to

the south of the site) is fully developed with no flow attenuation measures in place.

Peak flood levels, flows and velocities have been extracted from the model at each cross section, and nominated reporting points within the 2D domain, and are provided in Appendix 3. The peak discharge across the nominated reporting line (an off-site reference point indicated on Drawing No. 10849-206), is provided in Table 5.2.1. Although the off-site reference point is located downstream of the site boundary, it has been selected for the purposes of reporting discharge from the development as it is downstream of all proposed earthworks, including the construction of Broadwater Parkway (which extends beyond the site boundary) and thus accounts for all impacts of the proposed development. This approach results in modelling outputs that adequately represent hydraulic behaviour at the LPD.

Table 5.2.1 Peak site discharge for Base Case

ARI (yrs)	Peak discharge (m ³ /s)
1	4.1
2	6.7
5	10.7
10	13.3
20	17.1
50	20.5
100	23.9

The results in the above table indicate that the peak site discharge estimated using the hydraulic model is slightly lower than that of the hydrologic model alone. This would be expected as the hydrologic (WBNM) model algorithm does not consider the natural attenuation provided by the low flat topography and thick vegetation within the SEPP14 Coastal Wetland.

5.2.4 Create a Developed Case model

The model was adjusted to include the proposed development using the design surface supplied by BradLees Consulting on 22 February 2013.

The design drainage channel is trapezoidal in shape, with a base width of 3m, side slopes of 1v:3h and a depth of 2m and is intended to

contain all flows traversing the site. The design channel form has a small meander, resulting in a longer flowpath when compared to the Base Case.

A Manning's 'n' value of 0.043 has been used to represent 'long grass' within the design channel, as per Section 13 of Tweed Shire Council's Development Design Specification for Stormwater (D5). Upstream of the site, and downstream of the Broadwater Parkway, the Manning's 'n' values from the Base Case model have been maintained.

The proposed development includes two road crossings. Culverts have been sized to convey the design flows through each crossing based on the following criteria:

- Road 2 (south): no upstream water level afflux impacting offsite.
- Broadwater Parkway (north): (a) flood immunity for road during local flood events; and (b) minimum cover of 0.6m between inlet obvert and road level at culvert location.

Details of the modelled road crossings are provided in Table 5.2.2 (bottom of this page).

The model was then re-run using the Developed Case inflow hydrographs generated from the WBNM model for the same design storm events as for the Base Case. The Developed Case Sobek model layout is shown on Drawing No. 10849-207.

The resultant peak flows at the site's LPD are provided in Table 5.2.3. Full results at each modelled cross section and nominated reporting points within the 2D domain are in Appendix 3. As discussed in Section 4.2, the increase in peak site discharge will require flow attenuation measures to be implemented.

Table 5.2.3 Peak site discharge for Developed Case

ARI (yrs)	Peak discharge (m ³ /s)
1	5.7
2	8.8
5	13.3
10	16.0
20	19.7
50	23.4
100	27.0

5.2.5 Final detention design

As discussed in Section 4.3, it is intended to provide flow attenuation for the development using an online end-of-line surface detention basin between the Broadwater Parkway and the northern site boundary, as shown on Drawing No. 10849-207.

The detention storage would be provided by raising and extending an existing low-level bund along the northern site boundary to a level of approximately 2.2m AHD.

For the purposes of the current modelling, outlets from the detention area have been modelled at multiple locations along the bund, corresponding with depressions in the natural topography to ensure the hydraulic regime within the EEC can be maintained.

Details of the modelled outlets from the bundled detention area are included in Table 5.2.3 (following page). The profile of the outlet weir is shown on Drawing No. 10849-207.

The modelled outlets are subject to refinement during detailed design.

Table 5.2.2 Internal road crossings – modelled culvert details

Crossing	Type	Length (m)	Upstream IL (mAHD)	Downstream IL (M AHD)	Width/ Diameter (m)	Height (m)	No. of barrels
Road 2	RCP	24	13.9	13.8	1.5	n/a	6
Broadwater Parkway	RCBC	30	1.50	1.20	1.5	1.2	6

Notes: (a) The crossing details adopted in the modelling are indicative of the final culvert capacity required for each crossing and are subject to detailed design. (b) Due to its proximity to the upstream site boundary, the Road 2 crossing will most likely be constructed using a bebo arch (in place of the modelled culverts). Detailed design of this structure will ensure no upstream hydraulic impacts.

Table 5.2.3 Detention outlet details included in modelling

Structure	Type	Length (m)	Invert level (mAHD)	Width (m)	Height (m)	No. of barrels
1	RCBC	5	0.5	1.2	1.5	1
2	RCBC	5	0.8	1.2	1.2	2
3	WEIR	Invert level = 1.5mAHD (refer to Drawing 10849-207 for weir profile)				

5.2.6 Hydraulic modeling results

The resultant attenuated flows at the LPD are provided in Table 5.2.4 for comparison to the Base Case flows.

Table 5.2.4 Attenuated peak site discharge estimated by SOBEK model

ARI (yrs)	Base Case (m ³ /s)	Developed Attenuated Case (m ³ /s)
1	4.1	4.5
2	6.7	6.6
5	10.7	10.5
10	13.3	13.0
20	17.1	16.7
50	20.5	19.9
100	23.9	23.3

These results indicate that the proposed detention storage has sufficient capacity and appropriately sized outlet works to attenuate the Developed Case flows to rates comparable to the Base Case.

The resulting 100 year ARI flood inundation level is shown on Drawing No. 10849-208, whilst peak flood levels, depths, flows and velocities have been extracted from the model at each cross section and nominated reporting points within the 2D domain and are presented in Appendix 3.

Due to the steep nature of the site, the velocities in the channel under both existing and developed conditions are considered to be high and design of suitable methods to manage velocities within the site will be undertaken at the detailed design phase of the project.

5.2.7 Coincident regional flooding

As discussed in Section 5.2.2, sensitivity testing was carried out to estimate the maximum flood levels for the development, in particular, with

respect to the design surface level of Broadwater Parkway under coincident regional and local flood events, adopting a regional tailwater level of 2.9mAHD.

The results of this analysis indicate that under a combined 100 year ARI local storm and 100 year ARI regional tailwater, the Broadwater Parkway (approximate sag elevation of 2.69mAHD) would be inundated to a maximum depth of 0.21m. The corresponding peak velocity over the road is 0.03m/s, yielding a velocity-depth product of 0.006m²/s, which is below the safety threshold of 0.4m²/s and is thus considered acceptable.

Complete results for the sensitivity analysis are provided in Appendix 3.

5.2.8 Wetland hydrology in EEC

The detention storage area, between the Broadwater Parkway and the site boundary, overlaps a Freshwater Wetland EEC. As such, maintenance of the existing hydraulic regime within this area is a design objective.

The results of the hydraulic assessment indicate that although the peak flood levels during a local storm event will be increased when compared to existing conditions, the increase will be temporary and only for a short duration (approximately 9 hours) following each storm event. Plots of the estimated water levels within the EEC are included in Appendix 3.

Furthermore, the peak flood levels within the bunded detention area are significantly lower than regional flood levels (from the Terranora Broadwater) in this region. The minor changes to the hydrologic regime during local events is within variance of hydrologic conditions currently experienced in the EEC.

6 Conclusion

A hydrologic and hydraulic analysis has been prepared for the proposed Altitude Aspire development.

Peak site discharge rates for the Base Case have been established and the modelling has demonstrated that, providing the recommended detention storage volume is included in the detailed design, increased flows resulting from the development can be mitigated to rates comparable with the Base Case.

The modelling has also defined velocities within the drainage channel under developed conditions to inform the design and implementation of suitable management measures.

A sensitivity analysis has been carried out to assess peak flood levels in the case of coincident flooding from a regional flood event and local design storm event.

The assessment indicates the proposed development, will result in no adverse impacts on peak site discharge and peak flood levels external to the site.

7 Appendix 1 – G & S drawings




ORIENTATION
NORTH

SCALE
100 200 300 400 500
metres

ROBINA
PO Box 4115 Robina QLD4230 07 5578 9944
Email robina@access.gs www.access.gs

LEGEND

— Site boundary

SOURCES

Image source: Tweed Shire Council 'Area E' Aerial Photography
Image date: May 2007
(supplied by B&P Surveys 17/04/2013)

Background DCDB: supplied by B&P surveys
Received:17/04/2013

PROJECT

ALTITUDE ASPIRE
FRASER DRIVE
TERRANORA
NEW SOUTH WALES

CLIENT

NEWLAND
DEVELOPERS
PTY LTD

DRAWING

SITE
LOCATION

SCALE 1:10 000@A3	DATE 19/04/2013	DRAWN AJF	CHECKED CMA	PROJECT NO 10849	DRAWING NO 201
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Brisbane Sydney Melbourne and regions

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ORIENTATION
NORTH
SCALE
40 80 120 160 200
metres
ROBINA
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Email robina@access.gs www.access.gs

LEGEND
— Site boundary
— 0.5m contours
— 2.5m contours

SOURCES
Image source: Google Earth Pro
Image date: 24/06/2011

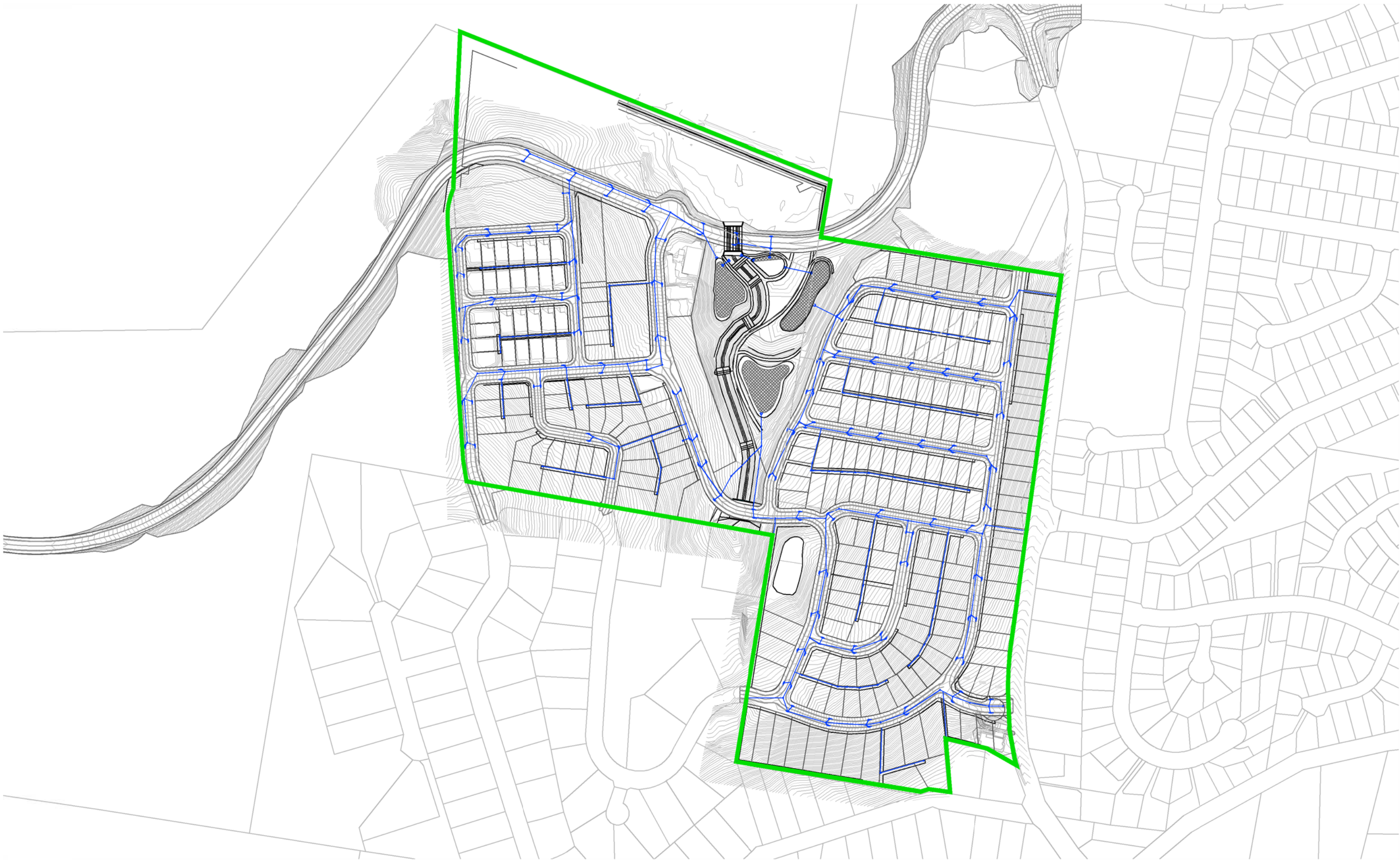
PROJECT
ALTITUDE ASPIRE
FRASER DRIVE
TERRANORA
NEW SOUTH WALES

CLIENT
NEWLAND
DEVELOPERS
PTY LTD

DRAWING
EXISTING
DEVELOPMENT

SCALE	DATE	DRAWN	CHECKED	PROJECT NO	DRAWING NO
1:4 000@A3	19/04/2013	AJF	CMA	10849	202

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ORIENTATION
NORTH

SCALE
40 80 120 160 200
metres

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LEGEND

- Site boundary
- 0.5m contours
- 2.5m contours
- Stormwater drains network

SOURCES

Base plan: BradLees Consulting
Received: 20/02/2013

Earthworks contours: BradLees Consulting
Received: 22/22/2013

Background DCDB: supplied by B&P surveys
Received: 17/04/2013

PROJECT
ALTITUDE ASPIRE
FRASER DRIVE
TERRANORA
NEW SOUTH WALES

CLIENT
NEWLAND
DEVELOPERS
PTY LTD

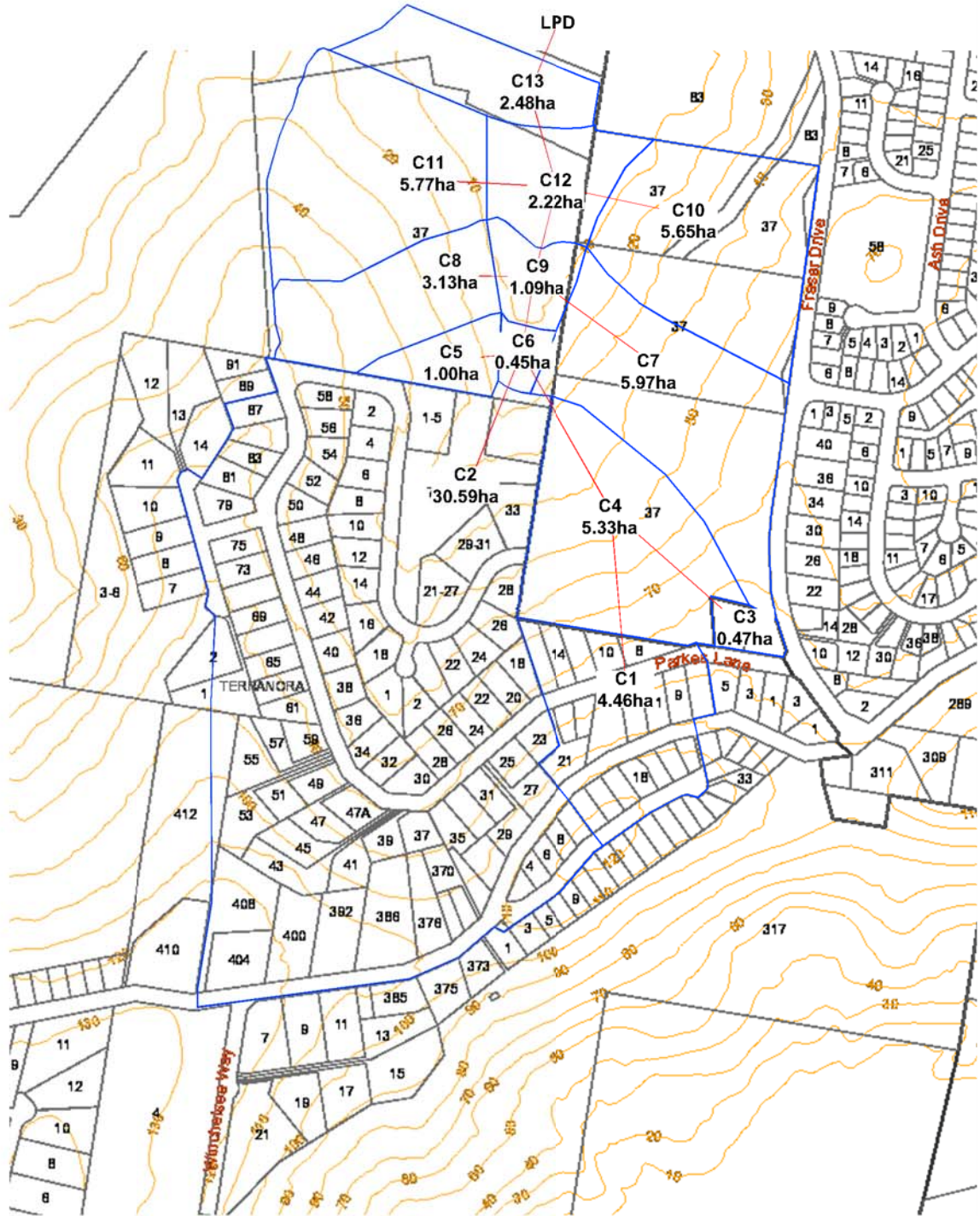
DRAWING
PROPOSED
DEVELOPMENT

SCALE 1:4 000@A3	DATE 19/04/2013	DRAWN AJF	CHECKED CMA	PROJECT NO 10849	DRAWING NO 203
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1:8 000@A3
100 200 300 400
metres

ORIENTATION
NORTH

SCALE
AS SHOWN

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LEGEND

- Catchment boundary
- 0.5m contours
- Landuse - open space, parks & drainage easement
- Landuse - existing external residential development

SOURCES

Image base: Tweed Shire Council - PDOnline database
Survey contours: B&P Surveys

PROJECT

ALTITUDE ASPIRE
FRASER DRIVE
TERRANORA
NEW SOUTH WALES

CLIENT

NEWLAND
DEVELOPERS
PTY LTD

DRAWING

EXISTING CASE
CATCHMENTS,
LANDUSE & WBNM
MODEL LAYOUT

SCALE
AS SHOWN

DATE
19/04/2013

DRAWN
AJF

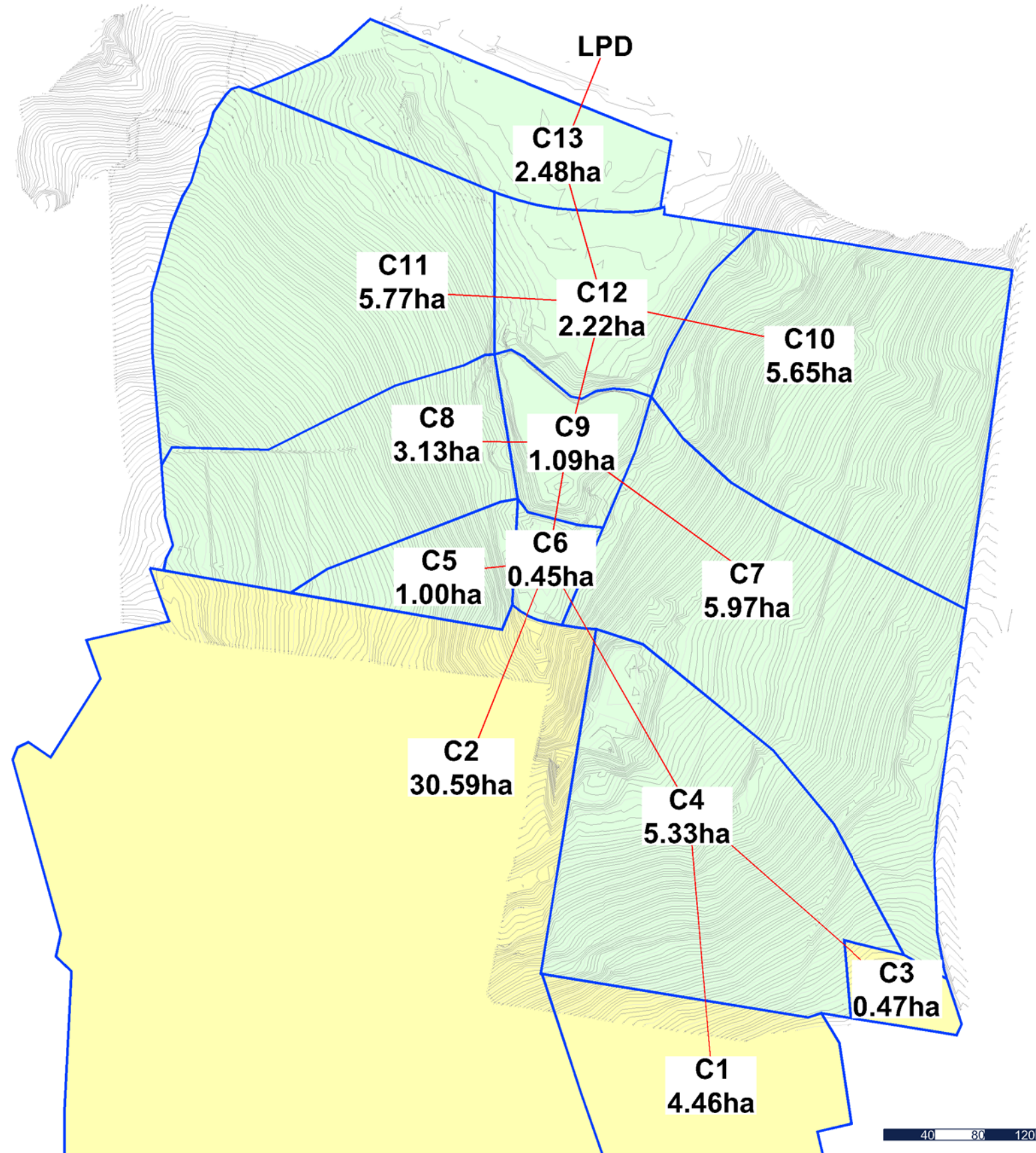
CHECKED
CMA

PROJECT NO
10849

DRAWING NO
204

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1:4 000@A3
40 80 120 160 200
metres