FIGURE 15

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Figure 15 - postdev materials.wor

ADOPTED TUFLOW MODEL ROUGHNESS FOR PROPOSED DEVELOPMENT CONDITIONS

3.3 ASSESSMENT OF POTENTIAL FLOOD IMPACTS

The modified TUFLOW model was used to simulate the 100 and 20 year recurrence design floods for post-development conditions.

It was not considered necessary to run the scenario comprising the 100 year recurrence flood with a 20 year recurrence tailwater level because the results of modelling for existing conditions indicate that flood behaviour at the precinct during the 100 year recurrence flood is relatively unaffected by the lesser tailwater condition (*refer above*).

The results from post-development simulations were compared with the results of modelling for existing conditions to develop *difference mapping* for flood levels and flow velocities.

3.3.1 Impact on Design 100 Year Recurrence Flood

Flood Levels

The flood level difference mapping contained in **Figure 16** shows the predicted impact that the development will have on peak 100 year recurrence flood levels.

As shown, the maximum increase in flood level will be about 120 mm and will occur adjacent to the Manning River, within the precinct boundary. An increase of about 50 mm is expected to occur within the footprint of the proposed marina.

The greatest off-site flood level increase will be only 20 mm and is expected to occur at Pioneer Street and at the rear of properties fronting to McRae Avenue (*refer* **Figure 16**). This flood level increase is considered to be relatively insignificant and is not expected to affect traffic along Pioneer Street or the dwellings at McRae Avenue.

Flow Velocities

Flow velocity difference mapping for the 100 year recurrence flood is provided in **Figure 17**. The mapping shows that the impact of the development will generally lead to decreases in peak flow velocity. The maximum decrease in velocity is expected to be larger than 1 m/s.

Despite the localised reductions in flow velocity, further interrogation of the post-development model results indicated that the development would not impact on the distribution of flood discharges along the Manning River. Nor is it expected to affect peak discharges downstream from the precinct.

3.3.2 Impact on Design 20 Year Recurrence Flood

Flood Levels

The flood level difference mapping contained in **Figure 18** shows the predicted impact that the development will have on peak 20 year recurrence flood levels.

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Figure 17 – 100 year vel diff.doc

CHANGE IN PEAK 100 YEAR RECURRENCE FLOW VELOCITY FOR POST-DEVELOPMENT CONDITIONS

FIGURE 18

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Figure 18 – 20 year flood level diff.doc

CHANGE IN PEAK 20 YEAR RECURRENCE FLOOD LEVELS FOR POST-DEVELOPMENT CONDITIONS

As shown, increases in flood level are typically confined to the precinct (*i.e., along the unnamed creek*) and are expected to be less than 30 mm. At properties adjacent to the precinct the peak increase in flood level is expected to be no greater than 20 mm.

This increase is considered to be relatively insignificant and is not expected to result in any measurable increase in flood damages to any adjacent dwellings or properties along McRae or Chatham Avenues.

The difference mapping in **Figure 18** shows some localised changes in peak flood level along the edge of the Manning River, opposite the precinct. It should be noted these small localised "spikes" and "troughs" are simply artefacts created through interpretation of the flood model results by the software used, particularly when exporting difference mapping along the edge of the flood extent. These localised increases and decreases are therefore, not expected to manifest as "real" results.

Flow Velocities

Flow velocity difference mapping for the 20 year recurrence flood is provided in **Figure 19** and shows that the impact of the development will generally lead to decreases in peak flow velocity. The maximum decrease in velocity is expected to be about 1 m/s.

3.4 IMPACT OF DEVELOPMENT ON LOCAL DRAINAGE

As discussed above, hydraulic modelling for the unnamed creek that passes through the site has been undertaken as part of the assessment of flooding scenarios for the Manning River.

However, these investigations have not included the assessment of a local drainage scenario involving local catchment runoff only with no tailwater flooding from the Manning River.

It is understood that further assessment of local drainage will be undertaken as a separate exercise at the Development Application stage for the precinct. This will involve the assessment of the future creek channel upgrade and the proposed stormwater system design for the precinct.

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CHANGE IN PEAK 20 YEAR RECURRENCE FLOW VELOCITY FOR POST-DEVELOPMENT CONDITIONS

4. CONSIDERATION OF CLIMATE CHANGE

4.1 BACKGROUND

The Pitt Street Waterfront Precinct is located within the estuarine reaches of the Manning River system and may therefore be susceptible to increased frequency of inundation due to the impacts of climate change.

Climate change has the potential to impact on existing flood characteristics, potentially leading to increased peak levels for floods of a specified frequency of occurrence or average recurrence interval. Increased peak flood levels could in turn result in a requirement for minimum floor levels to be raised by an amount commensurate with the projected increase in predicted peak flood level due to climate change.

Accordingly, an assessment of the impact of climate change on flooding during the 100 year recurrence event was undertaken to establish the suitability of the proposed development in the case that the predicted effects of climate change are realised.

4.2 CLIMATE CHANGE PREDICTIONS

The Department of Environment and Climate Change (*DECC*) has prepared a guideline for the consideration of climate change in flood management applications. The guideline is titled, *'Floodplain Risk Management Guideline; Practical Consideration of Climate Change'* and was published by DECC in October 2007.

The guideline considers the impact of climate change on <u>sea level</u> and <u>rainfall intensities</u>. The associated recommendations are based on research by the Intergovernmental Panel on Climate Change (*IPCC*) and recent modelling undertaken by CSIRO in Australia.

DECC recommends that consideration be given to the following three cases of sea level rise by 2090 to 2100:

- 0.18m increase (*low level impact*)
- 0.55m increase (*mid-range impact*)
- 0.91m increase (*high level impact*)

The DECC guideline also recommends that increases in peak rainfall and storm volume of between 10% and 30% by 2070 should also be considered (*DECC, 2007*):

4.3 POTENTIAL IMPACT OF SEA LEVEL RISE

The potential impact of sea level rise can be considered in terms of impact on water levels under normal tidal conditions (*i.e., during dry weather conditions*) and also in terms of impact on peak levels during major floods such as the 100 year recurrence event.

4.3.1 Impact on Tidal Water Levels

Based on available tidal information for the Manning River, it was determined that the mean still water level at the Pitt Street Waterfront Precinct is between 0 and 0.2 mAHD (*MHL, 2009*). In the absence of any flooding within the Manning River catchment, it is estimated that the peak spring tide level at the precinct would be about 1.0 to 1.2 mAHD. In other words, the highest high tide is likely to reach this level. This estimate is based on an assessment of tide gauge data for Taree between 2000 and the present (*MHL, 2009*).

It should be noted that the tidal water level at the precinct is typically not more than 50 mm higher than the tidal water level at the mouth of the Manning River for any given tidal cycle.

As discussed, current predictions by the IPCC and CSIRO indicate that sea level rise could be as much as 0.91 mAHD by 2100. It is expected that this rise in ocean level would propagate up the Manning River to the Pitt Street Waterfront Precinct and beyond.

Accordingly, in this scenario the still water level at the precinct could be increased to about 1.9 to 2.1 mAHD. If this was the case, existing low-lying areas within the precinct could become flooded during a normal tidal cycle and to a lesser extent, particular areas may even become permanently flooded. Notwithstanding, inundation would generally be limited to areas along the unnamed creek that passes through the site.

Re-development of the Pitt Street Waterfront Precinct will involve the construction of finished surfaces and minimum floor levels that will be above 3.5 mAHD, including the basement carpark level. Accordingly, all proposed development will be at least 1.4 metres above the maximum tide level that is expected to occur under the *high level* impact scenario for sea level rise.

4.3.2 Impact on Peak Flood Levels

As is the typical procedure for modelling river systems along the NSW coast, the ESTRY modelling for the Manning River incorporates an ocean tailwater level that considers the peak ocean level that might occur during a design storm event at sea.

In other words, the downstream tailwater condition accounts for any setup in water level associated with the presence of a low pressure cell over the ocean and additional factors, such as wind and wave setup.

This is considered to be a conservative approach to flood modelling that assumes the timing of the peak of the design storm over the ocean will coincide with the timing of peak flood levels from the local catchment. In reality, the likelihood of the peak level of flooding coinciding with the peak ocean level is not great.

It has been previously determined that the peak ocean level during a 100 year recurrence storm will be about 2.3 mAHD (*GTCC, 1991*). Combined with a *high range* sea level rise prediction of 0.91 metres, the peak 100 year recurrence flood level at the mouth of the Manning River could be as high as 3.2 mAHD by 2100.

If this tailwater level was projected up the Manning River towards Taree, it would intersect with the existing 100 year recurrence flood surface profile in the vicinity of Croki (*refer solid red line in* **Figure 20**). Croki is location approximately 11 kilometres downstream from the Pitt Street Waterfront Precinct.

It is expected that the impacts of sea level rise could project further upstream from this point because the raised tailwater level is likely to create a profile that "curves up" to the existing flood profile rather than intersect at 3.2 mAHD (*refer dashed red line in* **Figure 20**).

However, as indicated in **Figure 20**, it is unlikely that the increased tailwater level will have an effect at the downstream limit of the TUFLOW model developed for this study. The peak 100 year recurrence flood level at the downstream limit of the TUFLOW model is about 4.4 mAHD, which is 1.2 metres higher than the predicted ocean level (*refer* **Figure 20**).

Accordingly, it was determined that sea level rise will not impact on design 100 year recurrence flood levels at the Pitt Street Waterfront Precinct. As a result, an allowance for sea level rise was <u>not</u> incorporated into TUFLOW modelling for climate change scenarios.

Notwithstanding, the downstream boundary condition for the TUFLOW model was modified to account for estimated flood level increases associated with increases in river flow from increases in rainfall intensities across the catchment (*refer below*).

4.4 POTENTIAL IMPACT OF INCREASED RAINFALL

A median increase in peak rainfall of 20% has been chosen for investigations into the effects of climate change on flooding. This is considered to provide a median estimate of the potential impacts.

This is also considered to be in accord with the somewhat standard practice of adopting an increase in flowrates of 20% when undertaking sensitivity analyses for large-scale flood investigations.

The <u>hydrologic</u> model that was originally developed for the Manning River Flood Study has not been made available for these investigations. As discussed above, the upstream boundary condition for TUFLOW modelling has been extracted from the results and input files for the existing ESTRY flood model. As a result, an assessment of increased peak rainfall cannot be readily undertaken.

Instead, a 20% increase in 100 year recurrence flood discharges along the Manning River has been adopted for investigation of climate change impacts. This approach assumes that a 20% increase in rainfall will translate to a 20% increase in peak flow.

FIGURE 20

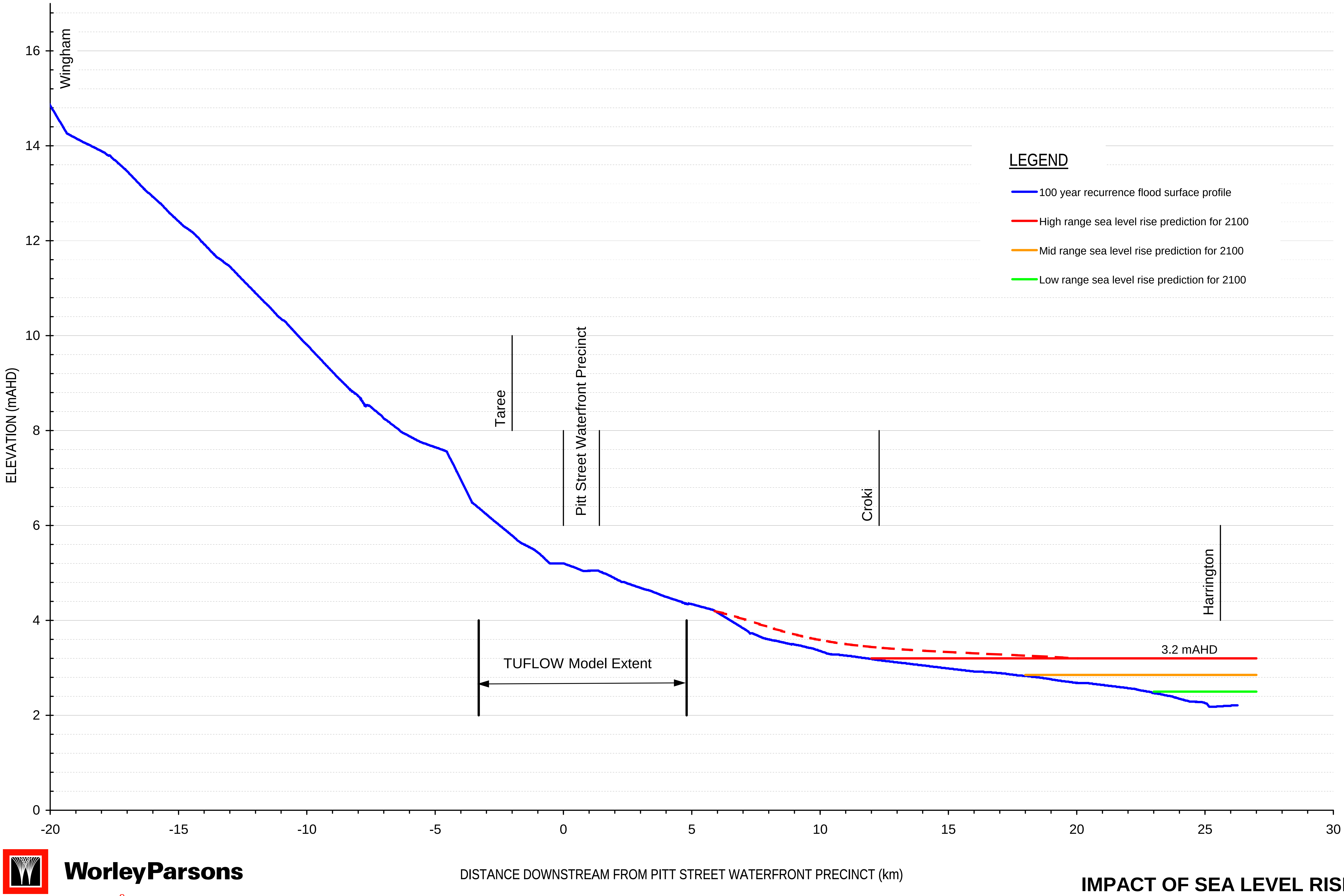

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Figure - CC 100 year profile.xls

IMPACT OF SEA LEVEL RISE ON FLOOD MODELLING AT THE PITT STREET WATERFRONT PRECINCT

4.5 MODELLING OF CLIMATE CHANGE SCENARIOS

4.5.1 Modification of TUFLOW Model Boundary Conditions

Upstream Boundary Condition

As discussed above, the upstream boundary condition of the TUFLOW model is defined by time-varying discharge hydrographs for the Manning River and at other inflow points, which have been extracted from the existing ESTRY model for the Manning River.

In order to model the impact of increased rainfall from climate change, the 100 year recurrence discharge hydrographs were modified to incorporate a 20% increase in flow across the entire hydrograph duration.

Downstream Boundary Condition

As outlined above, it was not considered necessary to incorporate an allowance for sea level rise into the downstream boundary condition for the TUFLOW model.

However, there was expected to be a small, but significant, increase in peak tailwater levels at the downstream boundary due to the 20% increase in flow that was incorporated into the model to simulate climate change effects.

Accordingly, the stage hydrographs that define the downstream boundary of the TUFLOW model were updated to reflect an increase in flood level of 0.15 metres. An increase of this magnitude was established through hydraulic calculations to test the effect of the increased flows on flood levels at the downstream boundary.

4.5.2 Modelling Results for Existing Conditions

The modified TUFLOW boundary conditions were used to simulate the climate change scenario described above.

The model results were extracted and compared to the results of modelling for existing conditions to develop flood level difference mapping that shows the potential impact of a 20% increase in rainfall on existing flood behaviour. The difference mapping is provided in **Figure 21**.

The mapping indicates that climate change could increase peak flood levels by between 200 and 300 mm across the precinct. The flood modelling also indicates that the flood level increase during the 100 year recurrence event could be up to about 400 mm at locations further upstream.

If this should be the case, the peak flood level at the precinct could be up to 5.5 mAHD. Habitable floor levels of proposed buildings at the precinct will be at least 1 metre above this level, indicating that climate change is unlikely to have a major impact on the development.

FIGURE 21

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Figure 21 – 100 year CC increase.doc

INCREASE IN PEAK 100 YEAR RECURRENCE FLOOD LEVELS FOR CLIMATE CHANGE SCENARIO

4.5.3 Modelling Results for Post-Development Conditions

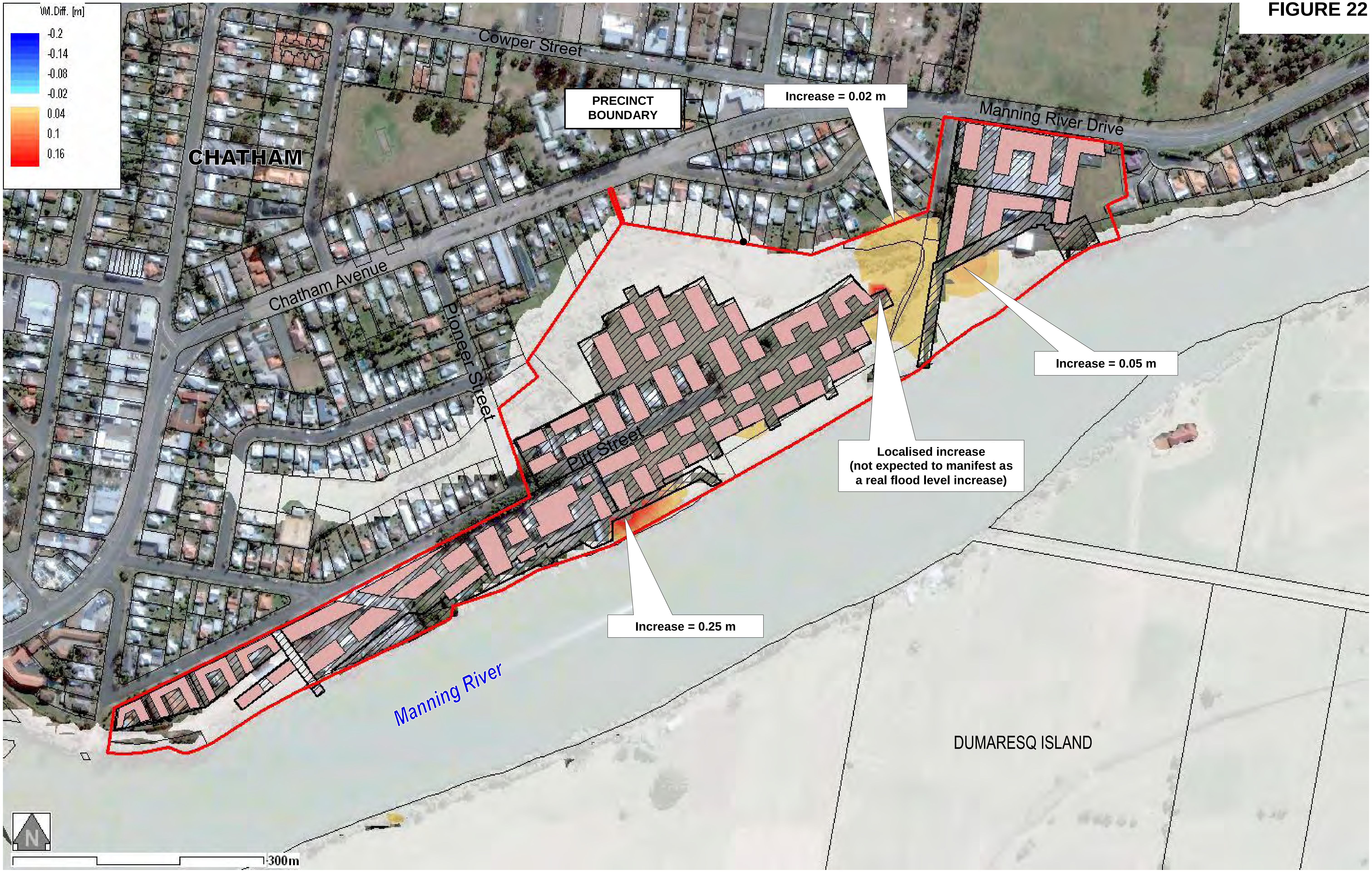
The modified TUFLOW boundary conditions were also used to simulate the climate change scenario for post-development conditions at the precinct.

The model results were extracted and compared to the results of climate change modelling for existing topographic conditions at the site. The associated flood level difference mapping is provided in **Figure 22** and shows the potential impact that the development may have on flood behaviour under a climate change scenario.

As shown, the potential impact of the development under a climate change scenario would be similar to the impacts under existing conditions (*compare* **Figures 22** *and* **16**). The maximum off-site flood level increase would be limited to 0.02 metres, which is considered to be negligible.

Flow velocity difference mapping for the 100 year recurrence flood is provided in **Figure 23**. The mapping shows that, under a climate change scenario, the proposed development may result an increase in the peak 100 year recurrence flow velocity of up to 1.7 m/s within the precinct. However, this is expected to occur across a very localised area near the proposed crossing of the unnamed creek.

Minor off-site velocity increases of up to 0.3 m/s are expected within the Manning River and also across a localised area of public open space within the drainage easement to the west of Pioneer Street (*refer* **Figure 23**). However, these increases are not expected to manifest as any significant impacts on nearby dwellings.



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CHANGE IN PEAK 100 YEAR RECURRENCE FLOOD LEVELS FOR POST-DEVELOPMENT CONDITIONS FOR CLIMATE CHANGE SCENARIO

FIGURE 23

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Figure 23 – 100 year CC vel diff.doc

CHANGE IN PEAK 100 YEAR RECURRENCE FLOW VELOCITY FOR POST-DEVELOPMENT CONDITIONS FOR CLIMATE CHANGE SCENARIO

5. PLANNING CONSIDERATIONS

It is understood that the Rezoning Consultation Group and Council have consulted with the Department of Planning (*DoP*) regarding the requirements of Section 117 (*Direction 4.3 – Flood Prone Land*) of the Environmental Planning and Assessment Act 1979.

It has thus been determined that the proposed rezoning of the precinct is <u>in</u>consistent with the requirements of Direction 4.3. However, it is understood that this inconsistency is seen to be acceptable if it can be shown that the potential impact of the proposed development on flooding is of minor significance.

Based on the results of TUFLOW modelling that is documented above and the difference mapping shown in **Figures 16** to **19**, it is predicted that the development will <u>not</u> have a significant impact on local flood behaviour. Accordingly, it is understood that the proposed development will be consistent with the requirements of Direction 4.3.

6. FLOOD EVACUATION PLAN

Due to the location of the Pitt Street Waterfront Precinct at the edge of the Manning River, it is necessary to consider the evacuation of residents and visitors from the precinct during times of major flooding of the Manning River.

6.1 THE NEED FOR EVACUATION

6.1.1 Safety of Residents and Visitors

A majority of the proposed residential apartments and commercial buildings will have a ground floor level of 6.5 mAHD or higher. This level is above the peak level of the 100 and 200 year recurrence floods. As a result, evacuation of residents and visitors from the precinct would not be required during flooding up to this magnitude, assuming that suitable access is provided to residential or commercial ground floors.

The Probable Maximum Flood level at the precinct will be up to 9.1 mAHD. The ground floor level of a majority of residential and commercial buildings is expected to be inundated during a flood of this magnitude. Accordingly, provisions should be made for the safe evacuation of residents and visitors from the ground level of the precinct during events larger than the 200 year recurrence flood.

Notwithstanding, it should be noted that the upper levels of the proposed apartment blocks will be higher than the peak level of the PMF and therefore could provide refuge for residents from lower floors.

6.1.2 Protection of Vehicles and Personal Belongings

A majority of the basement carparking areas will have a finished floor level of 3.5 mAHD, which is between 500 and 700 mm below the peak 20 year recurrence flood level at the precinct. Based on information contained in the Manning River Flood Study (*1991*), it is predicted that a flood level of 3.5 mAHD corresponds approximately to the peak level of the 10 year recurrence event.

If an "open" or undercroft carpark design is adopted, it is likely that inundation of the carpark would start to occur shortly after floodwaters exceed this level. As discussed above, the option to construct a wall around the carpark to offer protection during events up to the 20 or 50 year recurrence flood is also being considered. In this case, the expected frequency of inundation of the carpark would be reduced.

If a wall was installed to completely enclose the basement carpark, it is expected that inflow could still occur via seepage or through ventilation holes. However, the rate of inflow would be much slower.

In the event of inundation via any of these mechanisms, it is expected that residents would want to move their vehicles and any stored possessions from the basement carpark level to higher ground to avoid or reduce any potential flood damages.

Accordingly, protocols need to be established to ensure that the movement of vehicles from the basement carparking areas can occur safely, prior to inundation of the carparks.

6.2 GREATER TAREE LOCAL FLOOD PLAN

The Greater Taree Local Flood Plan (*1995*) is a sub-plan of the Greater Taree Local Disaster Plan (*Displan*). The Plan provides a summary of the protocols that are to be followed during a flood emergency within the Greater Taree area. It also contains details of the responsibilities of emergency personnel in the dissemination of flood warnings and the evacuation of residents at threat from flooding.

The Greater Taree area is included in the Oxley State Emergency Service (*SES*) Division and for emergency management purposes is within the Mid North Coast District.

The Greater Taree Local Flood Plan covers the area of Chatham, including the Pitt Street Waterfront Precinct.

6.3 FLOOD EVACUATION ROUTE

As discussed, the evacuation of residents may be required during events larger than the 200 year recurrence flood. Evacuation of vehicles and possessions from areas of basement carpark may be required during events greater than the 10, 20 or 50 year recurrence flood, subject to the design adopted for the carpark walls.

6.3.1 Specific Flood Risk Areas in the Vicinity of the Pitt Street Waterfront Precinct

The Greater Taree Local Flood Plan does not list the Pitt Street Waterfront Precinct as a specific flood risk area. However, surrounding areas near Browns Creek and Dawson River are considered to be risk areas.

As a result, road closures during major flooding can include the Victoria Street crossing of Browns Creek and the Manning River Drive crossing of Dawson River. The closure of these routes would effectively “cut off” any evacuation from the Pitt Street Precinct along routes to the east or west.

It is therefore recommended that any evacuation from the precinct be in a northerly direction to higher areas of Chatham.

6.3.2 Flood Evacuation Route and Refuge

The Digital Terrain Model (*DTM*) of areas surrounding the precinct was interrogated to determine a suitable evacuation route from the Pitt Street Waterfront Precinct to a location of higher ground. As discussed above, this DTM has been developed based on ALS survey data that was collected in 2005.

Based on this assessment, it is proposed that residents of the precinct be evacuated to Chatham High School, which is located approximately 2 kilometres north of the precinct. The proposed evacuation route to the high school is shown in red on **Figure 24**. It follows Pitt Street to Lyndhurst Street and then crosses Chatham Avenue into Oxley Street.

An alternative route to the flood refuge would start from the eastern end of the precinct at Bligh Street, and follow Manning River Drive into Cowper Street, which then turns into Oxley Street (*refer blue route in* **Figure 24**).

Both of these evacuation routes are expected to remain "open" during flooding up to the 200 year recurrence event (*and even greater*). The routes can also be used for the transportation of vehicles to higher ground during smaller flood events in which inundation of the basement carpark is expected to occur.

It is recommended that evacuating residents avoid travel along Pioneer Street as floodwaters are expected to overtop this roadway at the upstream limit of the unnamed creek.

6.4 FLOOD WARNINGS

The Greater Taree Local Flood Plan indicates that the State Emergency Service (*SES*) and the Bureau of Meteorology (*BOM*) both monitor river height gauges located at Wingham and Taree. Additional gauges are monitored at locations further upstream from Wingham.

The BOM issues flood warnings under the classification of "minor", "moderate" or "major", depending on the flood level reached at the gauges at Wingham and Taree. A major flood warning is issued when a flood level of 12.0 mAHD is reached at Wingham and/or a flood level of 4.0 mAHD is reached at Taree.

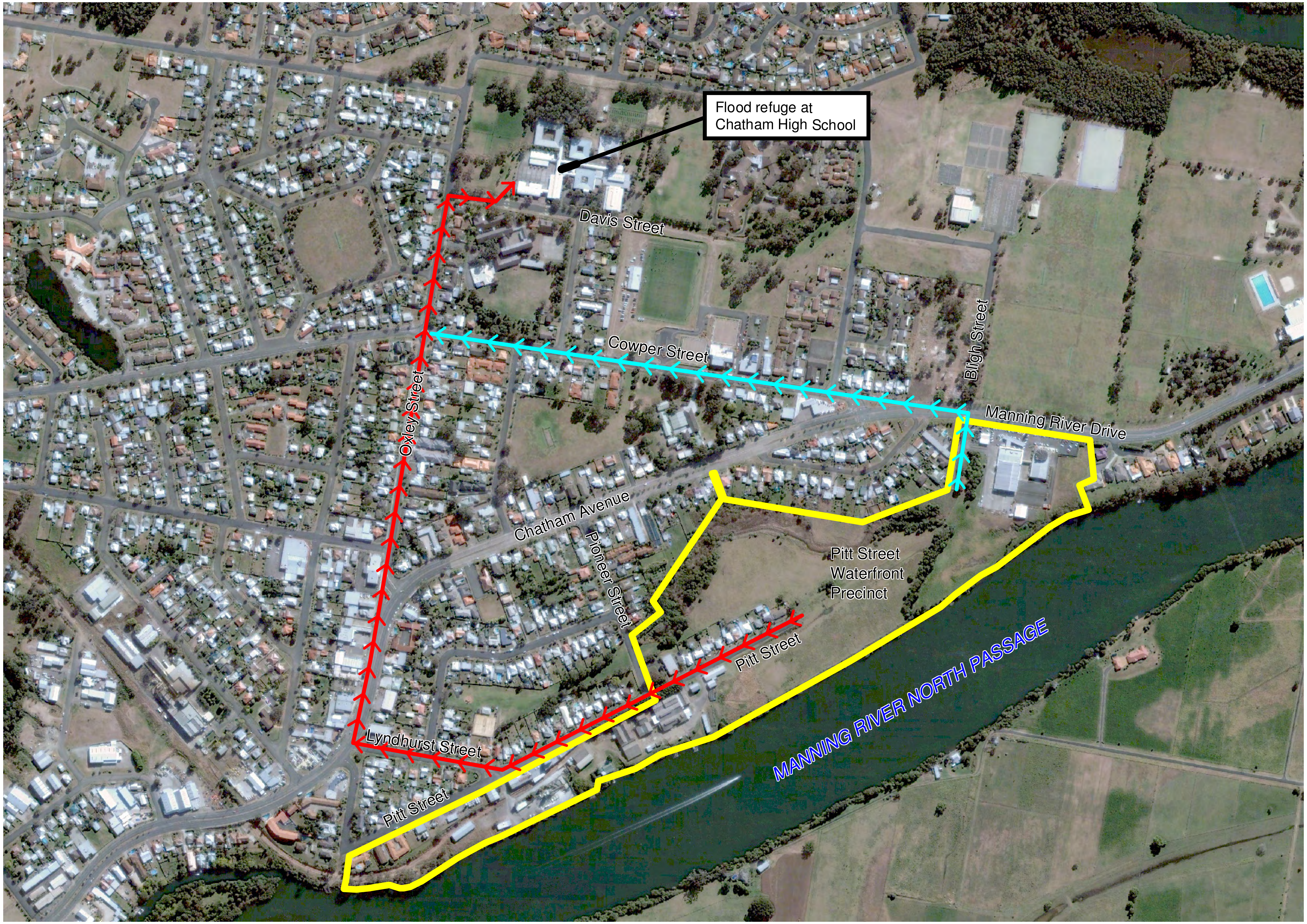
6.4.1 Removal of Vehicles and Possessions from Basement Carpark Areas

Based on flood level information contained in the Manning River Flood Study (*1991*), it was determined that a "major" flood corresponds approximately to the design 10 year recurrence event. As discussed above, flooding greater than an event of this magnitude is expected to cause inundation of the carpark areas if an undercroft or "open" design is adopted.

Accordingly, in this scenario it is recommended that evacuation of vehicles from the basement carpark areas be commenced upon receipt of a "major" flood warning for Wingham.

Based on a comparison of stage-hydrographs contained in the 1991 Flood Study, it is expected that the peak level of flooding during an event of this magnitude will occur at Taree (*and therefore Chatham*) approximately 4 hours after the peak level of flooding is reached at

FIGURE 24



LEGEND

Evacuation Route

Alternative Evacuation Route

N

0 100 200

Meters

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Figure 24 - Flood Evacuation Plan.wor

FLOOD EVACUATION ROUTE

Wingham. As a result, residents will have at least 4 hours warning time to move their vehicles or possessions and exit the basement level before inundation starts to occur.

The SES has indicated that around 4 hours is considered to be the minimum required time for flood evacuation once a flood warning is received (*pers comm. Steven Hart*). This timeframe incorporates an allowance for the reaction time of evacuating residents, time for residents to gather personal belongings and the time for mobilisation of SES personnel and equipment.

Accordingly, there is expected to be sufficient flood warning time for the Pitt Street Waterfront Precinct.

Notwithstanding, it is expected that a significant amount of vehicle traffic could result during evacuation. The proposed re-development of the precinct will incorporate up to approximately 1,700 car parking spaces, although the number of vehicles typically present would be closer to 500, based on the number of permanent residents.

It is recommended that measures be implemented to direct vehicles along the routes identified in **Figure 24**. It is envisaged that SES staff would be available to assist in this capacity.

It is also recommended that a Flood Warden (*or team of wardens*) be appointed for the precinct who can work in conjunction with SES staff to distribute flood warnings and oversee flood evacuation procedures. The warden(*s*) will need to monitor the level of inundation across the basement carpark levels (*if any*) and initiate measures to prevent residents entering the basement once floodwater depths reach greater than 0.4 metres and create hazardous conditions.

If the basement carpark design is to incorporate a perimeter wall to provide protection up to the 20 or 50 year recurrence flood, the estimated flood warning time of 4 hours would not be affected. However, the need to evacuate vehicles from the carpark areas would arise less frequently. In other words, rather than evacuation being required on average once every 10 years, the need to evacuate may arise only once every 20 or 50 years on average.

If a completely enclosed design is adopted for the carpark, then the rate of inflow of floodwaters to the basement would be considerably slower. The flood warning time could therefore be increased significantly for residents wanting to evacuate their vehicles.

However, it should be noted that inundation of the carpark could occur rapidly and hazardously once flooding overtops the crest level of the carpark entry points. It is assumed that the crest level would be similar to the proposed habitable floor level of 6.5 mAHD, or at an elevation to provide sufficient freeboard above the 100 year recurrence flood level of 5.2 mAHD.

In this scenario, the rise of floodwaters towards the crest level of carpark entry points would need to be monitored carefully so that access to the carpark by residents can be blocked during unsafe conditions.

6.4.2 Evacuation of Residents and Visitors

As discussed, the off-site evacuation of some ground floor residents and visitors may be required in the event that flooding exceeds the magnitude of the 200 year recurrence event.

According to stage-hydrographs contained in the Manning River Flood Study (*1991*), there will be approximately 3 to 4 hours warning time for the Pitt Street Precinct from when flooding reaches the level of the 200 year recurrence flood at Wingham (*16.5 mAHD*).

Due to the potential for inundation of the basement carpark to occur during relatively low-level flooding (*refer scenarios above*), it is possible that a majority of private vehicles would have been removed from the precinct before residents are instructed to evacuate. If this is the case, a number of buses may be required to transport residents to the flood refuge at Chatham High School.

Alternatively, on-site flood refuge could be provided for residents and visitors at specified refuge areas on the first floor of the proposed apartment blocks. This floor level is likely to be above the peak level of the Probable Maximum Flood of 9.1 mAHD.

6.5 FLOOD PREPAREDNESS AND EDUCATION

The preparedness and education of residents at the Pitt Street Waterfront Precinct will be critical in the effective execution of evacuation procedures during a major flood.

It is recommended that appropriate signage be installed at the pedestrian entrances to the basement carpark levels to warn residents of the potential flood risk. An example of such a sign is provided in **Appendix D**.

Similar signs should also be installed for above ground areas across the precinct, particularly at proposed public open space and tourism/entertainment areas.

7. CONCLUSIONS

As outlined in the above report, a TUFLOW model has been developed to simulate flooding across the Manning River floodplain in the vicinity of the Pitt Street Waterfront Precinct.

The model incorporates a detailed 2-Dimensional grid network to simulate flow across overbank areas and 1D channels to simulate flow along defined watercourse channels.

The TUFLOW model has been configured to derive boundary condition data from the results of broad scale ESTRY flood modelling for the Manning River that was undertaken in 1991. In other words, the TUFLOW model is effectively "embedded" within the ESTRY model.

The model has been used to simulate flooding for existing topographic conditions across the floodplain in the vicinity of the precinct and to confirm the peak flood level results obtained through previous ESTRY modelling.

The TUFLOW model has also been modified to incorporate the proposed redevelopment of the Pitt Street Waterfront Precinct in order to simulate post-development flood behaviour. The results of this modelling have been compared to the results of modelling for existing conditions to determine that the proposed development will not have a significant impact on local flood behaviour.

Accordingly, it is understood that the proposed development will be consistent with the requirements of Section 117 (*Direction 4.3 – Flood Prone Land*) of the Environmental Planning and Assessment Act 1979.

An assessment of the potential impact of climate change has determined that sea level rise is not likely to affect the peak level of flooding at the precinct during the 100 year recurrence event. Notwithstanding, an increase in peak rainfall associated with climate change could increase local flood levels by up to 300 mm by 2100. It should be noted that this peak level will not cause inundation of the proposed development. Furthermore, it has been determined that the proposed development will not have a significant impact on flood behaviour during the 100 year recurrence event under a climate change scenario (*i.e., if predicted climate change effects were to manifest by 2100*).

It has also been demonstrated that evacuation of residents and their personal belongings from the precinct (*if required*) can be undertaken safely in accordance with flood warnings issued by the SES and BOM.

8. REFERENCES

- Department of Environment and Climate Change (*2007*), *'Floodplain Risk Management Guideline; Practical Consideration of Climate Change'*.
- Department of Planning (*2007*), *'Local Planning Direction 4.3 – Flood Prone Land; Environmental Planning and Assessment Act 1979'*.
- Chow VT (*1959*), *'Open Channel Hydraulics'*; McGraw Hill Book Company, Inc.; Reissued 1988; ISBN 07 010776 9.
- Greater Taree City Council (*1991*), *'Manning River Flood Study – Volume 1'*.
- Greater Taree City Council (*1996*), *'Manning River Floodplain Management Study – Volume 1 (in draft)'*.
- Institution of Engineers (*1987*), *'Australian Rainfall and Runoff – A Guide to Flood Estimation'*; edited by DH Pilgrim.
- Manly Hydraulics Laboratory (*2009*), *Tide Data for Taree Gauge (208410); January 2000 – January 2009*.
- New South Wales Government (*2005*), *'Floodplain Development Manual: the management of flood liable land'*; ISBN 07313 03709.
- State Emergency Service (*1995*), *'Greater Taree Local Flood Plan – a Sub-Plan of the Greater Taree Local Disaster Plan'*.

Appendix A – MANNING RIVER HYDROGRAPHIC SURVEY CROSS-SECTIONS (1999)