8.2 Outline of identified options

A number of potential flood modification measures have been identified for consideration based on review of the existing flooding impacts, consultation with Council staff and previous consultation with the community during the Lower Macleay Flood Study (Jacobs, 2019). Several options were previously reviewed in the Lower Macleay Floodplain Management Study (Webb McKeown & Associates, 1997) and may be worth further consideration in this study with the benefit of the current flood models and knowledge of flooding conditions and in light of contemporary views in floodplain risk management.

The focus of the identified potential options is on the Lower Macleay floodplain. The Kempsey CBD Floodplain Risk Management Study (WMAwater, 2017) primarily considered options for mitigating flood risk around the CBD, and it is not the focus of this current study to revisit these CBD options.

Most of the identified options are aimed at reducing the time to drain the floodplain following a flood peak. It is acknowledged that it is not feasible to significantly reduce peak flooding in the Macleay, particularly in major events. Some options consider improvements to flood access, with modelling to assess potential resultant impacts recommended. There are a range of floodplain environmental management issues relevant to the Lower Macleay and it is outside the scope of this study to specifically address these in detail, although assessment of the identified options makes consideration of these environmental constraints and issues at a broad level.

Council, in consultation with DPE, are requested to consider the identified options and select up to 10 options and sub-options for further assessment including hydraulic modelling to quantify benefits and impacts to flooding conditions and cost estimation of options. Consultation with the floodplain management committee and general community should also be considered as appropriate.

8.2.1 Raising Crescent Head Road at The Corduroy

Discussion

Several options for raising Crescent Head Road at The Corduroy, on the Connection Creek floodplain to the west of Crescent Head, have been assessed in the TUFLOW model. Refer to Section **Error! Reference source not found.** for discussion of the flood modelling outcomes. The existing road has an elevation of about 1.5m AHD at its low point and is susceptible to becoming inundated and cutting off Crescent Head during flood events.

Options of raising the road by 0.1m, 0.3m and 0.6m and to an elevation of 3.2m AHD have been assessed. The existing transverse drainage was assumed to be retained. Flooding impacts resulting from the road raising options could be mitigated by providing increased drainage capacity, although the length of the floodplain crossing means substantial culvert structures would be required.

Recommendation

Medium to high priority for further assessment. Council may wish to test out options for transverse drainage upgrade with the aim of managing resultant flood impacts to within a certain acceptable level. The flood impact criteria could be selected based on the flooding of floor levels at affected properties.

8.2.2 Raising Crescent Head Road crossing at Rudders Lagoon

Discussion

Crescent Head Road crossing of Rudders Lagoon, in South Kempsey, was nominated by Council as an option to assess. Assessment of this option is covered by a scope variation and would be additional to the list of 10 options/sub-options for detailed assessment.

The road at this location was flood-affected during the March 2021 flood event, which was estimated as approximately a 10% AEP event. Table 8-1 indicates the levels of raising the bridge and road to achieve various

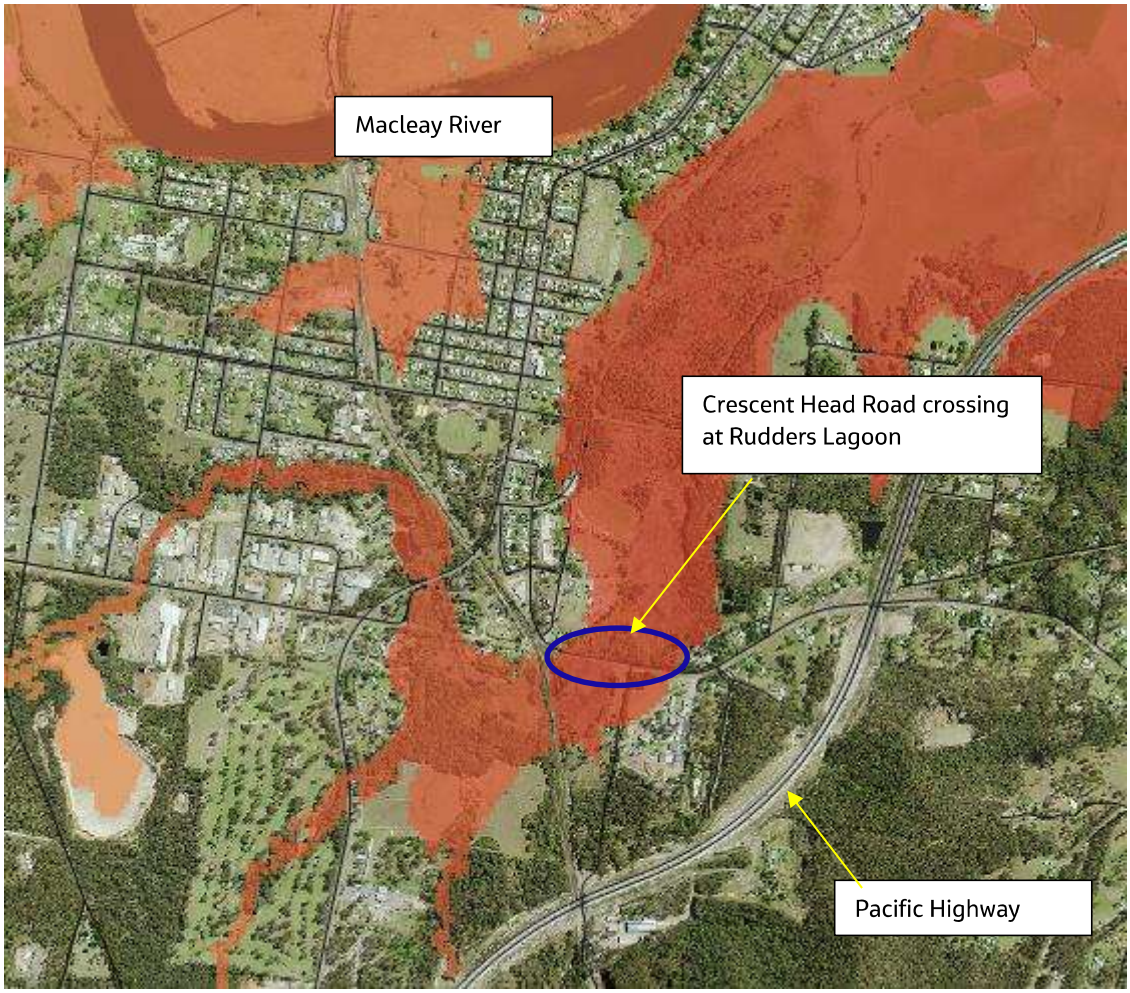
levels of flood immunity. Figure 8-2 shows the locality of the site and the 5% AEP flood extent, which indicates the extent of road which would be affected by the works.

Table 8-1: Levels of raising Crescent Head Road bridge at Rudders Lagoon for various flood immunity levels

Flood event AEP	Peak flood level (m AHD)	Raise road crossing to achieve flood immunity (with 0.5m freeboard to bridge deck level)* in m	Indicative length of road modified (m)
20%	4.12	0.82	350m
10%	4.16	0.86	350m
5%	5.12	1.82	440m
1%	6.20	2.90	500m

* Preliminary assessment

Figure 8-2: Location of Crescent Head Road crossing of Rudders Lagoon. 5% AEP flood extent shown.



Recommendation

High priority for assessment. Council should nominate a level for raising the bridge to achieve a required level of flood immunity. The option will be tested in the TUFLOW model to estimate resulting flood impacts.

8.2.3 Dredging of Macleay River

Discussion

Dredging of sections of the Macleay River was raised as an option for consideration by members of the community during the 2019 flood study. Certain sections of the river were reported to have become shallow particularly around Jerseyville, Rainbow Reach and Kinchela with several shoals having developed and which are exposed on some tides. Members of the community held the view that these areas could be dredged which would improve flow conveyance and flood conditions. They proposed that the dredged material could be sold for construction material, although Jacobs' view is that the sediment composition may not be suitable.

Dredging as an option was assessed in the Lower Macleay Floodplain Management Study (Webb McKeown & Associates, 1997) as not being a practical flood mitigation option due to high costs and environmental impacts. The 1997 study states that "modelling has shown that to have any real impact on flood levels the bed would need to be lowered by between 0.5 m and 1.0 m over a significant length. This would cost between $50M and $100M (in 1997 dollars) and would need to be regularly repeated". However, to address the current views held in the community, this option could readily be assessed in the TUFLOW model to confirm any flooding improvements.

It is expected that dredging would need to be repeated at regular intervals as new sediment enters the system and is re-worked by tidal and pluvial currents whereby shoals would likely form in similar locations. The interval between dredging projects could be 5 – 10 years.

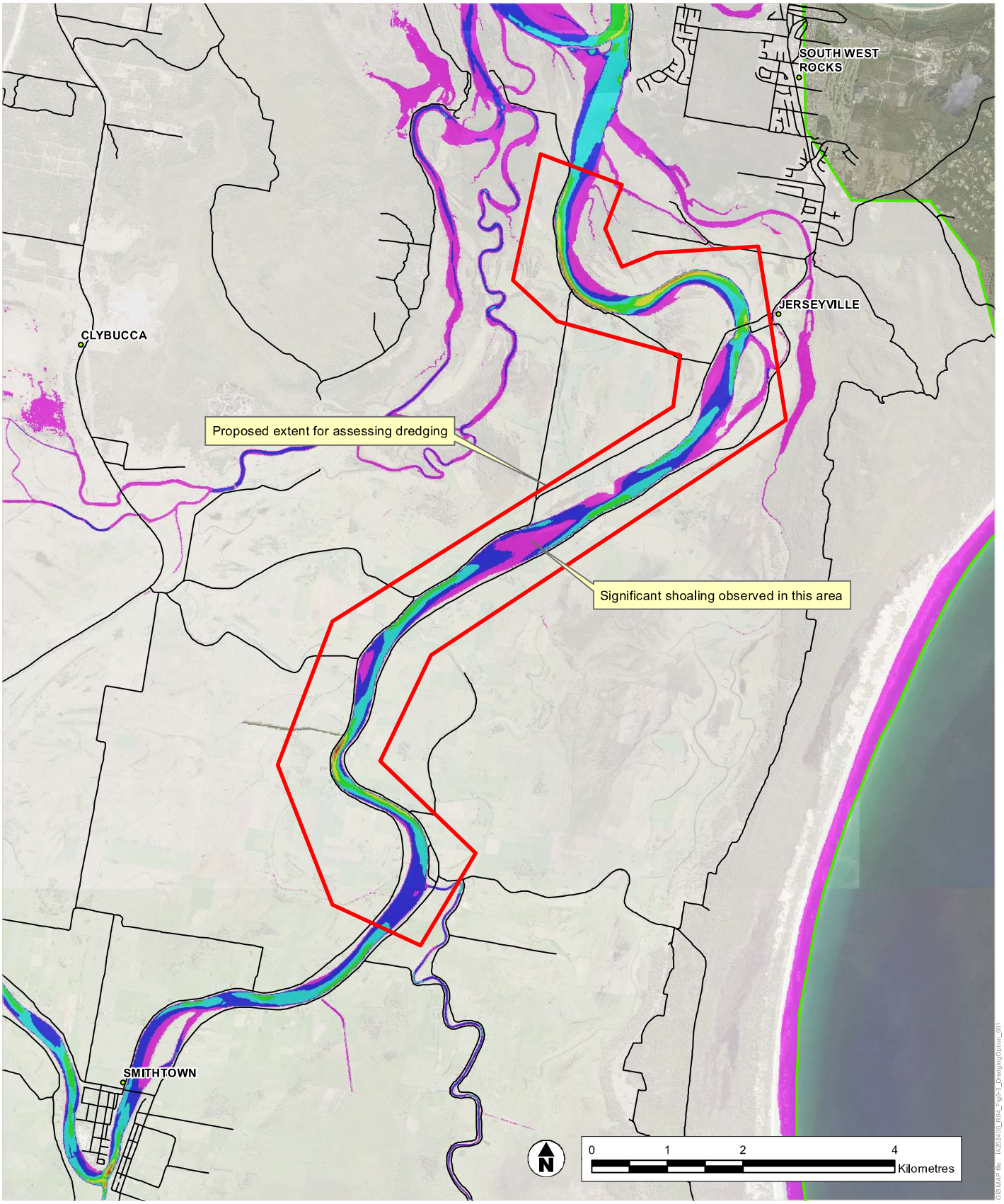
Dredging around Jerseyville bridge could affect the structural stability of the bridge. Numerous riverbank rock protection works could also be impacted by changed bed profiles and tidal current patterns. This would not be assessed in detail in this study.

Recommendation

Low to medium priority for further assessment.

There are a number of sand bars and shoals between Kinchela and South West Rocks which are as shallow as 1 to 2m depth (bed level -1 to -2m AHD) or less. The deeper holes on the bends of the river are at bed level -6m AHD or lower. Refer to Figure 8-3. Potential option for testing could involve lowering the bed elevation of the shoals to -3 or -4m AHD from Kinchela to South West Rocks. This would remove several small islands which have formed along this section of the river.

Dredging of other waterways such as Clyubbca Creek and Andersons Inlet have not been considered. Although shallow and a dredged system could improve flooding through Clybucca, the area appears to be environmentally sensitive and home to a number of oyster farms which would be impacted by dredging activities.



Legend

Existing bed elevation (m AHD)

- < -12
- -12 - -10
- -10 - -8
- -8 - -6
- -6 - -4
- -4 - -2
- -2- 0
- > 0

- Road
- Limit of Mapping

Jacobs

A3

SHEET 1 of 1

GDA 1994 MGA Zone 56

TITLE Potential Dredging Option for Assessment

PROJECT Lower Macleay River Floodplain Risk Management Study

DRAWN	PROJECT #	MAP #	REV	VER
CC	IA252400	FIGURE 8-3	1	1
CHECK	DATE			
LC	24/02/2023			

GIS MAP file: IA252400_R04_Fig8-3_DredgingOption_001

8.2.4 Disconnect Korogoro Creek and Killick Creek

Discussion

The option of disconnecting Korogoro Creek and Killick Creek from the Lower Macleay floodplain was previously discussed as a potential works option to reduce floodwater with poor water quality draining from the floodplain through the creek estuaries and causing blackwater fish kill events. This option would not improve flooding conditions in the Lower Macleay. If selected, the option should be tested to confirm whether there are any significant reductions in capacity to drain the floodplain or increases in duration of inundation post-flood.

Disconnecting the creeks from the floodplain should occur at or close to the existing headworks to maintain the creek tidal prism tidal flushing, and minimise the potential of the creek entrances closing up due to reduced tidal scouring.

Recommendation

Further assessment could be considered for this option as a low to medium priority.

8.2.5 Reinstate Rowes Cut

Discussion

This potential option was previously discussed with Council. It would involve earthworks and vegetation clearing to reinstate Rowes Cut as an ocean outlet for floodplain discharge. The Cut is currently in an unmaintained condition with the dune system filling the Cut and vegetation becoming re-established.

The option would be modelled as a lowered section of the dunes which would be washed out by flows during a flood event. It could be undertaken in conjunction with disconnecting Korogoro Creek from the Lower Macleay floodplain at Hat Head cross levee flood gate, at Rowes Cut. This would shorten the creek by about 20% in length, which may reduce the tidal prism and tidal scouring of the creek entrance, causing it to partially close and reduce access from the creek to the ocean by boat users at Hat Head.

Works associated with this option would occur within Hat Head National Park, which would require additional environmental permits and approvals. Periodic maintenance of the Cut would be required to maintain the lowered dune profile and manage vegetation.

Recommendation

Further assessment could be considered for this option as a low to medium priority. This option is unlikely to improve flooding conditions in the Lower Macleay. If selected, the option should be tested to confirm whether there are any significant reductions in capacity to drain the floodplain or increases in duration of inundation post-flood.

8.2.6 New ocean outlets

Discussion

There are several locations between the Macleay River entrance and Grassy Head which would overtop in the 0.2% AEP event. The dunes at one or more of these locations could be lowered and maintained at a reduced height (say 2m AHD; currently the dune level is around 4-5m AHD at the low points) to wash out during flood events to form new minor ocean outlets and help drain the Lower Macleay at a quicker rate post-flood. At 2m AHD, the lowered dune section would overtop in larger than 5% AEP event. The 5% AEP flood level at Fishermans Reach is approximately 1.9m AHD.

This option has the risk of the new outlets eroding wider than planned, with potential changes to the hydrodynamics of the Lower Macleay estuary system. Rock protection works to fix the opening width would be costly. At present there is no road access for maintenance activities, with vehicle access being limited to the beach.

Recommendation

This option is suggested as a low priority option for further assessment due to risks of impacts to the morphology and hydrodynamics of the Lower Macleay estuary during and following a flood event. Regular maintenance works would be required and vehicle access to the sites is limited to beach access from Grassy Head only.

8.2.7 Modify opening regime of flood control structures

Discussion

The flood control structures at Belmore River and Kinchela Creek are assumed to open when flood levels at the creek entrances reach 3.8m AHD and 3.0m AHD, respectively, under the current operation of the structures. This is when flooding is expected to start overtopping the levees on these watercourses and is about 0.3m below the 20% AEP flood level at the creek entrances.

The flood control structures could be assessed to open at a higher flood level to reduce inundation of the southern floodplain. Opening when the 20% AEP flood level is reached may reduce floodplain inundation slightly. It may require levees to be raised to reduce overtopping into the southern floodplain.

Opening the structures at the 10% AEP flood level would translate to opening them at approximately 0.4m higher flood level than currently. In the 10% AEP event the overflows from the river are significantly greater than in the 20% AEP (1009m^3/s in the 10% AEP event compared to 86m^3/s in the 20% AEP event. Refer to Table 8-4 in the Flood Study Update report (Jacobs, 2022). The effect on floodplain inundation of changing the opening stage of the flood control structures is likely to be minimal in the 10% AEP event and larger.

The Belmore River flood control structure conveys about 250m^3/s into the floodplain during the 20% AEP event, which is about 12% of the flow in the river at Smithtown gauge. Delaying opening the structure may result in increased overflow of the river into Smithtown in the 20% AEP event.

Delaying the opening of the flood control structures to a higher river level would mean about 6 – 10 hours less time for Council staff on ground to evacuate from the floodplain after opening the structures.

Recommendation

This option could be further assessed as a low to medium priority option and could be modelled as a sensitivity test option. The option would not reduce floodplain inundation in frequent events such as the 50% AEP event as the river flood levels would not reach sufficient height to trigger opening of the flood control structures. The influence of the flood control structures in the 10% AEP event and large is probably minimal, due to the river overflows to the southern floodplain over the natural banks being large compared to the flows through the structures. There may also be impacts to flooding in Smithtown in the 20% to 10% AEP events if the structures remain closed during those events.

8.2.8 Increased floodplain drainage capacity – floodgates and drains

Discussion

The floodplain is drained by numerous drains and floodgates to the Macleay River and main tributaries including Belmore River, Kinchela Creek and Clybucca Creek. Increasing the size and capacity of the drains and floodgates may help to improve the drainage times on the floodplain following a flood event. The peak flood levels are not expected to be improved.

This option could be tested with nominally doubling the capacity of the floodgate structures within the TUFLOW model. Most floodplain drains are not modelled in detail in the model and increasing their capacity in the model would be a crude representation.

The existing drains and floodgates on the Lower Macleay, in addition to other floodplains on the NSW North Coast, have been associated with poor water quality outcomes and aquatic ecology impacts due to acid sulfate runoff, lowered water table and increased risks of blackwater events. Increasing drainage capacity at drains and floodgates may worsen these impacts.

Recommendation

Ranked as a low priority option for further assessment due to risks of poor environmental outcomes. Further environmental study would be required to help quantify the risk of reduced water quality impacts and identify any mitigation strategies.

8.2.9 Increased floodplain drainage capacity – proposed Hat Head Road floodway

Discussion

Hat Head Road at Kinchela appears to act as a barrier to water on the floodplain draining more freely to the north. There are a number of minor pipe crossings but these appear to be small in size and were not included in the TUFLOW model due to absence of design details in Council's spatial data, but their small size means they are unlikely to significantly contribute to flow conveyance.

Figure 8-4 shows the ponding of water to the south of Hat Head Road in the 20% AEP event with reduced inundation on the floodplain to the north. It also indicates a low point in the road which is overtopped in the 20% AEP event. The low point could be raised to improve flood access in the 20% AEP event and a bank of culverts (say 200m wide) installed to allow floodwaters to discharge to the north, thereby reducing inundation times to the south of the road. Note that substantial raising of the road would be required to provide flood immunity in the 10% AEP event, as the existing road is overtopped for a length of 2km in that event.

There is about 0.8m difference in peak water level between south and north of the road in the 20% AEP event which would help with flow conveyance.

Ground levels upstream and downstream of the road would need to be lowered down to, say, 1-1.2m AHD to form a floodway into and out of the culvert bank. The road level is currently at 2.1 – 2.3m AHD and would need to be raised by about 0.6m to provide sufficient cover over the proposed culverts. Figure 8-5 illustrates the option.

There could be impact to internal access road for the property to the north of Hat Head Road at this location. There may be increases in flooding peak and duration to the north of the road in frequent flood events. There may be small increase in peak flood levels south of the road due to raising of the road.

Recommendation

This option could be assessed further at a medium priority, although noting that potential flooding, drainage and property impacts to the north of Hat Head Road may result in lowering of the priority.

Figure 8-4: Hat Head Road at Kinchela obstructing flow towards the north. 20% AEP flood depths shown.

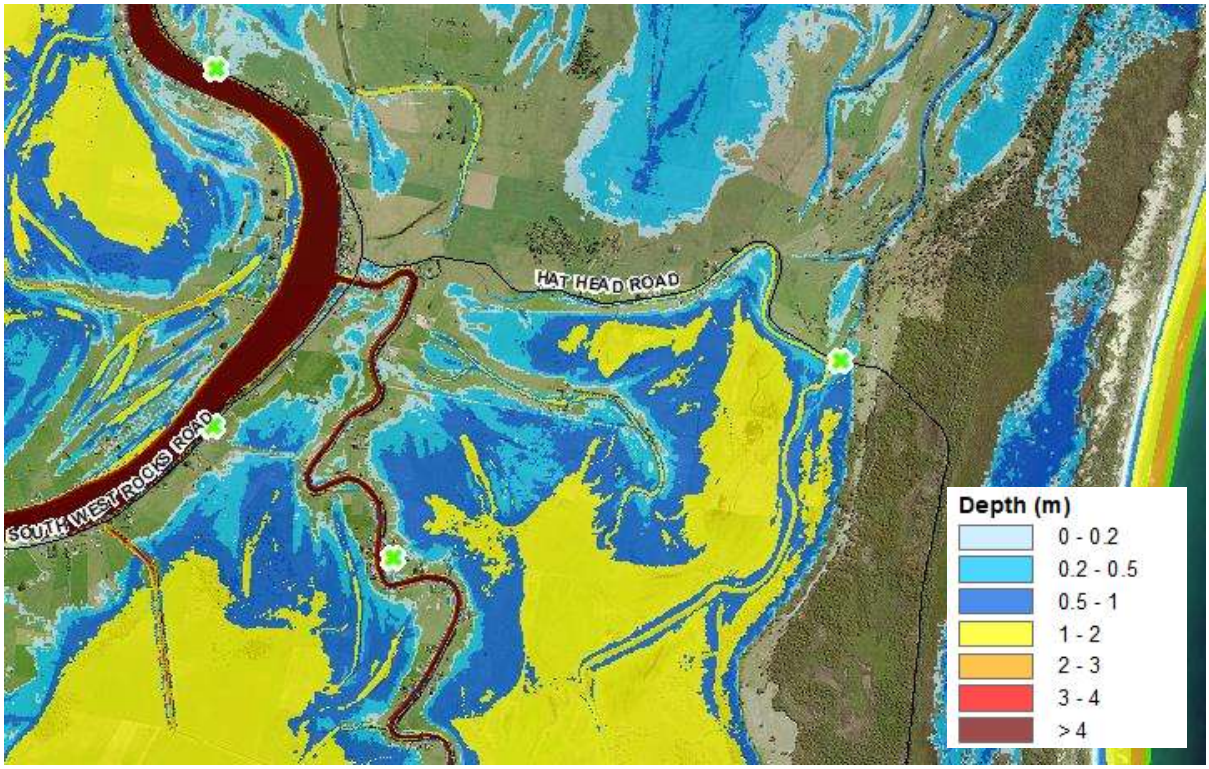
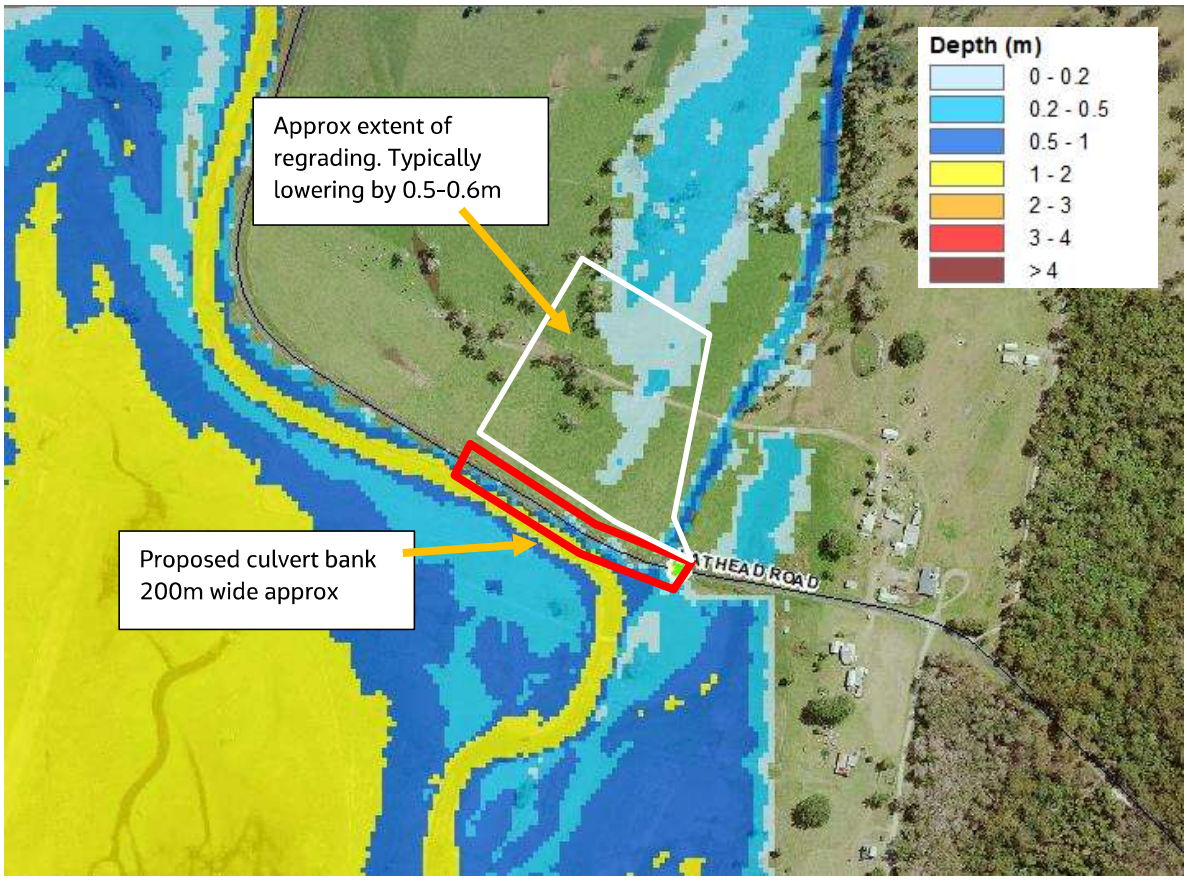


Figure 8-5: Illustration of Hat Head Road floodway option



8.2.10 Increased floodplain drainage capacity – Clybucca floodplain and drainage capacity at Macleay Valley Way

Discussion

Similar to Hat Head Road, the Macleay Valley Way appears to obstruct floodwater in the Clybucca Wetland and floodplain area from draining out to Clybucca Creek and Andersons Inlet. However, the difference in flood level between upstream and downstream of the road is less than 0.1m in the 20% AEP event and about 0.1m in the 10% AEP event. Increasing the transverse drainage on Clybucca Creek is unlikely to significantly improve durations of flooding upstream of Macleay Valley Way.

Recommendation

This option could be tested for sensitivity of flooding conditions as a low priority option.

8.2.11 Increased floodplain drainage capacity – Loftus Road crossing at Ryans Cut

Discussion

Discharge of floodwater through Ryans Cut to the ocean is currently limited by the capacity of the culvert/floodgate crossing at Loftus Road and potentially the width of the open channel upstream and immediately downstream of the crossing. The current crossing is 32m wide and the current peak discharge rates are about 140m^3/s in the 10% AEP event and 260m^3/s in the 5% AEP event. Doubling the capacity could improve drainage times for the southern floodplain. Peak flood levels are unlikely to be significantly improved.

The risk of a large blackwater fish kill at Ryans Cut is not expected to be significantly greater than the existing case, as the lagoon is small and currently becomes flushed out during flood events. Further environmental assessment would be undertaken in the detailed assessment to confirm risks.

Widening the crossing and channel would have impacts to adjacent properties and existing utilities (overhead power line, possibly underground utilities). Works downstream of Loftus Road would be in Hat Head national Park.

If Korogoro Creek is selected to be disconnected from the floodplain, this option could be a compensatory measure to maintain/increase drainage capacity.

Recommendation

It is suggested that doubling the width of Loftus Road crossing at Ryans Cut and associated flow capacity be assessed as a medium to high priority option.

8.2.12 Increased floodplain drainage capacity – Enlarged headworks on Belmore River and Kinchela Creek

Discussion

The existing headworks on the Belmore River and Kinchela Creek are relatively small compared to the width of the waterways. For example, the width of the headworks on Belmore River is about 12m compared to a channel width of 45m at that location, with a discharge rate of 64m^3/s during the recession in the 1% AEP event. On Kinchela Creek the headworks are 6m wide compared to a 35m channel width, with a 1% AEP event peak discharge rate of 20m^3/s.

This option has the potential to reduce inundation times in the southern floodplain. Enlargement of existing floodgates draining to the creeks could be required to further reduce inundation times.

The Belmore River and Kinchela Creeks have previously been described as “fish traps” (refer Lower Macleay Floodplain Management Study, Webb McKeown & Associates, 1997) where by during a flood event fish take refuge in the creeks out of highly turbid water in the main river. They become trapped by the turbid river water, poor water quality (low dissolved oxygen or pH) discharged by floodplain drains in the lower reaches of the

creeks as well as through the headworks, eventually succumbing to a fish kill event as the pocket of better water quality diminishes by the increased floodplain drainage. This option has the potential to increase the risk of this phenomenon.

Recommendation

Ranked as a moderate to high priority option for further assessment but might be downgraded due to risks of poor environmental outcomes. Further environmental study would be required to help quantify the risk of reduced water quality impacts and identify any mitigation strategies.

8.2.13 Raise and extend Smithtown levee

Discussion

An audit of Smithtown village levee was prepared on behalf of Council in 2015 (Kempsey Shire Council, 2015). The Smithtown levee is typically less than 0.5m in height from the natural surface level, although a section of levee approximately 80m in length at the Southern end of the levee is approximately 1.5m high on the protected side and up to approximately 2.5m high (from the natural surface level) on the river side. The crest is generally 1.7m to 2.5m wide, but with some localised wider sections. The shoulders generally are graded between 1V:2H and 1V:9H. The design crest level of the levee ranges from 4.43m AHD at its southern end to 4.32m AHD at its northern end.

A topographic survey showed that the existing crest level of the levee is on average 0.2m below the original levee crest design level, with the typical range being 0.1 – 0.4m below design level. Note that the existing levee is about 1m lower than design levels at the southern end, and about 0.5m at the eastern end of Jeffery Street. No evidence was found to suggest why the levee was constructed to the level. A number of undulating sections of levee were also identified, typically located in the yards of residential properties. The undulations appear to have been caused by localised erosion levee crest or as a result of garden beds and trees being planted on the levee.

Consideration for raising levee to design levels

Raising the existing levee to design levels would involve increasing the height by typically 0.1 – 0.4m, with localised raising of 0.5 to 1m. The levee is constructed close to existing buildings at a number of locations, including at the southern end where the levee is lower than design level by 1m. Assuming a steep side profile of 1:2, the footprint of the levee for a 1m raising would be 4m which is likely to impact on buildings and properties.

Comparing the current design flood level estimates to the design levee levels indicates that the Smithtown levee would be overtopped in the 10% AEP event at the southern end of the levee.

The existing levee extends along the eastern side of the village. There are several locations not covered by the levee which are overtopped in the 20% and 10% AEP events, refer to Figure 8-6 and Figure 8-7, respectively.

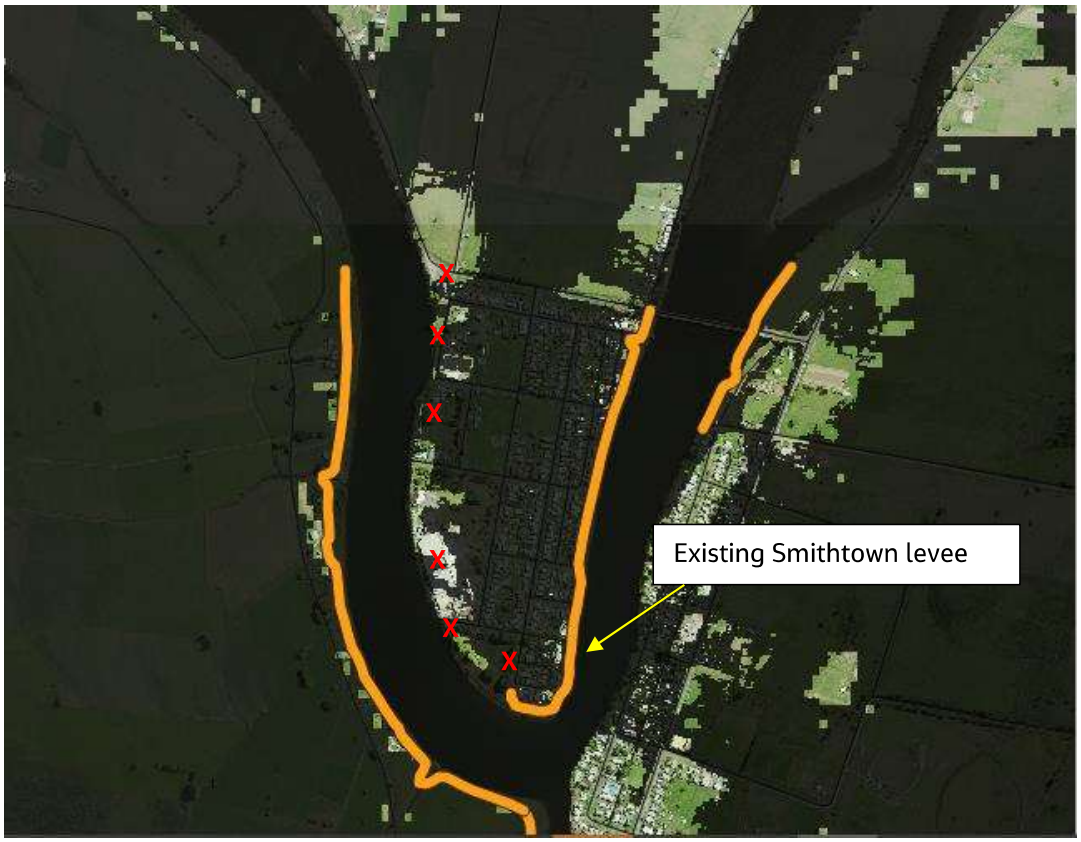
Recommendation

Recommended assessing raising the existing levee to design levels and raising the southern end of the levee to above the 10% AEP event as medium priority option for further assessment. There are expected to be challenges with fitting in levee raising within the existing properties and development.

The natural bank on the western side of Smithtown would also need to be raised and the existing levee extended to reduce overflows in the 10% AEP event.

Figure 8-6: 20% AEP flood extent at Smithtown showing breakouts at areas not covered by levee (marked X)

Figure 8-7: 10% AEP flood extent at Smithtown showing breakouts at areas not covered by levee (marked X)



8.2.14 Raise other levees to design levels or infill low sections

Discussion

Council commissioned audits of main levees in the Macleay around 2015, which identified that the levees are lower than their design crest level at a number of locations due to erosion or wearing down by cattle traffic. In some locations there are localised low points in the levees. The Rainbow Reach levee audit report found that for approximately 50% of the length of the levee the surveyed crest level is approximately 200mm below the design crest level. The Frederickton to Smithtown levee audit reported that the crests of the levees appear to have eroded with undulations and cattle tracks identified over the entire lengths of most of the levees, typically ±50-100mm in size.

The flood mapping from this current study indicates that most of the levees are overtopped by the 20% AEP event or smaller, as summarized in Table 8-5 in the Flood Study Update report (Jacobs, 2022). Noting that the objectives of the Macleay Flood Mitigation Scheme, as stated on Council's flood management web page, was to provide "Protection for the lower Macleay agricultural area from a 1 in 2.5 year flood event", overtopping of the levees in the 20% AEP event (approximately 1 in 4 to 1 in 5 year event) could be considered acceptable and within the objectives of the Scheme. The levees at Rainbow Reach and Old Pola Creek overtop in the 50% AEP event, although Figure 8-8 shows that the overtopping at Rainbow Reach affects mainly vegetated and low-lying wetland areas with a small area of pasture, while Figure 8-9 shows that the area behind Old Pola Creek levee would be affected by overflows to the east of the constructed levee section anyway.

The levee audit reports recommend remediation of the defects (including low points and sections below design crest levels) be undertaken.

Figure 8-8: Overtopping of Rainbow Reach levee in 50% AEP event

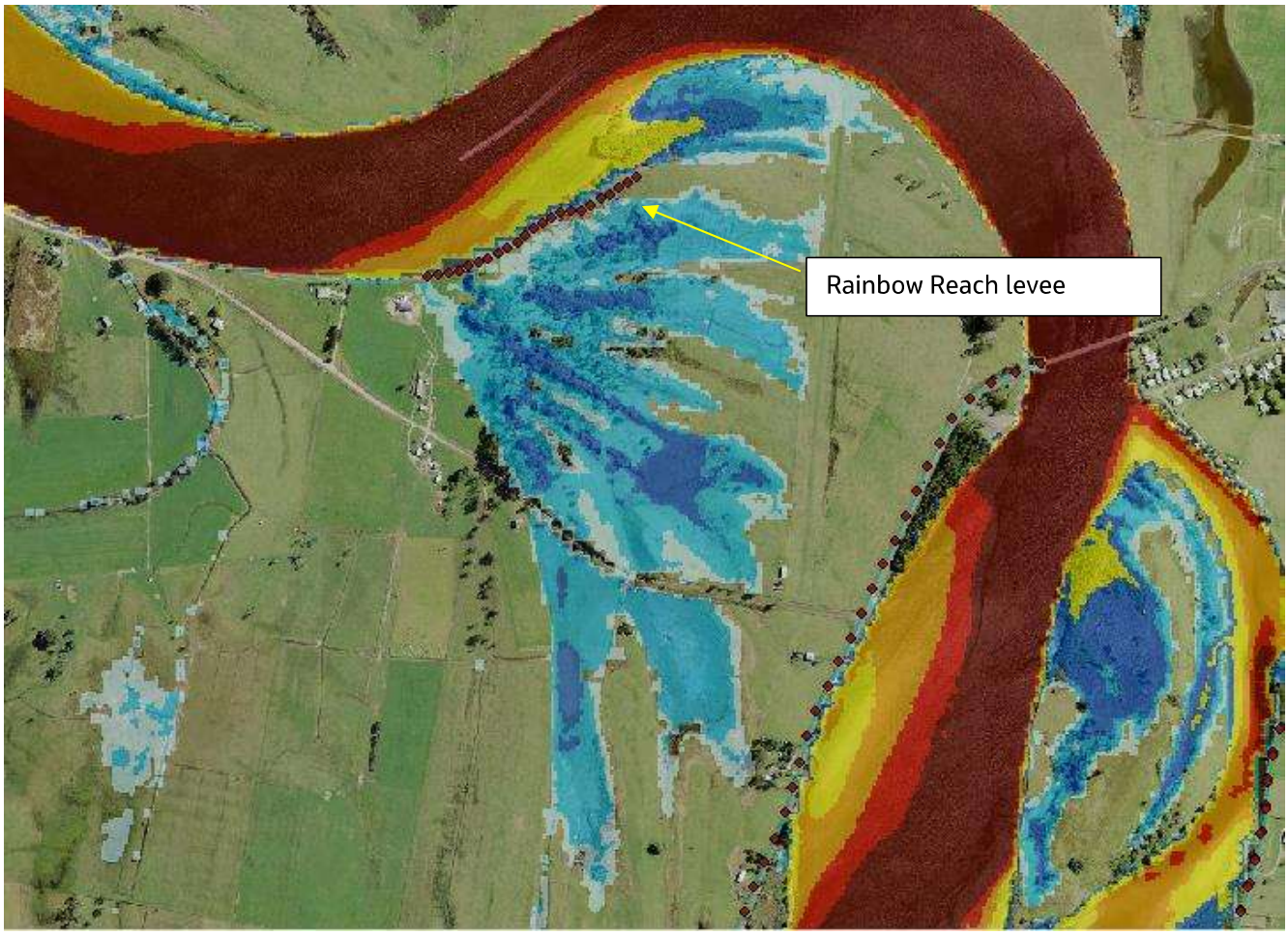
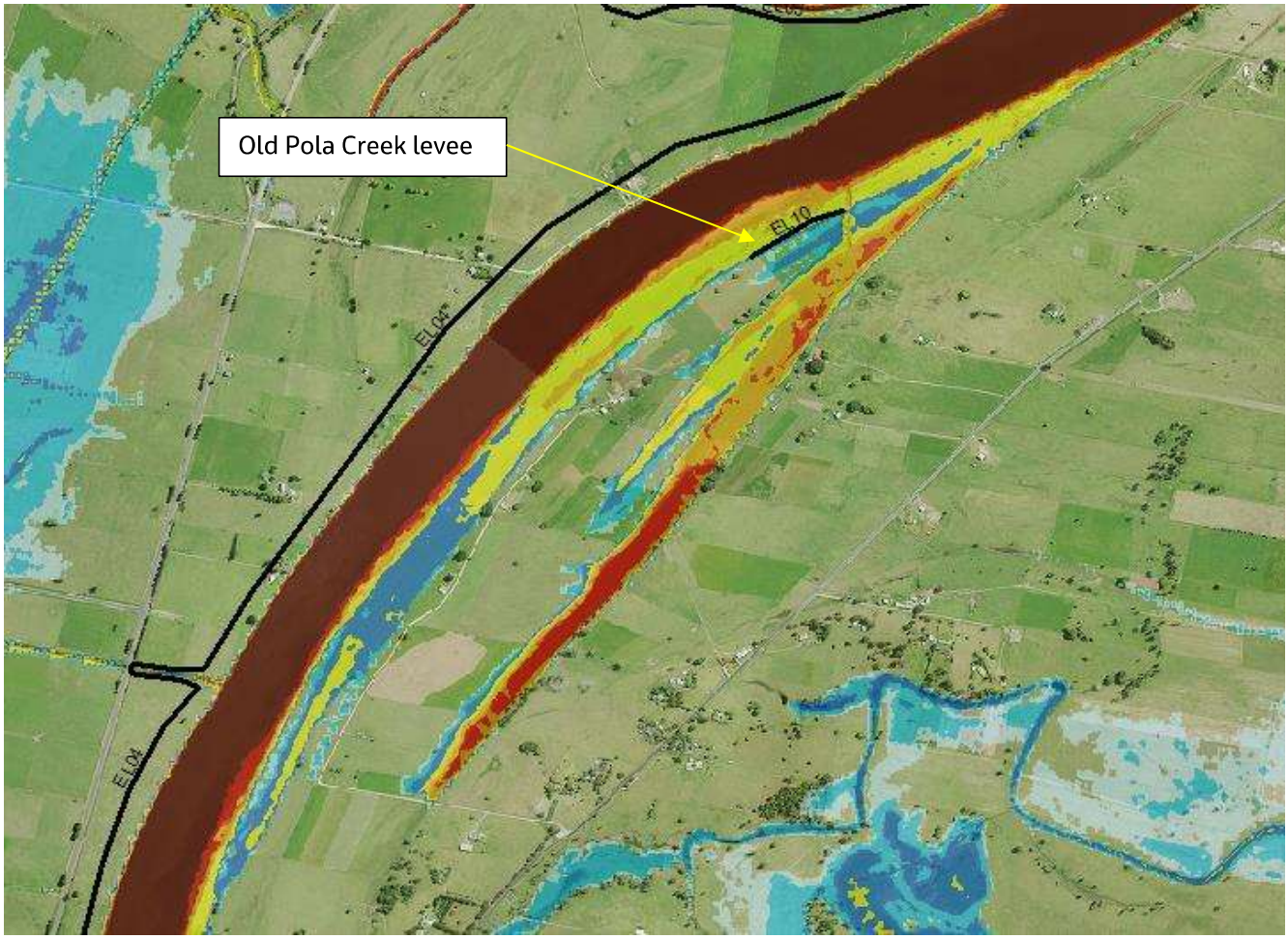


Figure 8-9: Overtopping of Old Pola Creek levee in 50% AEP event



Recommendation

Assessment of raising of Rainbow Reach levee to above the 50% AEP flood is considered a low to medium priority due to the relatively small area of pasture affected. However, the 1997 Floodplain Management Study (Webb McKeown & Associates, 1997) identified that landowners in this area at the time felt that they were not being treated fairly by the Flood Mitigation Scheme. The levee would need to be raised to not overtop by 0.2m in the 50% AEP event, without freeboard. Minor extension may be necessary. The levee would be outflanked and flooding would also occur due to other sources in the 20% AEP event.

Assessment of raising the existing length of Old Pola Creek levee to above the 50% AEP flood is considered a low priority due significant outflanking of the levee to the east. Extension of the levee could be considered as an option.

Assessment of raising the remaining levees to the design crest level could be undertaken as a medium to high priority, in line with the levee audit reports recommendations to investigate and undertake remediation of the levees. The height of raising the levees above existing levels to design level varies. There are sections along Frederickton to Smithtown requiring up to 0.5m raising. The levees at design level would likely still overtop in the 20% AEP event, so the benefits may be difficult to quantify.

8.2.15 Removal of Clybucca headworks

Discussion

The potential environmental works option of removing the Clybucca headworks has previously been discussed with Council. The works would have the objective of re-establishing the salt marsh wetland system in Clybucca. Complete removal of the headworks structure (rather than just the floodgate flaps) may result in minor improvement in drainage capacity and durations of inundation for areas upstream of the headworks.

Recommendation

The effect of these works on flooding could be assessed as a low to medium priority. These effects might be assessed in the separate hydraulics studies to be undertaken for the environmental project.

8.3 Options excluded from this assessment

The following options were previously assessed as a part of the Kempsey CBD Floodplain Risk Management Study (WMAwater, 2017). It is proposed not to reassess these options as a part of this study.

- Raise South West Rocks Road, Red Hill Ln to Austral Eden. It is understood that modelling assessment of raising the road by up to 300mm was previously undertaken for Council.
- South Kempsey Levee
- West Kempsey – Gladstone Street floodgate
- Kempsey – raise/repair levees. Raise Belgrade Street.