



CLARENCE VALLEY COUNCIL



YAMBA FLOODPLAIN RISK MANAGEMENT PLAN

FEBRUARY 2009

WEBB, McKEOWN & ASSOCIATES PTY LTD



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FOREWORD

The State Government's Flood Policy is directed at providing solutions to existing flooding problems in developed areas and to ensuring that new development is compatible with the flood hazard and does not create additional flooding problems in other areas.

Under the Policy, the management of flood liable land remains the responsibility of local government. The State Government subsidises flood mitigation works to alleviate existing problems and provides specialist technical advice to assist Councils in the discharge of their floodplain management responsibilities.

The Policy provides for technical and financial support by the Government through the following four sequential stages:

1. *Flood Study*
 - determine the nature and extent of the flood problem.
2. *Floodplain Risk Management Study*
 - evaluates management options for the floodplain in respect of both existing and proposed development.
3. *Floodplain Risk Management Plan*
 - involves formal adoption by Council of a plan of management for the floodplain.
4. *Implementation of the Plan*
 - construction of flood mitigation works to protect existing development,
 - use of Local Environmental Plans to ensure new development is compatible with the flood hazard.

The Yamba Floodplain Risk Management Plan constitutes the third stage of the management process for the township of Yamba. It has been developed for Clarence Valley Council and prepared by Webb, McKeown & Associates for the future management of flood liable lands in the area.

SUMMARY

LOWER CLARENCE VALLEY

The Clarence River has a catchment area of some 21,900 km² to its mouth at Yamba, and some 19,800 km² to Grafton. Grafton is the main commercial centre in the region and the most upstream river crossing point on the lower Clarence River floodplain. Downstream of Grafton the Clarence River meanders in a general north-east direction entering the Pacific Ocean through the training walls at Yamba.

The township of Yamba lies on the southern bank of the Clarence River and represents a major urban centre in the lower Clarence River valley. It has a permanent population of some 6,000 residents which doubles during the Christmas season.

HISTORY OF FLOODING

There is a long flood history on the lower Clarence River floodplain, particularly at Grafton. At Yamba there is only a limited flood history as flooding has not caused the devastating damage that has occurred elsewhere. The last significant flood on the Clarence River was in March 2001 but this did not cause damage to the township. The May 1996 flood recorded lower levels upstream in the Clarence River but resulted in more flooding problems at Yamba than in March 2001 due to higher ocean levels at the time of the flood.

LOWER CLARENCE RIVER FLOOD STUDY

The Lower Clarence River Flood Study Review (March 2004) established a 2D hydraulic model and determined design flood levels for the lower Clarence River floodplain from upstream of Grafton to the Pacific Ocean. This study supersedes a previous Public Works, Clarence River Flood Study (December 1988).

The Lower Clarence River Flood Study Review determined design flood levels, depths and hazards for the 5y, 20y, 100y, 500y ARI and Extreme events. One notable feature of the study is that the construction of levees in the last 100+ years near Grafton has raised flood levels at Grafton by up to 0.9 m. However, at Yamba any increase in flood level due to upstream levee construction is likely to be insignificant.

FLOOD HAZARD

Flooding at Yamba can occur as a result of a combination of high flows in the Clarence River, high ocean levels, wind wave action along the foreshore or from intense rain over the local catchment. The risk to life due to river flooding is considered to be low as inundation occurs gradually and with several hours (or days) warning. Similarly, flood hazard resulting from ocean storm surge is also considered low as there is likely to be several hours warning of an event, with the peak of the storm lasting for less than a day. The Floodplain Risk Management Study indicates a storm surge warning time of 6 to 24 hours. It should be noted however that the flood hazard can become high if the low

lying community to the west of the town does not respond to flood warnings as the available high ground is only accessible by Yamba Road, which is readily cut by floodwaters. The only road out of Yamba to the Pacific Highway is also inundated in the 10y ARI and greater flood events.

EXISTING FLOOD PROBLEM

A flood damages assessment for existing development at Yamba was undertaken across a range of design events. Due to the lack of surveyed floor level data this assessment was based on approximations derived from fill levels and road survey and is thus indicative only. Damages to public structures or utilities (bridges, roads, pumping stations) or for the complete collapse of buildings or structures were not considered.

FLOODPLAIN RISK MANAGEMENT PLAN

A list of all possible floodplain risk management measures which could be applied in the study area was developed in the Yamba Floodplain Risk Management Study. The assessment extended to examination of potential future development (whether intensification within existing urban zonings or the proposed rezoning at West Yamba). The measures were assessed in terms of their suitability and effectiveness for reducing the social, ecological, environmental, cultural and economic impacts of flooding. As part of this process a number of measures were identified as not being worthy of further consideration.

EXISTING DEVELOPMENT

The management measures presented in this Plan were developed following a detailed consideration of the outcomes of the Yamba Floodplain Risk Management Study. The recommended measures to manage the flood problem for existing development at Yamba are provided in Table i). Measures within each priority class (high, medium or low) are not listed in any particular order, each measure in each class has the same level of priority.

Table i): Recommended Floodplain Risk Management Measures

Measure	Estimated Cost	Responsibility	Priority
FLOOD MODIFICATION:			
Undertake a West Yamba levee feasibility study. It would be prudent to initiate this study following resolution of the West Yamba development and bypass proposals as these will have a significant influence on the levee alignment.	\$30,000	Council/DECC	High
Implement and maintain a local drainage issues database.	Negligible	Council/Residents	High
Undertake a study of wave runoff at Yamba.	\$25,000	Council/DECC	Medium
RESPONSE MODIFICATION:			
Update Flood Warning Program.	\$10,000	SES/BOM	High
Prepare a Flood Evacuation Plan for Yamba.	\$10,000	SES/Council	High
Implement a Flood Awareness Program.	Depends on nature of program	SES/Council/DEC C	High
PROPERTY MODIFICATION:			
Update Flood Related Development Controls (refer Table 2 and recommendations of Reference 4).	By Council	Council	High

Measure	Estimated Cost	Responsibility	Priority
Introduce controls on caravan parks in the floodplain.	By Council	Council	Medium
Implement a House Raising Program (not if levee constructed).	\$50,000/house	Council/DECC/Resident	Low

FUTURE DEVELOPMENT

All existing residential zoned land in Yamba has been developed (apart from isolated infill lots) and combined with a population and tourism growth of 3% per annum, there has been increasing pressure to develop new areas. Consequently, new development has been proposed for to be rezoned land at West Yamba and a draft LEP went on Public Exhibition from August to October 2006. There are a number of issues relating to this site (including flood-related) and it is not yet certain that the development will proceed. The only alternative to this is intensification within the existing developed areas. Both scenarios were evaluated in the Yamba Floodplain Risk Management Study as it is imperative that any additional development does not exacerbate the existing flood problem.

A summary of this evaluation and recommended measures is provided in Table ii). This Plan has addressed the implications of the proposed West Yamba development from a flooding point of view and has made flood related recommendations that should apply should the development proceed. However it is noted that whilst flooding issues are an important consideration for this development, that decision will need to balance a range of issues that include non flood related issues as well as the flood related ones. This Plan assists and informs that decision making process by identifying the key flood related issues and the measures required to address them. Whilst previous coarse level modelling and the recommended flood related measures indicate that the development could proceed with minimal impact on other areas the key issue for that planning consideration will be whether, on balance, risks and uncertainties are warranted in light of other planning merits.

Table ii): Key Issues - Future Development

MEASURE	Estimated Cost	Responsibility	Priority
CLIMATE CHANGE			
Development of a flood related climate change policy.	Depends on scope and methodology	Council	High
DEVELOPMENT WITHIN EXISTING URBAN ZONED LAND			
Provide emergency access:			
a) investigate flooding constraints to evacuation routes	a) \$20,000	a) Council/DECC	a) High
b) reconstruct evacuation routes as required by a)	b) unknown	b) Council/RTA	b) Medium
Ensure no adverse hydraulic or hydrologic impacts and layout compatible with water sensitive urban design,	Variable	Individual developments	On-going
Adequate evacuation planning undertaken,	Variable	Individual developments /Council	On-going
Include flood related development controls listed in Table 2.	\$10,000	Council	High
PROPOSED WEST YAMBA REZONING DEVELOPMENT			

Further detailed hydraulic modelling required to assess effects of fill and viability of a floodway between Golding and Freeburn Streets,	\$50,000	Council/DECC	High
A practical method of evacuation approved by the SES during the planning process needs to be in place prior to development consent,	\$20,000 (to investigate options). Construction costs unknown as dependant on above.	Council (reimbursed by development)	High
The proposed Master Plan must address water related cumulative issues,	\$40,000	Council/Developers	High
Possible floodplain management measures that should be included (if the development is to proceed) are: <ul style="list-style-type: none"> • a) a floodway, • b) a comprehensive flood evacuation strategy, • c) updated flood related development controls listed in Section 2.3.3. 	a) unknown b) \$20,000 c) \$10,000	a) Development b) Council & development c) Council	a) High b) High c) Medium
Other key Issues: <ul style="list-style-type: none"> • The use of flood modification measures (levees, etc.) to facilitate future development is generally not acceptable, • Any further development will exacerbate the flood hazard, • The proposal is not compatible with two background reports, 			

CLIMATE CHANGE

Current advice from world experts indicates that climate change will have adverse impacts upon sea level and rainfalls in NSW. Both of which may have significant influence on flood behaviour at Yamba.

The impact of a sea level rise is likely to be more significant than any increase in design rainfalls. Also, there is more certainty that sea levels will rise as a result of climate change than any increase in flood producing design rainfalls. It is prudent therefore to include some climate change allowance for setting floor levels and evacuation routes for both existing and proposed new development at Yamba.

It is recommended that Council develop a climate change policy. The issues that need to be addressed have been summarised in Section 2.4. In the interim, prior to the adoption of a policy, a 0.4 m climate change increase in the 100y ARI flood level should be applied for any major new development at Yamba, such as the proposed West Yamba rezoning.

PUBLIC EXHIBITION OF DRAFT PLAN

The Draft Plan was placed on public exhibition from 11th August to 26th September 2008. A public meeting was also held on 17th September 2008 at Yamba.

1. INTRODUCTION

The Clarence River has a catchment area of some 21,900 km² to its mouth at the Pacific Ocean and some 19,800 km² to Grafton. The catchment is bounded to the west by the Great Dividing Range, by the Doughboy Range / Dorrigo Plateau to the south and the Great Dividing Range / McPherson Range to the north. The Richmond Range and the Coast Range separate the smaller coastal catchments from the Clarence River.

The City of Grafton is historically the regional centre servicing the Clarence Valley and its hinterland. It was founded in the mid 1800's as the port for the exporting of timber from the region. Further downstream there are several towns, including Iluka on the northern side of the river mouth and Yamba on the southern side. Yamba has a population of approximately 6,000 and is a significant urban as well as tourist centre.

The mouth of the Clarence River is restricted by a northern and southern breakwater which are up to 500 m in length and several metres high.

Clarence Valley Council (CVC) engaged Webb, McKeown & Associates to prepare a Floodplain Risk Management Plan for Yamba. The objectives of this Plan are:

- to review the management measures described in the Yamba Floodplain Risk Management Study (Reference 1) aimed at reducing the impact of flooding on both existing and future development,
- to list the agreed measures for addressing the current and future flooding issues for the township of Yamba.

A glossary of flood related terminology is provided in Appendix A of the Yamba Floodplain Risk Management Study (Reference 1).

1.1 Floodplain Risk Management Process

As described in the Floodplain Development Manual (Reference 2), the Floodplain Risk Management Process entails four sequential stages:

- Stage 1: Flood Study.*
Stage 2: Floodplain Risk Management Study.
Stage 3: Floodplain Risk Management Plan.
Stage 4: Implementation of the Plan.

The Yamba Floodplain Risk Management Plan constitutes the third stage in the process and follows on from completion of the Yamba Floodplain Risk Management Study (Reference 1). The Flood Study stage was completed in March 2004 with publication of the Lower Clarence River Flood Study Review (Reference 3). In this study a two-dimensional hydraulic model was used to determine design flood

levels for the lower Clarence River floodplain, including Yamba. This Flood Study superseded a previous Flood Study completed in 1988.

1.2 History of Development

The Clarence River valley was first explored by Europeans in the early 1830's with the first settlement near Grafton in 1837 on the south side of the Clarence River. Subsequently several small rural settlements developed, including the township of Yamba.

Development at Yamba has occurred in distinct stages. The original township developed near the mouth of the Clarence River, on "Yamba Hill" (Figure 1). For the most part development in this area, and in general, east of Angourie Road (Figure 2), is flood free. There is a significant area of residential development adjacent to the boat harbour along Yamba Road (referred to here as "Middle Yamba") which has occurred over the last 30 years. A large portion of this area is on low-lying land and is flood liable. To the west of this is the newer development of Crystal Waters which is for the most part constructed on fill and could still be inundated in large flood events.

1.3 Clarence River County Council (now Clarence Valley Council)

The Clarence River County Council (CRCC) was formed in 1959 to perform all the duties under Section 494 of the Local Government Act of 1919 relating to the prevention or mitigation of menace to the safety to life or property from floods. As a result of the amalgamation of local councils in early 2004 the CRCC has been renamed as the Clarence Valley Council (CVC).

Prior to formation of the CRCC, works were undertaken by the relevant Councils or by drainage unions. The majority of these works are now under the control of the CVC but some are still privately owned by landowners or drainage unions.

1.4 Study Area

Yamba is located at the mouth of the Clarence River and is effectively surrounded by water with the Pacific Ocean to the east, the Clarence River to the north, Oyster Channel to the west and land extending to Lake Wooloweyah in the south (Figure 1). Yamba represents a major urban centre in the district and has a population of over 6,000 residents which doubles during the Christmas tourist season.

Development at Yamba is predominantly residential and tourist related with minor rural residential (Figure 2). A small commercial and business area is located near Yamba Hill on Yamba Street as well as an industrial estate within Middle Yamba (off Angourie Road). There are three caravan parks - Yamba Waters Holiday Park, Blue Dolphin Holiday Resort and Calypso Holiday Park. A large part of the town is on low-lying land, though Yamba Hill and Angourie (to the south) are on high ground.

The design of an upgrade to the sewerage treatment plant is currently being undertaken for the township, which will provide an increased capacity as well as improved processes.

Existing zoned land at Yamba is nearly completely developed and combined with population and tourism growth in the order of 3% per annum, there has been significant pressures to develop new areas. In 1995 the then Maclean Shire Council adopted a Strategic Land Use Plan (1995 - 2016) as the basis for the long term planning of the anticipated population growth of the shire. The Plan identified West Yamba (Figures 1 and 2) as providing additional urban land to accommodate population growth. A Local Environmental Plan (LEP) for West Yamba was placed on public exhibition from August to October 2006, however there are a number of issues with the proposal and to date the development at West Yamba remains in the planning stages. The only alternative to this site for accommodating population growth is intensification with existing developed areas.

At Yamba the designated Flood Planning Level (FPL) (or equivalent) has changed over the years, resulting in a number of existing buildings with floor levels below the current FPL. Figure 3 indicates the areas of fill within Yamba and the designated level to which it was undertaken. It should be noted that detailed survey to check these fill levels has not been undertaken. Also house floors may have been constructed exactly at the fill level (slab on ground) or slightly raised.

1.5 Previous Studies

A number of studies (economic, hydraulic and others) into flooding at Yamba have been undertaken and were reviewed as part of the Yamba Floodplain Risk Management Study (Reference 1), including:

- Clarence Valley Floodplain Management Study, 1980,
- Lower Clarence River Floodplain Management Study, 1993,
- Lower Clarence River Floodplain Management Plan, 1999,
- Lower Clarence River Flood Study Review, 2004 (Reference 3),
- Grafton and Lower Clarence Floodplain Risk Management Plan, 2007 (Reference 4).

1.6 Existing Flood Problem

Flooding at Yamba can occur as a result of four main mechanisms:

- Inundation due to high flows in the Clarence River during times of flood.
- Inundation from the Clarence River during times of high ocean levels (storm surge activity and/or high tides).
- Wind/wave action along the southern foreshore of the Clarence River.
- Intense rain over the township of Yamba causing ponding in low lying areas as a result of inadequate local drainage. This mechanism is largely outside the scope of this present investigation.

Design flood levels for Yamba were derived in the Lower Clarence River Flood Study Review (Reference 3) taking into account the first two mechanisms described above and are provided in Table 1.

Table 1: Design Flood Data

Event	Flood Level (mAHD)	Assumed Peak Ocean Level (mAHD)	House Floors Inundated (total assessed 2156)	Tangible Damages#
Extreme	3.39	2.6	2144	\$113,769,000
500y ARI	2.39	2.6	1226	\$31,741,000
100y ARI	2.34	2.6	1223	\$27,491,000
20y ARI	1.8	2.1	122	\$1,930,000
5y ARI	1.5*	0.8	0	\$0
Average Annual Damages				\$1,108,000

* The Flood Study Review indicates a level of 0.4 mAHD for the 5y ARI event at Yamba. This has been increased to 1.5 mAHD as 1.0 mAHD is approximately the peak tide level each year, thus the 5y ARI event must be greater than this, but less than 1.8 mAHD. If a more precise 5y ARI level is required it should be more accurately calculated and the above level represents an 'order of magnitude' only.
Excludes all non-residential damages.

The cost of flood damages and the extent of the disruption to the community will depend upon many factors. The resulting flood damages can be defined as being "tangible" or "intangible". Tangible damages are those for which a monetary value can be assigned, in contrast to intangible damages, which cannot easily be attributed a monetary value (stress, injury, loss to life, etc.).

The standard way of expressing flood damages is in terms of average annual damages (AAD). AAD represents the equivalent average damages that would be experienced by the community on an annual basis, by taking into account the probability of a flood occurrence. By this means the smaller floods, which occur more frequently, are given a greater weighting than the rare catastrophic floods.

A flood damages assessment was undertaken for existing development at Yamba with the results provided in Table 1. The damages assessment only took into account residential properties as it was not possible to estimate floor levels for commercial/light industrial buildings. Damages to tourist facilities (caravan parks) and public structures were also not assessed.

For these reasons the flood damages are indicative only and should only be used in the context for which they were intended - to give a indication of the magnitude of the flood problem and to provide preliminary estimates of benefit cost ratios for flood mitigation measures.

The Yamba Floodplain Risk Management Study (Reference 1) determined that the majority of Yamba would be classified as flood storage (those areas important for the temporary storage of floodwaters) with the Clarence River classified as floodway (those areas where a significant discharge of water occurs). However at a local level there will be floodways within Yamba that take floodwaters from the south through middle Yamba to the Clarence River.

Provisional hazard categorisation based on depth and velocity indicate that the majority of the existing developed areas on the floodplain is Low Hazard in the 100y ARI event but High Hazard in the PMF.

However, undertaking a comprehensive assessment of the flood hazard (taking into account access, additional concerns, warning time, evacuation difficulties, flood awareness, etc.) indicates that the majority of the floodplain has a High flood hazard classification for flood events greater than a 10y ARI Clarence River event.

The flood warning/time till inundation for the first two mechanisms are of the similar magnitude, approximately 24 hours. However as with all forms of warning it will vary from event to event and be dependent upon the circumstances at the time.

Yamba Road is the sole access into the township and it becomes inundated in approximately the 10y ARI or greater events. An additional access road into the town (from east of Oyster Channel to Yamba Hill) has been proposed (Yamba Bypass - Figure 3) however it remains in the concept stages and details regarding length, capacity, road level etc., have not yet been determined. As at November 2007 it is assumed that the bypass will not be flood free. A number of internal roads west of Angourie Road also become inundated during significant flooding events (10y ARI and greater).

2. FLOODPLAIN RISK MANAGEMENT MEASURES

The NSW Government's Floodplain Development Manual, 2005 (Reference 2) separates floodplain management measures into three broad categories:

Flood modification measures modify the flood's physical behaviour (depth, velocity) and include flood mitigation dams, retarding basins and levees.

Property modification measures modify land use including development controls. This is generally accomplished through such means as flood proofing (house raising or sealing entrances), planning and building regulations (zoning) or voluntary purchase.

Response modification measures modify the community's response to flood hazard by informing flood affected property owners about the nature of flooding so that they can make informed decisions. Examples of such measures include provision of flood warning and emergency services, improved information, awareness and education of the community and provision of flood insurance.

A number of methods are available for judging the relative merits of competing measures. The benefit/cost (B/C) approach has long been used to quantify the economic worth of each option on a relative basis enabling ranking against similar projects in other areas. However the potential environmental or social impacts of any proposed flood mitigation measure are of great concern to society and these cannot be evaluated using the classical benefit/cost approach. The public consultation program has ensured that identifiable social and environmental factors were considered in the decision making process.

2.1 Management Measures for Existing Development

The following sections discuss measures for the management of flooding for the existing residential development in Yamba. Existing development includes houses already constructed, those with development approval to be constructed and infill development. Future residential development is discussed separately in Sections 2.2 and 2.3.

2.1.1 Flood Modification

Flood modification involves changing the behaviour of the flood itself, by reducing flood levels or velocities, or excluding floodwaters from areas under threat. The initial review of these measures indicated that for economic, hydraulic and environmental reasons the following measures were not viable:

- dams,
- retarding basins (except for water quality or local catchment flooding),
- on-site stormwater detention (except for local catchment flooding),
- channel modifications (dredging, vegetation removal, channel straightening).

The following measures are considered viable:

Levee

A levee (possibly including pumps and flap-gated culverts) could be constructed to protect the majority (if not all) of the lowlying properties west of Yamba Hill. A draft levee configuration is shown on Figure 3 with an indicative construction cost of \$5 million and a benefit cost ratio of 2+. However an alternate and less expensive alignment may be viable to protect the older parts of West Yamba. A number of issues remain outstanding:

- potential hydraulic impacts elsewhere,
- access to the river,
- road access over the levee,
- construction materials,
- alignment,
- aesthetics,
- implications of climate change and wind wave effects,
- environmental impacts,
- proposed Yamba bypass,
- proposed West Yamba re-zoning,
- levee failure,
- landtake.

The proposal at this stage is to reconsider the viability of the proposed levee once the Yamba bypass and West Yamba developments have been resolved. These two developments have the potential to significantly alter the design and costings for the levee and therefore it is prudent to wait until their resolution. Initially a more detailed levee feasibility study should be undertaken which would investigate a possible levee alignment as well as undertake further public consultation. Previous studies have rejected a levee as it was considered that it would not be supported by the community.

Local Drainage Issues Database

Local drainage issues such as:

- ponding in low lying areas,
- inadequate drainage,
- blocked drains,
- malfunctioning flap-gated structures,
- excessive runoff,
- maintenance of pumps (possibly required with levee construction),
- surcharging of pipes,

typically arise in undulating low lying areas, such as in the urban areas west of Yamba Hill. In order to address these problems Council needs to implement and continually update a local drainage issues database.

Wave Runup Study

Wave runup has the potential to cause significant damage to structures along the foreshore. However little is known about this phenomenon. This study would investigate the magnitude, likelihood and damage potential of wave runup at Yamba as well as possible mitigation measures. It could be combined with a similar study for Iluka on the north side of the Clarence River.

2.1.2 Response Modification

Update Flood Warning Program

The existing flood warning program for Yamba is considered to be adequate. However possible improvements include, providing advice on the deadline when Yamba residents need to evacuate to high ground and ensuring best practice is employed on providing advice on ocean storm surge and wave runup activity. The program should be reviewed every two years (or after a significant flood event) so as to ensure it remains the best practice available.

Prepare a Flood Evacuation Plan

A Flood Evacuation Plan should be prepared by the SES to ensure that all Yamba residents can be safely moved to high ground during a flood. This document should be made available to residents and all local authorities (Rural Fire Service) and organisations.

Implement a Flood Awareness Program

A high level of flood awareness will ensure that damage to goods and the risk to life is minimised. A range of measures have been suggested in the Yamba Floodplain Risk Management Study (Reference 1).

2.1.3 Property Modification

Update Flood Related Development Controls

The strategic assessment and management of flood risk can prevent development occurring in unsuitable areas and will ensure that the potential damage to new developments, due to flooding, is reduced to acceptable levels. A number of proposals have been suggested for the lower Clarence Valley floodplain in Reference 4 and these are fully supported in this Plan. Table 2 lists additional proposals which should be considered by Council.

Table 2: Proposed Updated Development Controls

1.	To eliminated local drainage issues there should be a minimum residential floor elevation above the surrounding ground of 0.3 m.
2.	New building applications on land within 50 m of the southern foreshore of the Clarence River should consider potential wave runup impacts.
3.	Mangrove stands on the southern foreshore of the Clarence River provide significant protection from wave runup impacts and should be maintained for this reason.
4.	Any non-building structure (fence, wharf) must consider the potential wave runup impacts on the structure itself as well as the potential for deflecting the impacts to adjoining properties.
5.	Council must suitably inspect and maintain all local drainage structures (pipes, pits, flap-gated culverts, etc.).
6.	All new developments must consider access to high ground during a flood.
7.	Filling for building pads within existing zoned areas is permitted (i.e. no hydraulic modelling of the Clarence River is required) as long as it does not affect local drainage. Filling on a larger scale should only be permitted following a rigorous hydraulic and environment assessment. Council should maintain a database of filling to monitor its cumulative effects.
8.	The Flood Planning Level used to define land subject to flood related development controls and the minimum floor level of buildings in this area should be the 100y ARI flood level (2.34 mAHD +0.5 m freeboard (increase from existing 0.3 m freeboard). Council should introduce a Flood Planning Level for basement car parks.
9.	Materials used on buildings below the Flood Planning Level should be flood compatible (as far as possible).
10.	Applications for new buildings subject to flood related development controls must also consider the structural integrity including debris, velocity and buoyancy loadings.
11.	Council should monitor the type and location of fencing in the floodplain to ensure that it does not exacerbate the flood problem (particularly for local drainage flooding).
12.	Council must consider the damage to public assets as a result of flooding.

Introduce Controls on Caravan Parks in the Floodplain

Caravan parks on the floodplain can represent a significant hazard during a flood. This issue should be investigated further through a detailed inspection by the park manager and the SES to accurately assess the hazard. Following this, consideration should be given to implementing adequate safety provisions which would probably mean updating their existing flood evacuation plan. Consideration should also be given to introducing some of the special provisions indicated in the Yamba Floodplain Risk Management Study (Reference 1). At a minimum “at risk” parks should be clearly identified in the SES Local Flood Plan.

This issue was also noted as a measure in Reference 4.

Implement a House Raising Program

House raising can provide a viable means of flood protection for the 14 “suitable” buildings. The remaining buildings are unsuitable due to being either two-storey, brick construction or on a concrete slab. Initially, further investigation should be undertaken to assess the suitability of each house and the willingness of the owner. The final scheme may be either fully or partially funded as proposed in Reference 4. This measure would not be undertaken if a levee was constructed.

Voluntary purchase was considered but rejected due to the high cost per property and the fact that it would need to include all residential properties as they all have similar levels of hazard.

2.2 Management Measures - Development within Existing Urban Zoned Land

Development intensification within the existing town limits involves either the rezoning of residential/rural residential land to allow for higher densities (for example, from single dwellings to duplexes/units or from rural residential to residential lots, etc.) or as a result of intensification within the existing zoning (dual occupancies). It results in a change in the appearance of the town as well as placing increased pressures on the existing infrastructure.

The key flood related issues that need to be addressed with this type of development are listed below.

Provide Emergency Access

New development resulting in a significant increase in the town population would add to the strain on the SES and should only be approved if safe and practical access is available to high ground up to the Flood Planning Level.

Ensure no adverse Hydraulic or Hydrologic Impact and compatibility with Water Sensitive Urban Design

Studies must be undertaken by appropriate experts to confirm that the proposed development would cause no adverse hydraulic or hydrologic impacts and be compatible with the principles of water sensitive urban design.

Adequate Evacuation Planning Undertaken

A key flooding issue at Yamba is the lack of emergency access and the difficulties with evacuation. The general approach is one of “self help”. Any new development should have an appropriate flood evacuation plan to high ground. This would also include resident awareness and identification of evacuation routes.

The Use of Flood Modification Measures

The use of flood modification measures (e.g. levees) are an appropriate means of providing protection for existing flood liable properties. However these devices are not “fail safe” and are therefore not supported for use to protect new developments.

Include Flood Related Development Controls (Table 2)

A number of flood related development controls have been listed in Table 2. These should be implemented where possible.

CONCLUSIONS

The main issues with development intensification within existing residential/rural residential lands is ensuring that the “new” residents experience minimal flood damages and risk to life in events up to the Flood Planning Level. The general principle is that the SES and other rescue organisations are “set up” to cater for the demands from the presently zoned urban community within the floodplain.

However they do not have the capacity to cater for greater urban densities. Thus if the intensification can be achieved with no additional demands on the SES and minimal increase in flood damages to the community this type of development can be undertaken.

2.3 Proposed Rezoning at West Yamba

2.3.1 Introduction

West Yamba is a 690 hectare site of undeveloped land to the west of the existing township (Figures 1 and 4). Some 15 hectares have already been rezoned for industrial and commercial purposes. The land has a general ground level of from 1 m to 2 m AHD and is therefore inundated frequently and by over 1 m deep in the 100 year ARI event. It is proposed to construct houses for 2,000 - 2,500 people on this land as well as including environmental protection areas (refer Table 3 and Figure 4).

Table 3: Proposed Rezoning of West Yamba

Zone	Area (ha)
Urban Residential	106
Rural Residential	40.2
Special Uses	4.1
Open Space	3.8
Environmental Protection	449.3
Environmental Protection Buffer	30.9
National Parks	41.3
TOTAL	675.6

To overcome the low lying nature of the terrain, it is proposed that imported fill be placed on part of the land. Preliminary hydraulic modelling indicates that the impacts of this fill can largely be negated by the development of a designated floodway area (Figure 4).

2.3.2 Issues

There are a number of issues regarding this proposed development at West Yamba, those of direct relevance to flooding which have been investigated in the Yamba Floodplain Risk Management Study (Reference 1) are:

- source and impacts of fill,
- difficulties with the evacuation of residents to high ground, either within the new development or within Yamba township,
- potential environmental impacts,
- new development in the floodplain and the use of flood mitigation measures to facilitate new development,
- compliance with relevant policies.

A comprehensive assessment and resolution of these issues was beyond the scope of the Yamba Floodplain Risk Management Study, however, their significance in relation to the proposed development is summarised below.

Fill

Approximately 1.3 million m³ of fill may be required. This equates to approximately one truck movement every six minutes (includes return trip) for eight hours a day, five days a week for 9.5 years. The transport, noise and environmental impacts of this fill on the site and at the quarry have been addressed elsewhere and are outside the scope of this flood related assessment.

Two-dimensional hydraulic modelling to assess the hydraulic impacts of the fill has been undertaken and this concluded that the possible adverse impacts can be negated through formation of a floodway (Figure 4). More detailed hydraulic modelling needs to be undertaken at a subsequent stage to assess whether:

- there are affects on neighbouring areas in floods greater or smaller than the 100y ARI event?
- the use of a floodway (between Golding and Freeburn Streets) creates other issues such as an increase in flood hazard?

Evacuation Planning

Evacuation to high ground in Yamba is the preferred strategy. The provision of a designated flood refuge, on artificially high land within the development area, is an option for consideration, however, acknowledging that it will not have the range of other infrastructure available on Yamba Hill which can service the population during a major flood event (such as motels, hotels, clubs, shops etc.). A practical method of evacuation approved by the SES at the time of approval needs to be in place prior to development consent.

Environmental Impacts

This Plan is primarily concerned with environmental issues relating to flooding. This can be achieved with a Master Plan which should endeavour to achieve a holistic strategy to ensure that the development is integrated and does not create problems when attempting to address cumulative issues. This would include the potential impacts of increased human activity - nutrients, sedimentation, runoff - on the nearby exclusion zones during a flood or ocean event when WSUD capacities are exceeded.

New Development in the Floodplain and the use of Flood Mitigation Measures to Facilitate New Development

One key consideration in assessing the appropriateness of future development at West Yamba is whether new development on flood liable land and the use of flood mitigation measures to facilitate this new development is compatible with current floodplain management practice. As part of the existing township is flood-labile, additional development is adding to this problem, and will exacerbate it to some degree.

Compliance with Relevant Policies and Plans

As part of the LES Review, the West Yamba development was assessed for compliance with key policies governing the area. The Review considered the West Yamba development to be compliant with the Maclean Shire Council Strategic Land Use Plan and the North Coast Urban Planning Strategy (1995). However there were a number of plans/policies for which some issues remained.

Clarence Valley Settlement Strategy

This report did not specifically address redevelopment at West Yamba but further site specific hydraulic assessments have now been completed which address outstanding flood issues.

Healthy Rivers Commission Inquiry into NSW Coastal Lakes

A Coastal Lake Assessment and Management tool has been developed for Lake Wooloweyah and this provides some confidence that the draft LEP is sustainable in terms of its potential environmental impacts.

North Coast REP

Initially it was considered that the draft LEP was inconsistent with the North Coast REP. However Council has advised that the Department of Planning has not raised this as a concern.

Coastal Design Guidelines for NSW

This guideline does not encourage development on lands, such as at Yamba, which are subject to sea level rise, frequent flood hazard or where cut and fill is required to overcome flood hazard or coastal processes.

Grafton and Lower Clarence Floodplain Risk Management Plan (Reference 4)

This states that as a general principle, it is preferable that new urban areas are located outside of the floodplain and intensification of existing urban areas be restricted to a level that can be accommodated within the evacuation capacity of the State Emergency Services.

2.3.3 Floodplain Risk Management Measures

The following measures (in addition to those suggested in Section 2.1 of this report) should be considered if the West Yamba is to proceed.

Flood Modification

A floodway is required through the site to negate the increase in flood levels due to the proposed filling.

Response Modification

A comprehensive flood evacuation strategy is required. This might involve a flood refuge within the development or evacuation to high ground in Yamba (preferred strategy).

Property Modification

The use of planning controls for new development would reduce the impacts of flooding. At a minimum controls to ensure the following should be incorporated into the West Yamba Development Control Plan:

- lowest habitable floor is at 100y ARI (2.34 mAHD) + 0.5 m level (not including possible climate change increase),
- floor pad should be a minimum of 0.3 m above the ground level (to reduce local drainage issues),
- safe practical access from the property to high ground (where residents can remain safe for say 24 hours) must be available up to the 100y ARI event with consideration given to evacuation to high ground in the PMF event,
- key services remain operable during times of flood up to at least the 100y ARI + 0.5 m level,
- the local drainage system is designed so as to avoid local ponding, stormwater runoff is not to impact on the Oyster Channel or Lake Wooloweyah or adversely affect existing development,
- consideration given to the use of building materials below the flood planning level,
- the impact of fences on local drainage paths as well as during Clarence River flooding should be evaluated,
- emergency access to high ground (where residents can remain safe for 24 hours) must be provided prior to occupancy,
- the likely increase in design flood levels as a result of climate change (sea level rise) should be incorporated into the above.

2.4 Flood Planning Levels and Climate Change

The Intergovernmental Panel on Climate Change (2007 - Reference 5) considers that sea levels have risen and will continue to rise as a result of climate change. According to their advice the average global sea level rise (ignoring ice flow melt) may be between 0.18 m and 0.59 m by between the years 2090 to 2100. Including an ice flow melt component gives an adjusted range of 0.18 m to 0.79 m. Recent work by the CSIRO (Reference 6) indicates that the mean sea level along the NSW coast may rise by more than the global average. Based on the above information sea levels along the NSW coast may rise by between 0.18 m to 0.91 m by between the years 2090 and 2100.

According to the CSIRO climate change may also increase design rainfalls by up to 30%.

Climate change, particularly the rise in sea level will have a significant impact on flood levels at Yamba. The increase in design rainfalls will probably have a less significant impact.

In order to address the possible impacts of climate change, Council should implement a Council wide policy on climate change. This would include:

- adopting a rationale for determining the appropriate sea level rise and rainfall increases,
- determining what development works any climate change increases should apply to,

- determining an appropriate timeframe over which any climate change increases would apply. For example, would a tourist development with a 20 year life span have the same increase as a new subdivision that will have a life span of 70+ years?
- investigating whether there are means by which certain developments can proceed under the current FPLs by having a contingency so that measures can be retrofitted later when climate change is realised. There are many possible schemes such as:
 - leave land vacant for a future levee,
 - allow for planned retreat or a sacrificial part of the proposed development,
 - retrofit “pop up” flood gates.

If approval is given for the proposed rezoning at West Yamba, and Council’s climate change policy is not finalised, a climate change increase in the 100y ARI flood level (2.34 mAHD) of 0.4 m should be adopted as a minimum. Thus the FPL would be:

- 100y ARI level of 2.34 mAHD,
- plus 0.5 m freeboard,
- plus 0.4 m climate change increase in flood level,
- i.e. a FPL of 3.24 mAHD.

The rationale for adopting a 0.4 m climate change increase in the 100y ARI flood level at Yamba assumes:

- a maximum climate change increase of 0.9 m over the lifespan of the project (assumed to be 90+ years),
- a reduction of 0.1 m as the existing 0.5 m freeboard partially accounts for a climate change increase,
- a further reduction of 0.4 m as there is an opinion amongst coastal experts that the adopted design 100y ARI ocean level peak of 2.6 mAHD includes a conservative estimate of wave setup component and a more realistic level is 2.2 mAHD,
- thus 0.9 m increase - 0.1 m - 0.4 m = 0.4 m increase.

3. ACKNOWLEDGMENTS

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- Clarence Valley Council,
- Department of Environment and Climate Change,
- Floodplain Management Committee,
- residents of Yamba.

We acknowledge the valley wide flood planning works undertaken in Reference 4 and the need for consistent flood policies across the Clarence Valley.

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FIGURES



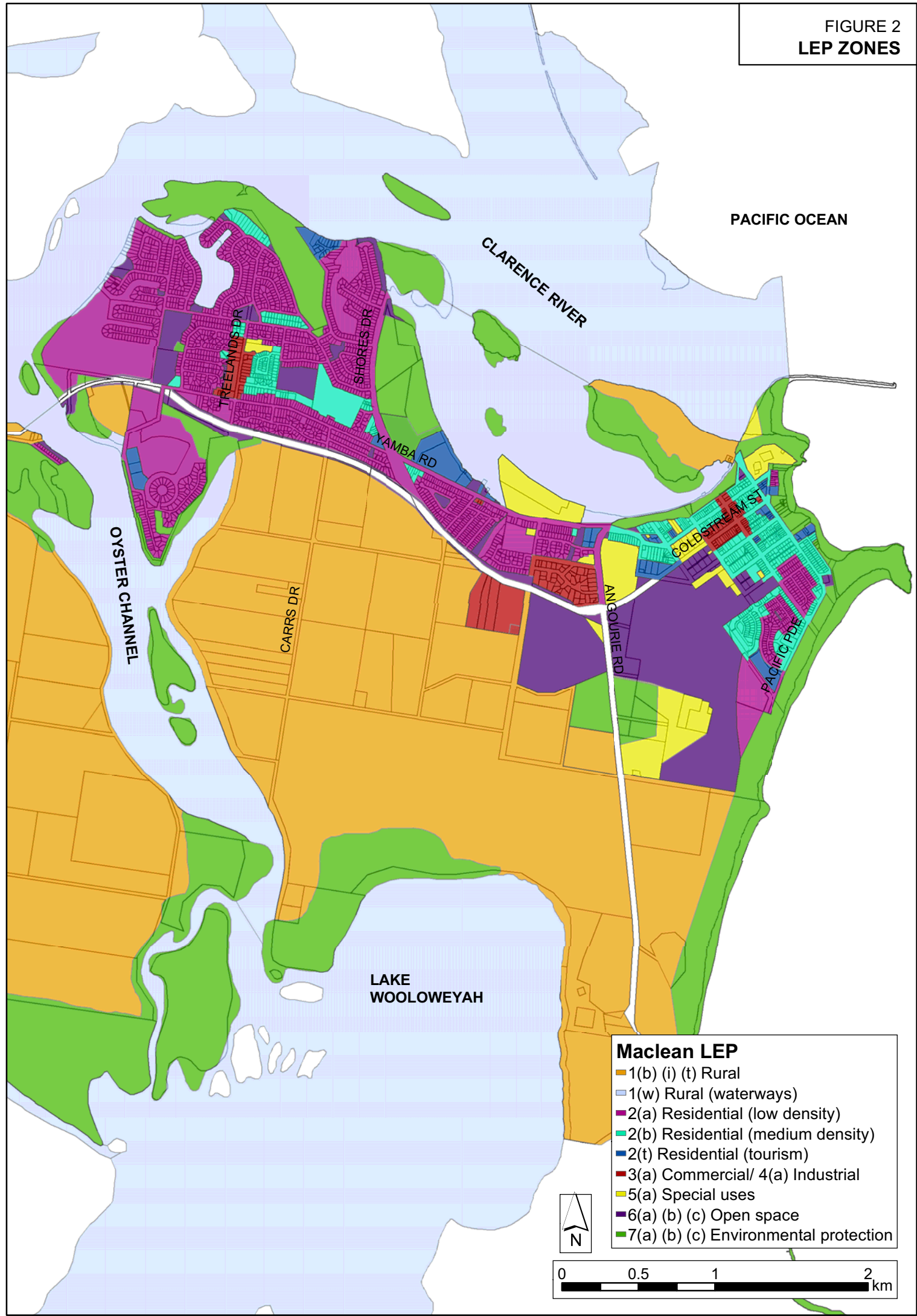
FIGURE 1
LOCALITY PLAN



IMAGES COURTESY GOOGLE EARTH



FIGURE 2
LEP ZONES



PACIFIC OCEAN

CLARENCE RIVER

OYSTER CHANNEL

LAKE WOLOWEYAH

- Maclean LEP**
- 1(b) (i) (t) Rural
 - 1(w) Rural (waterways)
 - 2(a) Residential (low density)
 - 2(b) Residential (medium density)
 - 2(t) Residential (tourism)
 - 3(a) Commercial/ 4(a) Industrial
 - 5(a) Special uses
 - 6(a) (b) (c) Open space
 - 7(a) (b) (c) Environmental protection

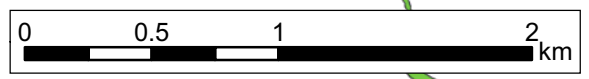
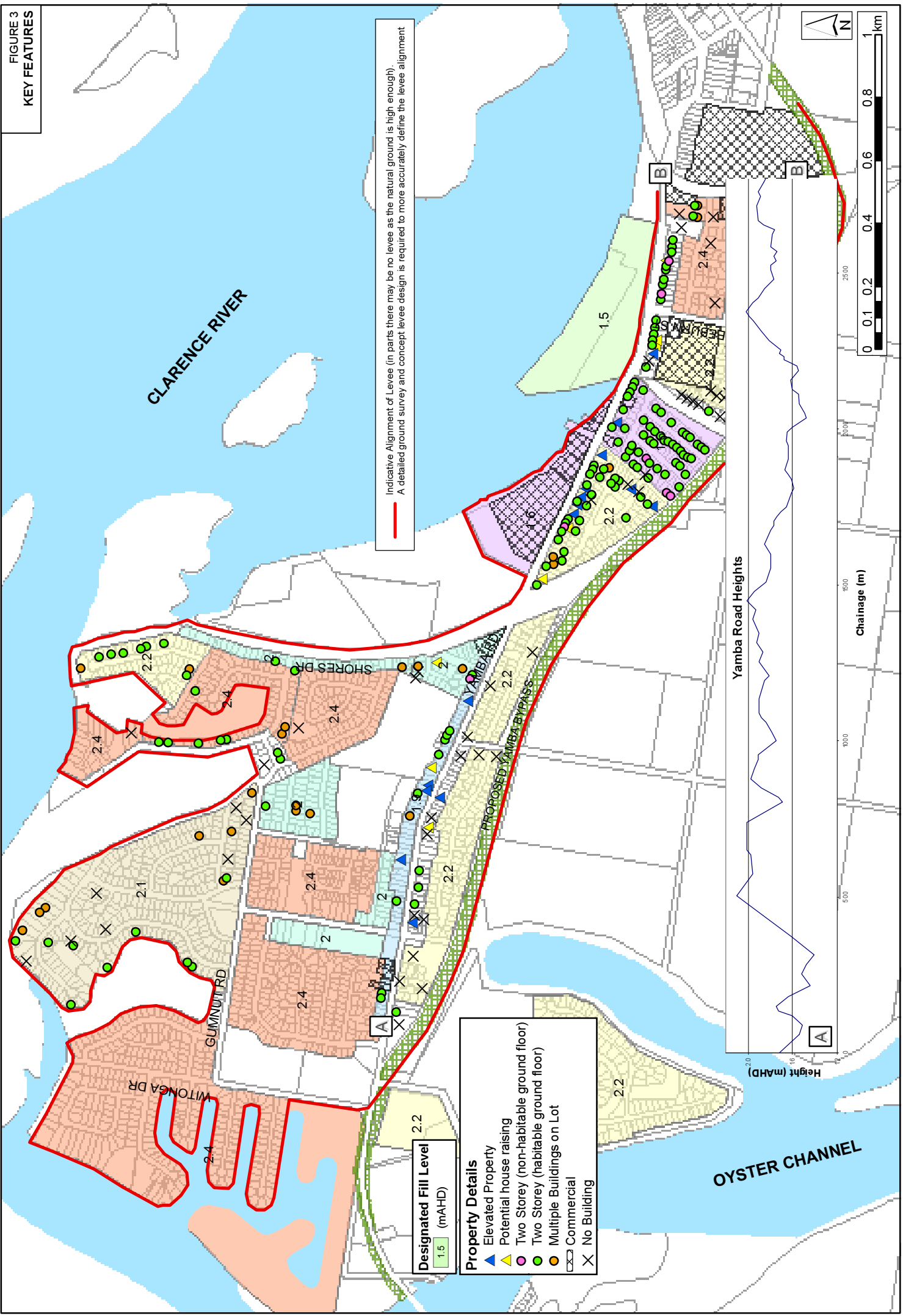


FIGURE 3
KEY FEATURES



— Indicative Alignment of Levee (in parts there may be no levee as the natural ground is high enough).
 — A detailed ground survey and concept levee design is required to more accurately define the levee alignment.

Designated Fill Level
 (mAHd)

- Property Details**
- ▲ Elevated Property
 - ▲ Potential house raising
 - Two Storey (non-habitable ground floor)
 - Two Storey (habitable ground floor)
 - Multiple Buildings on Lot
 - ▢ Commercial
 - × No Building

Note: The property details are based on a field inspection in November 2006 and have not been verified.

**FIGURE 4
PROPOSED WEST YAMBA
LEP ZONES**

