

## Attachment 5

### WSC Flooding Assessment - Extract from Development Engineering Report Dated 4 October 2011

**Date:** 4 October 2011  
**Responsible Officer:** Jenny Webb  
**Location:** 35-41 Wilfred Barrett Dr, THE ENTRANCE NORTH NSW 2261  
Lot 1 DP 862588, Lot 76 DP 227174  
**UBD Reference:** XXXX  
**Zoning:** **2A Residential2A Residential**  
**Owner:** Mr H J Clifford and Mr L W Clifford  
**Applicant:** Celex Pty Ltd  
**Date Of Application:** 12 April 2011  
**Application No:** DA/308/2011  
**Proposed Development:** Residential flat building - SEPP Affordable Rental Housing  
(Amended Plan)  
**Land Area:** 4623.00

#### Flood Studies

The property is partially flood affected during a 1% Annual Exceedance Probability (AEP) flood event by flood water originating from the Tuggerah Lakes. The total catchment area upstream of The Entrance is 740km<sup>2</sup>, and includes three interconnected lakes and three major rivers.

The Tuggerah Lakes Flood Study was completed in 1994 and identifies that the 1% AEP flood level for this development is RL 2.2m Australian Height Datum (AHD). The development plans indicate existing ground levels generally range between 1.3m AHD and 3.3m AHD. Other flood events up to the Probable Maximum Flood (PMF) were analysed and calculated, and which are summarised below in Table 1 – Flood Characteristics.

The 1% AEP flood event is defined as the probability or likelihood that a location will experience a flood of a particular size, in any one given year. If a location has a 1% chance of a particular sized flood occurring each year, then it can also be expressed as having a chance of that particular sized flood occurring once in 100 years. Similarly, chances of 50% and 5% may be expressed as having a chance of that particular sized flood occurring once in 2 years and 20 years respectively.

It must be noted that if a location experiences that particular size flood one year does not mean that the location will definitely not experience the same sized again flood for the next 99 years. Nor, if it has not experienced a flood of a particular size for 99 years, will it necessarily occur the next year.

#### History of Flooding

Historical records held by Council indicate that the highest know Tuggerah lakes flood level occurred in June 1949 (2.1m AHD), with other severe events occurring in April 1946 (1.9m AHD), May 1964 (1.9m AHD), April 1927 (1.8m AHD) and

The most recent flooding events occurred in June 2011 (0.91m AHD), February June 2007 (1.65m AHD), February 1992 (1.2m AHD) and February 1990 (1.6m AHD).

## Sea Level Rise

Sea level rise is an incremental process and will have medium- to-long term impacts. The best national and international projections of sea level rise along the NSW coast are for a rise relative to 1990 mean sea levels of 400mm by 2050 and 900mm by 2100. However, the Intergovernmental Panel on Climate Change (IPCC) in 2007 also acknowledged that higher rates of sea level rise are possible.

The *NSW Sea Level Rise Policy Statement* published by the NSW Government in 2009 was prepared to support consistent adaptation to projected sea level rise impacts. The policy statement included sea level rise planning benchmarks for use in assessing potential impacts of sea level rise in coastal areas, including use in flood risk assessments. The benchmarks are for a projected rise in sea level, relative to the 1990 mean sea level, of 0.4 metres by 2050 and 0.9 metres by 2100.

Component	Source	Year 2050	Year 2100
<b>Sea Level Rise</b>	International Panel on Climate Change (IPCC)	300mm	590mm
<b>Accelerated Ice Melt</b>	International Panel on Climate Change (IPCC)	(included in above value)	200mm
<b>Regional Sea Level Rise</b>	Commonwealth Scientific and Industrial Research Organisation (CSIRO)	100mm	140mm
<b>Rounding</b>	Department Environment, Climate Change and Water NSW	0mm	-30mm
<b>TOTAL</b>		400mm	900mm

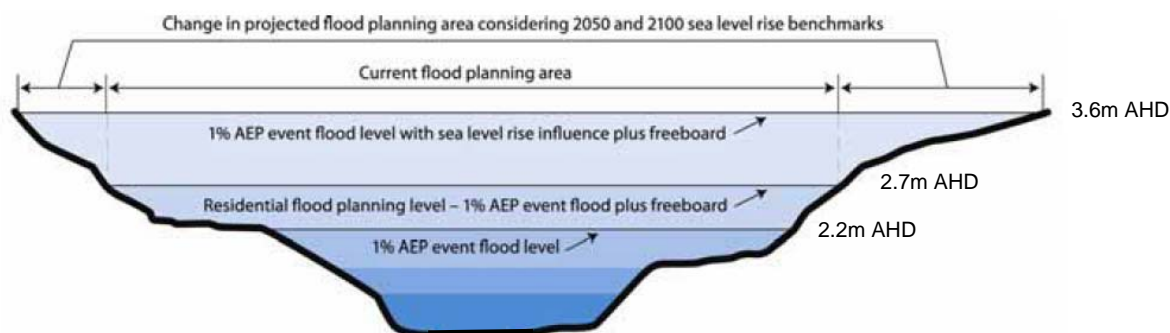
**Table 1 - Sea Level Rise Components and Sources**

Rounding was adopted by the NSW government as the projections have a degree of uncertainty, and adopting values to the nearest centimetre would imply unrealistic precision.

The *Flood Risk Management Guide - Incorporating Sea Level Rise Benchmarks in Flood Risk Assessments (the guide)* published by the NSW Government in 2009 was prepared to assist stakeholders to incorporate the sea level rise planning benchmarks in floodplain risk management planning and flood risk assessments for new development. The guide updates the sea level rise information in the *NSW Floodplain Development Manual* published by the NSW Government in 2005.

Considering the significance of the development in terms of population intensification, expected asset life and financial investment proposed by the applicant, it is considered appropriate to apply the higher sea level rise benchmark for the proposed development. The application of this benchmark has the affect of increasing the initial water level of Tuggerah Lake and the Pacific Ocean analysed in the Tuggerah Lakes flood study.

The guide states that “Where the site is below 4 metres AHD, an appropriate conservative assumption to estimate the 1% AEP flood level considering sea level rise is to add the sea level rise planning benchmarks to the 1% AEP flood level relevant to the site”. As stated previously, the development plans indicate existing ground levels generally ranging between 1.3m AHD and 3.3m AHD. The image below is an indicative cross section of the lake, provided to visually explain the flooding terminology used in this report, and has been annotated with the flood levels applicable to the development.



**Figure 1** – Indicative Tuggerah Lake Cross-section

It follows that it is appropriate to apply the higher sea level rise bench mark during flood assessment. The year 2100 flood levels have been used in assessment of the application.

Flood	50% AEP	20% AEP	5% AEP	1% AEP	PMF
Existing (m AHD)	0.91	1.36	1.8	2.2	2.7
Year 2100 (m AHD)	1.81	2.26	2.7	3.1	3.6

**Table 2 –Flood Levels**

### Tuggerah Lakes Floodplain Risk Management Study

The Tuggerah Lakes Floodplain Risk Management Study was completed in November 2010 and sought to evaluate management options for the floodplain in respect to both existing and proposed development.

The preparation of the study was a multi-disciplinary process, which involved the derivation of an appropriate mix of management measures to effectively manage the full range of flood risk. The intention of the study is to identify all relevant issues, quantify them and weigh them appropriately and inform the into an overall management plan. The factors considered in the Floodplain Risk Management Study include:

- Flood behaviour, danger and damage
- The community cost of flooding
- Future land use
- A comprehensive range of flood risk management measures
- The environmental needs of the floodplain areas, and
- Environmental and cultural impacts of management measures.

Following completion, the content of the study has been verified, peer reviewed and publically exhibited. The study, in conjunction with subsequent submissions, are intended to inform the Tuggerah Lakes Floodplain Risk Management Plan.

### Flood assessment

Under the NSW State Government's Flood Policy, the management of flood liable land remains the responsibility of local government. Accordingly, Council has a duty of care to ensure flood liable lands in the Wyong Shire are managed in accordance with their flood hazard and flood risk. Council's Development of Flood Prone Land policy (the policy) presents Council's current development controls applicable to the development and has been continually applied for a period exceeding 20 years.

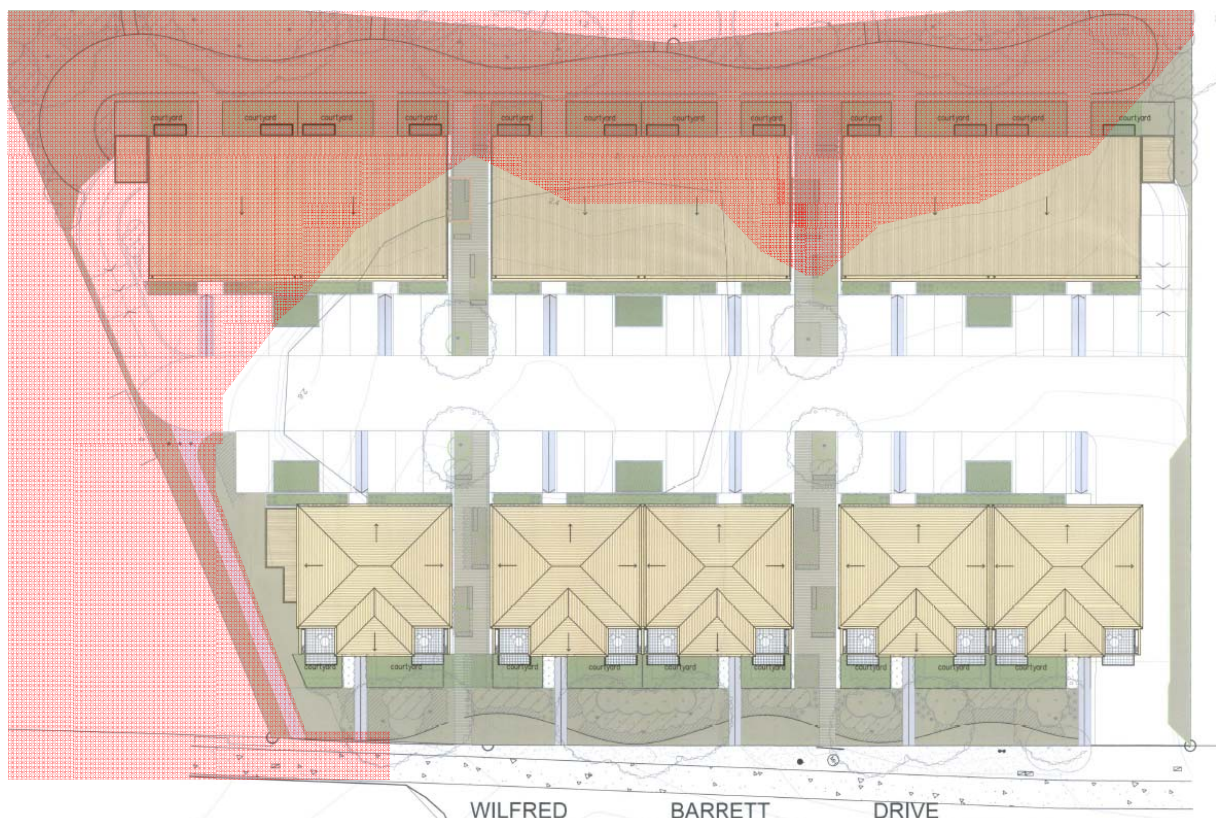
The application of the policy requires the categorisation of 'Type of Development' and 'Flood Hazard' to determine suitability of the proposed development. The 'Type of Development' for

the purpose of this policy meets the category of 'New Development' due to the proposed population intensification; however the determination of 'Flood Hazard' requires further consideration. A qualitative Flood Hazard Assessment has been undertaken to determine the 'Flood Hazard' in accordance with the policy.

## Flood Hazard Assessment

The policy requires categorisation of flood hazards in accordance with the *NSW Floodplain Development Manual*, which details the process to determine flood hazard category. The process involves firstly evaluation of hazard level from pure hydraulic principles, and then refining the hydraulic hazard category in light of other relevant factors affecting the safety of individuals to establish the true flood hazard category.

The initial step undertaken was the selection of the hydraulic categories of flood prone land (floodway, flood storage and flood fringe) and assignment of a provisional hydraulic hazard category (high hazard or low hazard). The hydraulic category of flood prone land applicable to the development is flood storage given flood affectation from Tuggerah Lakes. The provisional hydraulic category for flood water without velocity is exclusively based on flood depth, with depths less than 800mm being considered low hazard. On this basis, the development has been determined to be a mixture of both low hazard and high hazard, with Figure 1 showing an interpretation of high hazard flooding overdrawn on the architectural plans.



**Figure 2 – Approximate extent of Provisional High Hazard flooding (red)**

The hazard category from pure hydraulic principles is considered to be a combination of high hazard flood storage and low hazard flood storage.

The application of the policy requires determination of true flood hazard category, which was undertaken by refining the hydraulic hazard category in considering the following factors;

### Risk to Life

- *The proposed development should not result in any increased risk to human life*

The existing site contains a single residential dwelling approximately 50 years old with existing habitable floor level approximately 100mm below the sea level rise flood planning level. Completion of the development is likely to result in structurally superior dwellings above the sea level rise flood planning level.

The proposed development seeks approval for 43 units, which will increase population density in an area established to be hydraulically affected by high hazard flooding.

Self sufficient low hazard evacuation is available from the development towards the north. Future occupants may be reliant on emergency services for pedestrian evacuation is not viable given the distance to travel to the next township exceeds 4km.

- *Consequences for risk to life for floods up to the Flood Planning Level*

Occupants are predicted to be subject to prolonged flooding with the historical data and flood modelling indicating flood characteristics inhibiting access may be present for numerous days, with conditions close to peak remaining for approximately 24 hours. Assuming safe harbourage is provided; occupants will need to manage reduced or total unavailability of essential services and access to supplies, including medical services, electricity, sewerage, gas, telecommunications and potentially potable water generally due to the increased severity of flooding experienced south of the development.

- *Consequences for risk to life for floods greater than the Flood Planning Level*

The development may sustain damage for events larger than the design criteria. The floor levels have been proposed equal to the probable maximum level (including sea level rise) and are likely to have a safe place of refuge. Evacuation will be solely reliant on emergency services.

## The Cost

- *The additional economic and social costs that may arise from damage to property from flooding should not be greater than that which can reasonably be managed by the property owner nor in addition to those experienced by the general community.*

Flood insurance coverage is likely to be accessed by the future owners and damage is likely to be less than the general community given the access to modern construction techniques and materials. Flood insurance does not reduce flood damages, but transforms the random sequence of losses into a regular series of payments.

- *Economic factors with regard to not undertaking the development.*

The property is currently occupied by a single storey dwelling approximately 50 years old, and nearing achievement of reasonable estimates of asset and economic life.

It is anticipated that in the event the development does not proceed that the existing dwelling will continue to be used for residential purposes.

The costs involved in preparing the development application (design, supporting documentation and lodgement fees) will not be recouped through development of the land.

- *The cost to both the public and private sectors to service the development safely before and after in flood*

The proposed development is generally located within an existing residential area with existing public and private infrastructure. The development is not anticipated to generate significant additional servicing costs before or after floods.

The downstream The Entrance North sewer catchment was without sewer servicing for a period of 3 days during the June 2007 flood event. As noted above, the predicted 2100 1% AEP flood level is approximately 1.4m higher than the June 2007 flood event and the effect on sewer servicing is likely to be greater. While the development is unlikely to suffer onsite sewer surcharging, the downstream contamination of floodwater will potentially be exacerbated.

#### Warning and Evacuation

- *The availability of accurate information during a flood event on which evacuation strategies can be formulated. This must include consideration of loss of power and telephone landlines.*

The Tuggerah Lakes system is closely monitored during flood events, with updates regularly provided by the emergency management authorities. Access to accurate information is not anticipated to be an issue with current technology, surrounding community and adequate flood preparedness.

- *Available effective warning time and reliable access for the evacuation of an area potentially affected by floods up to the 1% AEP flood event for the proposed development.*

Flooding from Tuggerah Lakes generally features a relatively slow rate of rise over a number days to produce severe flood characteristics. Effective warning time is available. As discussed previously, low hazard self sufficient evacuation is available to the north.

- *Available effective warning time and reliable access for the evacuation of an area potentially affected by floods larger than that which the proposed development has been designed for. This includes consideration of floodwater depth and velocity.*

Similar to the above, a relatively slow rate of rise is applicable to floods in excess of the 1% AEP flood event. However, during floods in excess of the design flood would further restrict evacuation.

- *The development should not create land that will become an island in the floodplain*

The applicant is seeking to raise the development above the natural ground level to the sea level rise flood planning level. While this level may create the physical appearance of an island, the occupants are unlikely to experience the adverse effects of isolation.

#### Cumulative Effects of the Development

- *Evidence that the development does not detrimentally increase the potential flood affectation on other development or properties or infrastructure, either individually or in combination with the cumulative impact of development that is likely to occur in the same floodplain.*

The applicant has minimised the extent of filling, however the development will result in a minor loss of flood storage, similar to the relatively recent subdivision to the north.

- *Potential cumulative effects of approval of the development and precedents created for further cumulative development in the floodplain*

Minor loss of flood storage is proposed with the application associated with the low level carpark and fill. The loss of flood storage is commensurate with the other development around Tuggerah Lakes, and is not considered to set an undesirable precedent for other development in the floodplain.

#### Ecological Sustainable Development

- *Proposed development must be consistent with ecologically sustainable development principles*

In a flooding context, the development adequately considers the principles of ecologically sustainable development. In particular the development meets the principles of intergenerational equity and application of the precautionary principle by acknowledging and addressing predicted sea level rise.

#### Climate Change

- *The proposal adequately considers the impact of climate change.*

Sea level rise is one predicted element that has been discussed separately in this report, however other effects have the potential to affect peak flood levels such as increased temperatures, changes in rainfall patterns and increased frequency of extreme wind and storm events. The science in relation to these effects has not been developed to the extent where individual consideration is appropriate or possible. The conservative application of the sea level rise benchmarks and 500mm freeboard to habitable floor levels is considered adequate to overcome the unquantified effects.

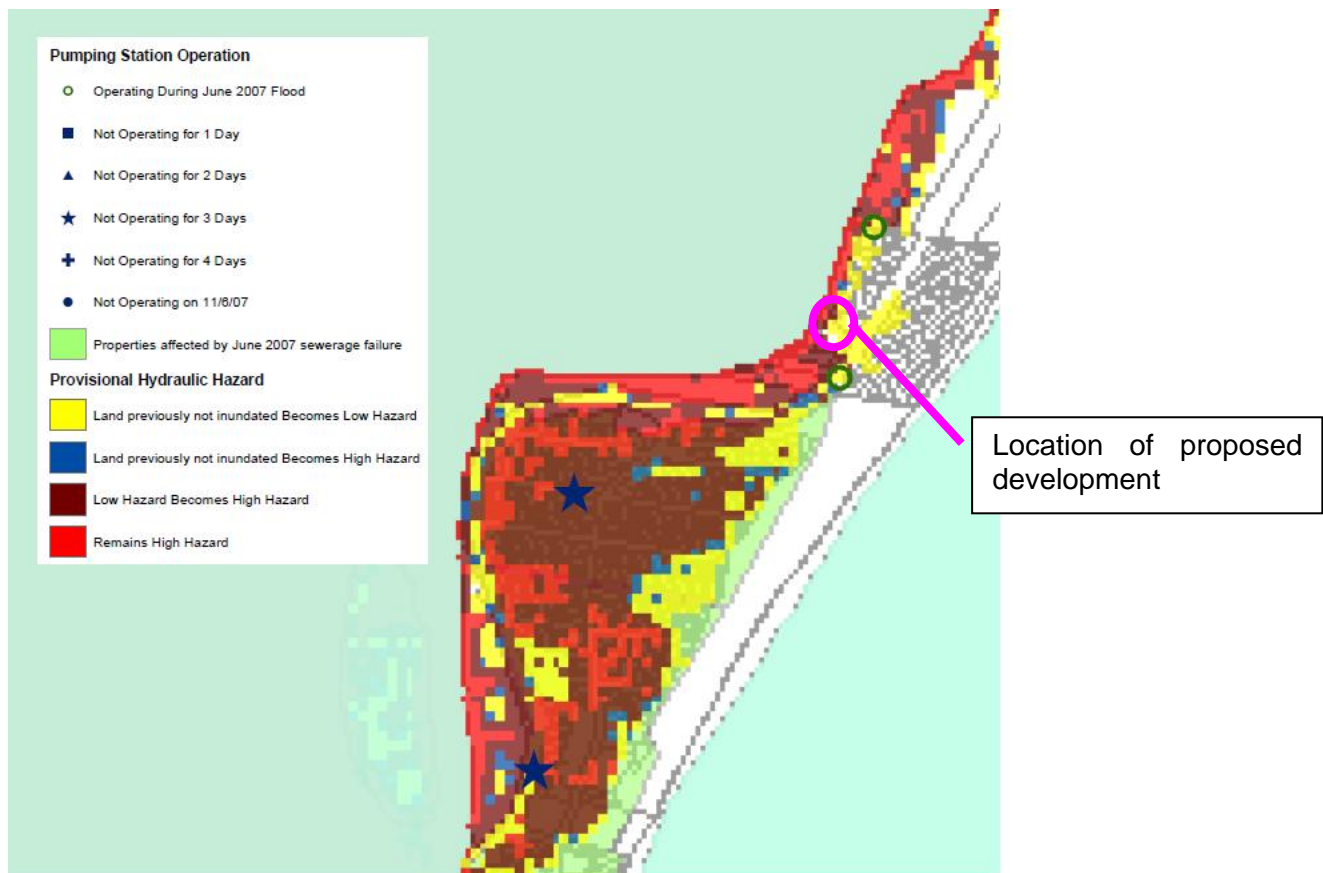
Based on the above flood assessment, and property modification measures, the true flood hazard category applicable to the development is considered to be wholly low hazard flooding. The development controls under Council's *Flood Prone Land Development* policy permit New Development in Low Hazard category flooding, subject to a merits assessment.

#### **Verification**

The contents of the Tuggerah Lakes Floodplain Risk Management Study have been reviewed to verify the flood assessment completed above. An extract from Figure 14A titled



*100 year ARI Hydraulic Hazard with 0.9m Sea Level Rise and Sewerage System Impact South and East Tuggerah Lakes. The figure identifies that the proposed development is partially affected by low hazard flooding.*



**Figure 3** - extract from Tuggerah Lakes Floodplain Risk Management Study - 100 year ARI Hydraulic Hazard with 0.9m Sea Level Rise and Sewerage System Impact South and East Tuggerah Lakes.

### Conclusion

The site has been demonstrated to be affected by low hazard flooding, including predicted sea level rise, and the application is supported on floodplain management grounds.