Casuarina Town Centre, *Casuarina—*

Stormwater Management Plan

FOR / Civil Engineering Services

CLIENT / Clarence Property Corporation

DOCUMENT NO / B16097-REP-C-0001 REV / 0 DATE / 10/05/2017

bgeeng.com—

EXECUTIVE SUMMARY

BG&E Pty Ltd have been commissioned by Clarence Property Corporation to prepare an amended major drainage design in response to the current Section 75W modification to Casuarina Town Centre Concept Plan and Project Application (MP 06-0258), dated July 23rd, 2016. The purpose of this document is to report on the proposed stormwater quantity and quality systems required for the development. A key outcome of this plan is to determine the required major drainage system for the development.

There is a currently approved drainage scheme for the proposed development undertaken by Cardno (East West Drainage Scheme Options Design Memo M1V2). This memorandum provides advice on the required major drainage system and water quality requirements. The assessment is undertaken using XP-RAFTS and requires the use of 3x Ø1650mm Reinforced Concrete Pipes (RCP) to convey a large portion of the site's runoff, including external catchments. These pipes extend over approximately 450m and discharge into the existing 4x Ø1050mm RCPs located under Casuarina Way. The 4x Ø1050mm RCPs are considered the outlet for the proposed development.

A design storm of 1% AEP has been adopted for the purpose of this assessment as it provides the worst case impact (major storm event), in accordance with QUDM 2013. Lesser events (minor storms) have not been assessed, however will be addressed at a later stage. In accordance with the requirements of the TCS DCP Section D5 the design of major systems is to include a factor of safety of 1.2. This factor has been applied to each catchment by providing a rainfall multiplier of 1.2. This in effect increases the rainfall hyetographs by 20% for all storm events.

The proposed drainage scheme for the development is summarised as follows.

- A major underground drainage system is proposed about the northern and western boundaries of the site to convey a large portion of the development's discharge, including external catchments;
- Drainage channels are proposed about the eastern boundary of the site, and to the northern boundary. These channels discharge into the major underground drainage system. This approach is in keeping with the drainage system and general urban design of the surrounding stages.
- Infiltration areas are proposed within the drainage channels and at dedicated locations to provide stormwater quality improvement for the 97% AEP event (1 in 3 month ARI); and
- Ultimately the proposed system discharges into the existing 4x Ø1050mm RCP culverts under Casuarina Way, which then drain to the existing 2x 2400x900mm RCBCs under Tweed Coast Road.

Based upon BG&E's analysis, it is proposed to replace the 3x Ø1650mm RCPs to a single 1x2700x1800 RCBC as the required inlet freeboard level can be retained during a 1% AEP event. This is achieved by using the Premium Model within DRAINS as it accounts for lag, storage and backwater effects.

The following outlines the key variables which have resulted in the reduction of the previously approved 3x Ø1650mm RCPs to the proposed single 2700x1800 RCBC:

- Lag – As the flow hydrograph builds within the proposed and existing overland flow paths (infiltration basins, proposed and existing channels) it is slow moving, noting that these flow paths are large and long with minimal grade. This in turn increases the travel time and in doing so flattens the hydrograph as the flow distributes along the travel path;

- Storage - The volumetric properties of the proposed and existing overland flow paths are considered within the model. This in turn relates to the backwater effects of the Premium Model. As water builds within the system, the backwater impact of the network prevents runoff from draining to the system outlet. This stores water within the upstream elements of the network, effectively detaining the water rather than forcing it through the network. This creates a far more realistic representation of actual fluid dynamics and how it operates.
- Hydraulic Performance – Given the shape of a box culvert, more water is able to enter the system at a lower level compared to a piped system. In doing this, less water is required to build within the infiltration/detention areas to discharge through the system. This decreases the required hydraulic head and allows more even flow distribution about the inlet and outlet of the culvert.

In accordance with the approved "15.07.23 – TSC Infiltration Equivalency Drainage Letter" approved by Council, the development provides areas for infiltration to treat the 97% AEP (1 in 3 month ARI) storm event. As stated within the above mentioned letter a total infiltration area of 4095m^2 is required. The proposed drainage scheme provides 5171m^2 of treatment area.

CONTENTS

Appendices

Document *Control*

Revision	Date	Description	Prepared	Reviewed	Approved
A	13/01/2017	Draft	Matt Worthington-Eyre	Ben Keith	
B	18/01/2017	Draft – Issued to TSC	Matt Worthington-Eyre	Ben Keith	
0	10/05/2017	Updated – External Catchments	Matt Worthington-Eyre	Ben Keith	Ben Keith

1 INTRODUCTION

1.1 Background

BG&E Pty Ltd have been commissioned by Clarence Property Corporation to prepare an amended major drainage design in response to the current Section 75W modification to Casuarina Town Centre Concept Plan and Project Application (MP 06-0258), dated July 23rd, 2016. The purpose of this document is to report on the proposed stormwater quantity and quality systems required for the development. A key outcome of this plan is to determine the required major drainage system for the development.

The proposed Town Centre development (Stage 2) is located adjacent to Casuarina Way, Casuarina within the Tweed Shire Council. Note that a previous stormwater strategy (East West Drainage Scheme Options Design Memo M1V2) is currently approved for the development, however this report once approved would supersede this aforementioned report.

The proposal is for a mixed use development comprising of residential allotments, mixed use (commercial/residential) buildings, and provides an internal road network with associated civil infrastructure.

1.2 Previous Assessments

As previously noted, there is a currently approved drainage scheme for the proposed development undertaken by Cardno (East West Drainage Scheme Options Design Memo M1V2). This memorandum provides advice on the required major drainage system and water quality requirements. The assessment is undertaken using XP-RAFTS and requires the use of 3x Ø1650mm Reinforced Concrete Pipes (RCP) to convey a large portion of the site's runoff, including external catchments. These pipes extend over approximately 450m and discharge into the existing 4x Ø1050mm RCPs located under Casuarina Way. The 4x Ø1050mm RCPs are considered the outlet for the proposed development.

BG&E have been commissioned by Clarence Property to undertake optimisation on the proposed major drainage system, and additional engineering services sufficient to obtain Development Approval for the site.

1.3 Study Methodology

The design methodology adopted in conducting the investigation can be summarised generally as follows:

- Review relevant standards, codes, policies and previously approved documents/plans;
- Determination of the stormwater quantity and quality requirements in accordance with the approved documents and Council's standards;
- Determine the proposed development's catchments and properties;
- Determine any external catchments and properties;
- Undertake detailed hydrologic and hydraulic analysis of the proposed development to determine the required major stormwater systems. This analysis includes sensitivity assessments of the major drainage scheme;
- Allocate suitable areas for stormwater treatment in keeping with the approved Council documents/plans; and

- Report results and outline required stormwater systems.

1.4 Standards & Peripherals

The following documents have been used as part of this review:

- Tweed Shire Council (TSC) Development Control Plan (DCP) Section A5 Development Design Specifications D5 – Stormwater Drainage Design;
- Queensland Urban Drainage Manual (QUDM) 2013 as specified within the TSC DCP Section D5;
- TSC Approved - East West Drainage Scheme Options Design Memo M1V2 prepared by Cardno, dated July 14th, 2016. Note this scheme represents the currently approved 3x Ø1650mm RCP major drainage system. This memorandum is provided within Appendix E;
- TSC Approved - SWINF 01 Infiltration Equivalency Catchment Plan prepared by Newton Denny Chapelle, dated July 2015. This plan is provided within Appendix F;
- TSC Approved - Casuarina Greenbelt Corridor Landscape Concept prepared by Design Team Ink, dated August 5th, 2016;
- TSC Approved - Infiltration Basin Configuration (SK No 7079/1-24) prepared and annotated by Cardno, dated July 23rd, 2015;
- TSC Approved - 15.07.23 - TSC Infiltration Equivalency Drainage Letter prepared by Newton Denny Chapelle, dated July 23rd, 2015; and
- WMA Water Independent Review Letter (117031/L170327) and associated comment register, prepared by WMA Water, dated March 28th, 2017.

1.5 Site Information

The following documents, sources and information have been used to represent the proposed Casuarina Town Centre, Casuarina Way, New South Wales.

- Survey provided by Newton Denny Chapelle;
- BG&E Sketch Casuarina Beach Town Centre – Stage 2 – Site Drainage Concept (SK-C-0012);
- East West Drainage Scheme Options Design Memo M1V2;
- Casuarina Greenbelt Corridor Landscape Concept;
- Infiltration Basin Configuration (SK No 7079/1-24);
- Light Detection and Ranging (LiDAR) data sourced from the NSW ELVIS – Foundation Spatial Data; and
- Dial Before You Dig (DBYD) information.

2 SITE CHARACTERISTICS

2.1 Location

The proposed development on Casuarina Way, Casuarina (Lot 15 on DP1198266) is prominently positioned in the centre of Casuarina, approximately 125m from the Pacific Ocean as shown in Figure 2.1. The site is approximately thirty eight (38) kilometres north of Byron Bay, NSW. The site currently has a small carpark for beach access and is generally undeveloped.

Figure 2.1 Site Location (Source: Google Earth 2016)

2.2 Topography

The Total Site area is 10.32 hectares. The existing site is currently used for car parking and what is believed to be infiltration/stormwater conveyance. The site contains a 10m wide base overland flow channel, which connects from the foreshore drain to the existing set of culverts under Casuarina Way. Based on site survey information the culverts are 4x Ø1050mm RCPs. Refer to the following Figure 2.2 for an overview of the existing site topography.

Located to the east of the site is a foreshore drain, which drains south to north and then into the site. Located to the north of the subject site is an external catchment, which appears to drain into a long foreshore channel. This channel then connects into the 10m wide overland flow channel within the site. The car parking area is raised above the conveyance/infiltration area by approximately 5m.

2.3 Water Courses

The existing site is predominately undeveloped with small vegetation and green space. The site is located approximately 125m west of the Pacific Ocean and 300m east of Cudgen Creek. Based on site topography

and existing drainage infrastructure it is believed the site discharges into Cudgen Creek, via a series of culverts under Casuarina Way and Tweed Coast Road.

2.4 Existing Land Use

The existing site is largely undeveloped and contains a small carpark for beach users.

2.5 Proposed Land Use

The proposed land use is for a mixed use commercial/residential development (town centre) comprising of an internal road network, commercial blocks and housing. Conceptual plans illustrating the proposed development are presented in Appendix A – Development Layout.

2.6 Existing Drainage Infrastructure

Based upon survey, DBYD search information and site investigations it appears the subject site has the following existing drainage infrastructure:

- 4x Ø1050mm RCPs – located under Casuarina Way. These culverts appear to be the current outlet for the site's overland flow path;
- 2x 2400x900 Reinforced Concrete Box Culverts (RCBC) – located under Tweed Coast Road. These culverts appear to discharge into Cudgen Creek;
- Approximately 800m long foreshore channel, providing a drainage outlet for the site's external catchment.

Refer to Appendix C for the stormwater scheme and B for the DBYD search results.

Figure 2.2 SIte Topography

3 STORMWATER QUANTITY ASSESSMENT

3.1 Design Criteria

The stormwater drainage system has been designed to meet the criteria specified in Tweed Shire Council Subdivision Specifications Development Control Plan (DCP) Section D5 – Stormwater Drainage Design. This document references the Queensland Urban Drainage Manual (QUDM) 2013 for the design of major and minor systems. The following Table 3.1 outlines the key design criteria for the proposed major system.

Table 3.1: Key Major Drainage Design Criteria

Parameter	Criteria	Reference / Comment
Design Event	1% AEP (1 in 100 year ARI) & 1% AEP + 20% rainfall increase	TSC DCP Section D5.04
Maximum Upstream Water Surface Level (m)	5.700	Based on providing 500mm freeboard to Lot 237 on DP1048494
Minimum Infiltration Area (m^2)	4095	As required within TSC Approved - 15.07.23 - TSC Infiltration Equivalency Drainage Letter
Foreshore Drain	No overtopping	TSC Approved - East West Drainage Scheme Options Design Memo M1V2

3.2 Assessment Methodology

The following outlines the methodology adopted for the assessment of the proposed development's stormwater drainage:

- Determine the site's catchment and associated parameters;
- Determine any existing external catchments and flow paths, and their associated properties;
- Produce a DRAINS model from the proposed drainage scheme detailed within Appendix C. Road pit and pipe drainage has not been modelled as the intention of this assessment is to confirm the major drainage system. The catchments proposed include a time of concentration inclusive of standard inlet time and travel time, based upon the revised layout and levels;
- Assess the impact of the Premium Hydraulic Model and it's applicability to the stormwater assessment;
- Determine the suitability of modelling the proposed water quality infiltration areas within DRAINS; and
- Determine the required major stormwater system for the development.

3.3 Model Calibration

The DRAINS model uses ILSAX time varying runoff and provides AR&R87 temporal patterns and hyetographs, the variables used for calibration include catchment fraction impervious and soil properties. These soil properties include initial loss, infiltration and surface storage which are of particular importance given the site is primarily sand and in close proximity to the beach. In order to represent the site conditions the soil type has been set at Type 1. This is comparable to sandy soils with high infiltration rates, typical of a coastal area. Note however that when modelling the time varying runoff from each catchment, an Antecedent Moisture Condition (AMC) of 3 has been adopted which simulates an already saturated surface (from preceding storm/rainfall events). This reduces the starting point of the soil's infiltration curve to reflect such conditions.

As noted within the WMA Water review letter, a review of the use of AR&R 2016 temporal patterns and rainfall has been undertaken. Figure 3.1 shows the comparison and indicates that for the 1% AEP design event the rainfall is less in the 1987 IFD database than that of the 2016 database. However, when considering the 1% AEP FOS (1.2 multiplier on rainfall) the 1987 data is similar to that of the 2016 IFD data. Due to the limitations of current software, the use of 2016 temporal patterns are not considered at this point in time.

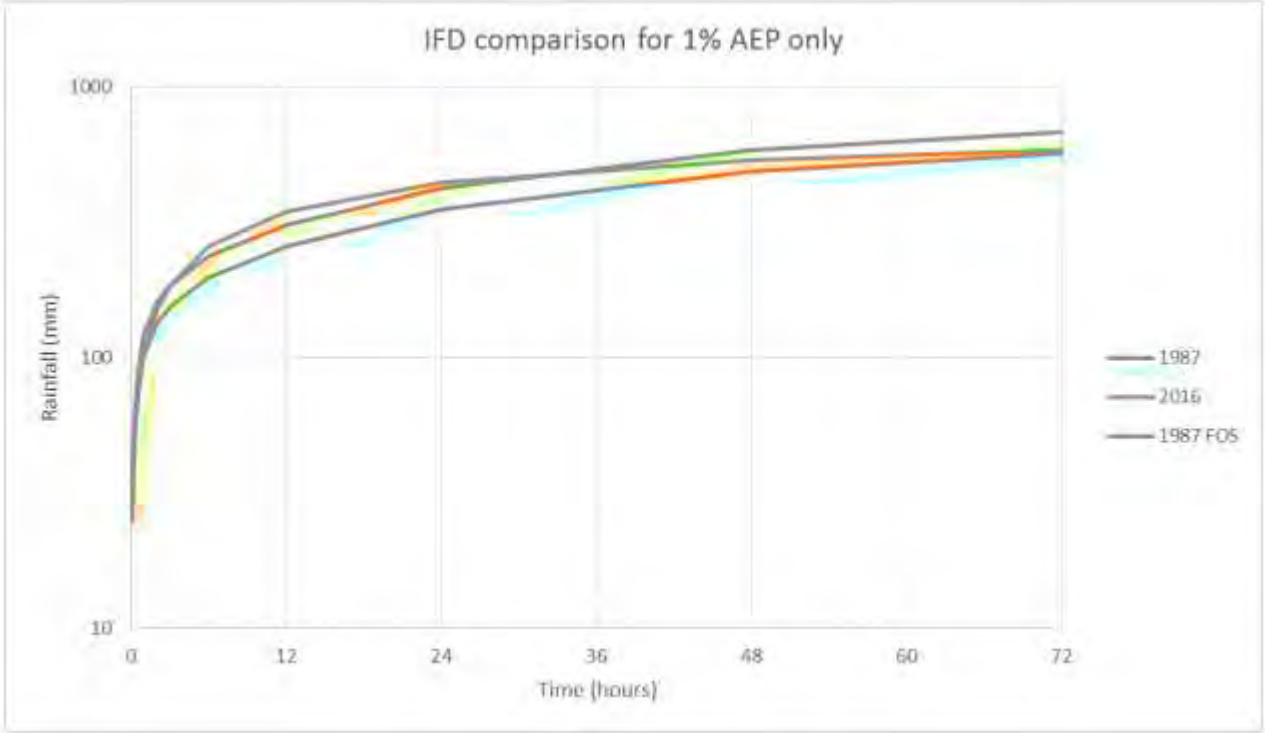


Figure 3.1 - 1% AEP Intensity Frequency Duration Comparison

(Sourced from Figure 1 of WMA Water letter 117031/L170327)

3.4 Proposed Drainage Scheme

The proposed drainage scheme for the development is summarised as follows.

- A major underground drainage system is proposed about the northern and western boundaries of the site to convey a large portion of the development's discharge, including external catchments;
- Drainage channels are proposed about the eastern boundary of the site, and to the northern boundary. These channels discharge into the major underground drainage system. This approach is in keeping with the drainage system and general urban design of the surrounding stages.
- Infiltration areas are proposed within the drainage channels and at dedicated locations to provide stormwater quality improvement for the 97% AEP event (1 in 3 month ARI); and
- Ultimately the proposed system discharges into the existing 4x Ø1050mm RCP culverts under Casuarina Way, which then drain to the existing 2x 2400x900mm RCBCs under Tweed Coast Road.

3.5 Lawful Point of Discharge

The proposed lawful point of discharge for the site is the existing 4x Ø1050mm RCPs which cross under Casuarina Way. This is in keeping with the current drainage scheme. The following Figure 3.2 outlines the DRAINS model layout. Refer to Appendix C for the proposed system.

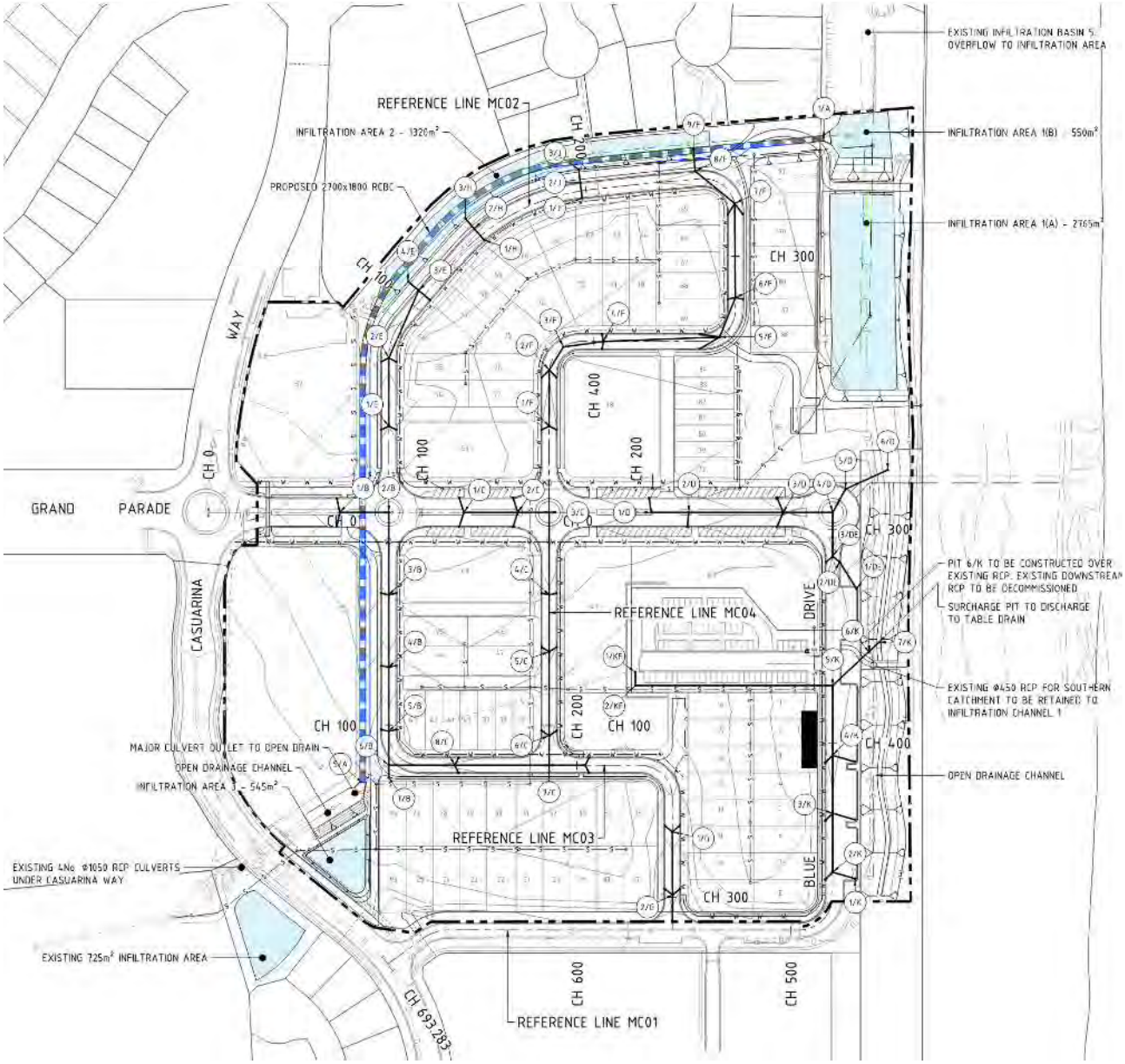


Figure 3.2 Stormwater Scheme

3.6 Catchment Representation

The development sub-catchment types were determined based on the proposed development layout. External catchments have been derived from LiDAR data and have been validated against aerial imagery and DBYD information. The following Table 3.2 outlines the post development catchment parameters. Refer to Appendix C for the proposed catchment plan and Appendix D for the external catchments.

Table 3.2: Catchment Parameters

Catchment	Area (ha)	Fraction Impervious (%)	Time of Concentration (mins)
Internal Catchments			
E1 Catchment	0.630	10	5
E2 Catchment	2.079	59	10
E3 Catchment	0.859	47	8
N Catchment	2.856	63	14
W Catchment	3.895	76	9
External Catchments			
External Southern Eastern Catchment	1.970	65	16
EX1	0.740	70	6
EX2	0.300	50	6
EX3	3.463	49	8.5
EX4	4.945	50	12.5
EX5	5.513	52	12
EX6	5.260	48	10.5
EX7	8.080	47	10.5

Note: - The existing catchments provided above have been derived from LiDAR, DBYD information and aerial imagery;

- The developed catchment breakdown has been based upon conceptual plans. Refer to Appendix A for the proposed development layout plan and pervious areas;

- The catchment times of concentration has been adopted from Table 4.6.3 of QUDM 2013 and calculated in accordance with Section 4.6 of QUDM 2013; and

- The fractions impervious for each catchment subtype have been adopted from Table 4.5.3 of the Queensland Urban Drainage Manual 2013.

3.7 Hydraulic Modelling Methodology

A design storm of 1% AEP has been adopted for the purpose of this assessment as it provides the worst case impact (major storm event), in accordance with QUDM 2013. Lesser events (minor storms) have not been assessed, however will be addressed at a later stage. In accordance with the requirements of the TCS DCP Section D5 the design of major systems is to include a factor of safety of 1.2. This factor has been applied to each catchment by providing a rainfall multiplier of 1.2. This in effect increases the rainfall hyetographs by 20% for all storm events.

The proposed drainage scheme has been modelled within DRAINS using the Premium Hydraulic Model to utilise the full St. Venant equations for unsteady flow dynamics. This approach uses extended data compared to the standard ISLAX model and accounts for the full hydrodynamic effects of critical flow, sub critical flow and storage within overflow routes. The incorporation of backwater calculations and storage provides significant improvements over the simple translation of the standard model, which can overestimate peak flows and water levels. Given the site provides for large, flat channels and underground conveyance the use of the Premium model allows the lag and storage inherent in such a system to be utilised. The following Figure 3.1 outlines the hydraulic grade line and flow hydrographs for the major culvert system at the inlet and outlet. A storm duration of 1 hour (critical storm duration) has been selected for this comparison. This is discussed further in Section 3.8 of this report.

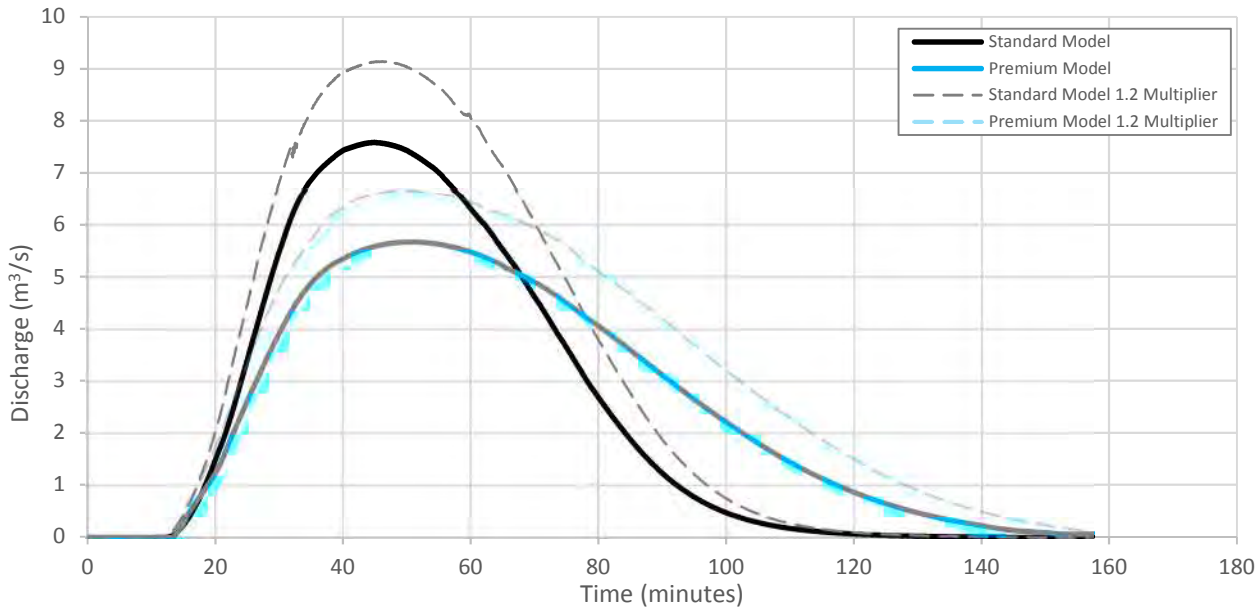


Figure 3.1 Major Culvert System – 1x2700x1800 RCBC Inlet Hydrograph 1 hour Storm Duration

As shown in Figure 3.1 the Premium model flattens the hydrographs and translates peaks resulting in reduced peak discharge. As assessment of total flow volumes for the standard and premium models provide a variance of approximately 4% for both the 1% AEP and 20% increase events, which can be attributed to storage of water within the system resulting in greater infiltration. Hence water is not considered lost from the system, merely stored and translated.

3.7.1 Infiltration

In accordance with the previously approved drainage scheme within SK008 and the Casuarina Greenbelt Corridor Landscape Concept, infiltration basins are provided to treat the 97% AEP (1 in 3 month ARI) storm events in accordance with TCS requirements.

The proposed and existing infiltration areas were modelled within DRAINS to replicate the numerous storage and detention locations within the network. The proposed basins have been provided for stormwater quality improvement in accordance with the Council approved scheme, however they will also act to infiltrate flow during a range of storm events greater than the 97% AEP. An infiltration rate of 100mm/hr has been adopted to reflect a saturated sub-strata and is considered applicable to the site sandy soils. This is consistent with the DRAINS soil type and AMC condition. As stated within the TSC Development Design Specification D7, infiltration rates of less than 6m/day can be adopted. The 100mm/hr rate used equates to 2.4m/day. As the model soil type matches this infiltration rate and the design AMC, this approach is considered appropriate. It is noted that sandy soils typically have a saturated hydraulic conductivity greater than 360mm/hr, and as such the use of a lower rate is considered conservative.

The model assumes the basins are full at the start of each storm event, which is again considered a conservative approach. This is done by setting the basin initial volume at the maximum storage elevation.

3.7.2 Open Drainage

In accordance with the previously approved drainage scheme within SK008 and the Casuarina Greenbelt Corridor Landscape Concept, open drainage is used to provide stormwater conveyance, minimise the reliance on underground systems and enhance local amenity. The proposed open drains have been modelled within DRAINS as detailed within Appendix C. A Mannings roughness of 0.043 has been adopted for all open drainage in accordance the TCS DCP Section D5.13. The following outlines the locations of the open drainage proposed within the scheme:

- 2m wide base channel along the eastern boundary of the site, from the south eastern boundary to the 30m wide infiltration channel;
- 30m wide base infiltration channel along the eastern boundary of the site, upstream of the proposed major culvert system;
- 3-4m wide base channel along the northern boundary of the site. This channel receives local catchment flow from the Northern, EX1 and EX2 catchment and is not used as a high flow bypass for the 2700x1800 RCBC culvert. During the modelled 1% AEP event, no bypass from the 2700x1800 RCBC culvert headwall enters the channel;
- 9m wide base channel about the south-western boundary of the site to connect the outlet of the proposed 2700x1800 RCBC culvert to the existing 4x Ø1050mm RCP culverts.
- Existing northern drainage channel of varying width. Refer to the channel profile and typical sections provided in Appendix D.

3.7.3 Downstream Conditions

The existing 4x Ø1050mm RCP culverts are the outlet for the proposed development, however limited information is available regarding the system hydraulics and downstream conditions. Hence in order to provide a conservative approach, it is assumed that the downstream water level of the culverts is set at the top of the outlet. This gives a constant water level of 3.98m AHD during the 1% AEP storm events.

The existing downstream 2x 2400x900mm RCBCs under Tweed Coast Road have not been included within the model however provide a larger cross sectional area than the 4x Ø1050mm RCP culverts, hence making the 4x Ø1050mm RCP culverts the limiting waterway for the proposed development and for the purpose of this assessment.

3.7.4 Freeboard

In accordance with the TCS DCP Section D5.12 freeboard of 500mm to structure floor levels has been provided. In keeping with the "East West Drainage Scheme Options Design Memo M1V2" the intention of this drainage scheme is to match or improve the peak water levels detailed in the memo. BG&E has assessed the existing site surface levels and determined that the required maximum water surface level to Lot 237 on DP1048494 is 5.7m AHD. This is to provide 500mm freeboard to the existing residences floor level of 6.2m AHD. Hence the maximum allowable water level at the proposed major drainage system inlet (about the foreshore swale) is 5.7m AHD. This level is to be adopted for both the 1% AEP and 1% AEP event including 20% rainfall increase.

3.8 Results

Based upon the above methodology the following Tables 3.3 and 3.4 details the hydraulic results for the large culvert system modelled within DRAINS, with a comparison to the "East West Drainage Scheme Options Design Memo M1V2". The below peak discharge information relates to a 1 hour (60 minutes) rainfall event, which coincides with the critical storm duration in the approved "East West Drainage Scheme Options Design Memo M1V2".

Table 3.2: Hydraulic Peak Discharge Results

Catchment	DRAINS Peak Water Surface Level (m)	SK008 Peak Water Surface Level @ INV/1 (m)	Required Maximum Water Surface Level (m) (Lot 237 Freeboard)
Culvert System Inlet (3x Ø1650mm RCP)	5.060	5.310 (3x Ø1650mm RCP)	5.7
Culvert System Outlet (3x Ø1650mm RCP)	4.400	-	-
Proposed Culvert System Inlet (1x 2700x1800 RCBC)	5.320	5.310 (3x Ø1650mm RCP)	5.7
Proposed Culvert System Outlet (1x 2700x1800 RCBC)	4.037	-	-

Table 3.3: Hydraulic Results 1.2 Rainfall Multiplier

Catchment	DRAINS Peak Water Surface Level (m)	SK008 Peak Water Surface Level @ INV/1 (m)	Required Maximum Water Surface Level (m) (Lot 237 Freeboard)
Approved Culvert System Inlet (3x Ø1650mm RCP)	5.260	5.670 (3x Ø1650mm RCP)	5.7
Approved Culvert System Outlet (3x Ø1650mm RCP)	4.510	-	-
Proposed Culvert System Inlet (1x 2700x1800 RCBC)	5.550	5.670 (3x Ø1650mm RCP)	5.7
Proposed Culvert System Outlet (1x 2700x1800 RCBC)	4.460	-	-

Based on the above analysis, it is proposed to replace the 3x Ø1650mm RCPs to a single 1x2700x1800 RCBC as the required inlet freeboard level can be retained during a 1% AEP event.

3.8.1 Blockage and Losses

In accordance with the TCS DCP Section D5 – Drainage Design and QUDM 2013, blockage and hydraulic losses within the system have been allowed for. As noted within the "East West Drainage Scheme Options Design Memo M1V2" the grated inlet structure at the upstream end of the culvert system shall be designed for a 50% blockage factor and the grated inlet shall have an open area equivalent to three times the area of the culvert system. As a hydraulic loss coefficient of 0.5 has been applied to the inlet headwall of the culvert system, an assessment of providing additional loss/blockage at the immediately upstream grated inlet screen has been undertaken. The following outlines the methodology used in this assessment:

- Determine culvert/pipe areas;
- Apply an area loss of 10% to account for grate bars and structure;
- Apply a 50% blockage to the grated inlet in accordance with the TCS DCP Section D.5;
- Determine 'net' grated inlet screen area at full height of inlet headwall for each culvert size;
- Determine 'net' grated inlet screen area at respective culvert height; and
- Assess resulting areas against culvert areas.

The following Table 3.5 details the grated screen area and blockage compared to the proposed culvert system.

Table 3.5: Blockage Assessment

Culvert System	System Cross Sectional Area (m^2)	Factored Grate Area at full headwall height (m^2)	Factored Grate Area at respective culvert height (m^2)
3x Ø1650mm RCP	6.410	12.410	5.440
1x 2700x1800 RCBC	4.860	10.230	4.940
1x 1200x900 RCBC	1.080	0.770	0.630

As shown within Table 3.4 the resulting open grate area (allowing for the grate and blockage) for the proposed single 2700x1800 RCBC is greater than the culvert area. From this the culvert itself is the governing hydraulic control and hence blockage has not been applied to the culvert inlet. In the event the grated inlet is more than 50% blocked, the culvert entry will dictate the headwater level.

For the proposed 1200x900 RCBC, the factored grate area is less than the opening area of the culvert. Due to this the grate becomes the hydraulic control. In order to adequately consider inlet blockage within the model, the hydraulic entry loss for this inlet has been increased from 0.5 to 2.0, effectively quadrupling the entry loss. This is important given the size of the culvert and the proximity to the urban environment, which increases the risk of rubbish, debris, etc. Modelling this increased hydraulic loss shows no adverse impacts.

3.8.2 Discussion

The proposed drainage scheme has been modelled within DRAINS, incorporating the Premium Model. This allows for the quasi 2-Dimesional assessment to be included which in turn allows the lag and storage associated with large drainage systems to be utilised. The models hydrology and input parameters remain unchanged from the Standard Model, with the key differentiator being the way in which the system hydraulics are calculated. The following outlines the key variables which have resulted in the reduction of the previously approved 3x Ø1650mm RCPs to the proposed single 2700x1800 RCBC:

- Lag – As the flow hydrograph builds within the proposed and existing overland flow paths (infiltration basins, proposed and existing channels) it is slow moving, noting that these flow paths are large and long with minimal grade. This in turn increases the travel time and in doing so flattens the hydrograph as the flow distributes along the travel path;
- Storage - The volumetric properties of the proposed and existing overland flow paths are considered within the model. This in turn relates to the backwater effects of the Premium Model. As water builds within the system, the backwater impact of the network prevents runoff from draining to the system outlet. This stores water within the upstream elements of the network, effectively detaining the water rather than forcing it through the network. This creates a far more realistic representation of actual fluid dynamics and how it operates.
- Hydraulic Performance – Given the shape of a box culvert, more water is able to enter the system at a lower level compared to a piped system. In doing this, less water is required to build within the infiltration/detention areas to discharge through the system. This decreases the required hydraulic head and allows more even flow distribution about the inlet and outlet of the culvert.

4 STORMWATER QUALITY ASSESSMENT

4.1 Water Quality Treatment Scheme

In accordance with the approved "15.07.23 – TSC Infiltration Equivalency Drainage Letter" approved by Council, the development provides areas for infiltration to treat the 97% AEP (1 in 3 month ARI) storm event. As stated within the above mentioned letter a total infiltration area of 4095m^2 is required. The proposed drainage scheme provides 5171m^2 of treatment area. Refer to Appendix C for the location of each treatment area.

4.2 Proposed Treatment

The proposed stormwater treatment areas are proposed for infiltration:

- A 2756m^2 infiltration area is proposed about the of the 2700x1800 RCBC culvert, which is to treat the eastern catchments;
- A 550m^2 infiltration area is proposed upstream of the 2700x1800 RCBC culvert, which is to treat the eastern and external catchments;
- A 1320m^2 infiltration channel is proposed along the northern boundary of the site, which is to treat the northern catchment. Note that this channel is not a high flow bypass channel for the 2700x1800 RCBC, and is not affected by the headwater level of the culvert in a 1% AEP event. The channel receives direct catchment from the northern catchment, via road crossing outlets. This channel then discharges into the 2700x1800 RCBC via a 1200x900mm RCBC into a manhole structure; and
- A 545m^2 infiltration basin is proposed about the south-western boundary of the site, which is to treat the majority of the western catchment. A portion of the western catchment will bypass this treatment.

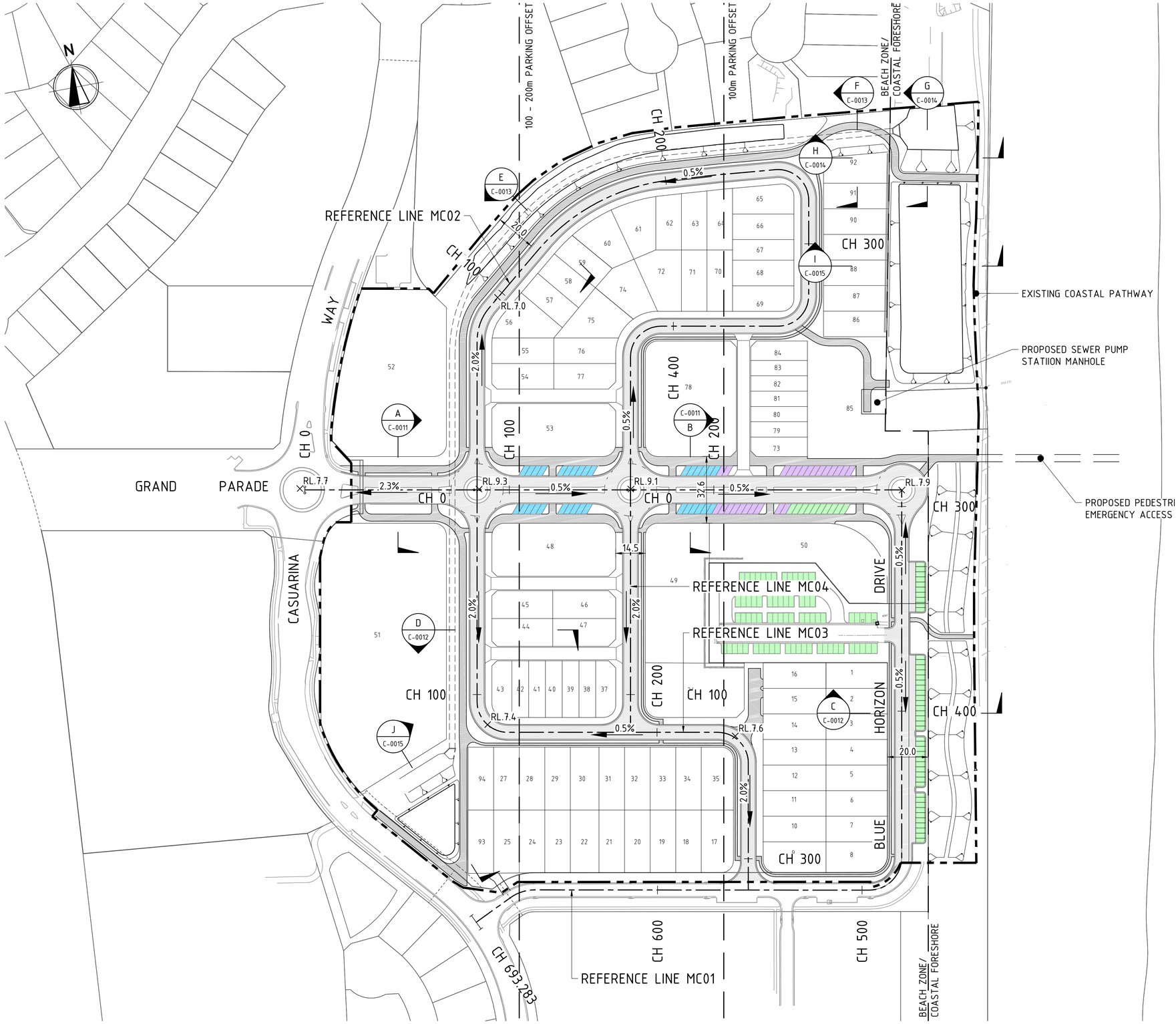
5 CONCLUSION

This stormwater management plan outlines the proposed drainage scheme for the revised layout and levels, which is in keeping with the current Council approved scheme. A single 2700x1800 RCBC culvert is proposed to act as the major drainage system, in conjunction with the large open channels and infiltration areas.

Further details of the proposed stormwater drainage system will be provided to Council in future applications (i.e. Construction Certificate submission), however this document demonstrates that suitable stormwater quantity and quality management is achievable under the current development proposal.

APPENDIX A

Development Layout



LEGEND

- DESIGN CONTROL LINE (CH 100)
- LIMIT OF WORKS BOUNDARY
- PROPOSED ROAD GRADE (2%)
- PROPOSED LEVEL (RL.8.0)
- PROPOSED RETAINING WALL (1.0m)
- PROPOSED ROAD
- PROPOSED PATH
- PARKING BAYS - 0m TO 100m (134 TOTAL)
  - 71 EXISTING BLUE HORIZON DRIVE
  - 8 TRESTLES AVENUE
  - 55 PROPOSED BAYS
- PARKING BAYS - 100m TO 200m (32 TOTAL)
- PARKING BAYS - ADDITIONAL (24 TOTAL)

0 10 20 30 40 50 60m
SCALE 1:1000 AT A1 SIZE

REV	DATE	DESCRIPTION	RVD
A	09.05.17	ISSUED FOR DA APPROVAL	B.K

CLIENT: CLARENCE PROPERTY

Brisbane *Office*—
74-76 Bowen St, Spring Hill QLD 4000
P / +61 7 3167 3300
E / info@bgeeng.com
bgeeng.com—

PROJECT: CASUARINA BEACH
TOWN CENTRE - STAGE 2
CASUARINA WAY, NSW 2487

STATUS: PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION

DRAWN	DESIGNED	CHECKED	APPROVED
C.K	B.J	M.W	B.K

DATUM	GRID	SCALE	
MGA94	AHD	1:1000	AT SIZE

TITLE: SITE LAYOUT PLAN

PROJECT No.	DRAWING No.	REV.
B16097	C-0003	A

\\BGEBNEFS02\PROJECTS\BGE\BNE\B16097\100 DRAWINGS\102 CIVIL\AUTOCAD\B16097-DRG-C-0003.DWG
9/05/2017 5:03:49 PM

APPENDIX B

DBYD Search Information

Dial Before You Dig (DBYD)
Pipeline Location Information

Customer Service | 1300 292 872 | (02) 6670 2400
PO Box 816 Murwillumbah NSW 2484
Fax (02) 6670 2429 | ABN 90 178 732 496
tsc@tweed.nsw.gov.au | www.tweed.nsw.gov.au

To:
BG&E - Mr Bruce Fernandez
74 Bowen Street
Spring Hill QLD 4000

Email: bruce.fernandez@bgeeng.com
Phone: 07 3167 3300
Fax: Not Supplied
Mobile: Not Supplied

Enquiry Details

Utility ID	17550
Sequence Number	58092180
Enquiry Date	11/01/2017 12:21
Response	**AFFECTED**
Address	Casuarina Way Casuarina
Location in Road	CarriageWay,Footpath,Nature Strip
Activity	Subdivision

Enquirer Details

Customer ID	1616855		
Contact	Mr Bruce Fernandez		
Company	BG&E		
Email	bruce.fernandez@bgeeng.com		
Phone	07 3167 3300	Mobile	Not Supplied

Enquirer Responsibilities

Asbestos Cement Pipes: Some of Council's pipe assets are constructed of AC (Asbestos Cement). In most instances our plans will indicate the pipe construction material. For any diggings in the vicinity of these pipes need to be aware of health implications of disruption to AC pipes. Individual risk assessments need to be conducted for working near these pipes to ensure protection of your staff.

Internal Drainage: Map does not cover internal drainage to property.

Damage: Tweed Shire Council reserves all rights to recover compensation for any damage to Sewer mains, Water mains and Stormwater.

On Site Locations: Tweed Shire Council provides on site location for D.B.Y.D. requests only. For onsite sewer mains, water mains and stormwater drain locations please contact Tweed Shire Council on (02) 6670 2600 at least 2 to 3 days prior to commencement.

Overview Map

Sequence No: 58092180
Casuarina Way Casuarina

Date: 11/01/2017

1:5000 @ A3 Portrait

Legend:
DBYD Work Area

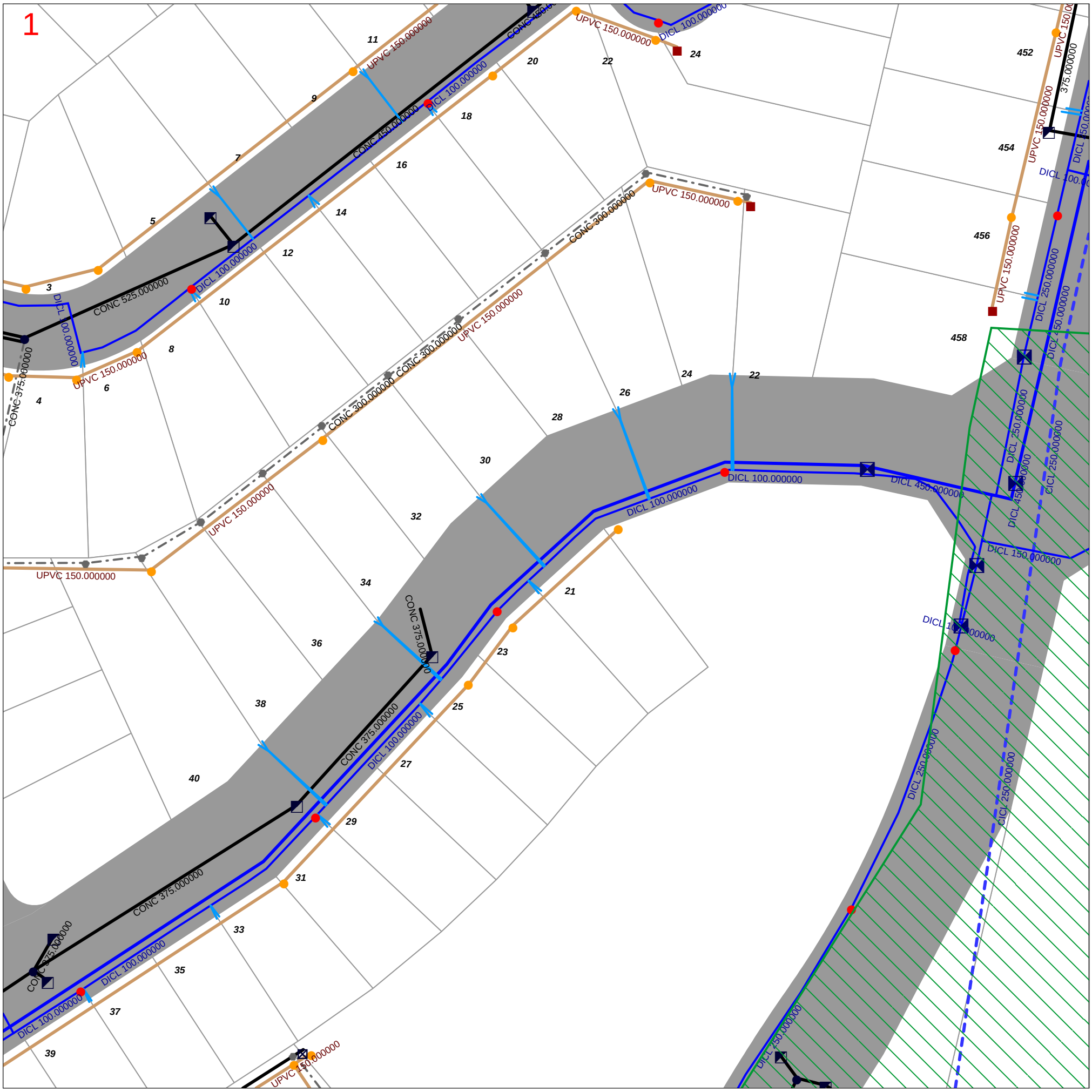
Imagery sourced from OpenStreetMaps

While every care is taken to ensure the accuracy of this data, Tweed Shire Council makes no representations or warranties expressed or implied, statutory or otherwise, about its accuracy, reliability, completeness or suitability for any particular purpose and disclaim all responsibility and all liability (including without limitation, liability in negligence) for all expenses, losses, damages (including indirect or consequential damage) and costs which may be incurred as a result of data being inaccurate in any way and for any reason. This information is supplied for general guidance and is to be considered indicative and diagrammatic only. The information contained on this document remains valid for 30 days only from the date of supply.
Please note that water pipes and sewer rising mains operate under high pressure and present a significant risk for any work around them while live. These mains will have associated thrust blocks that should also be considered in design/construction clearances.

Map 1

Sequence No: 58092180
Casuarina Way Casuarina

Date: 11/01/2017



Sewer Pipeline
- Sewer Rising Main
- Sewer Rising Main (Abandoned)
- Sewer Rising Main (Private)
- Sewer Vacuum Main
- Sewer Gravity Overflow
- Sewer Gravity Main (0-200mm)
- Sewer Gravity Main (225-600mm)
- Sewer Gravity Main (700-900mm)
- Sewer Gravity Main (Abandoned)
- Sewer Gravity Main (Private)

Stormwater Pipeline
- Stormwater Culvert
- Stormwater Culvert (Abandoned)
- Stormwater Channel
- Stormwater Channel (Abandoned)
- Stormwater Pipe (0-975mm)
- Stormwater Pipe (1000-2100mm)
- Stormwater Pipe (Abandoned)
- Stormwater Pipe (Private)

Communication Cable
- Communications Cable

Water Pipeline
- Water Service
- Water Main (0-250mm)
- Water Main (300-1000mm)
- Water Main (Abandoned)
- Water Pipe (Private)

Sewer Node
- Vent Stack
- Vacuum Chamber
- Sewer Pump Station
- Sewer Pump
- Sewer Valve
- Sewer Endcap
- Sewer Manhole
- Private Sewer Point

Stormwater Node
- Stormwater Manhole
- Drop Inlet
- Kerb Inlet
- Wingwall
- Private Stormwater Point

Communication Node
- Communications Node

Water Node
- Water Pump Station
- Reservoir
- Water Valve
- Water Endcap
- Hydrant
- Private Water Point

General
- Property Boundary
- DBYD Work Area

1:600 @ A3 Portrait

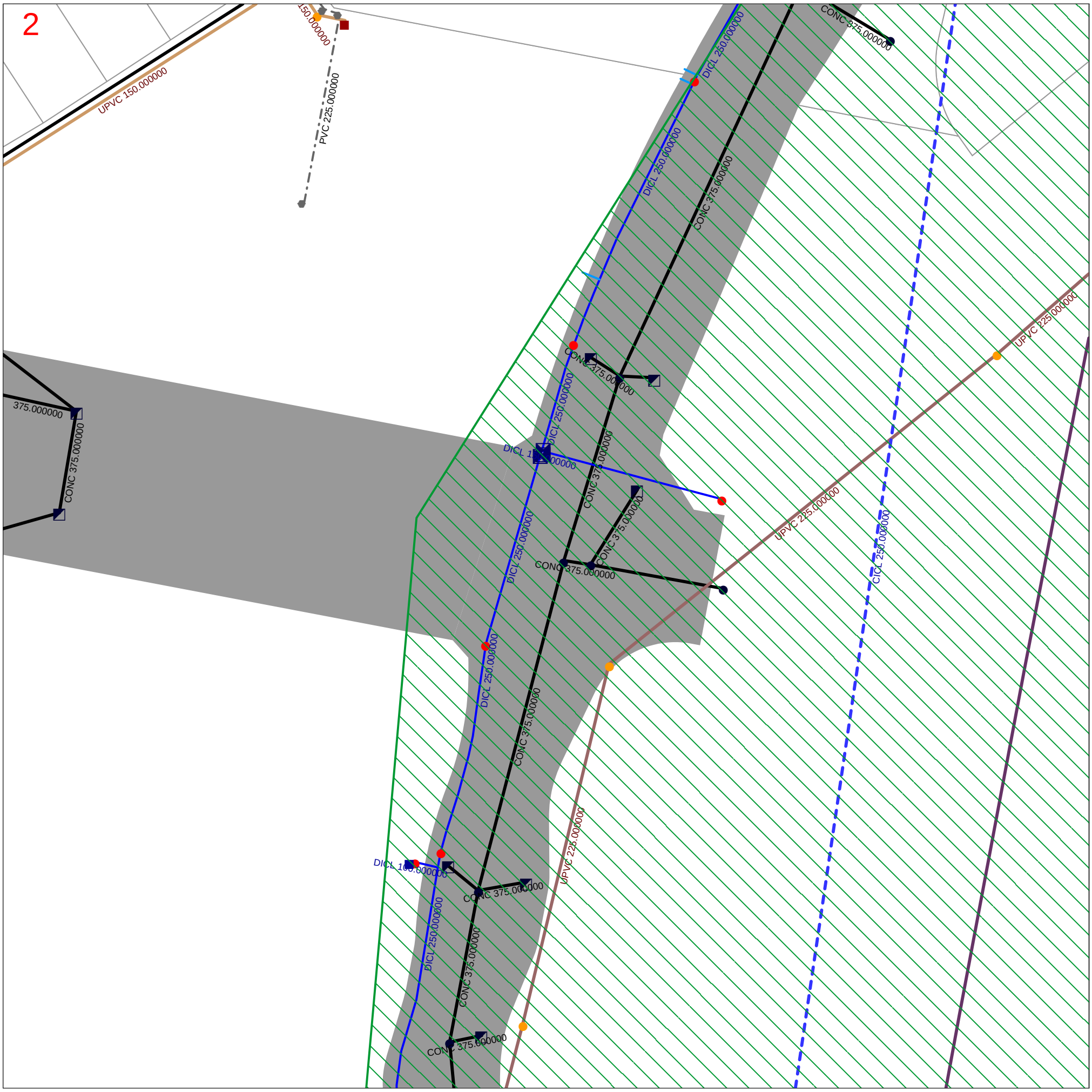
Date printed: 11/01/2017

Boundaries shown should be considered approximate only

Map 2

Sequence No: 58092180
Casuarina Way Casuarina

Date: 11/01/2017



Sewer Pipeline
- Sewer Rising Main
- Sewer Rising Main (Abandoned)
- Sewer Rising Main (Private)
- Sewer Vacuum Main
- Sewer Gravity Overflow
- Sewer Gravity Main (0-200mm)
- Sewer Gravity Main (225-600mm)
- Sewer Gravity Main (700-900mm)
- Sewer Gravity Main (Abandoned)
- Sewer Gravity Main (Private)

Stormwater Pipeline
- Stormwater Culvert
- Stormwater Culvert (Abandoned)
- Stormwater Channel
- Stormwater Channel (Abandoned)
- Stormwater Pipe (0-975mm)
- Stormwater Pipe (1000-2100mm)
- Stormwater Pipe (Abandoned)
- Stormwater Pipe (Private)

Communication Cable
- Communications Cable

Water Pipeline
- Water Service
- Water Main (0-250mm)
- Water Main (300-1000mm)
- Water Main (Abandoned)
- Water Pipe (Private)

Sewer Node
- Vent Stack
- Vacuum Chamber
- Sewer Pump Station
- Sewer Pump
- Sewer Valve
- Sewer Endcap
- Sewer Manhole
- Private Sewer Point

Stormwater Node
- Stormwater Manhole
- Drop Inlet
- Kerb Inlet
- Wingwall
- Private Stormwater Point

Communication Node
- Communications Node

Water Node
- Water Pump Station
- Reservoir
- Water Valve
- Water Endcap
- Hydrant
- Private Water Point

General
- Property Boundary
- DBYD Work Area

1:600 @ A3 Portrait

Date printed: 11/01/2017

Boundaries shown should be considered approximate only

Please note that water pipes and sewer rising mains operate under high pressure and present a significant risk for any work around them while live. These mains will have associated thrust blocks that should also be considered in design/construction clearances.

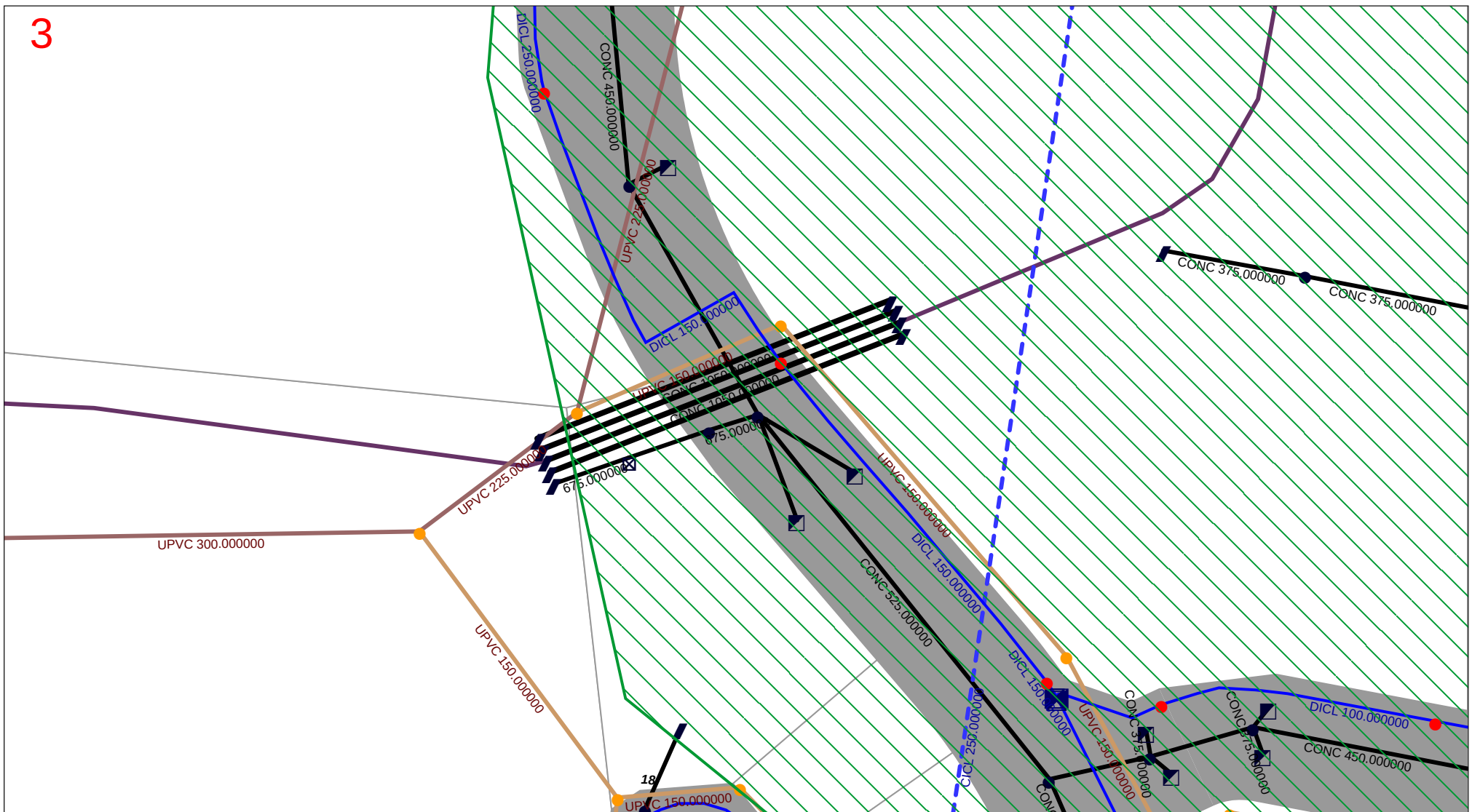
DIAL BEFORE YOU DIG www.1100.com.au

Map 3

Sequence No: 58092180
Casuarina Way Casuarina

TWEED SHIRE COUNCIL

Date: 11/01/2017



Sewer Pipeline
- Sewer Rising Main
- Sewer Rising Main (Abandoned)
- Sewer Rising Main (Private)
- Sewer Vacuum Main
- Sewer Gravity Overflow
- Sewer Gravity Main (0-200mm)
- Sewer Gravity Main (225-600mm)
- Sewer Gravity Main (700-900mm)
- Sewer Gravity Main (Abandoned)
- Sewer Gravity Main (Private)

Stormwater Pipeline
- Stormwater Culvert
- Stormwater Culvert (Abandoned)
- Stormwater Channel
- Stormwater Channel (Abandoned)
- Stormwater Pipe (0-975mm)
- Stormwater Pipe (1000-2100mm)
- Stormwater Pipe (Abandoned)
- Stormwater Pipe (Private)

Communication Cable
- Communications Cable

Water Pipeline
- Water Service
- Water Main (0-250mm)
- Water Main (300-1000mm)
- Water Main (Abandoned)
- Water Pipe (Private)

Sewer Node
- Vent Stack
- Vacuum Chamber
- Sewer Pump Station
- Sewer Pump
- Sewer Valve
- Sewer Endcap
- Sewer Manhole
- Private Sewer Point

Stormwater Node
- Stormwater Manhole
- Drop Inlet
- Kerb Inlet
- Wingwall
- Private Stormwater Point

Communication Node
- Communications Node

Water Node
- Water Pump Station
- Reservoir
- Water Valve
- Water Endcap
- Hydrant
- Private Water Point

General
- Property Boundary
- DBYD Work Area

N

1:600 @ A3 Portrait

Date printed: 11/01/2017
© Land and Property Information (LPI) & Tweed Shire Council. Boundaries shown should be considered approximate only

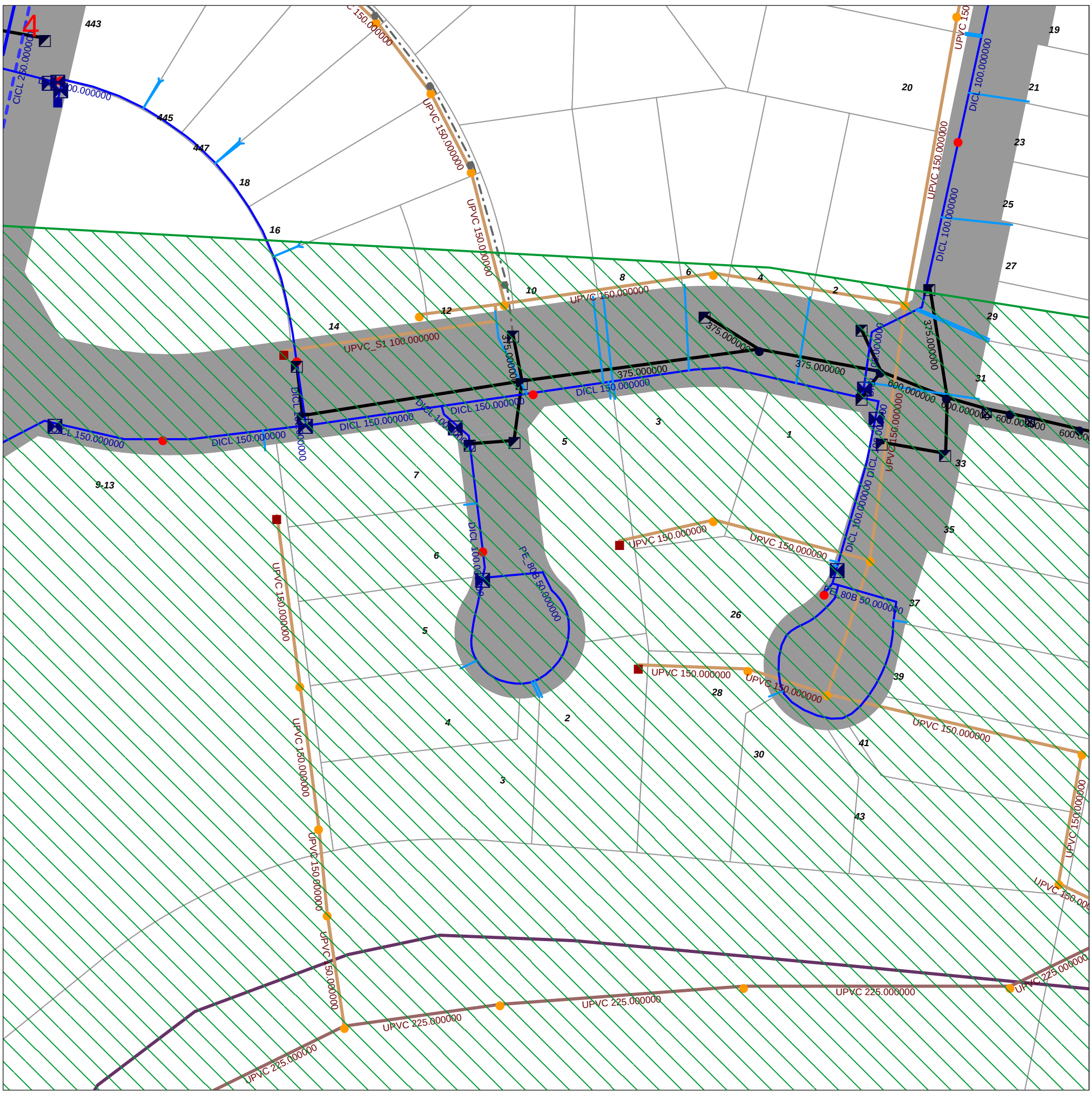
DIAL BEFORE YOU DIG www.1100.com.au

Map 4

Sequence No: 58092180
Casuarina Way Casuarina

TWEED SHIRE COUNCIL

Date: 11/01/2017



Sewer Pipeline
- Sewer Rising Main
- Sewer Rising Main (Abandoned)
- Sewer Rising Main (Private)
- Sewer Vacuum Main
- Sewer Gravity Overflow
- Sewer Gravity Main (0-200mm)
- Sewer Gravity Main (225-600mm)
- Sewer Gravity Main (700-900mm)
- Sewer Gravity Main (Abandoned)
- Sewer Gravity Main (Private)

Stormwater Pipeline
- Stormwater Culvert
- Stormwater Culvert (Abandoned)
- Stormwater Channel
- Stormwater Channel (Abandoned)
- Stormwater Pipe (0-975mm)
- Stormwater Pipe (1000-2100mm)
- Stormwater Pipe (Abandoned)
- Stormwater Pipe (Private)

Communication Cable
- Communications Cable

Water Pipeline
- Water Service
- Water Main (0-250mm)
- Water Main (300-1000mm)
- Water Main (Abandoned)
- Water Pipe (Private)

Sewer Node
- Vent Stack
- Vacuum Chamber
- Sewer Pump Station
- Sewer Pump
- Sewer Valve
- Sewer Endcap
- Sewer Manhole
- Private Sewer Point

Stormwater Node
- Stormwater Manhole
- Drop Inlet
- Kerb Inlet
- Wingwall
- Private Stormwater Point

Communication Node
- Communications Node

Water Node
- Water Pump Station
- Reservoir
- Water Valve
- Water Endcap
- Hydrant
- Private Water Point

General
- Property Boundary
- DBYD Work Area

N

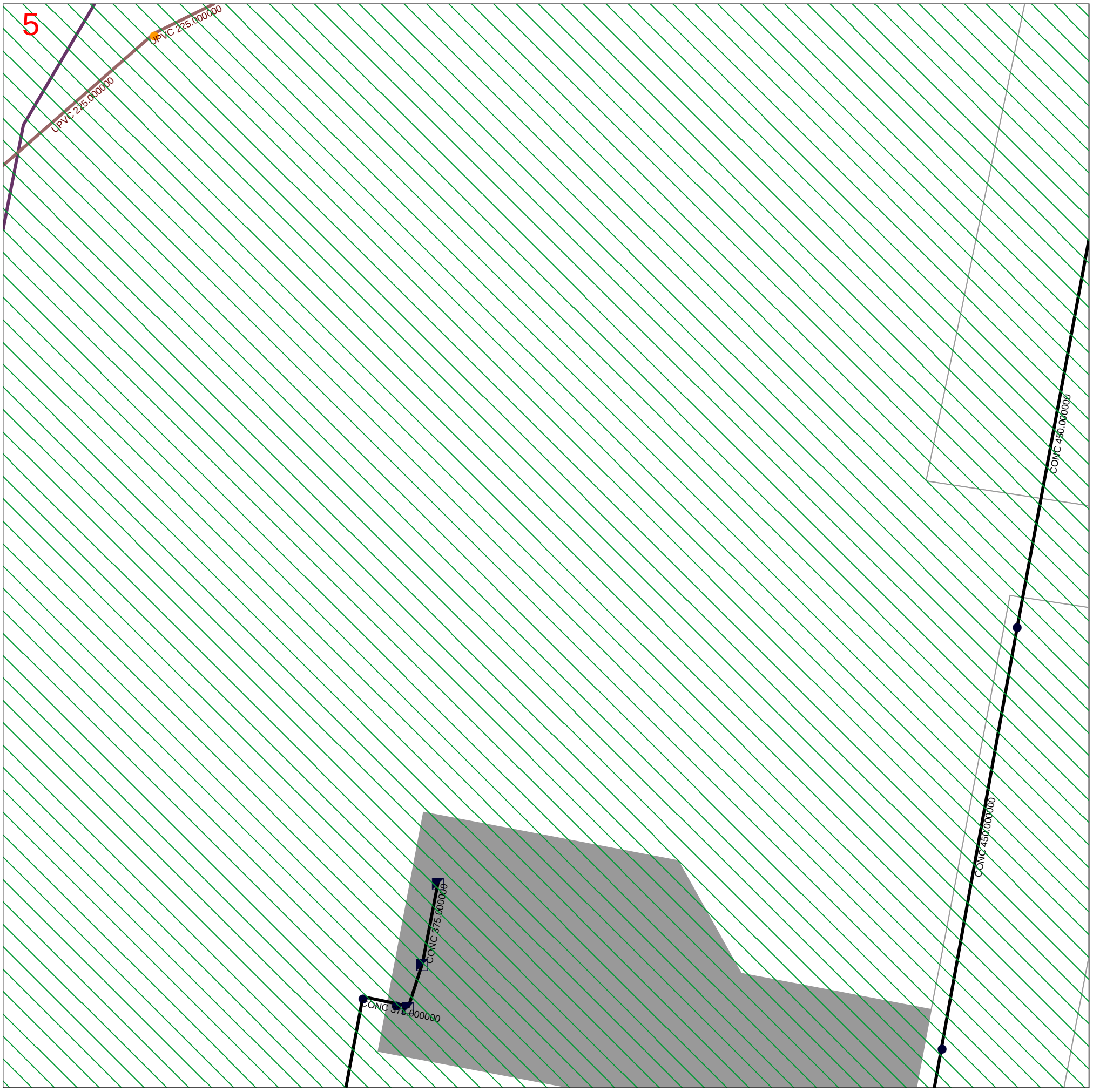
1:600 @ A3 Portrait

Date printed: 11/01/2017
© Land and Property Information (LPI) & Tweed Shire Council. Boundaries shown should be considered approximate only

Map 5

Sequence No: 58092180
Casuarina Way Casuarina

Date: 11/01/2017



Sewer Pipeline
- Sewer Rising Main
- Sewer Rising Main (Abandoned)
- Sewer Rising Main (Private)
- Sewer Vacuum Main
- Sewer Gravity Overflow
- Sewer Gravity Main (0-200mm)
- Sewer Gravity Main (225-600mm)
- Sewer Gravity Main (700-900mm)
- Sewer Gravity Main (Abandoned)
- Sewer Gravity Main (Private)

Stormwater Pipeline
- Stormwater Culvert
- Stormwater Culvert (Abandoned)
- Stormwater Channel
- Stormwater Channel (Abandoned)
- Stormwater Pipe (0-975mm)
- Stormwater Pipe (1000-2100mm)
- Stormwater Pipe (Abandoned)
- Stormwater Pipe (Private)

Communication Cable
- Communications Cable

Water Pipeline
- Water Service
- Water Main (0-250mm)
- Water Main (300-1000mm)
- Water Main (Abandoned)
- Water Pipe (Private)

Sewer Node
- Vent Stack
- Vacuum Chamber
- Sewer Pump Station
- Sewer Pump
- Sewer Valve
- Sewer Endcap
- Sewer Manhole
- Private Sewer Point

Stormwater Node
- Stormwater Manhole
- Drop Inlet
- Kerb Inlet
- Wingwall
- Private Stormwater Point

Communication Node
- Communications Node

Water Node
- Water Pump Station
- Reservoir
- Water Valve
- Water Endcap
- Hydrant
- Private Water Point

General
- Property Boundary
- DBYD Work Area

N

1:600 @ A3 Portrait

Date printed: 11/01/2017
© Land and Property Information (LPI) & Tweed Shire Council.
Boundaries shown should be considered approximate only

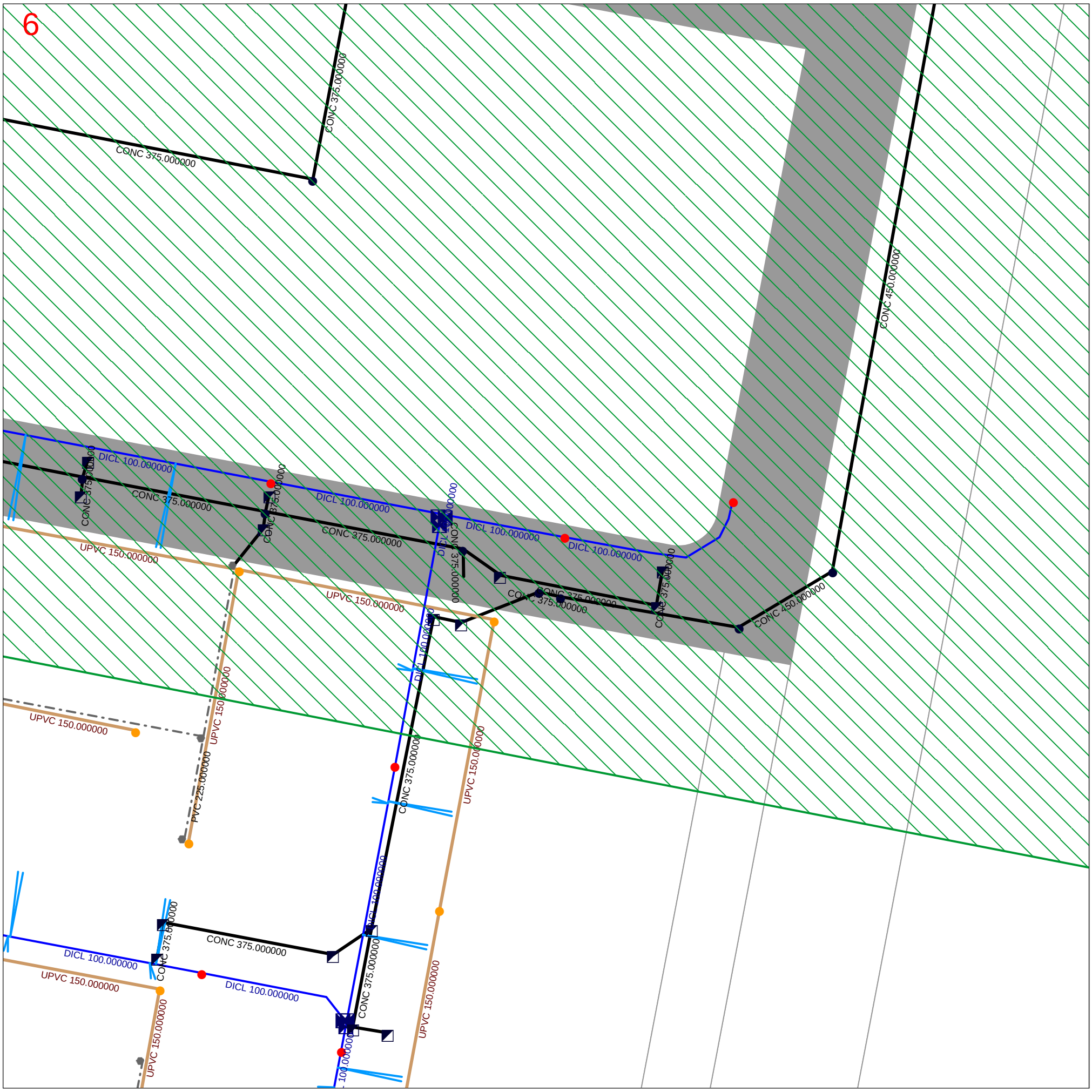
DIAL BEFORE YOU DIG www.1100.com.au

Map 6

Sequence No: 58092180
Casuarina Way Casuarina

TWEED SHIRE COUNCIL

Date: 11/01/2017



Sewer Pipeline
- Sewer Rising Main
- Sewer Rising Main (Abandoned)
- Sewer Rising Main (Private)
- Sewer Vacuum Main
- Sewer Gravity Overflow
- Sewer Gravity Main (0-200mm)
- Sewer Gravity Main (225-600mm)
- Sewer Gravity Main (700-900mm)
- Sewer Gravity Main (Abandoned)
- Sewer Gravity Main (Private)

Stormwater Pipeline
- Stormwater Culvert
- Stormwater Culvert (Abandoned)
- Stormwater Channel
- Stormwater Channel (Abandoned)
- Stormwater Pipe (0-975mm)
- Stormwater Pipe (1000-2100mm)
- Stormwater Pipe (Abandoned)
- Stormwater Pipe (Private)

Communication Cable
- Communications Cable

Water Pipeline
- Water Service
- Water Main (0-250mm)
- Water Main (300-1000mm)
- Water Main (Abandoned)
- Water Pipe (Private)

Sewer Node
- Vent Stack
- Vacuum Chamber
- Sewer Pump Station
- Sewer Pump
- Sewer Valve
- Sewer Endcap
- Sewer Manhole
- Private Sewer Point

Stormwater Node
- Stormwater Manhole
- Drop Inlet
- Kerb Inlet
- Wingwall
- Private Stormwater Point

Communication Node
- Communications Node

Water Node
- Water Pump Station
- Reservoir
- Water Valve
- Water Endcap
- Hydrant
- Private Water Point

General
- Property Boundary
- DBYD Work Area

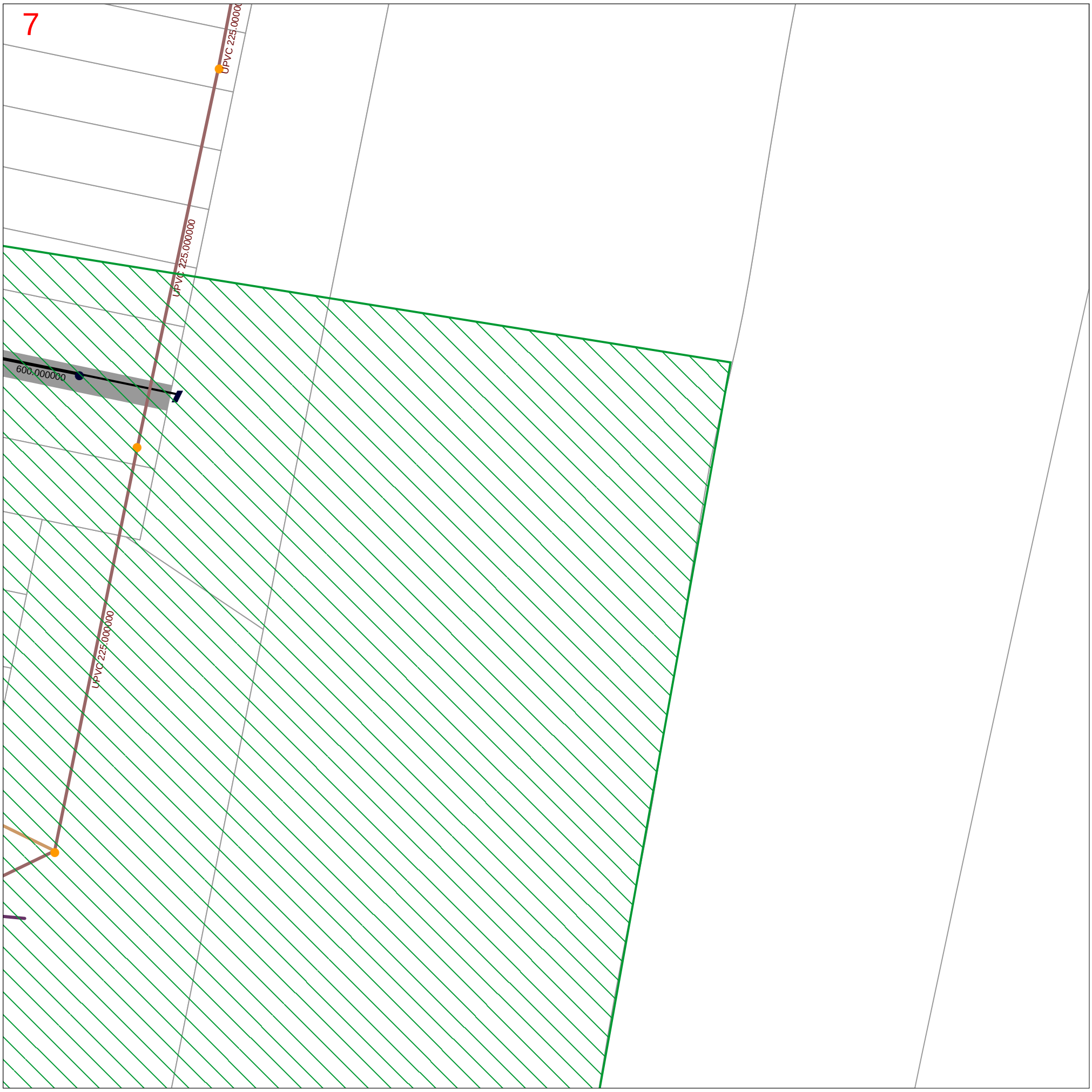
1:600 @ A3 Portrait

Date printed: 11/01/2017
© Land and Property Information (LPI) & Tweed Shire Council. Boundaries shown should be considered approximate only

Map 7

Sequence No: 58092180
Casuarina Way Casuarina

Date: 11/01/2017



Sewer Pipeline
- Sewer Rising Main
- Sewer Rising Main (Abandoned)
- Sewer Rising Main (Private)
- Sewer Vacuum Main
- Sewer Gravity Overflow
- Sewer Gravity Main (0-200mm)
- Sewer Gravity Main (225-600mm)
- Sewer Gravity Main (700-900mm)
- Sewer Gravity Main (Abandoned)
- Sewer Gravity Main (Private)

Stormwater Pipeline
- Stormwater Culvert
- Stormwater Culvert (Abandoned)
- Stormwater Channel
- Stormwater Channel (Abandoned)
- Stormwater Pipe (0-975mm)
- Stormwater Pipe (1000-2100mm)
- Stormwater Pipe (Abandoned)
- Stormwater Pipe (Private)

Communication Cable
- Communications Cable

Water Pipeline
- Water Service
- Water Main (0-250mm)
- Water Main (300-1000mm)
- Water Main (Abandoned)
- Water Pipe (Private)

Sewer Node
- Vent Stack
- Vacuum Chamber
- Sewer Pump Station
- Sewer Pump
- Sewer Valve
- Sewer Endcap
- Sewer Manhole
- Private Sewer Point

Stormwater Node
- Stormwater Manhole
- Drop Inlet
- Kerb Inlet
- Wingwall
- Private Stormwater Point

Communication Node
- Communications Node

Water Node
- Water Pump Station
- Reservoir
- Water Valve
- Water Endcap
- Hydrant
- Private Water Point

General
- Property Boundary
- DBYD Work Area

N

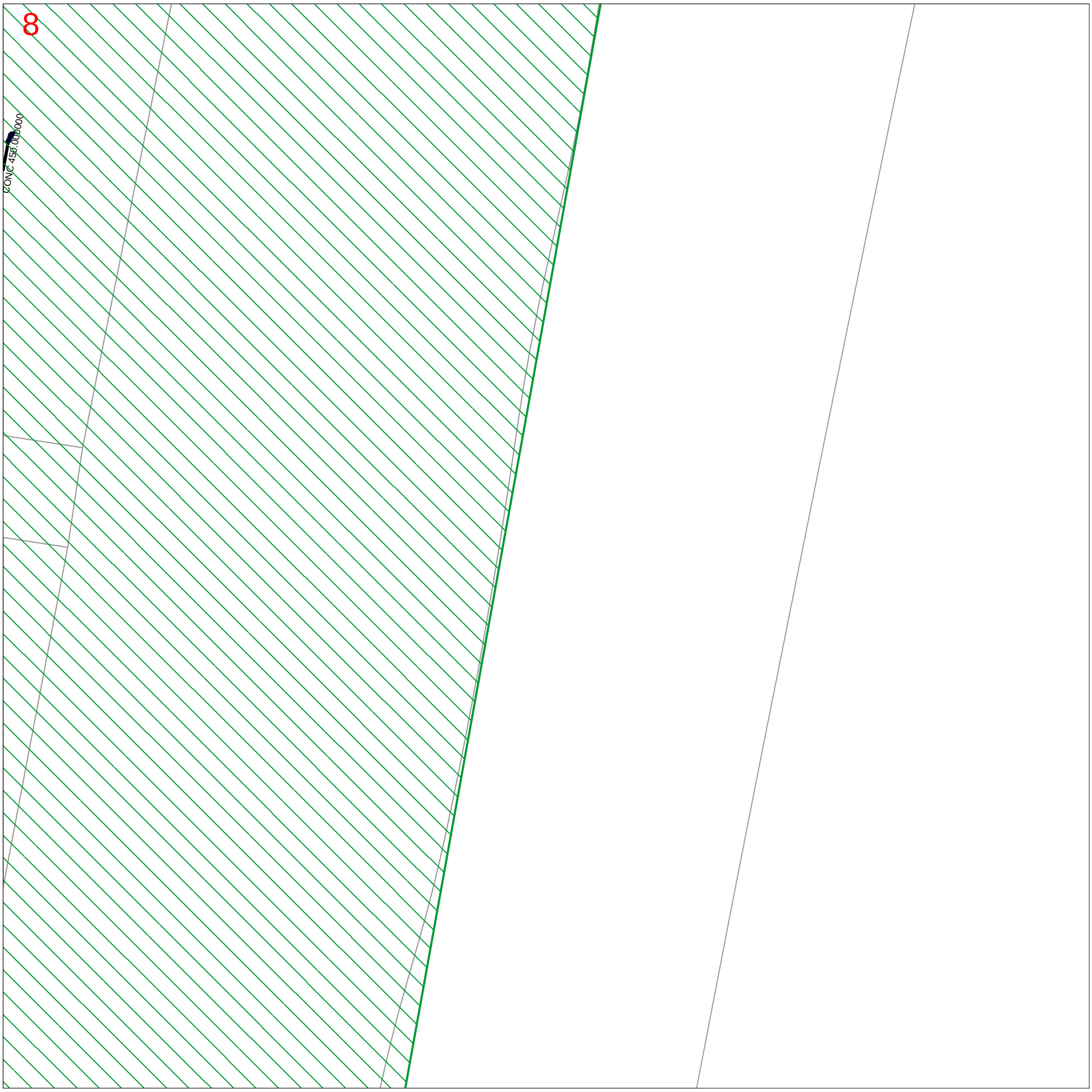
1:600 @ A3 Portrait

Date printed: 11/01/2017
© Land and Property Information (LPI) & Tweed Shire Council.
Boundaries shown should be considered approximate only

Map 8

Sequence No: 58092180
Casuarina Way Casuarina

Date: 11/01/2017



Sewer Pipeline
- Sewer Rising Main
- Sewer Rising Main (Abandoned)
- Sewer Rising Main (Private)
- Sewer Vacuum Main
- Sewer Gravity Overflow
- Sewer Gravity Main (0-200mm)
- Sewer Gravity Main (225-600mm)
- Sewer Gravity Main (700-900mm)
- Sewer Gravity Main (Abandoned)
- Sewer Gravity Main (Private)

Stormwater Pipeline
- Stormwater Culvert
- Stormwater Culvert (Abandoned)
- Stormwater Channel
- Stormwater Channel (Abandoned)
- Stormwater Pipe (0-975mm)
- Stormwater Pipe (1000-2100mm)
- Stormwater Pipe (Abandoned)
- Stormwater Pipe (Private)

Communication Cable
- Communications Cable

Water Pipeline
- Water Service
- Water Main (0-250mm)
- Water Main (300-1000mm)
- Water Main (Abandoned)
- Water Pipe (Private)

Sewer Node
- Vent Stack
- Vacuum Chamber
- Sewer Pump Station
- Sewer Pump
- Sewer Valve
- Sewer Endcap
- Sewer Manhole
- Private Sewer Point

Stormwater Node
- Stormwater Manhole
- Drop Inlet
- Kerb Inlet
- Wingwall
- Private Stormwater Point

Communication Node
- Communications Node

Water Node
- Water Pump Station
- Reservoir
- Water Valve
- Water Endcap
- Hydrant
- Private Water Point

General
- Property Boundary
- DBYD Work Area

N

1:600 @ A3 Portrait

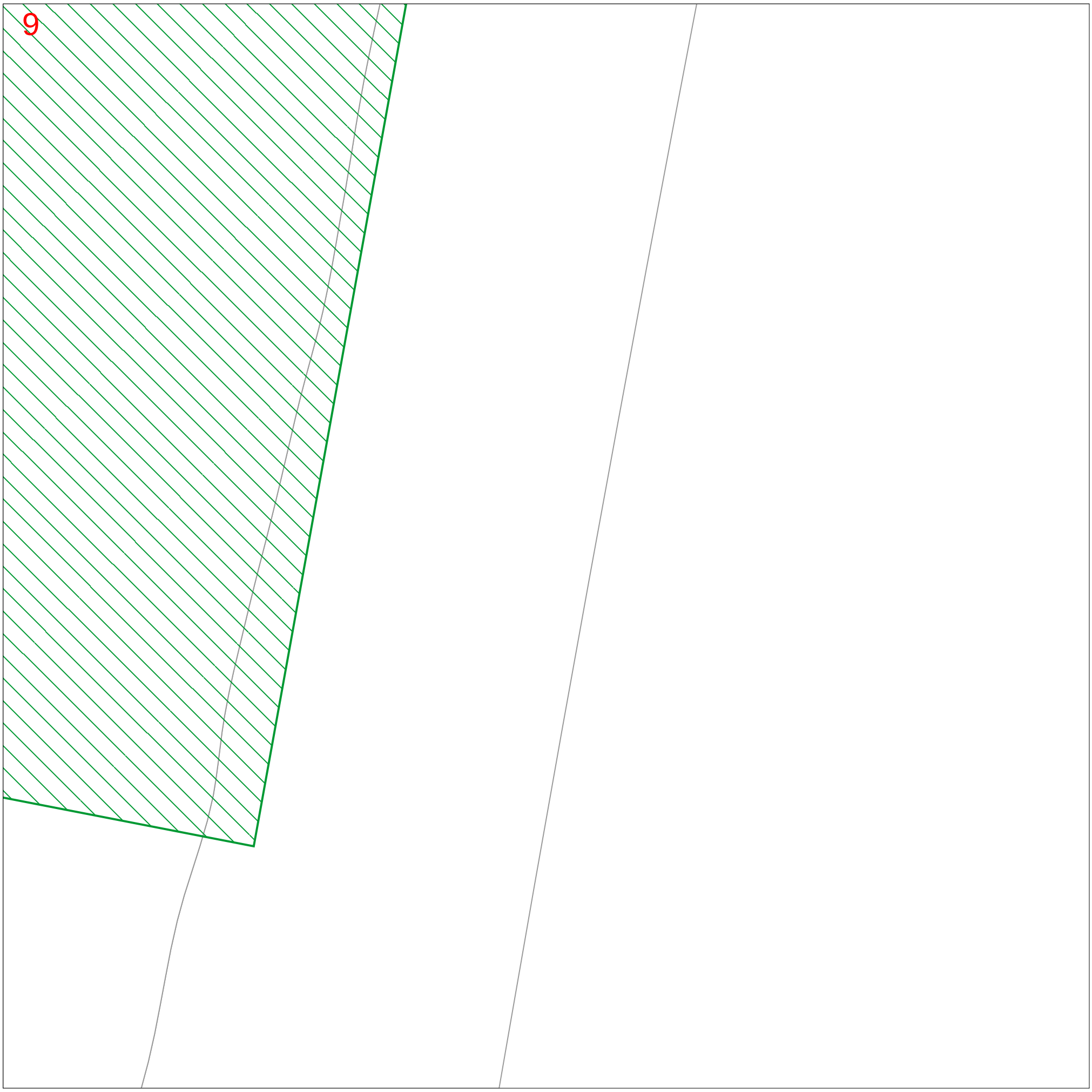
Date printed: 11/01/2017

Boundaries shown should be considered approximate only

Map 9

Sequence No: 58092180
Casuarina Way Casuarina

Date: 11/01/2017



Sewer Pipeline
- Sewer Rising Main
- Sewer Rising Main (Abandoned)
- Sewer Rising Main (Private)
- Sewer Vacuum Main
- Sewer Gravity Overflow
- Sewer Gravity Main (0-200mm)
- Sewer Gravity Main (225-600mm)
- Sewer Gravity Main (700-900mm)
- Sewer Gravity Main (Abandoned)
- Sewer Gravity Main (Private)

Stormwater Pipeline
- Stormwater Culvert
- Stormwater Culvert (Abandoned)
- Stormwater Channel
- Stormwater Channel (Abandoned)
- Stormwater Pipe (0-975mm)
- Stormwater Pipe (1000-2100mm)
- Stormwater Pipe (Abandoned)
- Stormwater Pipe (Private)

Communication Cable
- Communications Cable

Water Pipeline
- Water Service
- Water Main (0-250mm)
- Water Main (300-1000mm)
- Water Main (Abandoned)
- Water Pipe (Private)

Sewer Node
- Vent Stack
- Vacuum Chamber
- Sewer Pump Station
- Sewer Pump
- Sewer Valve
- Sewer Endcap
- Sewer Manhole
- Private Sewer Point

Stormwater Node
- Stormwater Manhole
- Drop Inlet
- Kerb Inlet
- Wingwall
- Private Stormwater Point

Communication Node
- Communications Node

Water Node
- Water Pump Station
- Reservoir
- Water Valve
- Water Endcap
- Hydrant
- Private Water Point

General
- Property Boundary
- DBYD Work Area

1:600 @ A3 Portrait

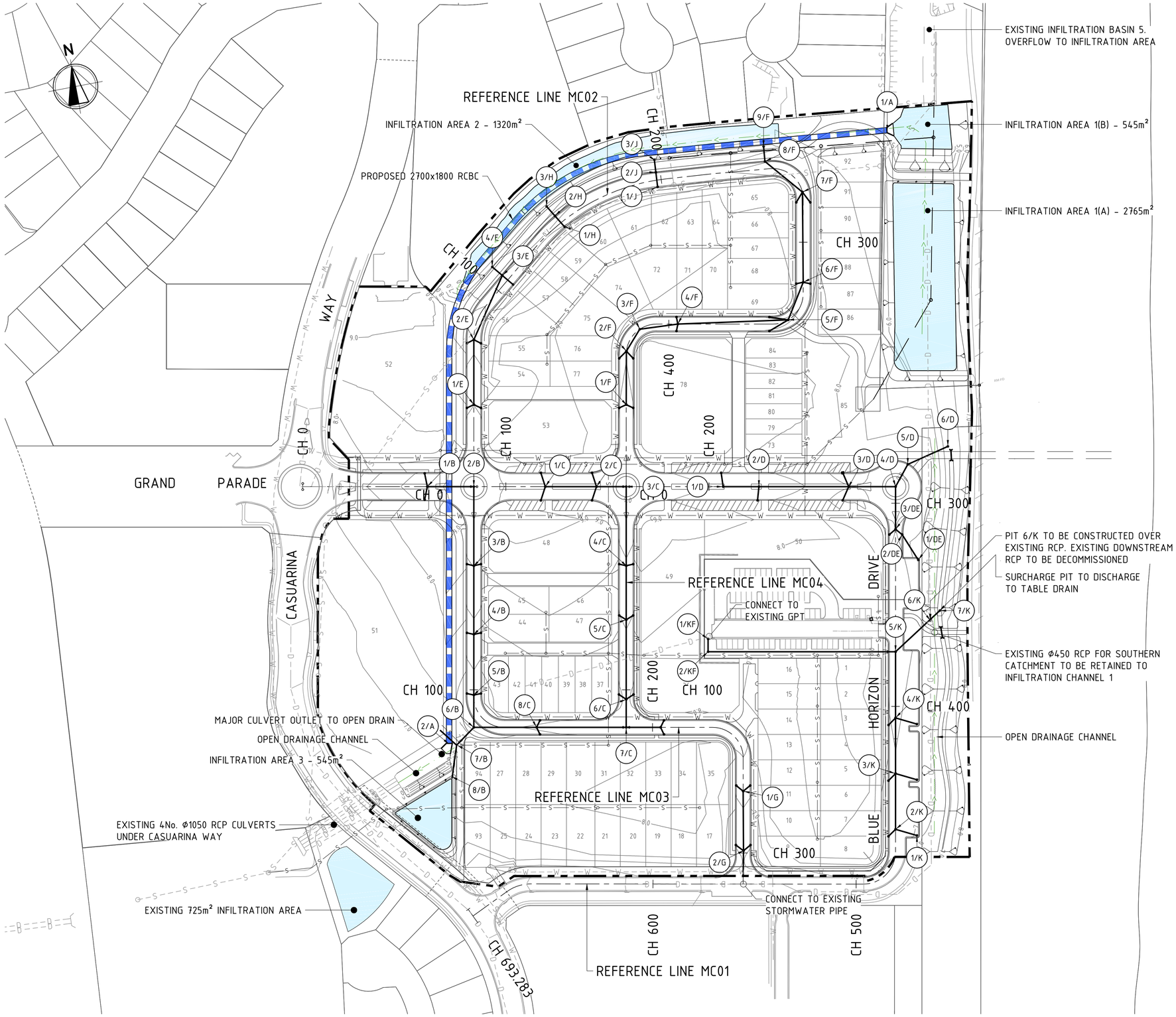
Date printed: 11/01/2017

Boundaries shown should be considered approximate only

Please note that water pipes and sewer rising mains operate under high pressure and present a significant risk for any work around them while live. These mains will have associated thrust blocks that should also be considered in design/construction clearances.

APPENDIX C

Proposed Stormwater Drainage Scheme



LEGEND

- CH 100 — DESIGN CONTROL LINE
- LIMIT OF WORKS BOUNDARY
- PROPOSED LIP OF KERB
- PROPOSED RETAINING WALL
- PROPOSED MINOR STORMWATER NETWORK
- PROPOSED MAJOR CULVERT AND HEADWALL
- 4/F — PROPOSED DRAINAGE STRUCTURE
- INFILTRATION AREA (5900m² TOTAL)
- PROPOSED SWALE DRAIN
- PROPOSED TRUNK SEWER ALIGNMENT (0.3m - 5.0m DEEP)
- PROPOSED SEWER ALIGNMENT (0m - 3.0m DEEP)
- PROPOSED WATER
- PROPOSED WATER CONNECTION
- 29.00 — PROPOSED CONTOURS
- EXISTING WATER
- OH — EXISTING OVERHEAD POWER LINE
- 24.75 — EXISTING CONTOURS

NOTE

1. BIO-RETENTION IS TO BE PROTECTED FROM SEDIMENT INPUTS DURING HOUSING CONSTRUCTION. BIO-RETENTION TO BE HANDED OVER TO COUNCIL AFTER 90% HOUSING CONSTRUCTION IS COMPLETE.

0 10 20 30 40 50 60m
SCALE 1:1000 AT A1 SIZE

REV	DATE	DESCRIPTION	RVD
A	09.05.17	ISSUED FOR DA APPROVAL	B.K

CLIENT: CLARENCE PROPERTY

Brisbane *Office*—
74-76 Bowen St, Spring Hill QLD 4000
P / +61 7 3167 3300
E / info@bgeeng.com
bgeeng.com—

PROJECT: CASUARINA BEACH
TOWN CENTRE - STAGE 2
CASUARINA WAY, NSW 2487

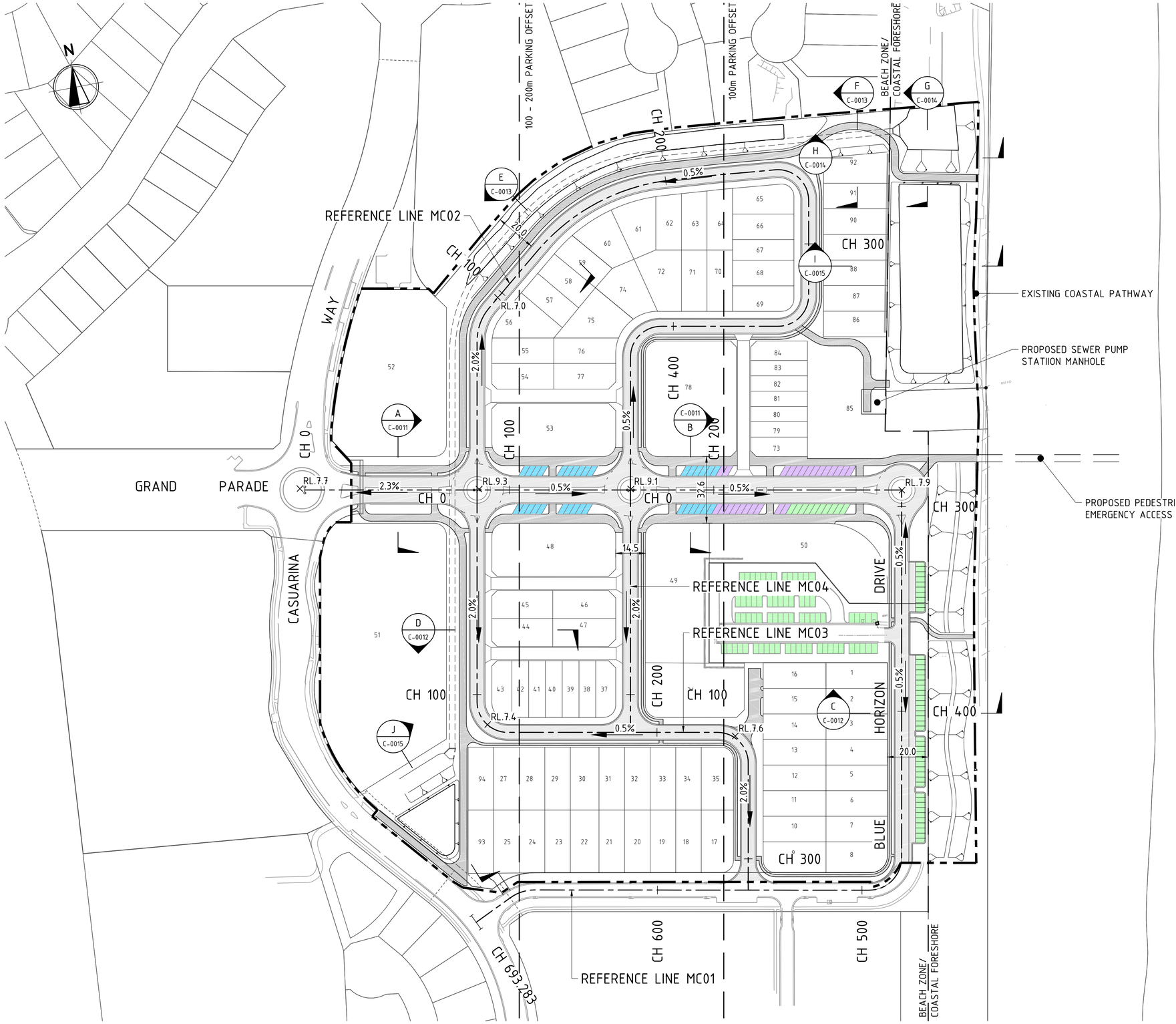
STATUS: PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION

DRAWN	DESIGNED	CHECKED	APPROVED
C.K	B.J	M.W	B.K

DATUM	GRID	SCALE	PROJECT No.	DRAWING No.	REV.
MGA94	AHD	1:1000 AT SIZE	B16097	C-0030	A

TITLE: STORMWATER LAYOUT PLAN SHEET 1

9/05/2017 5:17:20 PM \\BGEBNEFS02\PROJECTS\BGE\BNE\B16097\100 DRAWINGS\102 CIVIL\AUTOCAD\B16097-DRG-C-0030.DWG



LEGEND

- DESIGN CONTROL LINE (CH 100)
- LIMIT OF WORKS BOUNDARY
- PROPOSED ROAD GRADE (2%)
- PROPOSED LEVEL (RL.8.0)
- PROPOSED RETAINING WALL (1.0m)
- PROPOSED ROAD
- PROPOSED PATH
- PARKING BAYS - 0m TO 100m (134 TOTAL)
  - 71 EXISTING BLUE HORIZON DRIVE
  - 8 TRESTLES AVENUE
  - 55 PROPOSED BAYS
- PARKING BAYS - 100m TO 200m (32 TOTAL)
- PARKING BAYS - ADDITIONAL (24 TOTAL)

0 10 20 30 40 50 60m
SCALE 1:1000 AT A1 SIZE

REV	DATE	DESCRIPTION	BY
A	09.05.17	ISSUED FOR DA APPROVAL	B.K

REV	DATE	DESCRIPTION	BY

CLIENT: CLARENCE PROPERTY

Brisbane *Office—*
74-76 Bowen St, Spring Hill QLD 4000
P / +61 7 3167 3300
E / info@bgeeng.com
bgeeng.com—

PROJECT: CASUARINA BEACH
TOWN CENTRE - STAGE 2
CASUARINA WAY, NSW 2487

STATUS: PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION

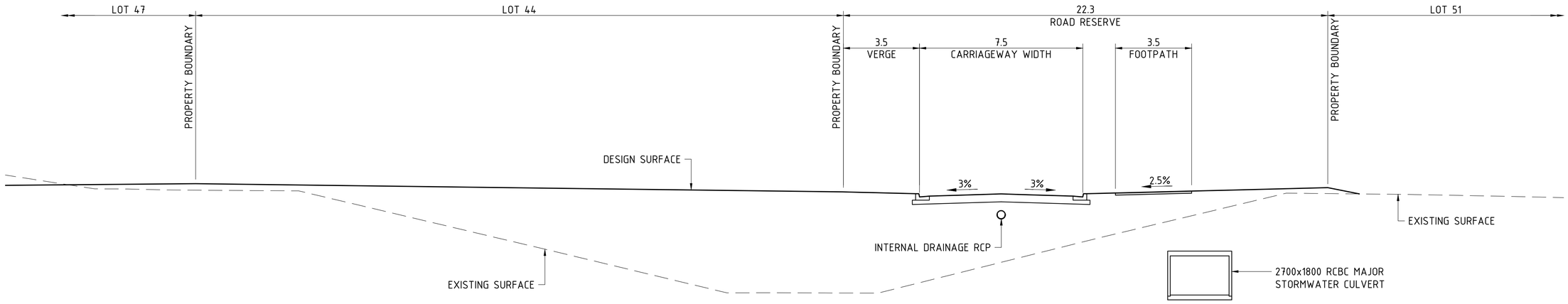
DRAWN	DESIGNED	CHECKED	APPROVED
C.K	B.J	M.W	B.K

DATUM	GRID	SCALE	
MGA94	AHD	1:1000	AT SIZE

TITLE: SITE LAYOUT PLAN

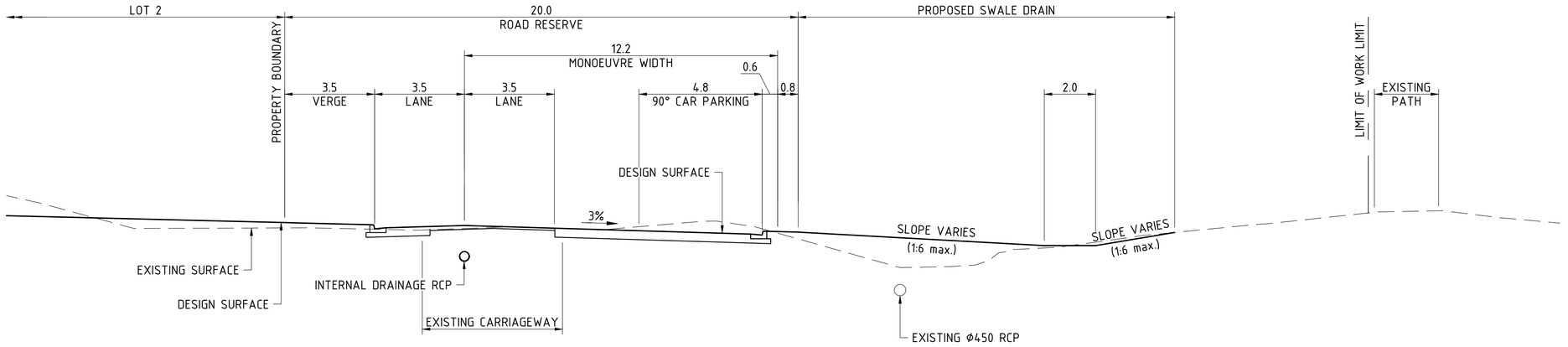
PROJECT No.	DRAWING No.	REV.
B16097	C-0003	A

\\BGEBNEFS02\PROJECTS\BGE\BNE\B16097\100 DRAWINGS\102 CIVIL\AUTOCAD\B16097-DRG-C-0003.DWG
9/05/2017 5:03:49 PM



TYPICAL SECTION D

SCALE 1:100



TYPICAL SECTION C - BLUE HORIZON DRIVE

SCALE 1:100

0 1 2 3 4 5 6m
SCALE 1:100 AT A1 SIZE

REV	DATE	DESCRIPTION	RVD
A	09.05.17	ISSUED FOR DA APPROVAL	B.K

REV	DATE	DESCRIPTION	RVD

CLIENT: CLARENCE PROPERTY

Brisbane *Office*—
74-76 Bowen St, Spring Hill QLD 4000
P / +61 7 3167 3300
E / info@bgeeng.com
bgeeng.com—

PROJECT: CASUARINA BEACH
TOWN CENTRE - STAGE 2
CASUARINA WAY, NSW 2487

STATUS: PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION

DRAWN	DESIGNED	CHECKED	APPROVED
C.K	B.J	M.W	B.K

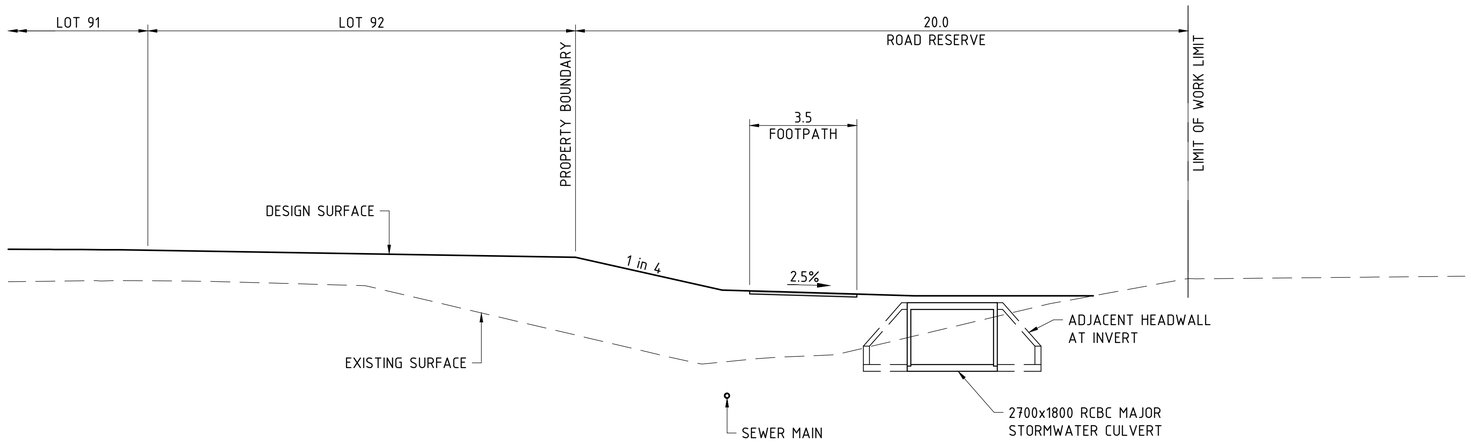
DATUM	GRID	SCALE
MGA94	AHD	1:50 AT SIZE

TITLE: BULK EARTHWORKS SECTIONS SHEET 2

PROJECT No.	DRAWING No.	REV.
B16097	C-0012	A

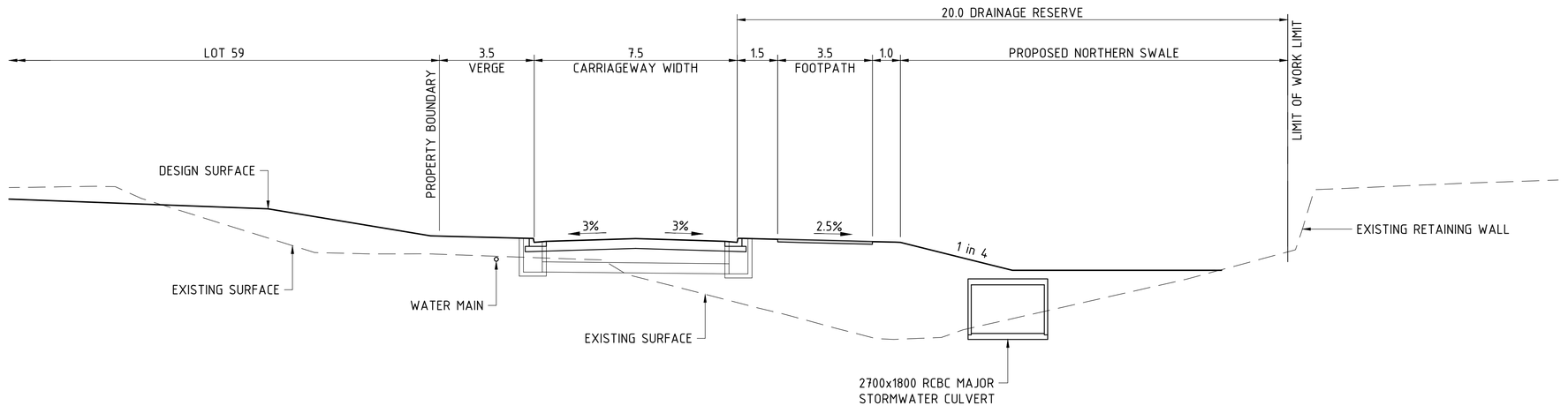
9/05/2017 5:03:57 PM \\BGEBNEFS02\PROJECTS\BGE\BNE\B16097\100 DRAWINGS\102 CIVIL\AUTOCAD\B16097-DRG-C-0011 TO C-0019.DWG

\\BGEBNEFS02\PROJECTS\BGE\BNE\B16097\100 DRAWINGS\102 CIVIL\AUTOCAD\B16097-DRG-C-0011 TO C-0019.DWG
9/05/2017 5:03:57 PM



TYPICAL SECTION F

SCALE 1:100



TYPICAL SECTION E - NORTHERN BOUNDARY DRAINAGE RESERVE

SCALE 1:100

0 1 2 3 4 5 6m
SCALE 1:100 AT A1 SIZE

REV	DATE	DESCRIPTION	RVD
A	09.05.17	ISSUED FOR DA APPROVAL	B.K

REV	DATE	DESCRIPTION	RVD

CLIENT: CLARENCE PROPERTY

Brisbane *Office*—
74-76 Bowen St, Spring Hill QLD 4000
P / +61 7 3167 3300
E / info@bgeeng.com
bgeeng.com—

PROJECT: CASUARINA BEACH
TOWN CENTRE - STAGE 2
CASUARINA WAY, NSW 2487

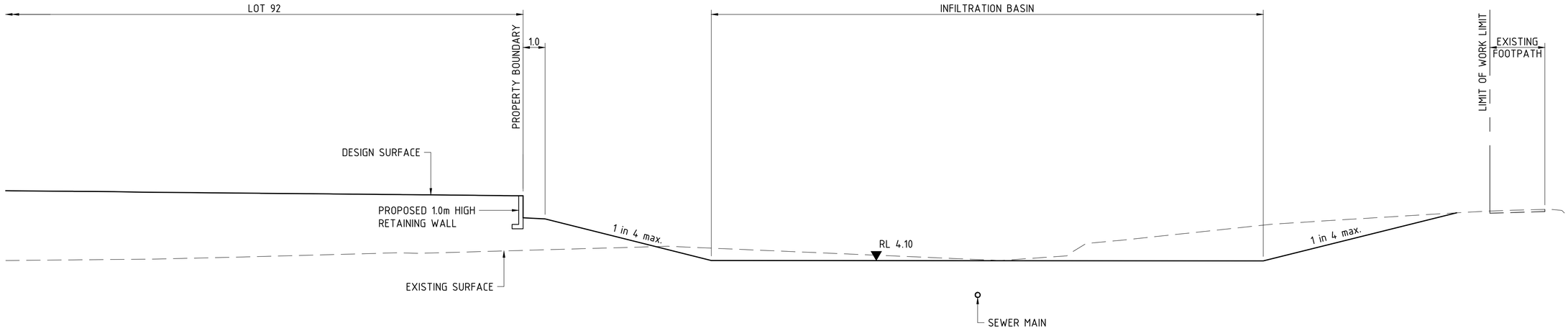
STATUS: PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION

DRAWN	DESIGNED	CHECKED	APPROVED
C.K	B.J	M.W	B.K

DATUM	GRID	SCALE	
MGA94	AHD	1:50	AT A1 SIZE

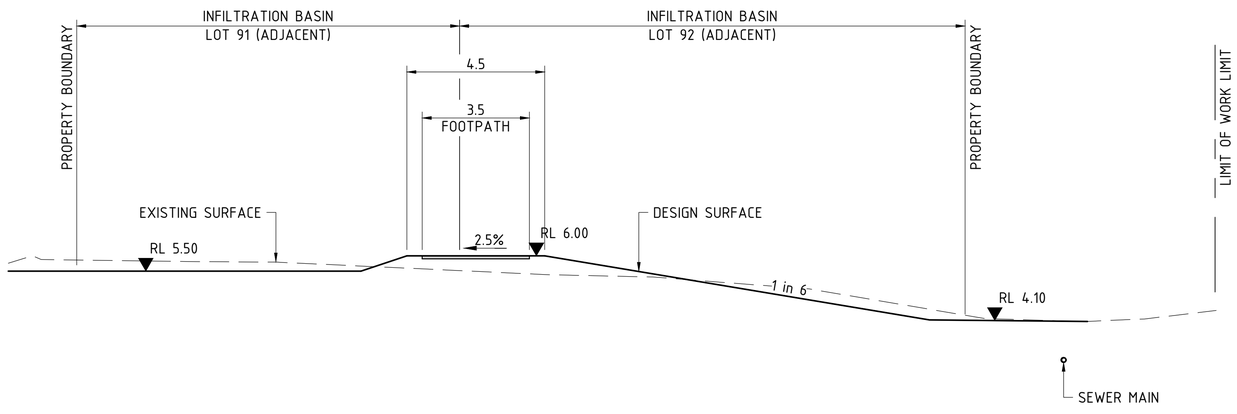
TITLE: BULK EARTHWORKS SECTIONS SHEET 3

PROJECT No.	DRAWING No.	REV.
B16097	C-0013	A



TYPICAL SECTION H - EASTERN INFILTRATION BASIN

SCALE 1:100



TYPICAL SECTION G

SCALE 1:100

0 1 2 3 4 5 6m
SCALE 1:100 AT A1 SIZE

REV	DATE	DESCRIPTION	RVD
A	09.05.17	ISSUED FOR DA APPROVAL	B.K

REV	DATE	DESCRIPTION	RVD

CLIENT: CLARENCE PROPERTY

Brisbane *Office—*
74-76 Bowen St, Spring Hill QLD 4000
P / +61 7 3167 3300
E / info@bgeeng.com
bgeeng.com—

PROJECT: CASUARINA BEACH
TOWN CENTRE - STAGE 2
CASUARINA WAY, NSW 2487

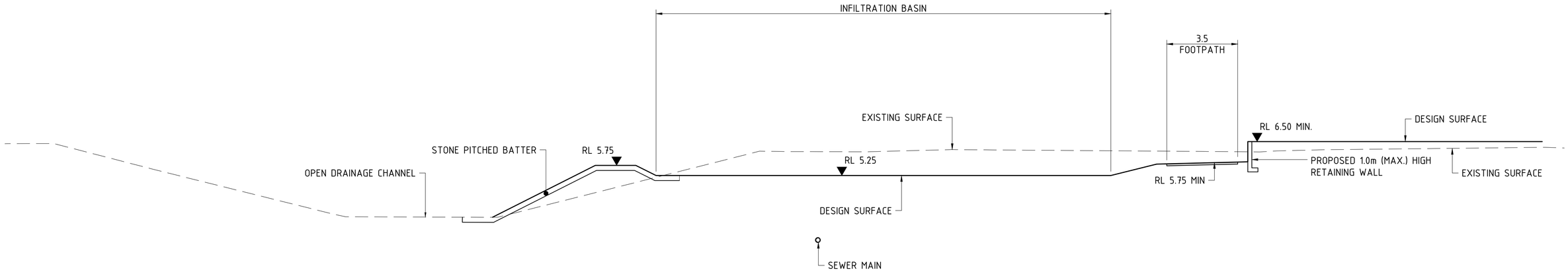
STATUS: PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION

DRAWN	DESIGNED	CHECKED	APPROVED
C.K	B.J	M.W	B.K

DATUM	GRID	SCALE	
MGA94	AHD	1:50	AT A1 SIZE

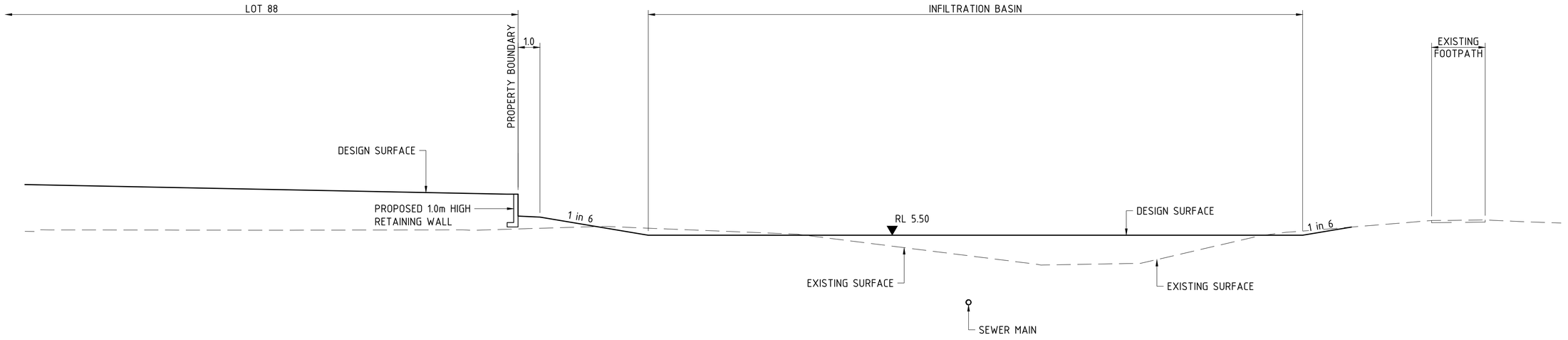
TITLE: BULK EARTHWORKS SECTIONS SHEET 4

PROJECT No.	DRAWING No.	REV.
B16097	C-0014	A



TYPICAL SECTION J

SCALE 1:100



TYPICAL SECTION I - EASTERN INFILTRATION BASIN

SCALE 1:100

0 1 2 3 4 5 6m
SCALE 1:100 AT A1 SIZE

REV	DATE	DESCRIPTION	RVD
A	09.05.17	ISSUED FOR DA APPROVAL	B.K

REV	DATE	DESCRIPTION	RVD

CLIENT: CLARENCE PROPERTY

Brisbane *Office*—
74-76 Bowen St, Spring Hill QLD 4000
P / +61 7 3167 3300
E / info@bgeeng.com
bgeeng.com—

PROJECT: CASUARINA BEACH
TOWN CENTRE - STAGE 2
CASUARINA WAY, NSW 2487

STATUS: PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION

DRAWN	DESIGNED	CHECKED	APPROVED
C.K	B.J	M.W	B.K

DATUM	GRID	SCALE
MGA94	AHD	1:50 AT SIZE

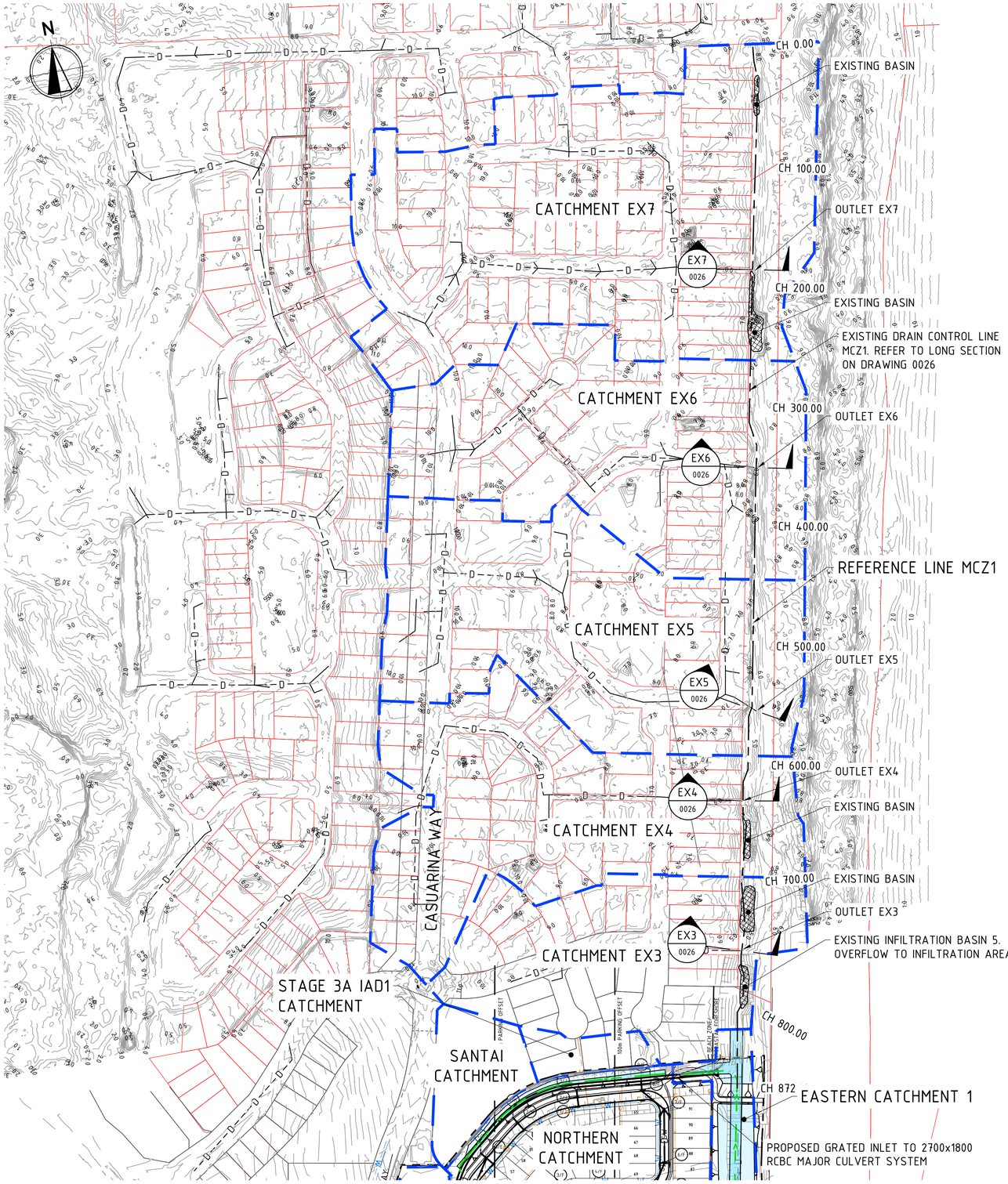
TITLE: BULK EARTHWORKS SECTIONS SHEET 5

PROJECT No.	DRAWING No.	REV.
B16097	C-0015	A

9/05/2017 5:04:00 PM \\BGEBNEFS02\PROJECTS\BGE\BNE\B16097\100 DRAWINGS\102 CIVIL\AUTOCAD\B16097-DRG-C-0011 TO C-0019.DWG
\\BGEBNEFS02\PROJECTS\BGE\BNE\B16097\100 DRAWINGS\102 CIVIL\AUTOCAD\B16097-DRG-C-0011 TO C-0019.DWG
9/05/2017 5:04:00 PM

APPENDIX D

Existing Northern Catchment Details



LEGEND

- REFERENCE LINE
- CATHCMENT BOUNDARY
- PROPOSED INTERNAL DRAINAGE NETWORK
- EXISTING DRAINAGE NETWORK
- OPEN CHANNEL/OVERLAND FLOW PATH
- INFILTRATION AREA
- EXISTING CONTOUR

CATCHMENT TABLE

CATCHMENT	AREA (ha)	FRACTION IMPERVIOUS (%)	TIME OF CONCENTRATION (MINS)
OVERALL EXISTING DRAIN	28.301		
EX1	0.740	70	6.0
EX2	0.300	50	6.0
EX3	3.463	49	8.5
EX4	4.945	50	12.5
EX5	5.513	52	12.0
EX6	5.260	48	10.5
EX7	8.080	47	10.5

SKETCH ONLY

0 20 40 60 80 100 120m
SCALE 1:2000 AT A1 SIZE

BG&E

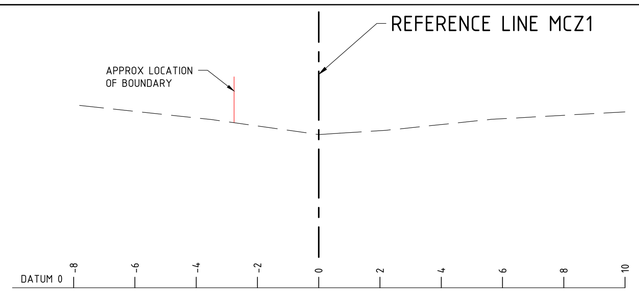
DATE	10.05.17
SCALE	1:2000
GRID	MGA 94, AHD
PREPARED	SS
SHEET	

PROJECT: CASUARINA BEACH TOWN CENTRE - STAGE 2

TITLE: NORTHERN DRAINAGE CATCHMENT PLAN

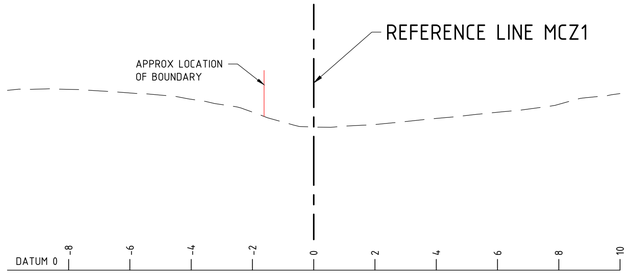
PROJECT No. B16097 | SKETCH No. SK-C-0025 | REV B

10/05/2017 9:05:05 AM P:\BGE\BNE\B16097\100 DRAWINGS\102 CIVIL\AUTOCAD\SKETCHES\B16097-SK-C-0025.DWG



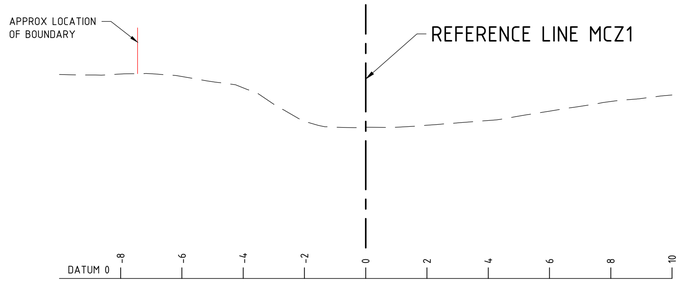
CROSS SECTION EX3

SCALE 1:100



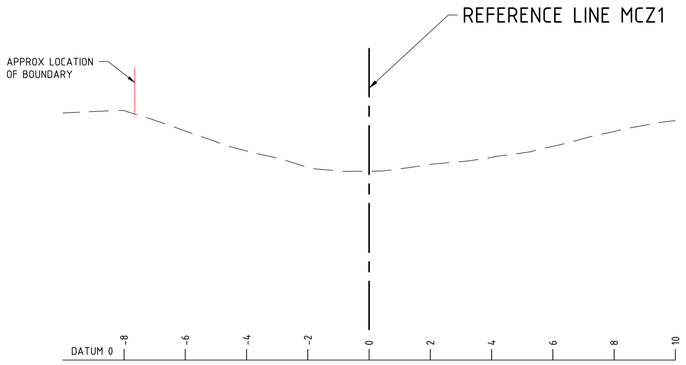
CROSS SECTION EX4

SCALE 1:100



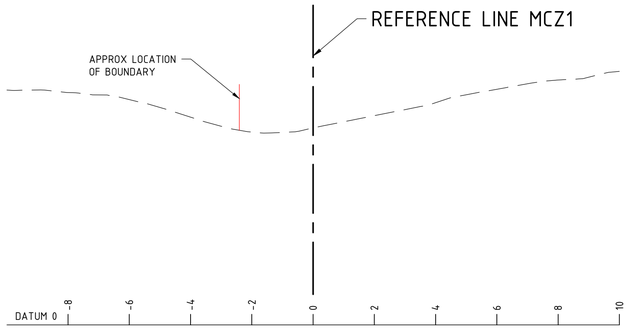
CROSS SECTION EX5

SCALE 1:100



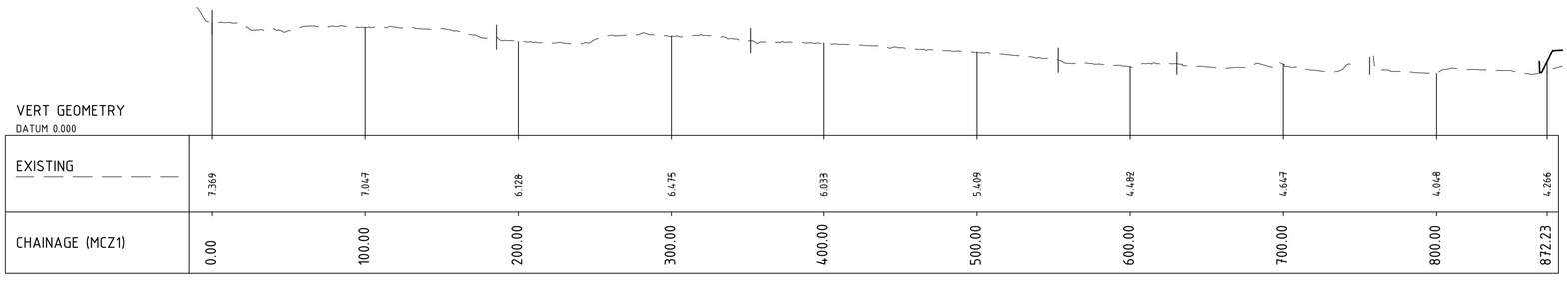
CROSS SECTION EX6

SCALE 1:100



CROSS SECTION EX7

SCALE 1:100



PROFILE - MCZ1

SCALE 1:2000H, 1:200V

SKETCH ONLY

0 1 2 3 4 5 6m
SCALE 1:100 AT A1 SIZE

0 2 4 6 8 10 12m
SCALE 1:200 AT A1 SIZE

0 20 40 60 80 100 120m
SCALE 1:2000 AT A1 SIZE

DATE 10.05.17	PROJECT CASUARINA BEACH TOWN CENTRE - STAGE 2		
SCALE 1:2000H, 1:200V	TITLE EXISTING DRAIN SECTIONS		
GRID MGA94, AHD			
PREPARED SS			
SHEET	PROJECT No. B16097	SKETCH No. SK-C-0026	REV B

10/05/2017 9:01:51 AM P:\BGE\BNE\B16097\100 DRAWINGS\102 CIVIL\AUTOCAD\SKETCHES\B16097-SK-C-0026.DWG

APPENDIX E

East West Drainage Scheme Options Design Memo M1V2

Technical Memorandum 2

Title	**Casuarina Town Centre** **East West Drainage Scheme Options**		
Client	Clarence Property Corporation Ltd	**Project No**	721783
Date	14 July 2015	**Status**	Version 2
Author	Adam Turner	**Discipline**	
Reviewer	Rod Barry	**Office**	Gold Coast

This design summary outlines the drainage strategy prepared as part of the investigation to replace the existing Casuarina Town Centre east-west swale drain with an appropriately sized pipe drainage system.

East West Pipe System Design Criteria

In order to reconfigure the east-west drainage system from an open channel to a pipe culvert system, the following design criteria was considered.

> The pipe culvert system will need to be designed to have sufficient capacity to convey the 100 year ARI flow from the contributing catchment area.
> The grated inlet structure at the upstream end of the pipe system shall be designed for a 50% blockage factor.
> The inlet structure shall have an angled grate with an open area equivalent to three times the area of the total combined pipe areas.
> A review of survey information of the northern precinct provided by Newton Denny Chapelle (NDC), shows the lowest surveyed level for the existing properties fronting the coastal drainage swale is RL5.92mAHD.
> NDC's survey information also indicated that the existing lowest surveyed level along footpath was RL5.56mAHD, and the lowest point in the dune to the east of the footpath is RL5.90mAHD. At this level flow will overtop the swale and discharge towards the beach.
> For open channels that convey major design flows, such as the frontal swale Tweed Shire Council's D5 – Stormwater Drainage Design Development Design Specification outlines that a minimum of 500mm freeboard shall be provided between the 100 year ARI flood level and the floor level of adjacent structures.
> To minimise head losses at the various pit structures, centre lines of the inlet and outlet pipes should be aligned, rather than be aligned with the centre of the pit structure.
> Rock scour protection must be provided at the upstream inlet and downstream outlet of all culverts.

Pipe System Proposed

The previous Technical Memorandum prepared by Cardno (dated 6 September 2013), based on discussions between Cardno and NDC, covered four options which were analysed in the hydraulic modelling package XP-STORM.

Option 4 outlined in the previous memorandum has been selected as the preferred drainage configuration to replace the existing east-west swale drain, which involves the proposed extension of the culvert system along the alignment of the current east-west swale drain up to the existing frontal swale system.

A minor adjustment to the alignment of the pipes was made to ensure that the changes in direction are all less than 45^{o} to reduce the losses through the manhole structures.

Refer to Cardno Sketch No. SK007_B for a schematic layout of the proposed scenario, showing the revised alignment of the pipes, and the locations of the upstream nodes IN/1 (at the inlet to the culvert system), NS50 and NS60 (within the existing northern precinct reach of the frontal swale).

Events Greater than 100 Year ARI

For drainage systems designed to convey the 100year ARI event it is important to consider the impacts of events greater that the 100 year ARI event. Tweed Shire Council's D5.04 Design Rainfall Data requires that the design of major systems a factor of safety of 1.2 shall be applied to design rainfall intensities to properly account for blockages, obstructions, loss of cross section over time, and potential impacts of climate change.

There are two design requirements for the 1.2 x 100 year ARI event. Firstly, to ensure that a freeboard of 500mm to the floor level of adjoining properties. Information provided by NDC stated that the lowest adjoining floor level is at RL6.2mAHD at Lot 237 DP1048494 (being 43 Beech Lane). The second control is to ensure that there is no discharge to the beach in a 1.2 x 100 year ARI event.

The 1.2 x Q100 event was achieved in storm by increasing the 100 year ARI rainfall within the XP storm model by a factor of 1.2, which resulted in increases in required flows from the catchments. A comparison of the flows from the catchments is shown in Table 1 below.

Table 1 1.2 x 100 Year ARI Critical Storm comparison with 100 year ARI Event

Catchment Node ID	Critical Flow Duration	XP Storm 100 Year ARI Peak Flow (m^3/s)	XP Storm 1.2 x 100 Year ARI Peak Flow (m^3/s)
Town Centre Precinct			
NE	60	1.42	1.83
SE	60	0.91	1.11
E	60	1.87	2.30
Northern Precinct			
1	60	1.54	1.95
7	60	1.97	2.47
16	60	2.24	2.78
30	60	1.44	1.80
41	60	2.50	3.11
62	60	0.76	0.93

Table 2 summarises the peak flood levels in the 100 year ARI event and the 1.2 x the 100 year ARI event, following the adjustments made to the alignment of the proposed pipes.

Table 2 Summary Peak Flood Levels

ARI Event	Critical Storm	Pipe Configuration	Water Surface Level @ Node IN/1 (m AHD)	Water Surface Level @ Node NS60 (m AHD)	Water Surface Level @ Node NS50 (m AHD)
100 Year ARI Event	60	3 x 1650 @ 0.1%	5.31	5.43	5.53
1.2 Times 100 Year ARI Event	60	3 x 1650 @ 0.1%	5.67	5.71	5.75

As outlined above, the design criteria for the 1.2 x 100 year ARI flood event is to ensure no discharge towards the beach while maintaining a 500mm freeboard to the floor levels of the adjoining lots. Based on the survey information provided by NDC, the existing lowest surveyed level along footpath was RL5.56mAHD, and the existing lowest surveyed level along the beach front was RL5.90mAHD.

During the 1.2 times 100 Year ARI event at the location of the low point in the path the peak flood level is approximately RL5.71mAHD, as shown in Table 1 above.

Cardno (Qld) Pty Ltd | ABN 57 051 074 992
Level 2 Podium Level - Emerald Lakes Town Centre
1/3321 Central Place, Carrara, Qld 4211
PO Box 391, Nerang, Qld 4211
Tel: 07 5539 9333 Fax: 07 5502 1586
Email: gco@cardno.com.au Web: www.cardno.com.au

Cardno® Shaping the Future

EXISTING CULVERT No. 11
CREEK
LOut11
TWEED COAST ROAD
OUTLET 11
BASIN B
BASIN C
TCSC
TCW
TCNW
D/S SWALE
CENT
OUT/1
TCN
BASIN A
TCSW
BASIN D
TCS
TCE
TCSE
PIPE SE
FS
TCS3
E-W PIPE
3/1
IN/1
TCNE
NS60
NS50
1
7
O1
O7

W CATCHMENT
Q_{100} = 0.6 m^3/sec
C_{100} = 0.90
A = 0.89ha
T_c = 6.5min

SC CATCHMENT
Q_{100} = 1.2 m^3/sec
C_{100} = 0.90
A = 1.65ha
T_c = 6.5min

NW CATCHMENT
Q_{100} = 1.4 m^3/sec
C_{100} = 0.86
A = 2.86ha
T_c = 15min

STAGE 3A IAD1
Q_{100} = 0.2 m^3/sec
C_{100} = 0.80
A = 0.30ha
T_c = 6min

CENTRAL CATCHMENT
Q_{100} = 3.0m^3/sec
C_{100} = 0.78
A = 9.78ha
T_c = 22.5min

SW CATCHMENT
Q_{100} = 0.6 m^3/sec
C_{100} = 0.80
A = 1.28ha
T_c = 14min

N CATCHMENT
Q_{100} = 1.7 m^3/sec
C_{100} = 0.84
A = 3.70ha
T_c = 17.5min

EAST-WEST PIPE CULVERT SYSTEM
3 x ⌀1650mm RCP

SANTAI
Q_{100} = 0.5 m^3/sec
C_{100} = 0.85
A = 0.74ha
T_c = 8min

S CATCHMENT
Q_{100} = 1.1 m^3/sec
C_{100} = 0.82
A = 2.40ha
T_c = 16.5min

E CATCHMENT
Q_{100} = 1.9 m^3/sec
C_{100} = 0.83
A = 4.03ha
T_c = 16min

SE CATCHMENT
Q_{100} = 0.9 m^3/sec
C_{100} = 0.83
A = 1.97ha
T_c = 16min

NE CATCHMENT
Q_{100} = 1.4 m^3/sec
C_{100} = 0.75
A = 3.26ha
T_c = 15min

OUTLET 1
Q_{100} = 1.5 m^3/sec
C_{100} = 0.84
A = 3.60ha
T_c = 17.5min

OUTLET 7
Q_{100} = 2.0 m^3/sec
C_{100} = 0.80
A = 5.00ha
T_c = 19.9min

SE CATCHMENT
PIPE FLOWS DISCHARGE TO EAST FRONTAL SWALE. OVERLAND FLOWS TO DISCHARGE TO WEST.

FS CATCHMENT
Q_{100} = 0.8 m^3/sec
C_{100} = 0.54
A = 1.65ha
T_c = 5min

PACIFIC OCEAN

FROM INFORMATION SUPPLIED BY NDC, LOWEST SURVEYED PROPERTY LEVEL ON 7F ZONE BOUNDARY RL 5.92. FLOOR LEVEL RL6.2

FROM INFORMATION SUPPLIED BY NDC, LOWEST SURVEYED FOOTPATH LEVEL RL5.56, LOWEST SURVEYED LEVEL ALONG BEACH FRONT RL5.90.

LEGEND:

- TOWN CENTRE SITE BOUNDARY
- TOWN CENTRE CATCHMENT BOUNDARY
- CENTRAL CATCHMENT BOUNDARY
- NORTHERN CATCHMENT BOUNDARY
- XP STORM NODES
- XP STORM LINKS – COMBINED PIPE & OVERLAND FLOW
- XP STORM LINKS – PIPE FLOW ONLY
- XP STORM LINKS – OVERLAND FLOW ONLY
- PIPE FLOW DISCHARGE LOCATION
- OVERLAND FLOW DIRECTION
- 7F ZONE WESTERN BOUNDARY
- Q100 FLOOD LEVEL CONTROL POINT LOCATIONS

SUMMARY OF PEAK FLOOD LEVELS			
ARI EVENT	WATER SURFACE LEVEL @ NODE IN/1 (mAHD)	WATER SURFACE LEVEL @ NODE NS60 (mAHD)	WATER SURFACE LEVEL @ NODE NS50 (mAHD)
100 YEAR ARI EVENT	5.310	5.430	5.530
1.2 x 100 YEAR ARI EVENT	5.670	5.710	5.750

0 50 100 150m
SCALE @ A1 1 : 1500

Clarence Property Corporation Limited
Casuarina Town Centre
East - West Drainage Scheme
Option 4 - Pipe Through To Frontal Swale

Date: August 2013
Drawing Number: 721783-002 SK008
Revision: A

DATE PLOTTED: 14 July 2015 10:55 AM
CAD FILE: P:\721783 Casuarina Pipe Drainage of Existing Swale\03 Design\Cad\03 Sketches\721783_002_SK008_A.dwg

AUSTRALASIA ASIA AFRICA MIDDLE EAST UK/EUROPE NORTH AMERICA LATIN AMERICA

APPENDIX F

SWINF 01 Infiltration Equivalency Catchment Plan

Date: 23 July 2015
Our Ref: 13/054

General Manager
Tweed Shire Council
PO Box 816
MURWILLUMBAH NSW 2484

Attention: Mr Steve Twohill

Re: Infiltration Equivalency For Casuarina Town Centre Project
Part 3A Approval Project No: 06-0258 & Council Reference: 10/0222

Newton Denny Chapelle (**NDC**) have been engaged by Clarence Property (**proponent**) to amend the Part 3A Approval (Project No: 06-0258) to incorporate an urban residential layout that is more of a small lot residential format.

A core element of the proposal is the piping and filling of the existing swale which traverses through the Casuarina Town Centre site and to maintain a green vegetative corridor. As discussed with you on the 10 July 2015, a key component of any amendment to the swale is to also achieve compliance with SK No 7079/1/24 Rev B (March 2001) due to this drawing being referenced with part of consent condition B47 as reproduced below:

> *(i) Design detail that demonstrates the equivalency of the proposed stormwater infiltration system with the plan "Infiltration Basin Configuration - Draining to Controlled Outlet No. 11", Cardno MBK, Plan Reference SK No. 7079/1-24 Rev B, 7 March 2001. Infiltration basins shall be designed to absorb the 3 month ARI (deemed to be 40% of the 1 year ARI event) storm runoff from the public stormwater system, based on a maximum infiltration rate determined in accordance with Council's Development Design Specification D7 – Stormwater Quality Section D7.9.9. Design detail must clearly identify the size and extent of the contributing catchment to each infiltration basin. Infiltration basins shall be wholly contained within land dedicated to Council. Basins shall be readily maintainable, and shall only contain structures and other infrastructure where it does not conflict with performance objectives or maintainability.*

It is our desire to work with TSC officers in achieving an approval in principle as to an appropriate infiltration configuration that satisfies the "equivalency" provisions such that we may lock in a layout footprint that meets stormwater objectives. This will then enable further detailed planning and engineering design work to proceed to accompany our modification submission.

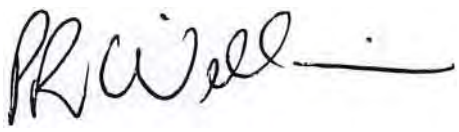
We enclose for your approval in principle consideration the following details:

(i) An infiltration catchment layout plan which has 4095m^2 of available infiltration area.
(ii) Copy of marked up SK7079/1-24 Rev B plan showing nominal 4,110m^2 of infiltration area required.
(iii) Landscaping concept plans showing how the infiltration areas would integrate with the green belt corridor.

As identified at our meeting of the 10 July 2015, we have endeavoured to drain as much water as reasonably possible to the east. This results in the drainage system within the dunal foreshore area being significantly modified and includes the removal of some of the recently installed piped drainage so as to accommodate a large infiltration basin footprint.

We trust these details are satisfactory to enable a considered assessment of our request, however should you have any questions regarding this matter, please do not hesitate contacting myself or our Mr Damian Chapelle of this office.

Yours sincerely,
NEWTON DENNY CHAPELLE



PETER WILLIAMS
Civil Engineer

Encl. *Drg No SWINF 01 Infiltration Equivalency Catchment Plan (Newton Denny Chapelle)*
Drg No 15/243 01, 02 & 03 Casuarina Infiltrate Swale Landscape Concept Plan (Design Team Ink)
Drg No SK7079/1-24 Rev B Infiltration Basin Configuration Draining To Controlled Outlet No 11 (Cardno)