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Park Beach Floodplain Management Options Assessment

Final Report

May 2018

Coffs Harbour City Council

Park Beach Floodplain Management Options Assessment

Prepared for:	Coffs Harbour City Council
Prepared by:	BMT WBM Pty Ltd (Member of the BMT group of companies)

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Synopsis: **Report for the Park Beach Floodplain Management Options Assessment which investigates and presents floodplain management options for Park Beach, Coffs Harbour. The study identifies the existing flooding characteristics and identifies various measures to mitigate the effects of flooding**

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Executive Summary

The Coffs Creek and Park Beach Flood Study was prepared for Coffs Harbour City Council (Council) by BMT WBM in 2017. The study defined the existing flood behaviour in the Coffs Creek catchment, including the suburb of Park Beach.

This study utilises the modelling developed for the Flood Study to assess potential floodplain management options for reducing flood risk within Park Beach. Further detail regarding the history of flooding, model development and existing flood risk for the Coffs Creek catchment (including Park Beach) is provided within the Coffs Creek and Park Beach Flood Study.

A flood damages assessment for Park Beach is presented in Section 2 and calculated that under existing catchment conditions the annual average damage (AAD) of flooding in Park Beach costs around $211,600.

A number of potential floodplain management options were initially assessed, including upgrade to a number of existing alignments and/or the provision of new alignments. The performance of each option was assessed in isolation and in various combinations. From the preliminary assessment, four management options to mitigate flooding and the associated cost in Park Beach were considered in detail. Table 1 summarises the estimated reduction in AADs, the capital cost of implementing the flood mitigation works and the benefit cost ratio (BCR) calculated by adopting a discount rate of 4%, 7% and 11% over a 50 year life span.

Due to the Park Beach area flooding under a range of short and long storm durations, it is likely that the standard approach to estimating flood damages may under-estimate the average annual cost of flood damages, as locations are typically only impacted by a limited range of shorter or longer durations. The reduction in AADs (and therefore BCRs) for each of the options considered in this study are likely an under-estimation. However, it is difficult to quantify to what extent this under-estimation occurs. However, when comparing the relative performance of options, the Macauleys Headland and northern railway culvert upgrades are more cost-effective than the York Street Oval and Hogbin Drive options.

Table 1 Summary of Floodplain Management Options

Option	Reduction in AADs	Cost Estimate	BCR		
			7%	11%	4%
Macauleys Headland outlet upgrade (RCPs)	$60,400	$5.2M	0.16	0.10	0.25
Railway culvert upgrade (north location)	$12,100	$800K	0.22	0.14	0.34
York Street Oval outlet	$19,500	$3.8M	0.07	0.05	0.11
Railway culvert upgrade (south location), Hogbin Drive culvert upgrade and channel works	$7,400	$1.0M	0.10	0.07	0.16

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1 Introduction

The Coffs Creek and Park Beach Flood Study was prepared for Coffs Harbour City Council (Council) by BMT WBM in 2017. The study defined the existing flood behaviour in the Coffs Creek catchment, including the suburb of Park Beach.

The primary objective of the flood study was to define the flood behaviour within Coffs Harbour through the establishment of appropriate numerical models. The study produced information on flood flows, velocities, levels and extents for a range of flood event magnitudes under existing catchment and floodplain conditions.

This study utilises the modelling developed for the Flood Study to assess potential floodplain management options for reducing flood risk within Park Beach. Further detail regarding the history of flooding, model development and existing flood risk for the Coffs Creek catchment (including Park Beach) is provided within the Coffs Creek and Park Beach Flood Study.

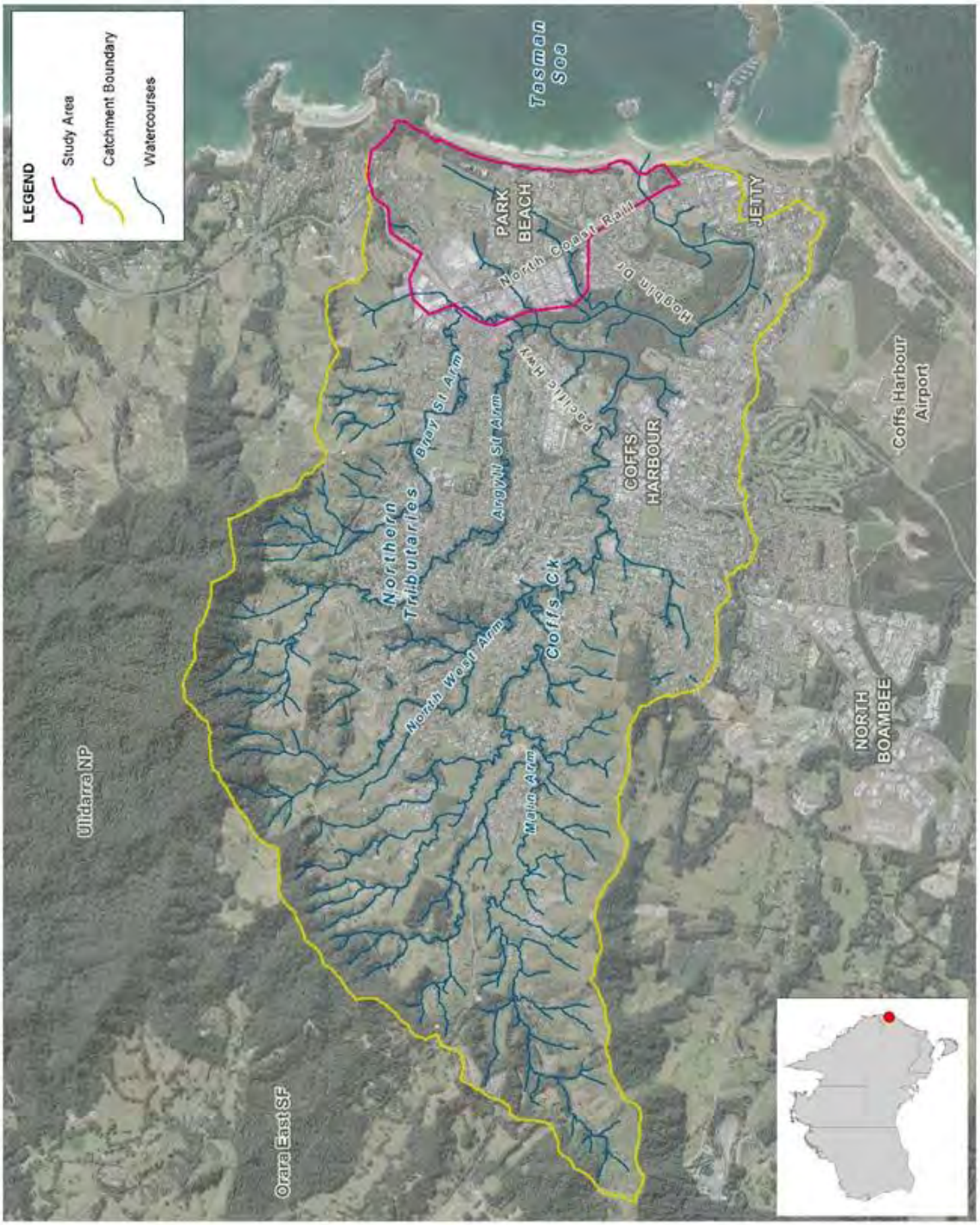
The Draft Park Beach Floodplain Management Options Assessment was placed on public exhibition from 28th February to 30th March 2018. The exhibition sought public comments and feedback on the study. No comments were received during the public exhibition period.

1.1 Study Location

Coffs Harbour is situated on the NSW mid-north coast around 430 km north of Sydney and 320 km south of Brisbane. Typical of catchments in the region, the Coffs Creek catchment is bounded by mountainous ranges to the west with a narrow floodplain area extends some 70 km along the coast. The Coffs Creek catchment drains an area of around 25 km^2 into the Tasman Sea.

Most of the Coffs Harbour city is located within the catchment of Coffs Creek as shown in Figure 1-1. Coffs Creek consists of many branching streamlines and can be divided into three sections; Coffs Creek, including the main arm and minor tributaries to the north west; the Northern Tributaries of Coffs Creek, running adjacent to Bray Street and Argyll Street; and the area located east of the railway line, draining the low-lying areas of Park Beach.

This study will focus on floodplain risk management options for the suburb of Park Beach, as identified on Figure 1-1. The Park Beach study area is around 2.25 km^2 and is bound by Park Beach to the east, the North Coast Rail to the west and the Macauleys Headland ridgeline to the north.



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Study Locality

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2 Flood Damages Assessment

2.1 Types of Flood Damage

The definitions and methodology used in estimating flood damage are summarised in the Floodplain Development Manual. Figure 2-1 summarises the “types” of flood damages as considered in this study. The two main categories are 'tangible' and 'intangible' damages. Tangible flood damages are those that can be more readily evaluated in monetary terms, while intangible damages relate to the social cost of flooding and therefore are much more difficult to quantify.

Tangible flood damages are further divided into direct and indirect damages. Direct flood damages relate to the loss, or loss in value, of an object or a piece of property caused by direct contact with floodwaters. Indirect flood damages relate to loss in production or revenue, loss of wages, additional accommodation and living expenses, and any extra outlays that occur because of the flood.

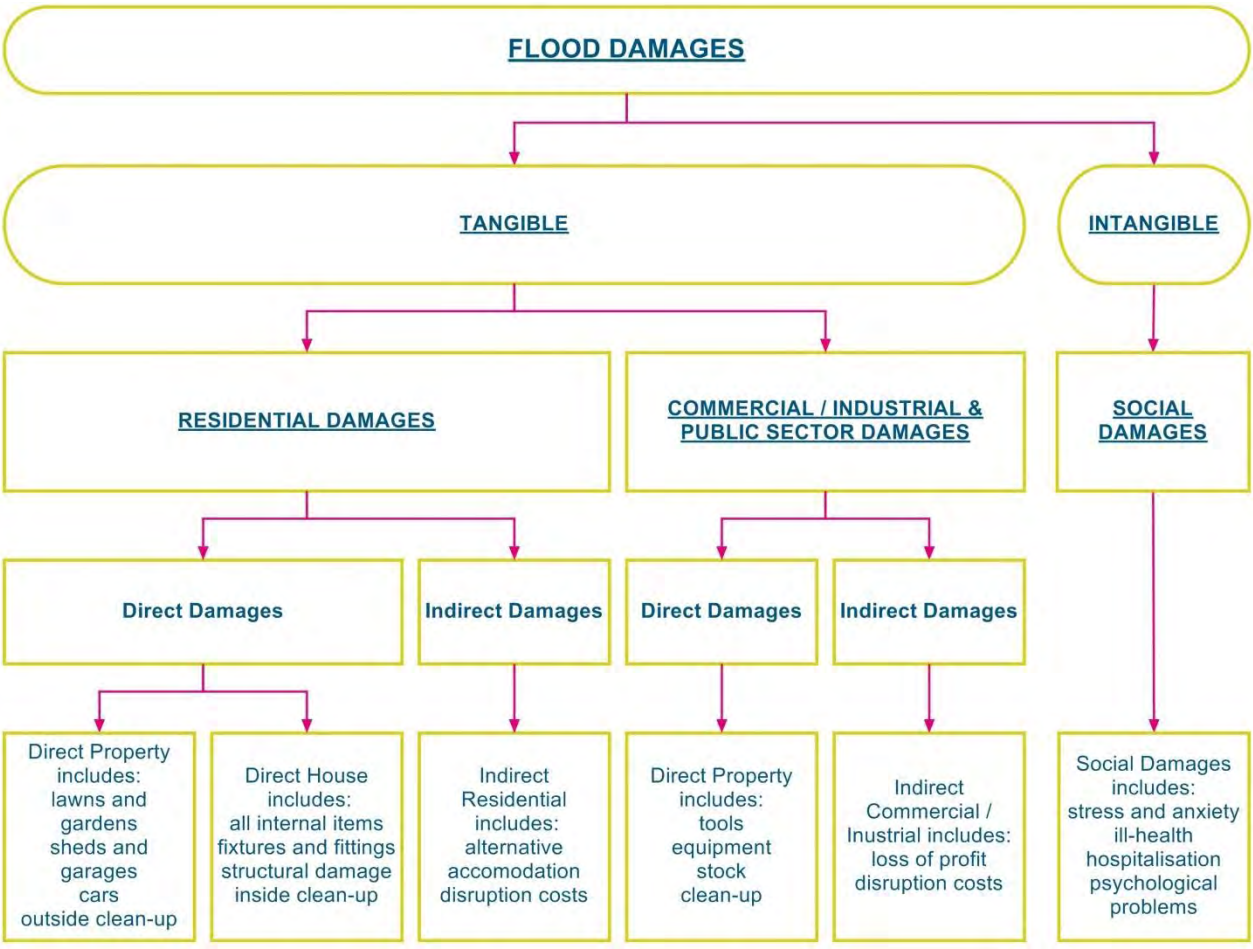


Figure 2-1 Types of Flood Damage

2.2 Basis of Flood Damage Calculations

Flood damages have been calculated using the data base of potentially flood affected properties and a number of stage-damage curves derived for different types of property within the catchment.

These curves relate the amount of flood damage that would potentially occur at different depths of inundation, for a particular property type. Residential damage curves are based on the OEH guideline stage-damage curves for residential property.

Different stage-damage curves for direct property damage have been derived for:

- Residential dwellings (categorised into small, typical or raised categories);
- Caravan Park dwellings (at half the value of the residential dwellings); and
- Commercial premises (categorised into low, medium or high damage categories).

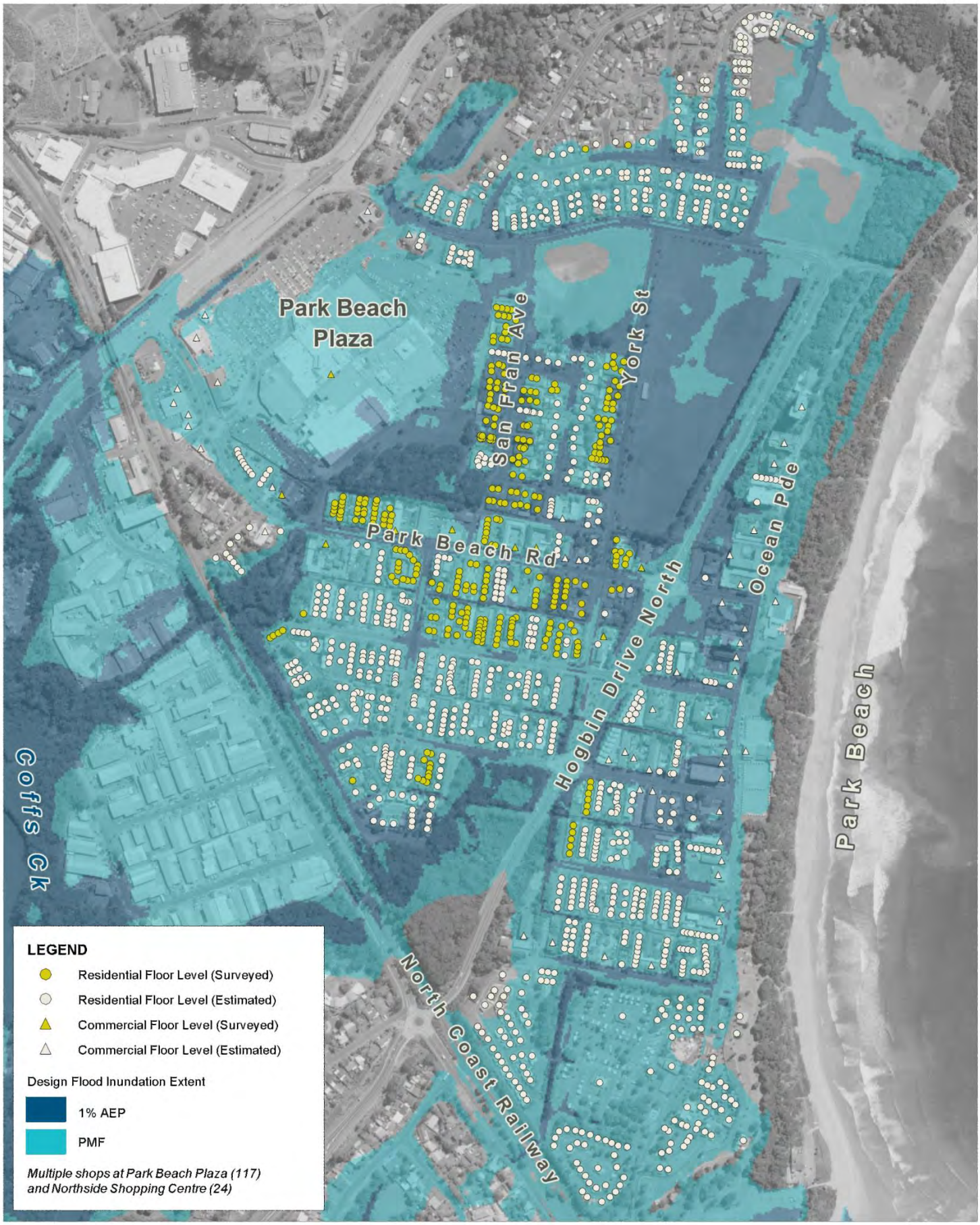
The adopted flood damage curves are included in Appendix A.

A database of flood affected properties has been developed to assess direct damages. Property floor levels have been gathered from previous investigations (Paterson Consultants (1997) and de Groot and Benson (2010)). Properties located within the floodplain but outside of the 1% AEP extent that did not have floor level survey available were estimated from the LiDAR DEM, assuming a floor level 0.25 m above ground. Figure 2.2 shows the property database established for the assessment. The breakdown of surveyed to estimated floor levels, is shown along with residential to commercial properties. Commercial properties were distinguished from residential properties via a visual assessment of aerial photography and Google Street-View.

Apart from the direct damages calculated from the derived stage-damage curves for each flood affected property, other forms of flood damage include:

- Indirect residential, commercial and industrial damages, taken as a percentage of the direct damages;
- Infrastructure damage, based on a percentage of the total value of residential and business flood damage; and
- Intangible damages relate to the social impact of flooding and include:
  - inconvenience,
  - isolation,
  - disruption of family and social activities,
  - anxiety, pain and suffering, trauma,
  - physical ill-health, and
  - psychological ill-health.

The damage estimates derived in this study are for the **tangible damages only**. Whilst intangible losses may be significant, these effects have not been quantified due to difficulties in assigning a meaningful dollar value.



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Park Beach Property Database

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2.3 Tangible Flood Damages

2.3.1 Assessment of Direct Damages

The peak depth of flooding was determined at each property for the 5%, 2%, 1%, 0.5% and 0.2% AEP events and the PMF. The associated direct flood damage cost to each property was subsequently estimated from the stage-damage relationships. For residential properties the flood damage curves include external damages incurred below floor level. For external damages where the flood depth is below floor level, a nominal $1,000 value has been adopted. Total damages for each flood event were determined by summing the predicted damages for each individual property.

The Average Annual Damage (AAD) is the average damage in dollars per year that would occur in a designated area from flooding over a very long period of time. In many years there may be no flood damage, in some years there will be minor damage (caused by small, relatively frequent floods) and, in a few years, there will be major flood damage (caused by large, rare flood events). Estimation of the AAD provides a basis for comparing the effectiveness of different floodplain management measures (i.e. the reduction in the AAD).

2.3.2 Estimation of Indirect Damages

The indirect damages are more difficult to determine and would vary for each flood event, particularly with the duration of the flood inundation. Previous studies detailing flood damages from actual events have found that the indirect damages for residential properties are typically in the order of 20% of the direct damages. The indirect damages associated with commercial properties are typically higher and a value of 40% of the calculated direct damages has been adopted.

2.4 Park Beach Flood Damages

2.4.1 Residential Flood Damages

The assessment of the residential flood damages is presented in Table 2-1. From this data the AAD for residential properties was calculated as being $160,300 in direct damages and $32,100 in indirect damages, giving a total value of $192,400 for all affected residential properties.

Table 2-1 Summary of Residential Flood Damages

Design Event	Properties Flooded Above Floor	Direct Damages ($)	Indirect Damages ($)	Total Damages ($)
5% AEP	12	422,100	84,400	506,500
2% AEP	18	628,300	125,700	754,000
1% AEP	33	1,324,600	264,900	1,589,500
0.5% AEP	71	2,893,200	578,600	3,471,800
0.2% AEP	151	6,074,000	1,214,800	7,288,800
PMF	1,123	73,481,900	14,696,400	88,178,300
AAD	**-**	**160,300**	**32,100**	**192,400**

2.4.2 Caravan Park Flood Damages

The flood damages associated with the caravan park have used the residential flood damage curves with a factor of 0.5 applied to the damage value. The assessment of the caravan park flood damages is presented in Table 2-2. From this data the AAD for caravan park properties was calculated as being $3,100 in direct damages and $600 in indirect damages, giving a total value of $3,700 for all affected caravan park properties.

Table 2-2 Summary of Caravan Park Flood Damages

Design Event	Properties Flooded Above Floor	Direct Damages ($)	Indirect Damages ($)	Total Damages ($)
5% AEP	0	-	-	-
2% AEP	0	-	-	-
1% AEP	0	-	-	-
0.5% AEP	0	-	-	-
0.2% AEP	0	-	-	-
PMF	118	3,143,700	628,700	3,772,500
AAD	**-**	**3,100**	**600**	**3,700**

2.4.3 Commercial Flood Damages

The assessment of the commercial flood damages is presented in Table 2-3. From this data the AAD for commercial properties was calculated as being $22,400 in direct damages and $9,000 in indirect damages, giving a total value of $31,400 for all affected commercial properties.

Table 2-3 Summary of Commercial Flood Damages

Design Event	Properties Flooded Above Floor	Direct Damages ($)	Indirect Damages ($)	Total Damages ($)
5% AEP	0	-	-	-
2% AEP	3	24,900	10,000	34,900
1% AEP	7	87,000	34,800	121,800
0.5% AEP	8	172,200	68,900	241,100
0.2% AEP	15	263,700	105,500	369,200
PMF	192	20,033,100	8,013,200	28,046,300
AAD	**-**	**22,400**	**9,000**	**31,400**

2.4.4 Infrastructure and Public Utilities Damages

Public utilities include roads, railways, parklands and underground water, sewerage, power and telephone services and installations. The damages sustained by public utilities comprise the replacement or repair of assets damaged by floodwaters, the cost of clean-up of the installations as well as the collection and disposal of clean-up material from private property.

For the purposes of this study an estimate of the damage cost of $12,000 per hectare has been adopted, as was adopted in the Woolgoolga Floodplain Risk Management Study and Plan (BMT WBM, 2016). The assessment of public utilities damages is presented in Table 2-4. From this data the AAD for public utilities was calculated as being $4,300.

Table 2-4 Summary of Public Utilities Flood Damages

Design Event	Area of Urban Area Flooded (ha)	Total Damages ($)
5% AEP	2.4	28,800
2% AEP	3.2	38,400
1% AEP	4.0	48,000
0.5% AEP	4.9	58,800
0.2% AEP	6.1	73,200
PMF	15.2	182,400
AAD	**-**	**4,300**

2.4.5 Total Tangible Flood Damages

The total tangible flood damages for residential, caravan park and commercial properties and the damage to public utilities were combined, as presented in Table 2-5. From this data the combined AAD was calculated as being $231,900, comprised as follows:

- $192,400 from residential properties;
- $3,700 from properties within the caravan park;
- $31,400 from commercial properties; and
- $4,300 from public utilities.

Table 2-5 Summary of Total Tangible Flood Damages

Design Event	Residential Flood Damages ($)	Caravan Park Flood Damages ($)	Commercial Flood Damages ($)	Public Utilities Flood Damages ($)	Total Tangible Flood Damages ($)
20% AEP	506,500	-	-	28,800	535,300
5% AEP	754,000	-	34,900	38,400	827,200
2% AEP	1,589,500	-	121,800	48,000	1,759,300
1% AEP	3,471,800	-	241,100	58,800	3,771,700
0.2% AEP	7,288,800	-	369,200	73,200	7,731,200
PMF	88,178,300	3,772,500	28,046,300	182,400	120,179,500
AAD	**192,400**	**3,700**	**31,400**	**4,300**	**231,900**

3 Floodplain Management Options Assessment

All of the flood floodplain management options considered include improvements to existing stormwater drainage and involve increasing the capacity of the stormwater pipe network to convey flood flows – reducing the amount of overland flooding. The most effective way to achieve this is to increase the size and/or number of stormwater pipes along the affected alignments. However, this is achieved through significant capital cost and there is also the residual risk associated with stormwater pipe and/or inlet blockages that can reduce the effective capacity of the network during a flood event.

A number of potential floodplain management options were initially assessed, including upgrade to a number of existing alignments and/or the provision of new alignments. The performance of each option was assessed in isolation and in various combinations. Table 3-1 summarises the various options considered.

Table 3-1 Summary of Preliminary Floodplain Management Options Assessment

Option		Details of Preliminary Assessment
1	Railway culvert upgrade (north location)	Increase existing culvert capacity by a factor of four.
2	Railway culvert upgrade (south location)	Increase existing culvert capacity by a factor of four.
3	Combination of 2, with Hogbin Drive culvert upgrade and channel works	Hogbin Drive existing culvert capacity increased by a factor of two, with channel cleared and excavated.
4	York Street alignment	New/upgraded pipe alignment (twin 1.2 m RCP) initiated at York Street.
5	Combination of 1 and 4	-
6	Combination of 1, 2 and 4	-
7	Variation of 4 - York Street alignment linked to inlet at York Street Oval	Extension of twin 1.2 m RCP east to Hogbin Drive and then north to York Street Oval inlet.
8	Combination and 1 and 7	-
9	Combination of 1, 2 and 7	-
10	Macauleys Headland outlet upgrade	Increasing existing outlet drainage capacity by a factor of two and provision of additional drainage) along Arthur Street (twin 1.2 m RCP) and to an inlet at York Street Oval.
11	Combination of 1 and 10	-
12	Fitzgerald Street alignment	New pipe alignment (twin 0.9 m RCP) located east of Hogbin Drive draining south of caravan park.

Based on the results of the preliminary assessment, four options were identified that provided a significant reduction in flood inundation to warrant further investigation. These options are:

- Macauleys Headland outlet upgrade;
- Railway culvert upgrade (north location);
- York Street Oval outlet; and

- Railway culvert upgrade (south location), Hogbin Drive culvert upgrade and channel works.

This section details the preliminary design (optimising the size and configuration of drainage alignments), performance and economic viability of the four floodplain management options selected for detailed investigation.

The flood damages assessment completed for each of the management options follows the same methodology as detailed in Section 2. Where surveyed property flood levels were not available, they have been estimated. Due to the nature of flooding in Park Beach and the magnitude of flood mitigation offered by the options considered (e.g. a 0.2 m reduction in peak flood level over a large storage area), the damage estimates will be influenced by the assumed floor levels. As such, the damage estimates presented in this report are estimates only to allow for a relative benefit of each option to be compared.

3.1 Macauleys Headland outlet upgrade

This option involves increasing the capacity of the stormwater drainage outlet at Macauleys Headland. Combined with an additional drainage alignments from Arthur Street and the York Street Oval, the purpose of this is redirect a significant volume of floodwater currently stored within the York Street Oval to the north of the Park Beach catchment to discharge onto Park Beach rather than being discharge into Coffs Creek under the railway.

Preliminary Design

In order to re-direct flood flow to the Macauleys Headland outlet, two additional drainage alignments were included:

- Arthur Street alignment – single 1.2 m diameter pipe running west to east toward the York Street Oval; and
- York Street Oval alignment – twin 2.1 m x 1.2 m (W x H) box culvert aligned north to south adjacent to the York Street road reserve.

Both additional alignments intersect at the corner of York Street and Arthur Street, and then drain to the existing junction pit at the Headland via the Arthur Street and Richmond Drive. At the junction pit, the existing twin 1.2 m diameter outlet pipe is to be replaced with a triple 2.1 m x 1.2 m (W x H) box culvert. A concept drawing of the proposed works is contained in Appendix B.

The drainage design provided in the report is conceptual only. Optimised design and costing would be completed within future design stages if this option was selected to be implemented by Council.

Performance

The TUFLOW model was simulated with the drainage works / upgrades incorporated for the range of design flood events considered. In refining the preliminary concept design, the performance of a range of pipe sizes was considered.

The peak flow and total volume of flow through various drainage alignments in Park Beach is summarised in Table 3-2 for a number of potential outlet configurations. The location of each reported pipe flow is shown on Figure 3-1.

Table 3-2 Performance of Various Macauleys Outlet Configurations (1% AEP 9-hour)

Drainage Location	Macauleys Outlet Configuration			
	2 x 1.2 RCP (Existing)	4 x 1.2 RCP	6 x 1.2 RCP	3 x 2.1x1.2 RCBC
	Peak Flow (m^3/s)			
Plaza	0.6	0.5	0.5	0.5
York Street	0.7	0.8	0.8	0.8
Macauleys	4.4	7.4	9.3	9.8
	Total Volume (ML) *within simulated time period*			
Plaza	13.4	4.5	1.6	1.0
York Street	20.6	21.5	21.6	21.6
Macauleys	61.9	124	144	147
Total (all above)	95.9	150	167	169
	Flow Split			
Plaza	14%	3%	1%	1%
York Street	21%	14%	13%	13%
Macauleys	65%	83%	86%	87%

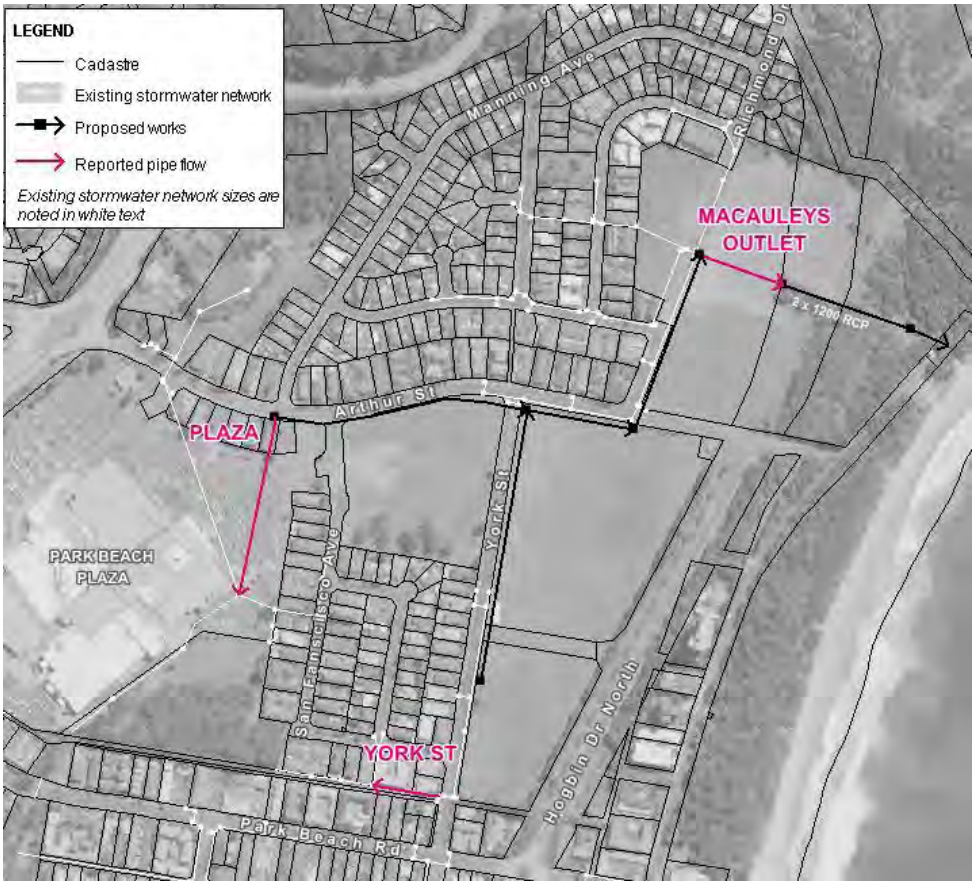


Figure 3-1 Macauleys Headland Outlet Reported Pipe Flow Locations

The major flooding issue in Park Beach is the inability of floodwaters to drain from the low-lying areas around York Street and San Francisco Road. The provision of an additional outlet in the York Street Oval along with increased capacity at the Macauleys Headland Outlet results in a significant re-distribution of flow and an increased ability to drain floodwater from the area. With reference to Table 3-2, it can be seen that for the existing scenario around 65% of the total flow conveyed through the pipe networks assessed is serviced by Macauleys outlet. Under the recommended upgrade scenario, this increases to over 85%.

The peak flow through the “Plaza” and “York Street” alignments does not markedly change for all scenarios considered, indicating that these alignments are flowing at capacity and are not being under-utilised in the proposed upgrade scenarios.

Simulation of either the 6 x 1.2 m RCP or 3 x 2.1 x 1.2 RCBC outlet configuration gave similar results in terms of reduction in peak flood levels. Flood issues in the following locations were addressed for events up to and including the 0.2% AEP design event:

- York Street Oval / Columbus Circuit / southern end of San Francisco Avenue;
- the eastern end of Park Beach Road (located west of Hogbin Drive North); and
- the stretch of Park Beach Road between Ocean Parade and Hogbin Drive North.

The peak flood level reduction at the 1% AEP event as a result of incorporating the Macualeys Headland outlet upgrades into the TUFLOW model is presented in Figure 3-2. It can be seen that across most of the impacted area the peak flood levels reduce by around 0.15 - 0.20 m and the area of inundation is significantly reduced. Peak flood level impact maps for the range of design events simulated can be found in Appendix C.

A summary of the annual average damages in Park Beach as a result of this work, including the total reduction in flood damages, is presented in Table 3-3.

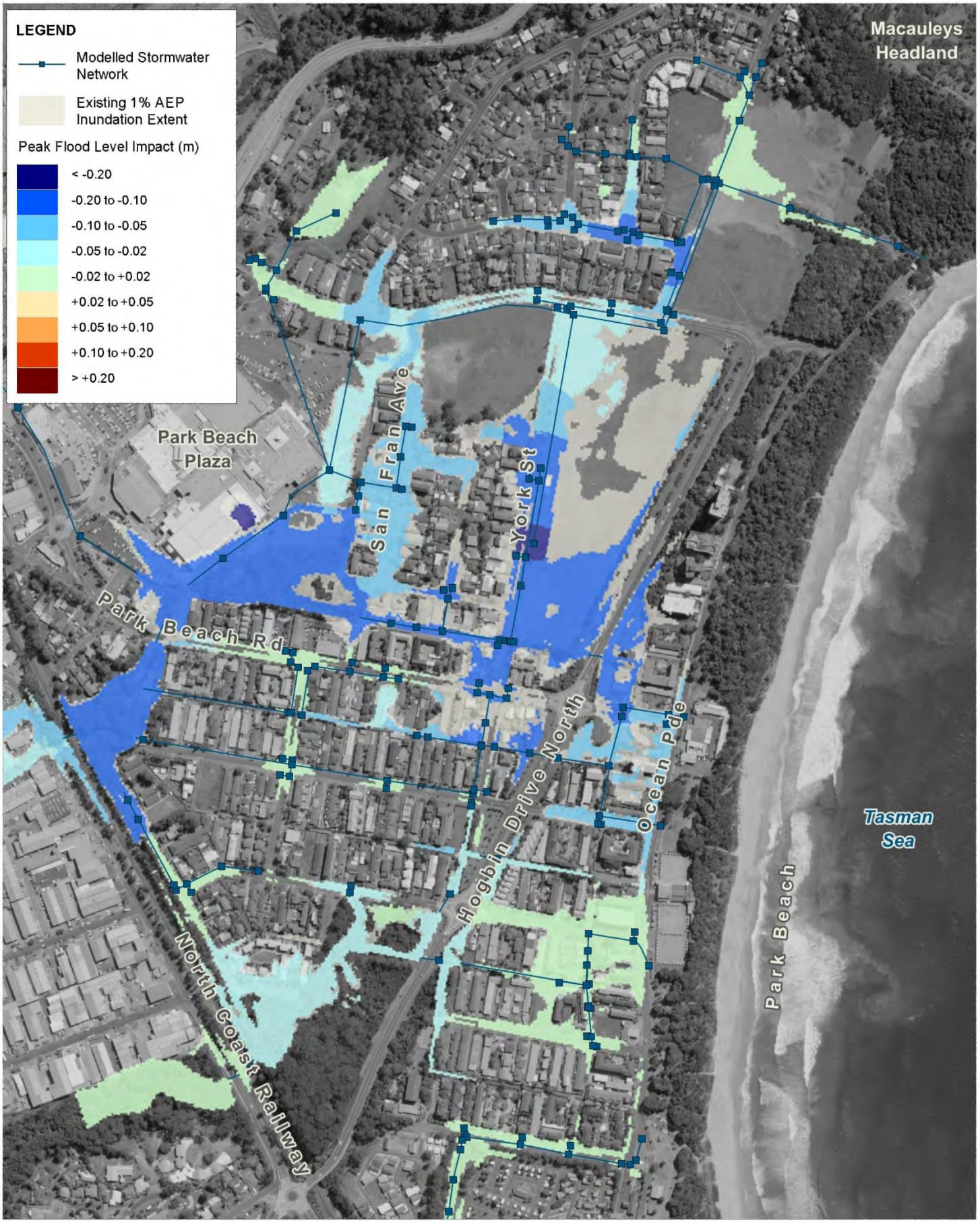
Economic Viability

The cost estimate for this option is in the order of $7.8M. This high cost is largely attributed to the length of reinforced concrete box culverts required. As box culverts are more expensive than pipes, an alternate option was costed where equivalent pipes were assumed which also allowed the existing twin 1.2 m diameter pipes at the outlet to be maintained.

For the pipe option, the York Street Oval alignment (twin 2.1 m x 1.2 m (W x H) box culvert) was replaced with four 1.2 m diameter pipes and the Macauleys Headland outlet (triple 2.1 m x 1.2 m (W x H) box culvert) replaced with six 1.2 m diameter pipes. The cost estimate for this version of the Macauleys Headland outlet upgrade is slightly lower, in the order of $5.2M.

The estimates are for construction only and do not include traffic management, dewatering, service relocation or acid sulfate soil management (if required). Cost estimates are provided in Appendix D.

When assessing the performance of the scheme over a standard 50-year life span, the reduction in damages must be reduced to a net present day value. When adopting a discount rate of 7% this gives a benefit-cost ratio (BCR) of 0.11, or between 0.07 and 0.17 when adopting a discount rate of 11% or 4% respectively. If considering the reinforced concrete pipe option, the BCR increases to 0.16 (discount rate of 7%), or between 0.11 (11%) and 0.25 (4%).



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Macauleys Headland Outlet Upgrade
1% AEP Peak Flood Level Impact

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Table 3-3 Annual Average Damages for Macauleys Headland Outlet Upgrade

Property Type	AAD ($)
Residential	134,200
Caravan Park	3,800
Commercial	29,500
Public Utilities	3,200
Total	**170,600**
Total Reduction in AAD (Baseline – Option)	61,300

The total reduction in AADs for this option of $61,300 is significant, however the high cost of construction results in an unfavourable BCR. It is noted that costs for this option could be reduced if tied in with future possible residential development (if any) of effected land by property owners, which could improve the economic viability of implementing such drainage works.

3.2 Railway culvert upgrade (north location)

A large proportion of floodwater in Park Beach is discharged into Coffs Creek via the Park Beach Plaza tributary. The merit of increasing the capacity of the railway embankment culvert is assessed in this option.

Preliminary Design

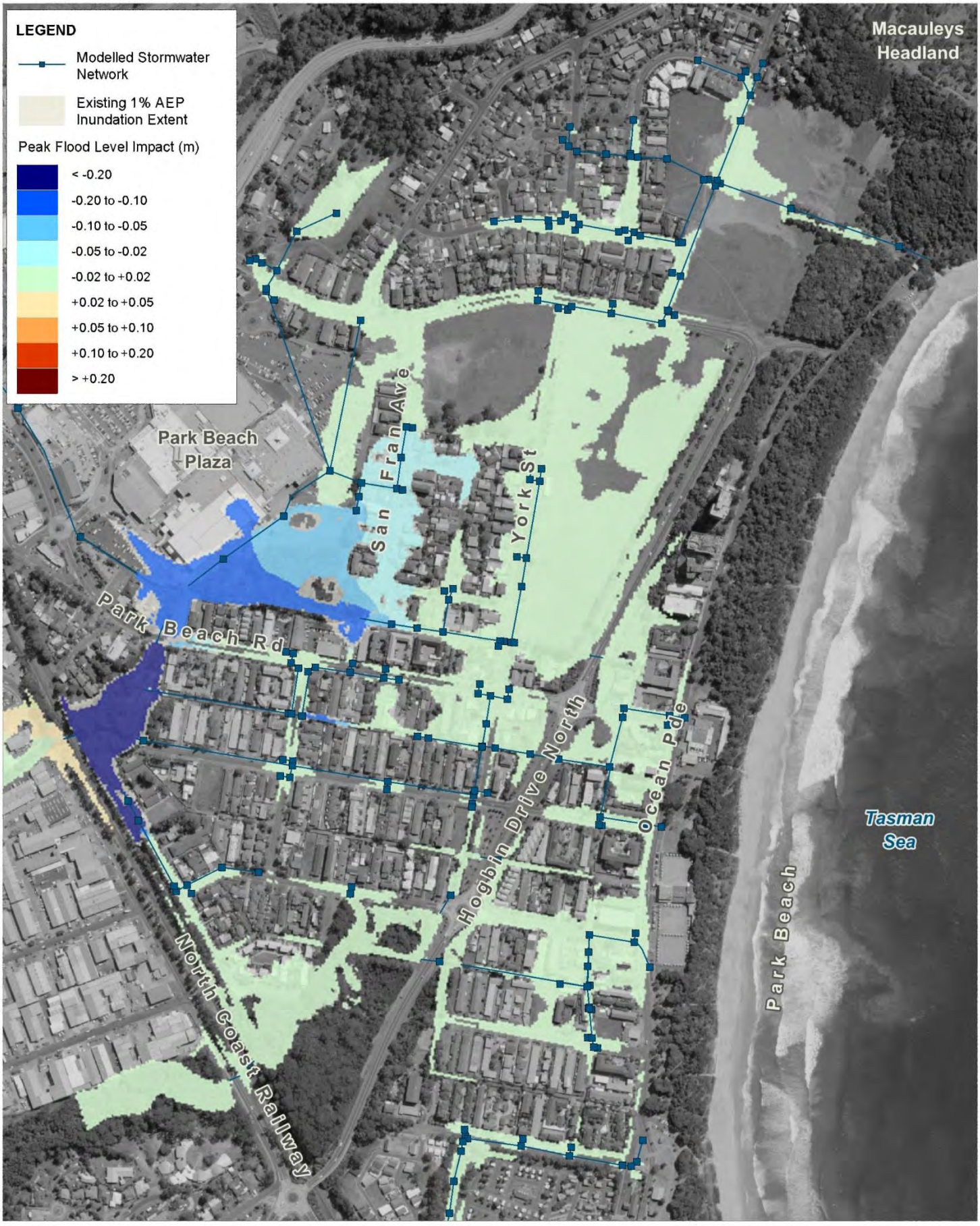
The existing single 3 m x 2.7 m (W x H) box culvert located on the Park Beach Plaza tributary of the North Coast railway will be supplemented with an additional twin box culvert of the same size. A concept drawing is contained in Appendix B.

Performance

Within the TUFLOW model, the existing culvert was replaced with a triple 3 m x 2.7 m (W x H) box culvert and the full range of design flood events were simulated. The results show that the additional flow conveyance under the railway embankment at this location is affective at reducing the peak flood levels upstream. For the 1 % AEP design flood event, a reduction in peak flood levels is modelled to extend from the railway to San Francisco Avenue, as presented in Figure 3-3. Peak flood level impact maps for the range of design events simulated can be found in Appendix C.

For the existing condition simulation, the model results indicate that the Orlando Street roadway becomes inundated with almost 0.3 m of floodwater during the 1% AEP event. With reference to Figure 3-3, there is a minor increase in peak flood levels downstream of the railway line as a result of increasing the capacity of the northern railway culvert. The modelled impact is in the order of 0.02 to 0.04 m and does not alter the extent of inundation for this event.

The peak flood conditions in Coffs Creek are not likely to be increased due to the difference in the relative timings and magnitude of the catchment flood response. The local Park Beach catchment is much smaller in comparison to the wider Coffs Creek catchment and therefore flows are largely discharged before the main Coffs Creek flood wave arrives.



Title:

Railway Culvert (North Location) Upgrade
1% AEP Peak Flood Level Impact

Figure: **3-2**

Rev: **A**

N

0 125 250m

Approx. Scale

BMT WBM

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A summary of the annual average damages in Park Beach as a result of this work, including the total reduction in flood damages, is presented in Table 3-4.

Table 3-4 Annual Average Damages for Railway Culvert Upgrade (North Location)

Property Type	AAD ($)
Residential	181,200
Caravan Park	3,700
Commercial	29,800
Public Utilities	4,100
Total	**219,000**
Total Reduction in AAD (Baseline – Option)	12,900

Economic Viability

The cost estimate for this option is in the order of $800K. The cost of replacing a railway culvert was estimated from rates detailed in the Capital Cost and Delivery Program of the Melbourne-Brisbane Inland Rail Alignment Study (ARTC, 2010), adjusted for inflation to 2017. Cost estimates are provided in Appendix D.

When assessing the performance of the scheme over a standard 50-year life span, the reduction in damages must be reduced to a net present day value. When adopting a discount rate of 7% this gives a benefit-cost ratio (BCR) of 0.23, or between 0.15 and 0.36 when adopting a discount rate of 11% or 4% respectively.

3.3 York Street Oval outlet

This option assesses the merit of supplying an additional stormwater alignment draining the York Street Oval storage area into the Park Beach Plaza tributary. This option aims to address the flood inundation emanating from filling of the York Street Oval storage area.

Preliminary Design

The proposed new alignment is to use a single 2.4 m x 1.2 m box culvert commencing at the south-eastern corner of the oval and running south adjacent to Hogbin Drive north road reserve (under Park Beach Road), before heading west along an un-named laneway off York Street. The stormwater alignment will discharge into the Park Beach Plaza tributary between Park Beach Road and the railway. A concept drawing of the proposed works is contained in Appendix B.

Performance

The proposed stormwater drainage upgrades were included into the TUFLOW model and the range of design flood conditions were simulated. As a result of providing additional conveyance toward the Park Beach Plaza tributary railway culvert, peak flood levels in the vicinity of the York Street Oval, including San Francisco Avenue and Park Beach Road (Ocean Parade end), are reduced. For the 1% AEP design flood event, reductions in the order of 0.05 – 0.10 m were

modelled, as seen in Figure 3-4. Peak flood level impact maps for the range of design events simulated can be found in Appendix C.

A summary of the annual average damages in Park Beach as a result of this work, including the total reduction in flood damages, is presented in Table 3-5.

Economic Viability

The cost estimate for this option is in the order of $3.8M. Cost estimates are provided in Appendix D.

Table 3-5 Annual Average Damages for York Street Oval Outlet

Property Type	AAD ($)
Residential	173,900
Caravan Park	3,700
Commercial	31,100
Public Utilities	3,700
Total	**212,400**
Total Reduction in AAD (Baseline – Option)	19,500

When assessing the performance of the scheme over a standard 50 year life span, the reduction in damages must be reduced to a net present day value. When adopting a discount rate of 7% this gives a benefit-cost ratio (BCR) of 0.07, or between 0.05 and 0.11 when adopting a discount rate of 11% or 4% respectively.

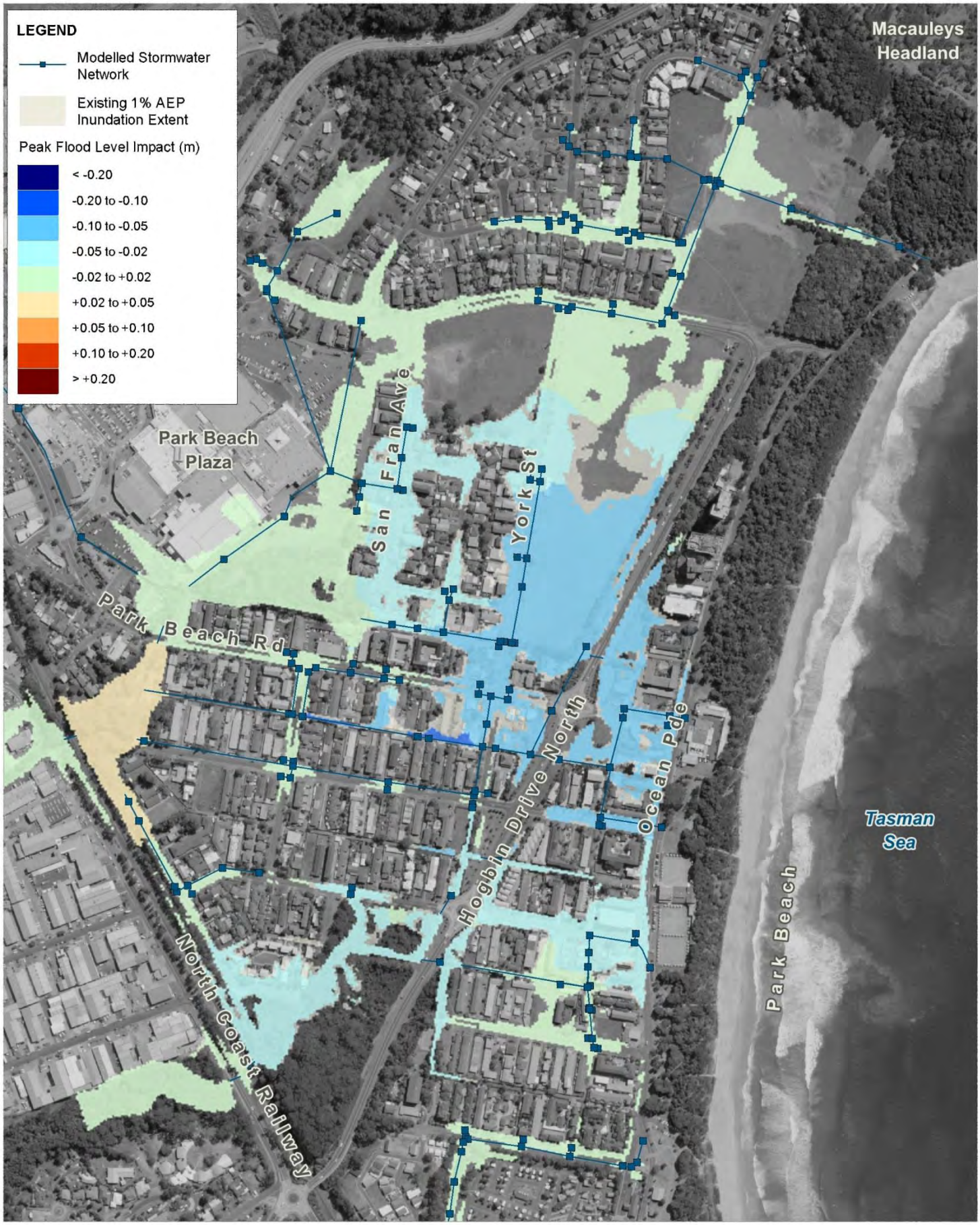
3.4 Railway culvert upgrade (south location), Hogbin Drive culvert upgrade and channel works

The potential to reduce flooding in the vicinity of Prince Street between Hogbin Drive and Ocean Parade is assessed in this option by upgrading Hogbin Drive cross-drainage and the southern railway culvert.

Preliminary Design

The existing single 1.2 m x 0.9 m (W x H) box culvert draining under the North Coast railway located at the southern end of the study area toward Hogbin Drive will be supplemented with an additional twin box culvert of the same size. Downstream of the railway, existing drainage under Orlando Street is provided in the form of a single 1.2 m diameter pipe. This will be increased to a triple 1.2 m diameter pipe.

The merit of increasing these culverts only was assessed, however Hogbin Drive cross-drainage became the limiting factor in any flood mitigation east of Hogbin Drive. As such, the Hogbin Drive culvert capacity will be doubled (increased from triple 1.2 m diameter pipes to a bank of six 1.2 m pipes).



Title:

York St Oval Outlet
1% AEP Peak Flood Level Impact

Figure: 3-3

Rev: A

N

0 125 250m

Approx. Scale

BMT WBM
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Filepath : K:\N20327_Coffs_Creek\MapInfo\Workspaces\Figures\PB_FRMS\DRG_009_171004_PB_1%AEP_Opt11a_001.wor

To improve conveyance downstream of Hogbin Drive, channel works were also incorporated. This involved increasing width of channel to 8 m (from around 4 m), lowering the channel bed by 0.5 m and clearing vegetation. A concept drawing is contained in Appendix B.

Performance

The TUFLOW model was simulated with the drainage upgrades and channel works incorporated for the range of design flood events considered. To simulate clearing the channel from vegetation, the Manning's 'n' value was reduced from 0.12 to 0.08.

This option provides minimal reduction to flood affected properties for the 1% AEP design event with the exception of Prince Street east of Hogbin Drive where flood levels are reduced by 0.05 – 0.10 m and Condon Street, where any inundation is completely removed. The peak flood level impact map for the 1% AEP design event modelled as a result of implementing this option is shown in Figure 3-5. Peak flood level impact maps for the range of design events simulated can be found in Appendix C.

A summary of the annual average damages in Park Beach as a result of this work, including the total reduction in flood damages, is presented in .

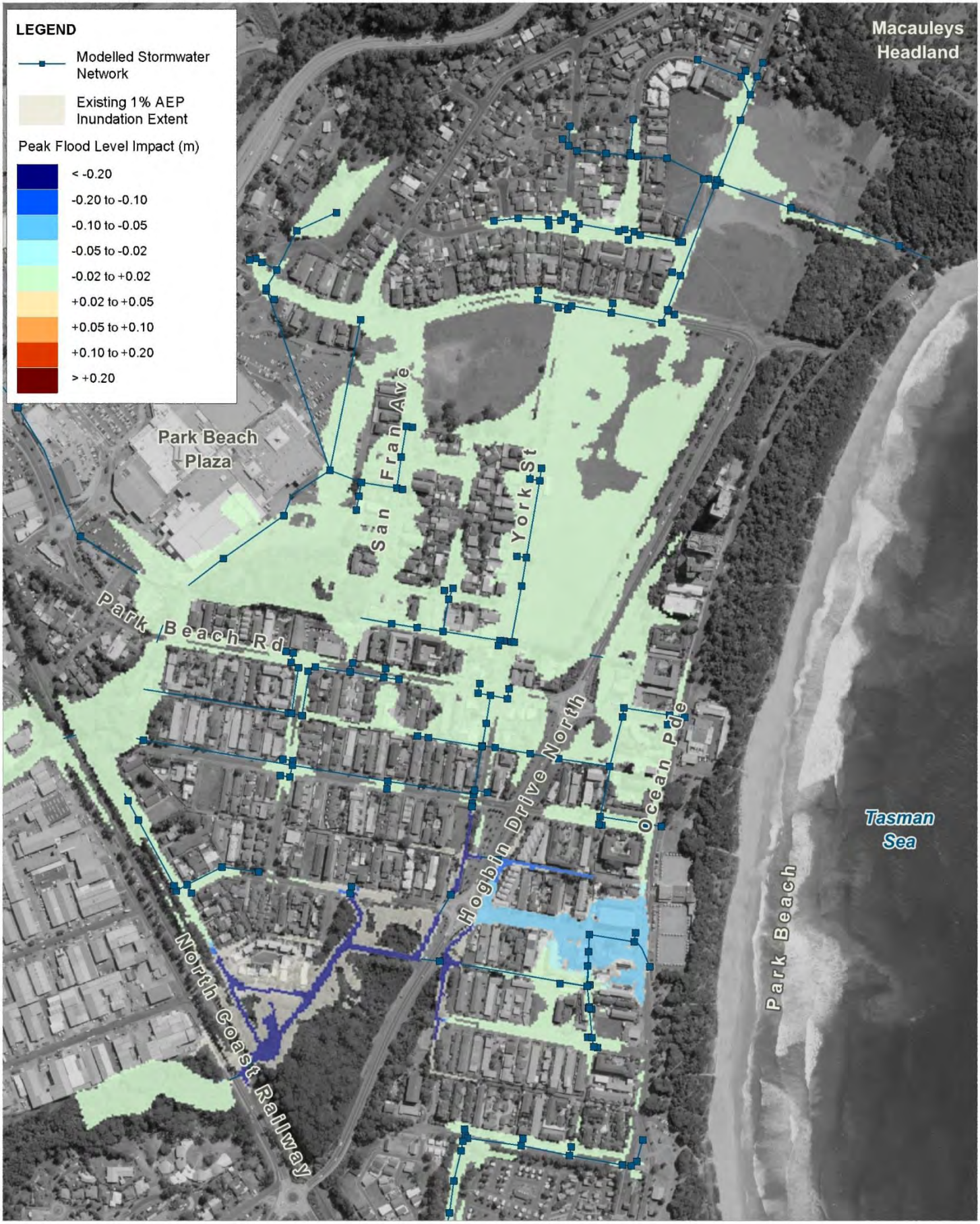
Table 3-6 Annual Average Damages for Railway Culvert Upgrade (South Location), Hogbin Drive Culvert Upgrade and Channel Works

Property Type	AAD ($)
Residential	185,600
Caravan Park	3,700
Commercial	31,000
Public Utilities	4,100
Total	**224,400**
Total Reduction in AAD (Baseline – Option)	7,500

Economic Viability

The cost estimate for this option is in the order of $1.0M. Cost estimates are provided in Appendix D.

When assessing the performance of the scheme over a standard 50 year life span, the reduction in damages must be reduced to a net present day value. When adopting a discount rate of 7% this gives a benefit-cost ratio (BCR) of 0.10, or between 0.07 and 0.16 when adopting a discount rate of 11% or 4% respectively.



Title:

Railway Culvert (South) and Hogbin Drive Culvert Upgrade 1% AEP Peak Flood Level Impact

Figure: 3-4

Rev: A

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0 125 250m

Approx. Scale

BMT WBM

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4 Conclusion

The flood damages assessment completed in Section 2 calculated that under existing catchment conditions the annual average damage (AAD) of flooding in Park Beach costs around $211,600.

Four flood management options to mitigate flooding and the associated cost in Park Beach were considered. Table 4-1 summarises the estimated reduction in AADs, the capital cost of implementing the flood mitigation works and the benefit cost ratio (BCR) calculated by adopting a discount rate of 4%, 7% and 11% over a 50 year life span.

Table 4-1 Summary of Floodplain Management Options

Option	Reduction in AADs	Cost Estimate	BCR		
			7%	11%	4%
Macauleys Headland outlet upgrade (RCPs)	$60,400	$5.2M	0.16	0.11	0.25
Railway culvert upgrade (north location)	$12,100	$800K	0.23	0.15	0.36
York Street Oval outlet	$19,500	$3.8M	0.07	0.05	0.11
Railway culvert upgrade (south location), Hogbin Drive culvert upgrade and channel works	$7,400	$1.0M	0.10	0.07	0.16

It should be noted that for the purposes of design flood estimation a critical storm duration of 9 hours was adopted for Park Beach. However, the extent and depth of flood inundation resulting from both longer and shorter duration design events is not dissimilar to that of the critical duration. Modelled peak flood levels extracted at San Francisco Avenue and York Street oval for a range of design storm durations are presented on Figure 4-1 for the 5% AEP and 1% AEP design flood events. With reference to Figure 4-1, it can be seen that the 9-hour storm results in the critical condition at both locations but all other simulated storm durations in excess of the 2-hour event are within 0.1 m of the peak 9-hour level.

It is therefore likely that the standard approach to estimating flood damages may under-estimate the average annual cost of flood damages, as locations are typically only impacted by a limited range of shorter or longer durations, rather than across the full range. The reduction in AADs (and therefore BCRs) for each of the options considered in this study are likely an under-estimation. It is difficult to quantify to what extent this under-estimation occurs. However, when comparing the relative performance of options, the Macauleys Headland and northern railway culvert upgrades are more cost-effective than the York Street Oval and Hogbin Drive options.

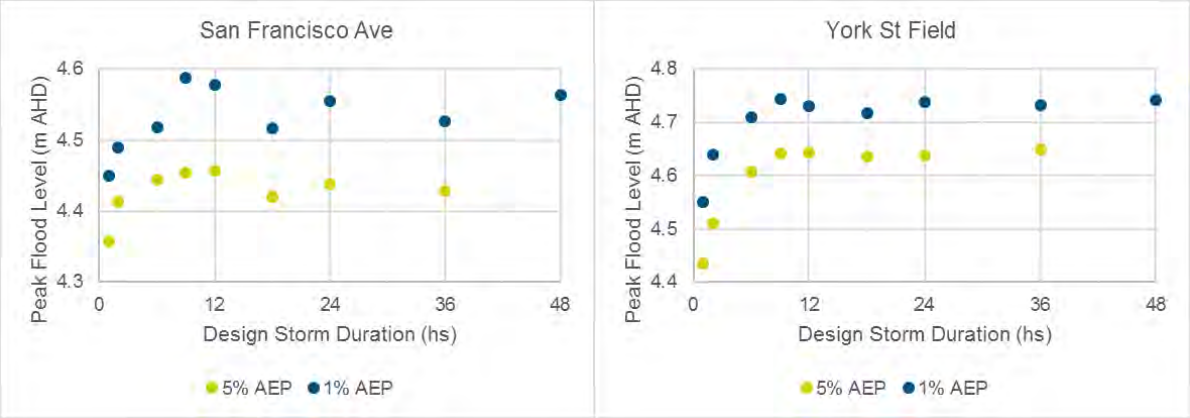

Figure 4-1 Peak Flood Levels in Park Beach for a Range of Design Storm Durations

5 References

ARTC (2010) *Melbourne – Brisbane Inland Rail Alignment Study: Appendix J Capital Cost and Delivery Program.*

Australian Bureau of Statistics (2017, September 13) *6302.0 – Average Weekly Earnings, Australia, May 2017.* Retrieved from http://www.abs.gov.au/ausstats/abs@.nsf/mf/6302.0/

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NSW Department of Infrastructure, Planning and Natural Resources (DIPNR) (2005) *Floodplain Development Manual.*

Paterson Consultants Pty Ltd (1997) *Northern Tributaries of Coffs Creek Floodplain Risk Management Study.*

Appendix A Flood Damage Curves

Table A-1 Residential Flood Damages

Above Floor Flood Depth (m)	Damage	Above Floor Flood Depth (m)	Damage
-0.5	$1,000	1.6	$81,526
-0.1	$1,000	1.7	$83,473
0.0	$29,866	1.8	$85,419
0.1	$50,774	1.9	$87,365
0.2	$52,579	2.0	$89,311
0.3	$54,383	2.1	$89,983
0.4	$56,188	2.2	$90,654
0.5	$57,993	2.3	$91,325
0.6	$59,797	2.4	$91,996
0.7	$61,602	2.5	$92,668
0.8	$63,406	2.6	$93,339
0.9	$65,211	2.7	$94,010
1.0	$69,849	2.8	$94,681
1.1	$71,795	2.9	$95,353
1.2	$73,741	3.0	$96,024
1.3	$75,688	3.1	$96,695
1.4	$77,634	3.2	$97,366
1.5	$79,580	3.3	$98,038

Table A-2 Commercial Flood Damages

Above Floor Flood Depth (m)	Damage			Above Floor Flood Depth (m)	Damage		
	Light	Medium	Heavy		Light	Medium	Heavy
0.0	$0	$0	$0	0.8	$52,500	$108,000	$201,900
0.01	$600	$3,600	$6,900	0.9	$54,000	$111,000	$225,000
0.05	$3,600	$9,000	$15,600	1.0	$60,000	$123,000	$243,000
0.1	$6,900	$15,600	$31,200	1.1	$64,500	$130,500	$261,000
0.2	$15,000	$30,000	$63,000	1.2	$69,000	$138,000	$279,000
0.25	$21,000	$39,000	$78,000	1.25	$72,000	$147,000	$297,000
0.3	$24,000	$45,000	$87,000	1.3	$72,900	$150,000	$299,400
0.4	$30,000	$57,000	$113,100	1.4	$73,800	$153,000	$306,000
0.5	$33,000	$69,000	$138,000	1.5	$75,000	$156,000	$312,000
0.6	$39,000	$81,000	$156,000	1.75	$81,000	$165,000	$330,000
0.7	$43,500	$92,100	$180,900	2.0	$87,000	$174,000	$348,000
0.75	$51,000	$105,000	$192,000	3/.0	$90,000	$180,000	$360,000

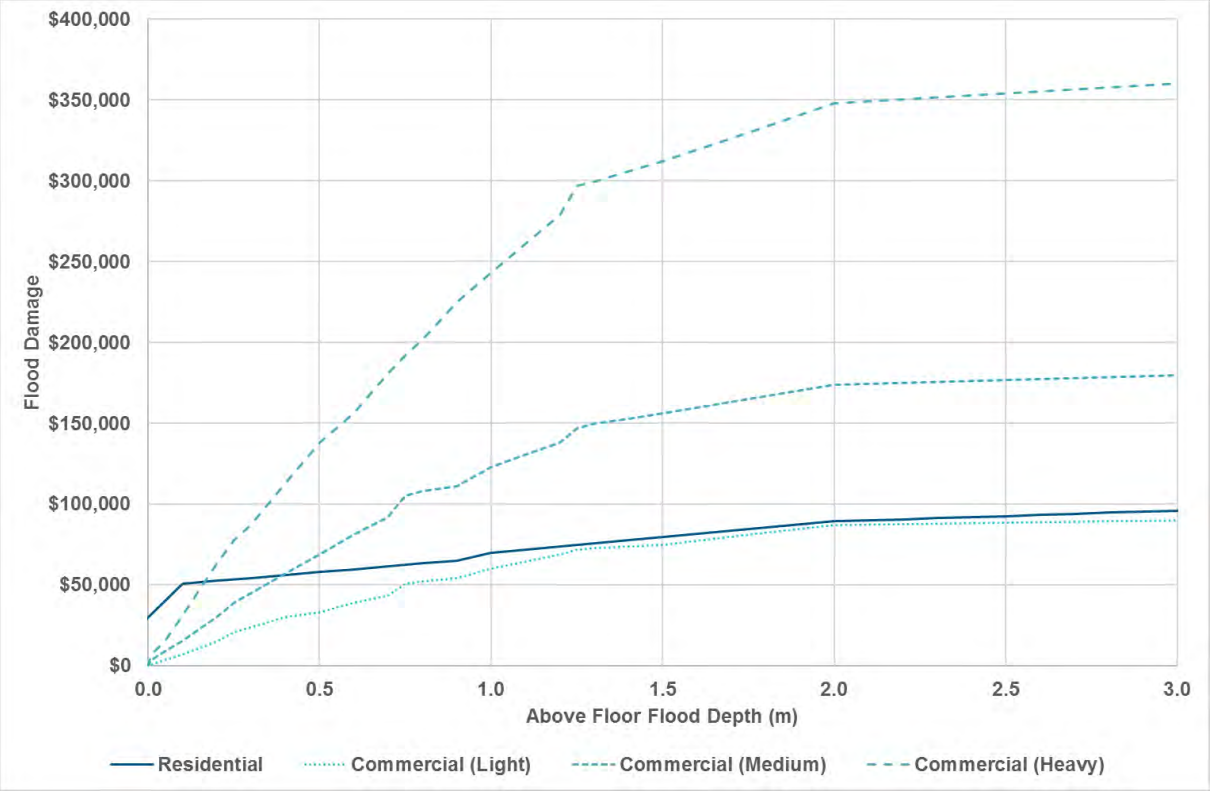

Figure A-1 Flood Damage Curves

Appendix B Flood Modification Measures Concept Design Drawings

Title:

Macauleys Headland Outlet Upgrade (RCBCs) Preliminary Concept Plan

Figure: B-1

Rev: A

BMT WBM endeavours to ensure that the information provided in this map is correct at the time of publication. BMT WBM does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.

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Approx. Scale

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Title:

Macauleys Headland Outlet Upgrade (RCPs) Preliminary Concept Plan

Figure: B-2

Rev: A

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Approx. Scale

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www.bmtwbm.com.au

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Title:

Railway Culvert Upgrade (North Location) Preliminary Concept Plan

Figure: **B-3**

Rev: **A**

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Approx. Scale

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Title:

York Street Oval Outlet
Preliminary Concept Plan

Figure: **B-4**

Rev: **A**

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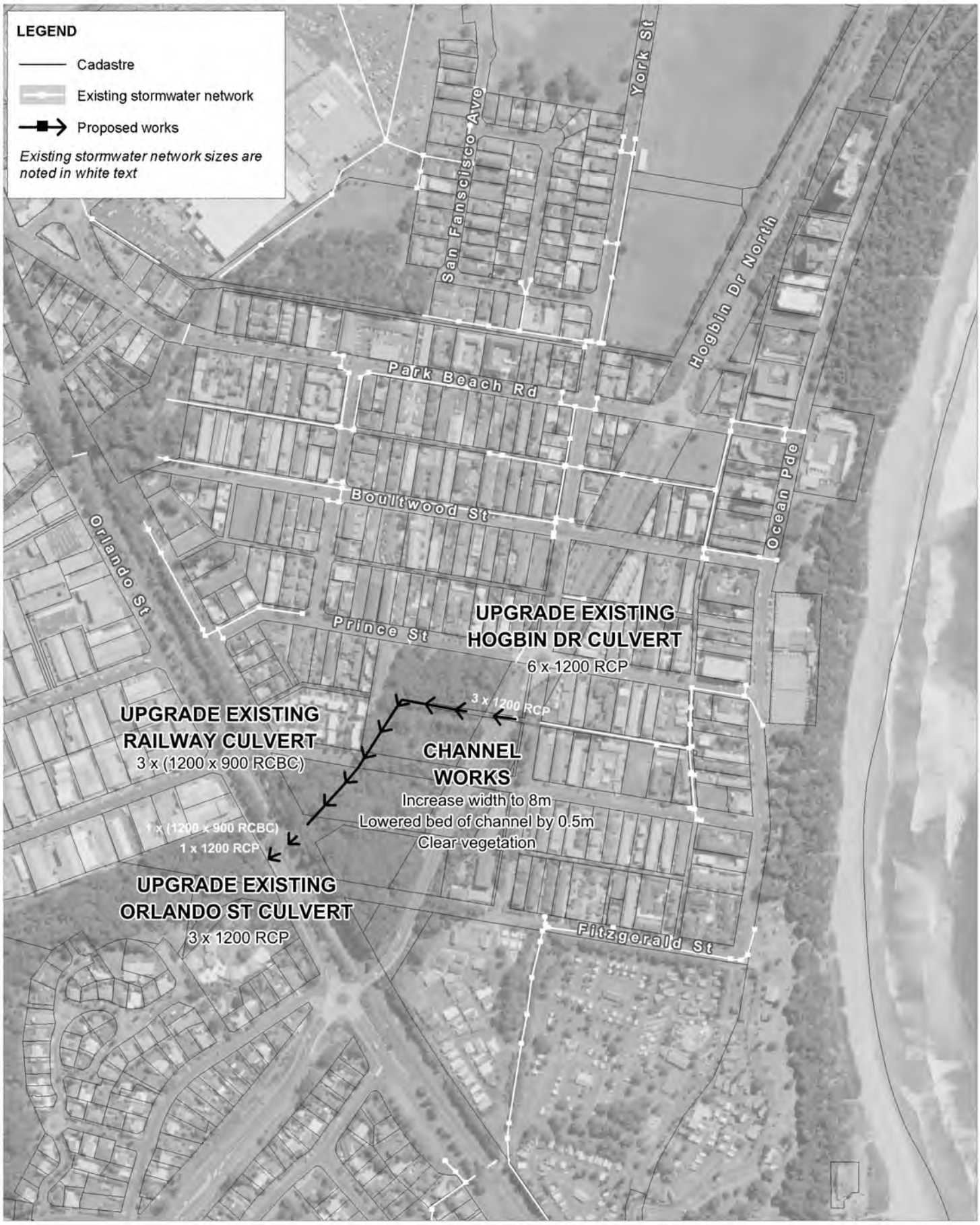

Title:

Railway Culvert (South) and Hogbin Drive Culvert Upgrade Preliminary Concept Plan

Figure: B-5

Rev: A

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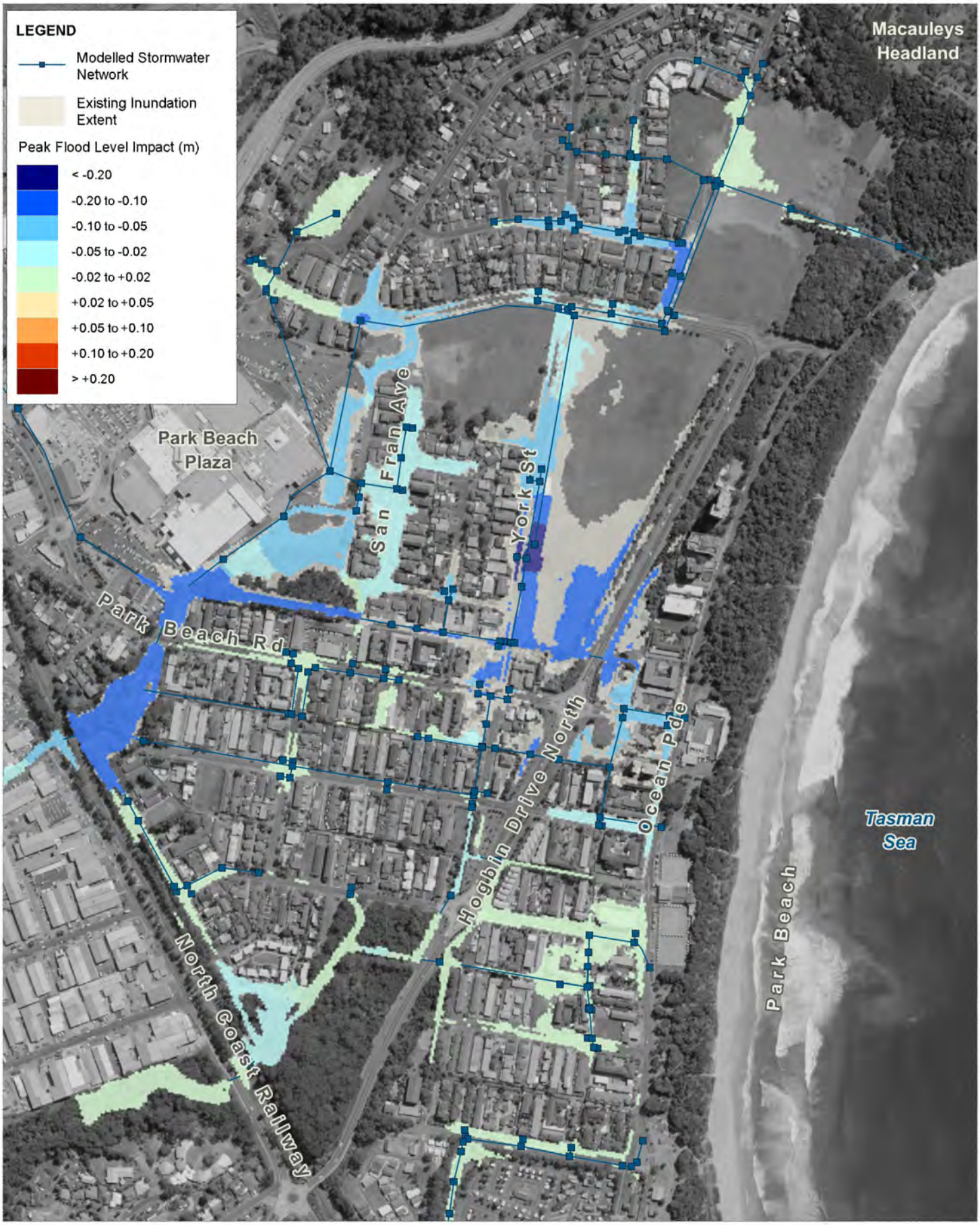
Appendix C Flood Modification Options Peak Flood Level Impact Mapping



Title:

Macauleys Headland Outlet Upgrade
5% AEP Peak Flood Level Impact

Figure: C-1

Rev: A

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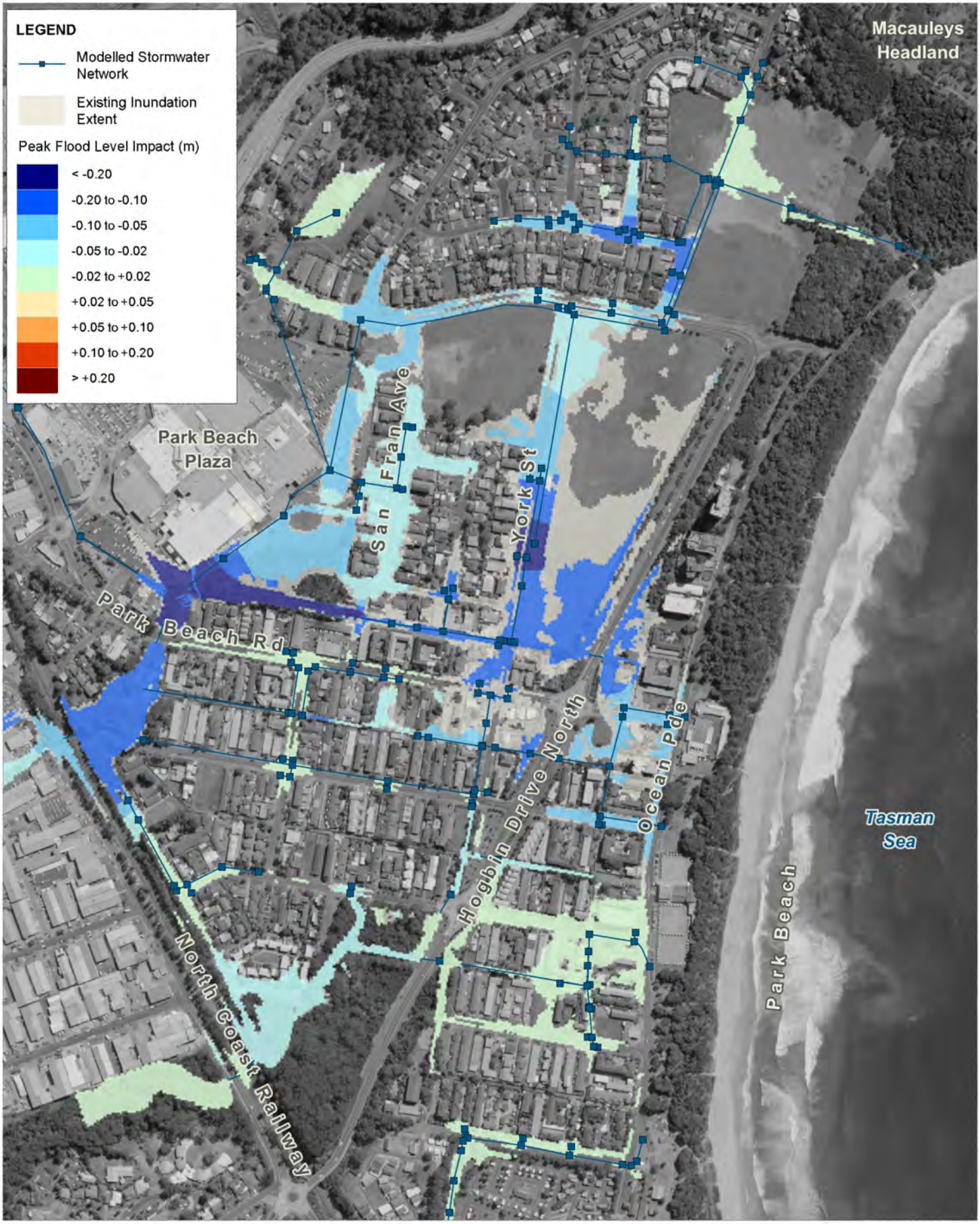

Title:

Macauleys Headland Outlet Upgrade
2% AEP Peak Flood Level Impact

Figure: C-2

Rev: A

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Approx. Scale

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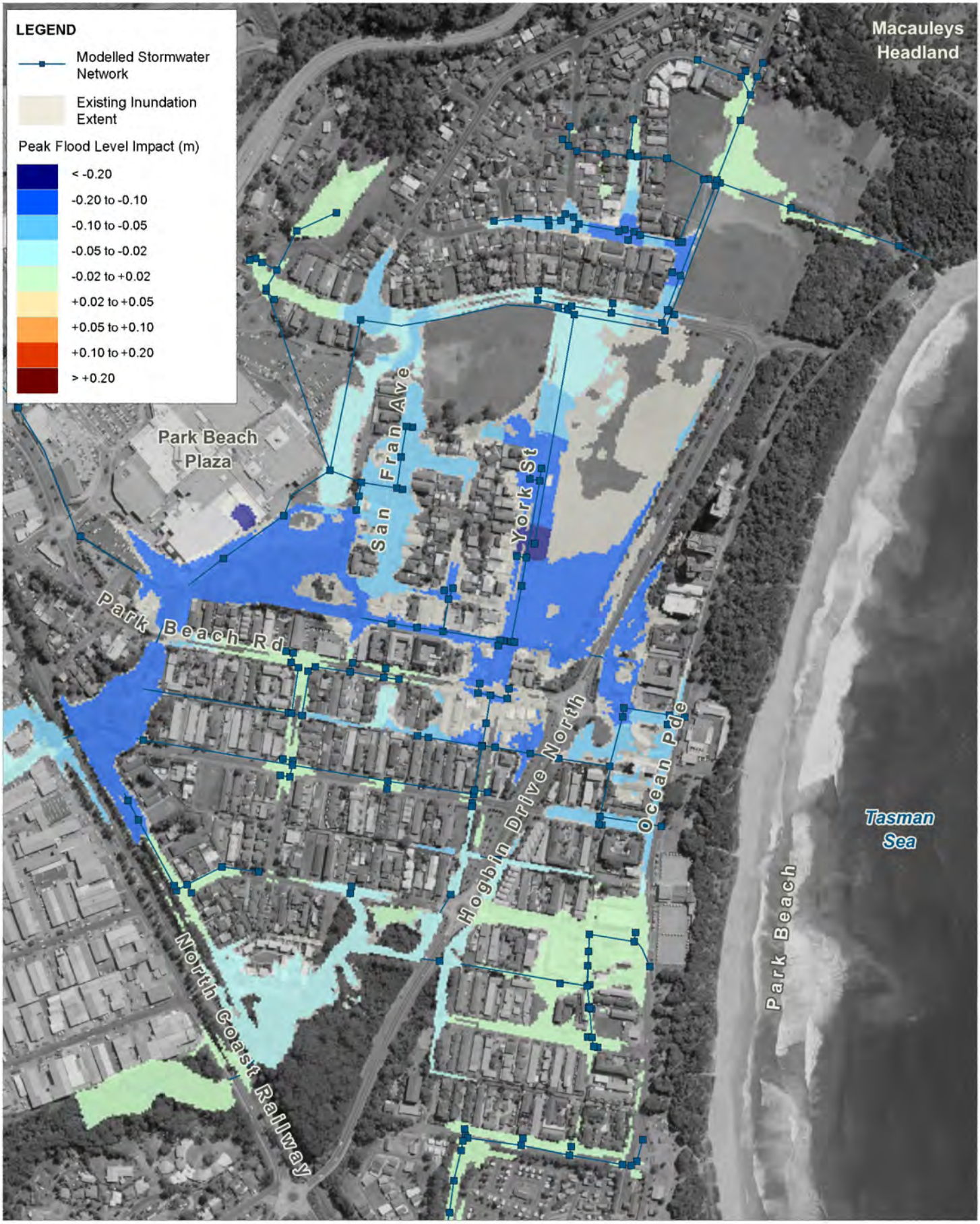

Title:

Macauleys Headland Outlet Upgrade
1% AEP Peak Flood Level Impact

Figure: C-3

Rev: A

N

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Approx. Scale

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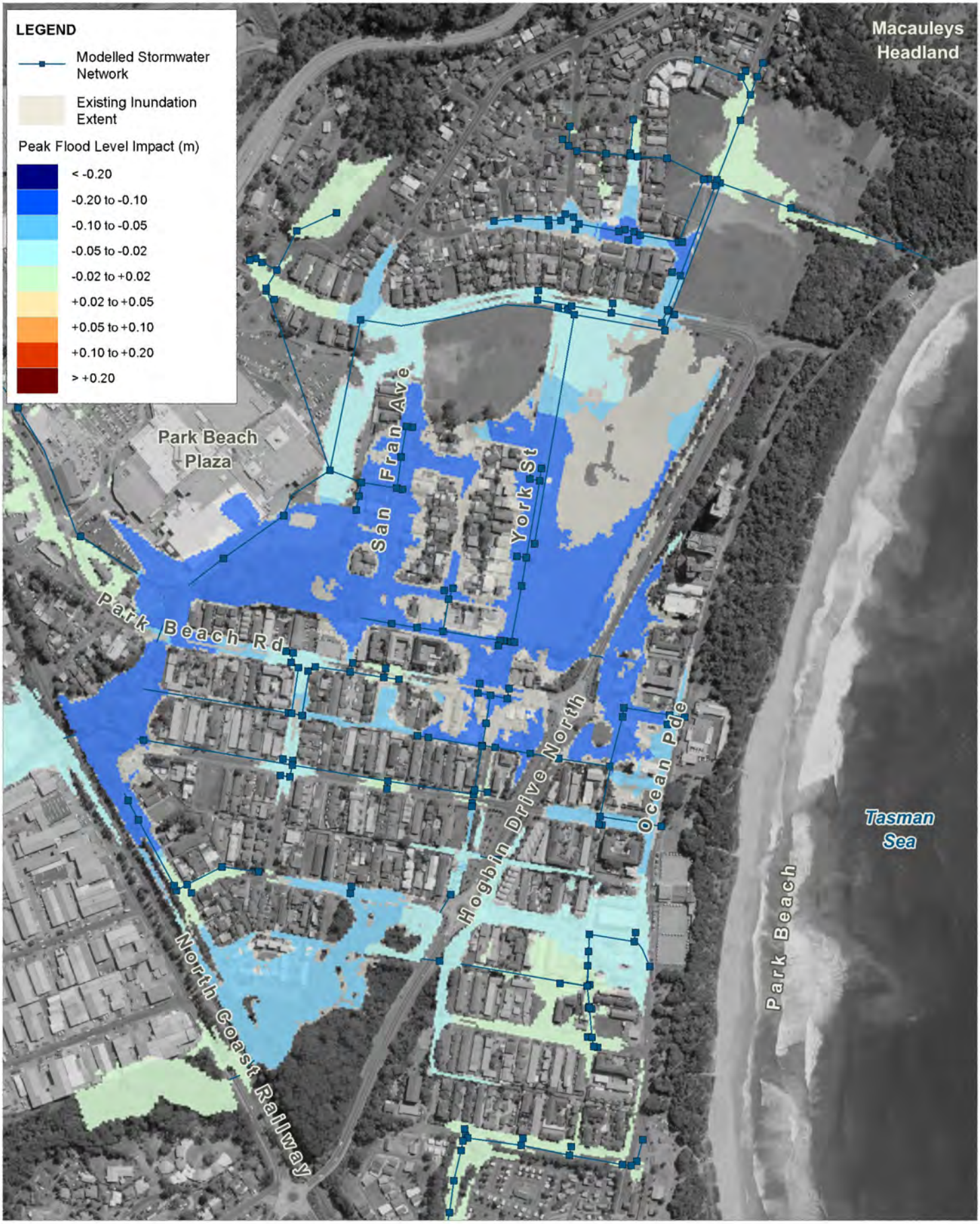

Title:

Macauleys Headland Outlet Upgrade
0.5% AEP Peak Flood Level Impact

Figure: C-4

Rev: A

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Approx. Scale

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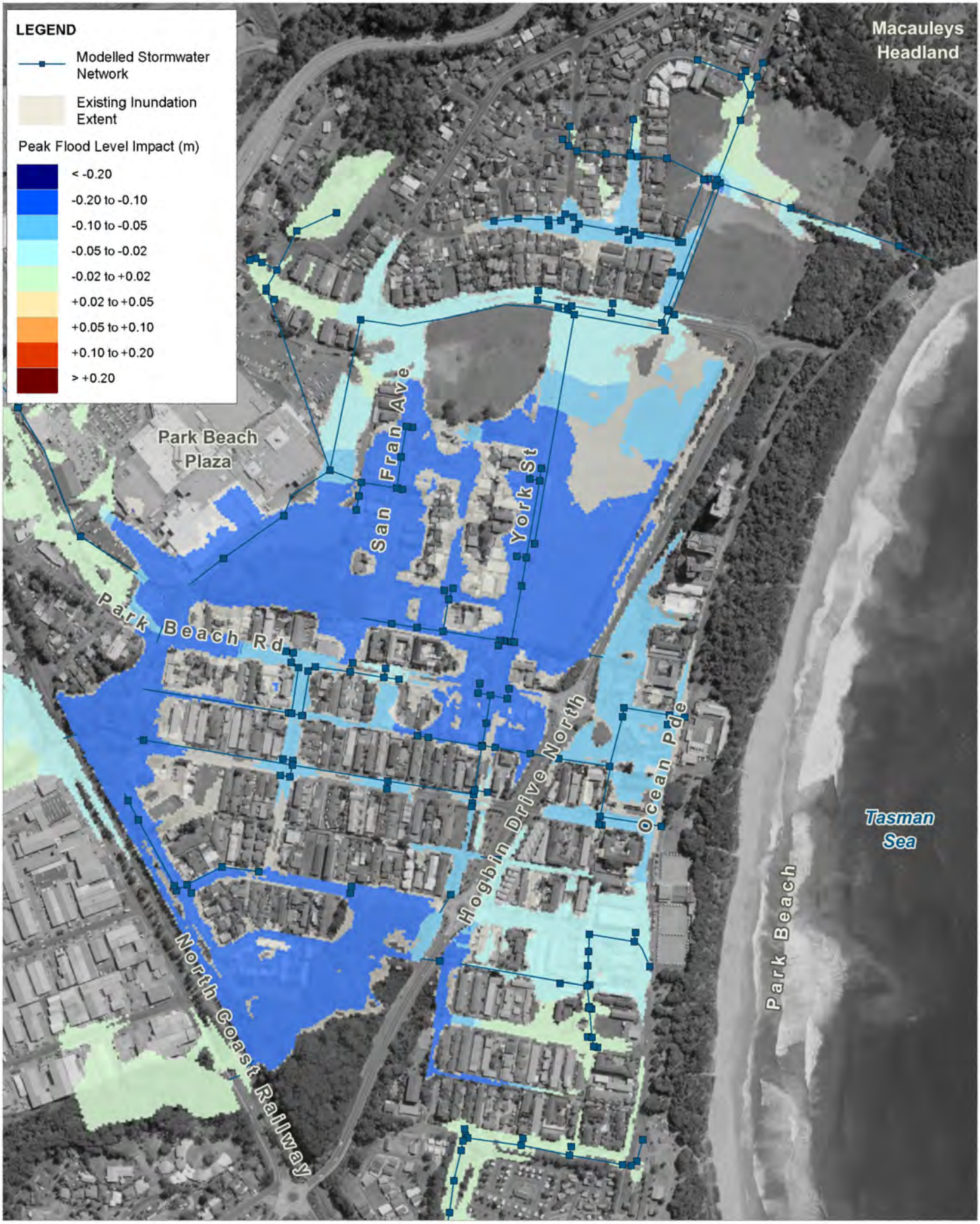

Title:

Macauleys Headland Outlet Upgrade
0.2% AEP Peak Flood Level Impact

Figure: C-5

Rev: A

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Approx. Scale

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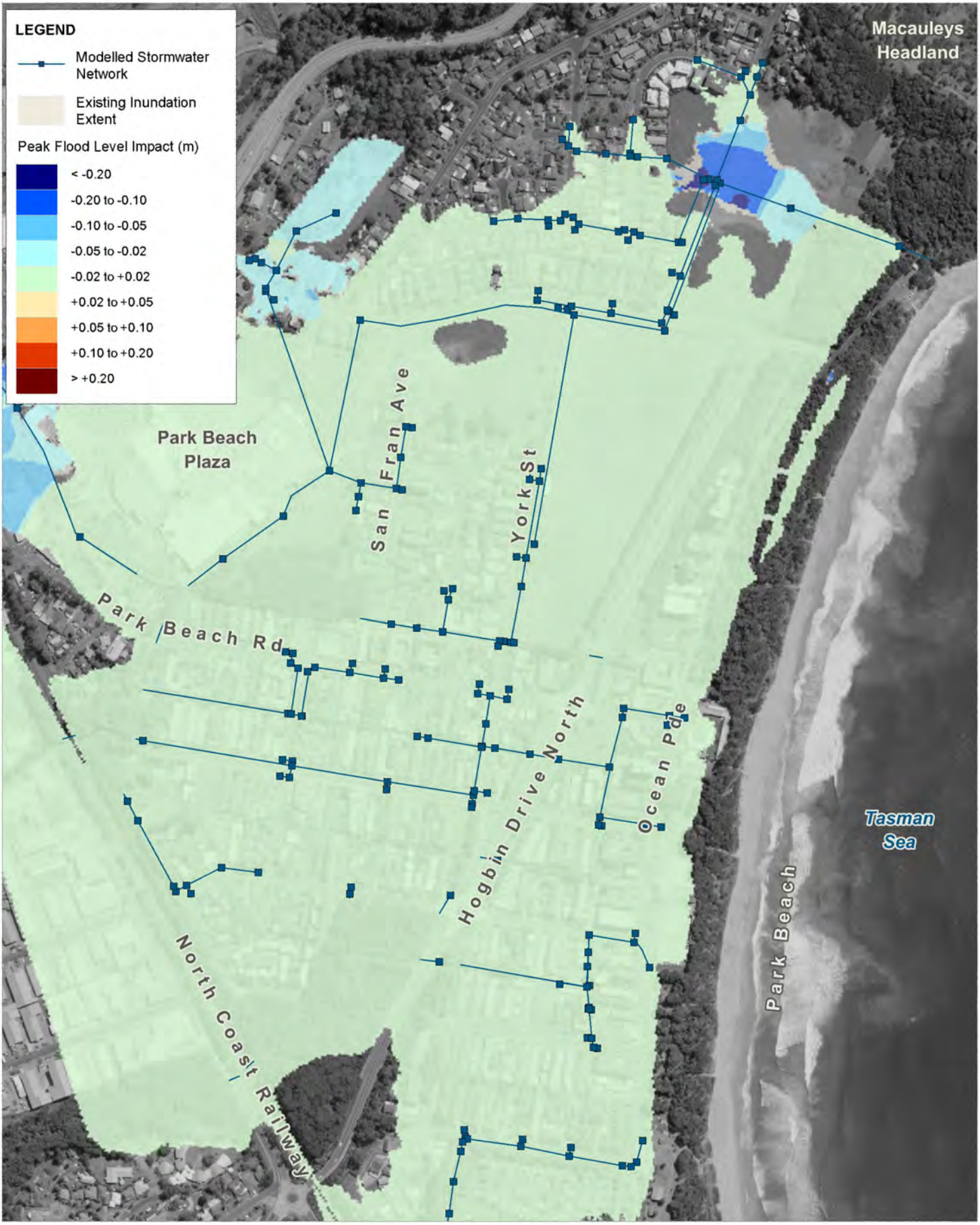

Title:

Macauleys Headland Outlet Upgrade PMF Peak Flood Level Impact

Figure: C-6

Rev: A

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Approx. Scale

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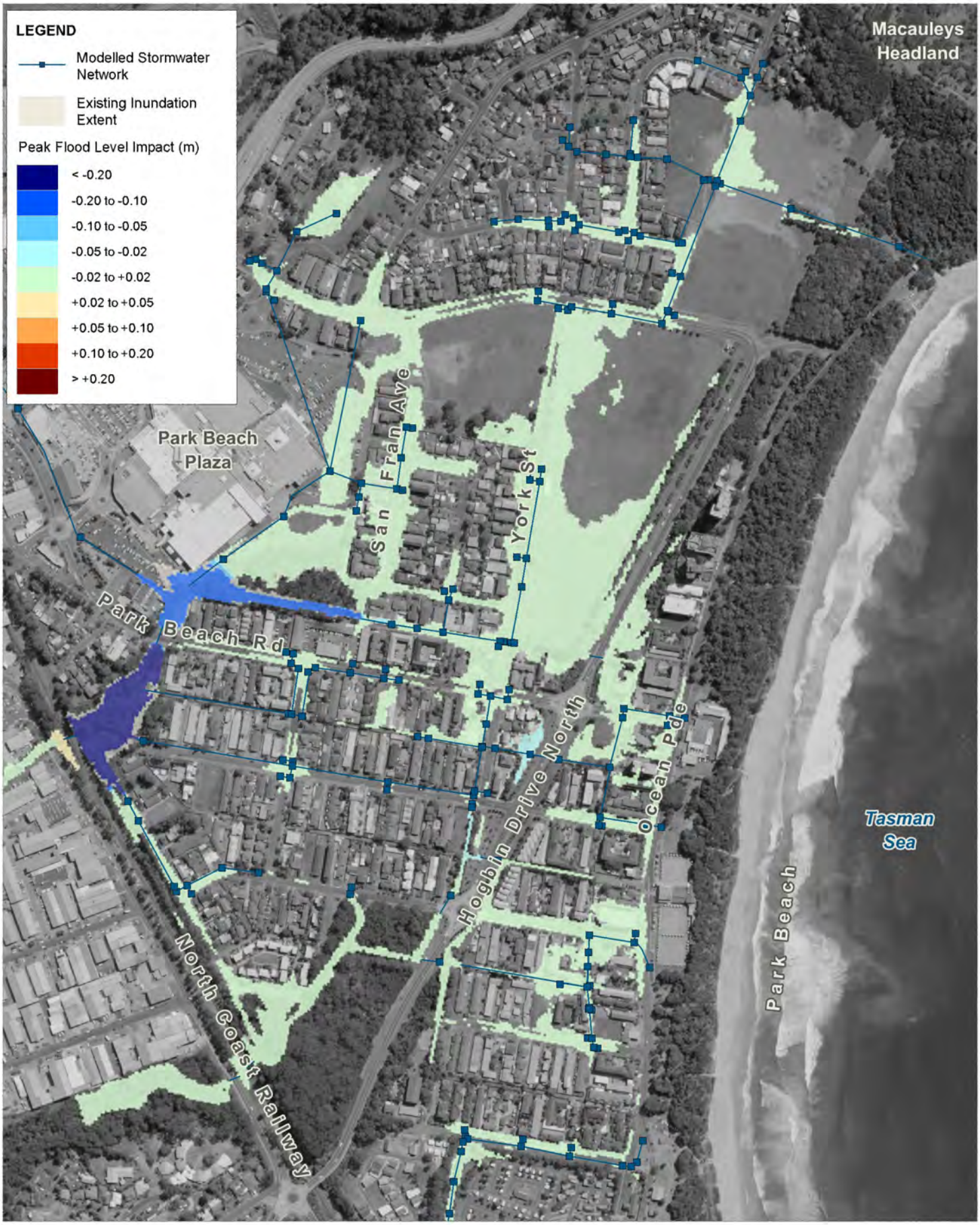

Title:

Railway Culvert (North Location) Upgrade
5% AEP Peak Flood Level Impact

Figure: C-7

Rev: A

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0 125 250m

Approx. Scale

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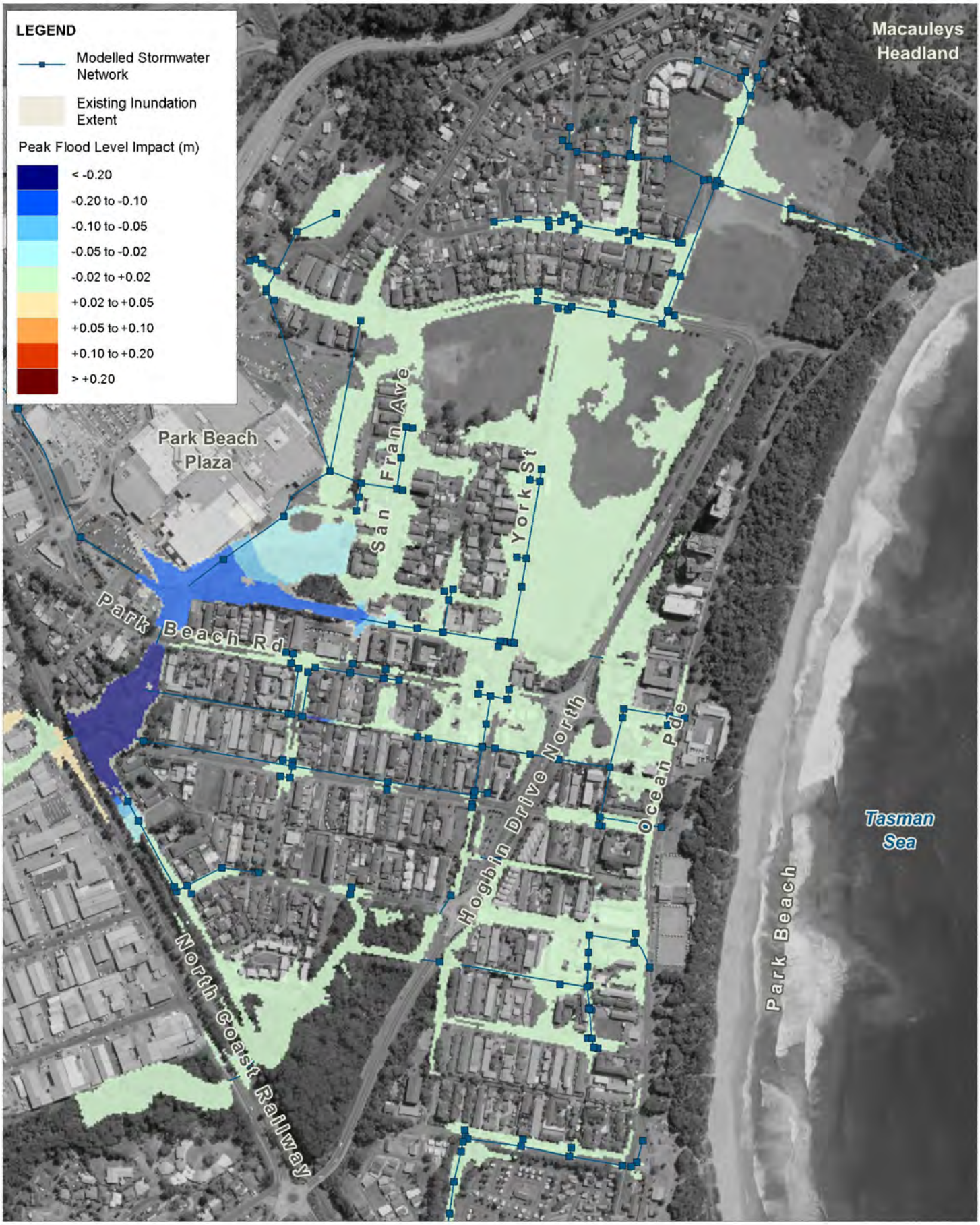

Title:

Railway Culvert (North Location) Upgrade
2% AEP Peak Flood Level Impact

Figure: C-8

Rev: A

N

0 125 250m

Approx. Scale

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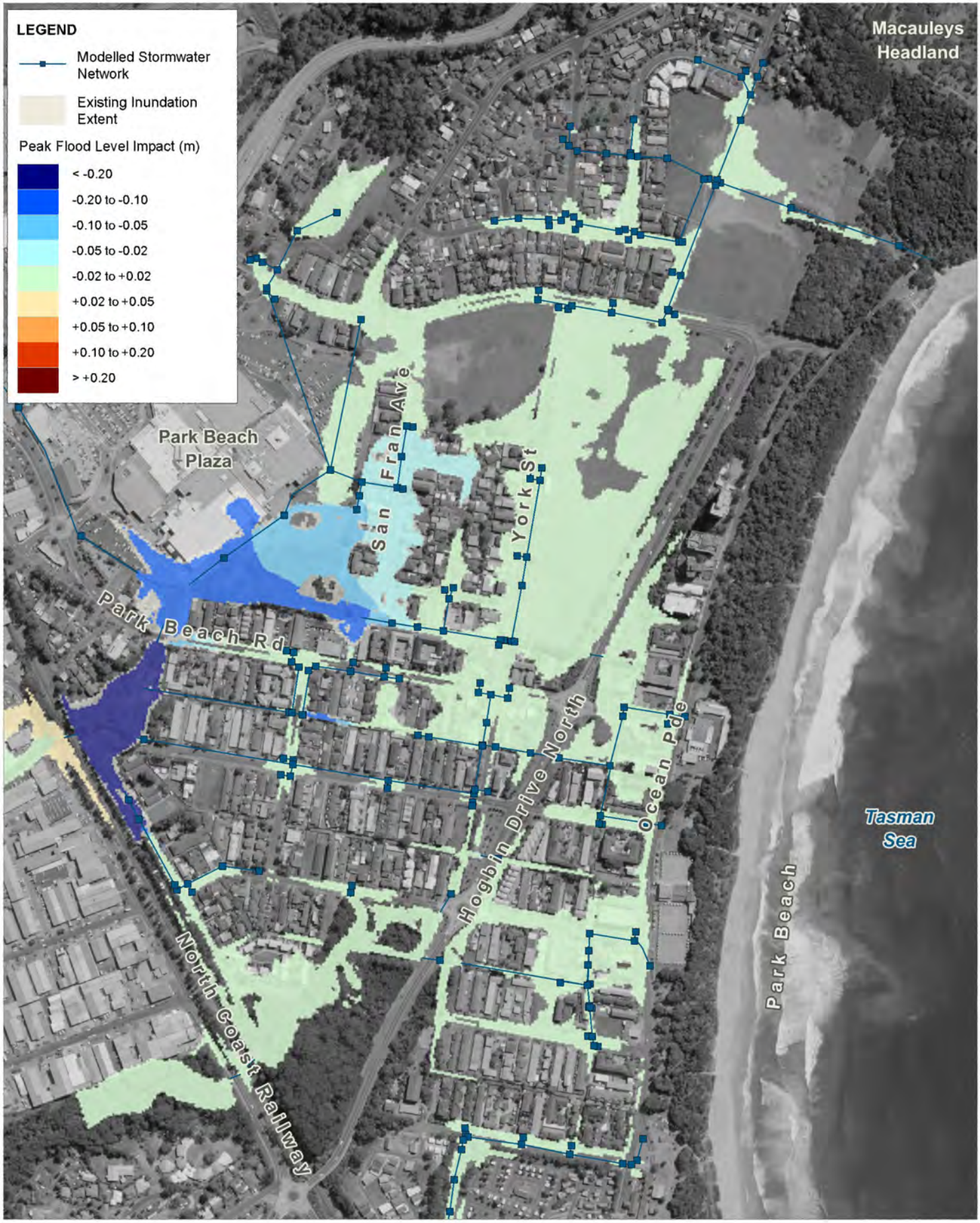

Title:

Railway Culvert (North Location) Upgrade
1% AEP Peak Flood Level Impact

Figure: C-9

Rev: A

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0 125 250m

Approx. Scale

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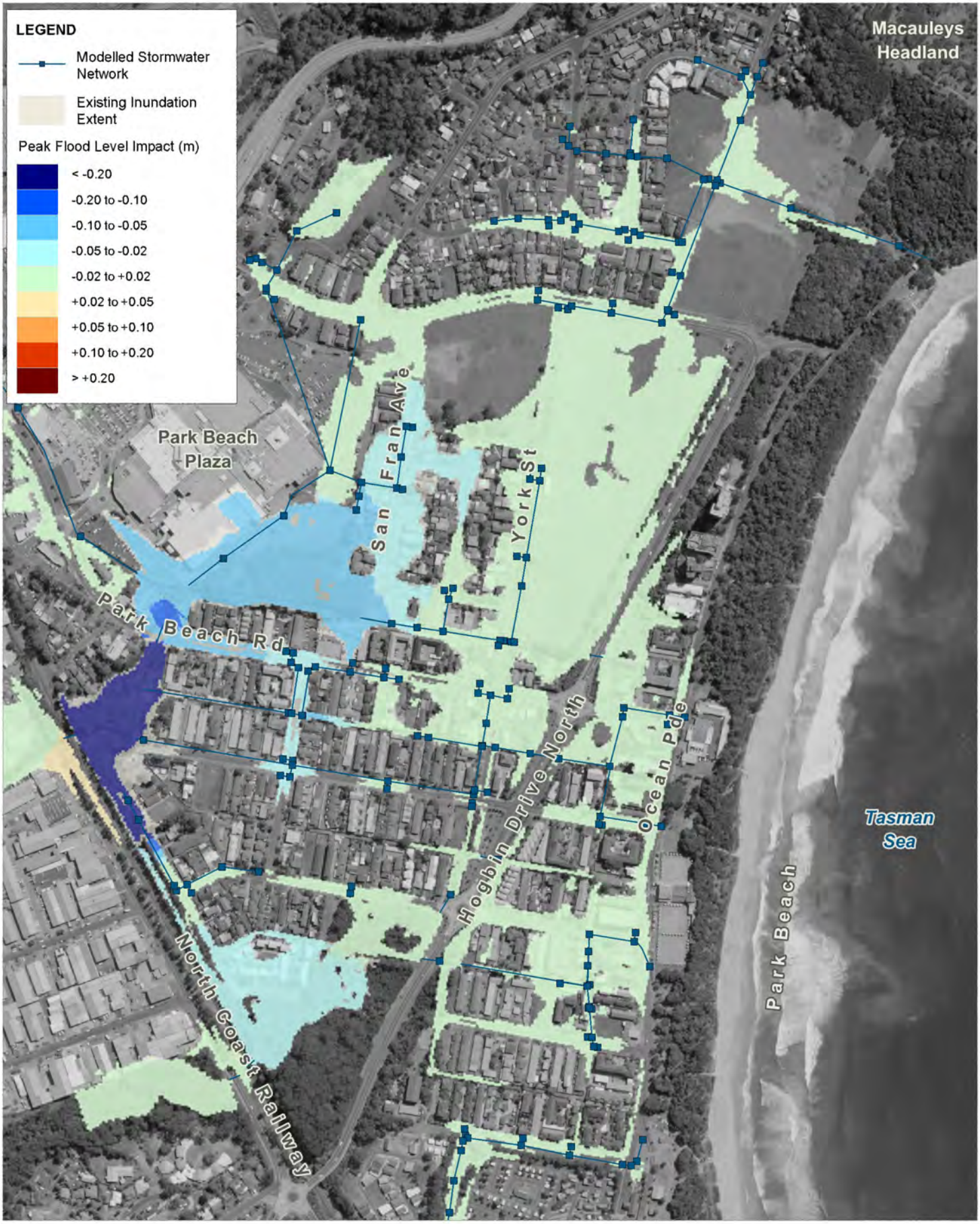

Title:

Railway Culvert (North Location) Upgrade
0.5% AEP Peak Flood Level Impact

Figure: C-10

Rev: A

N

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Approx. Scale

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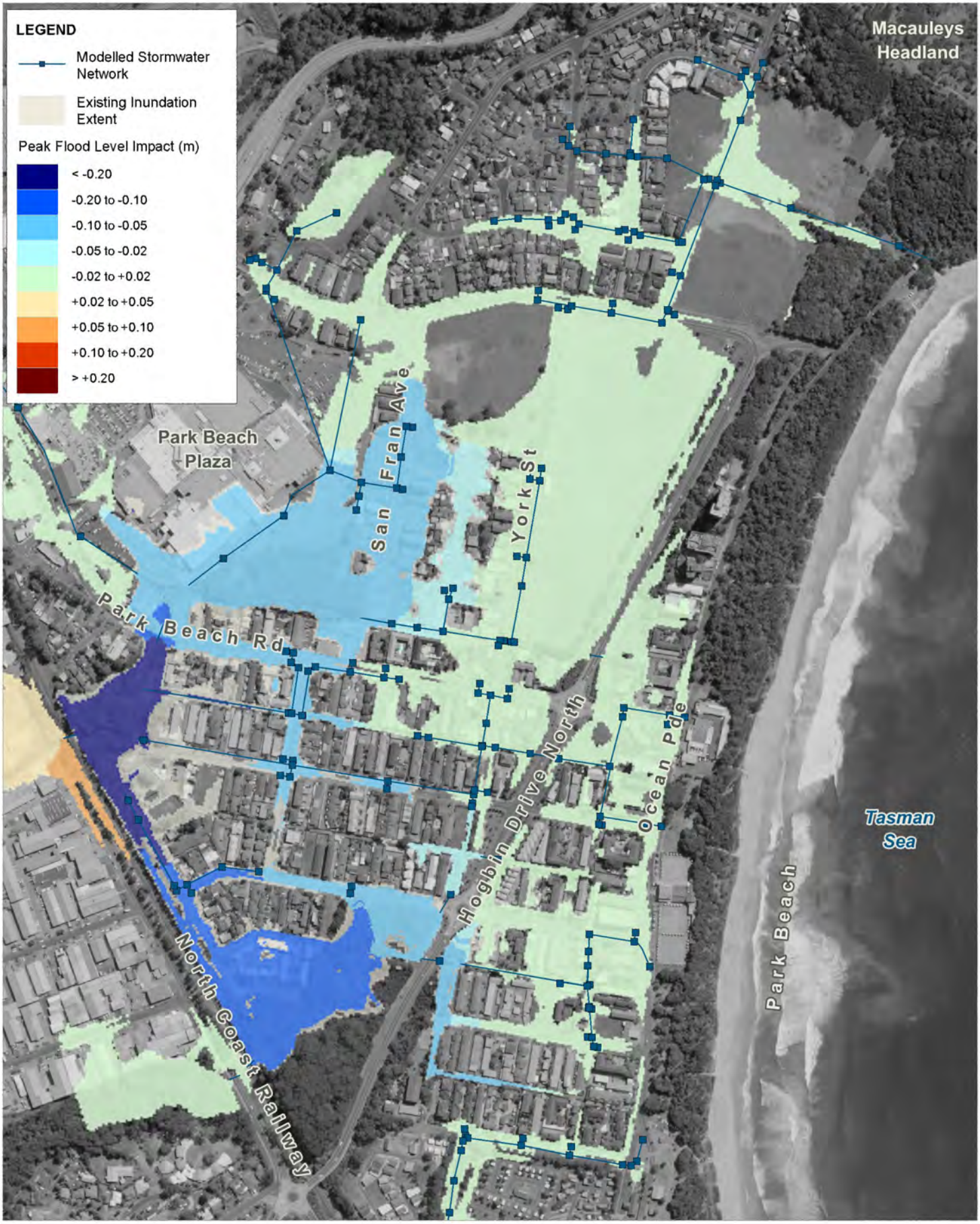

Title:

Railway Culvert (North Location) Upgrade
0.2% AEP Peak Flood Level Impact

Figure: C-11

Rev: A

N

0 125 250m

Approx. Scale

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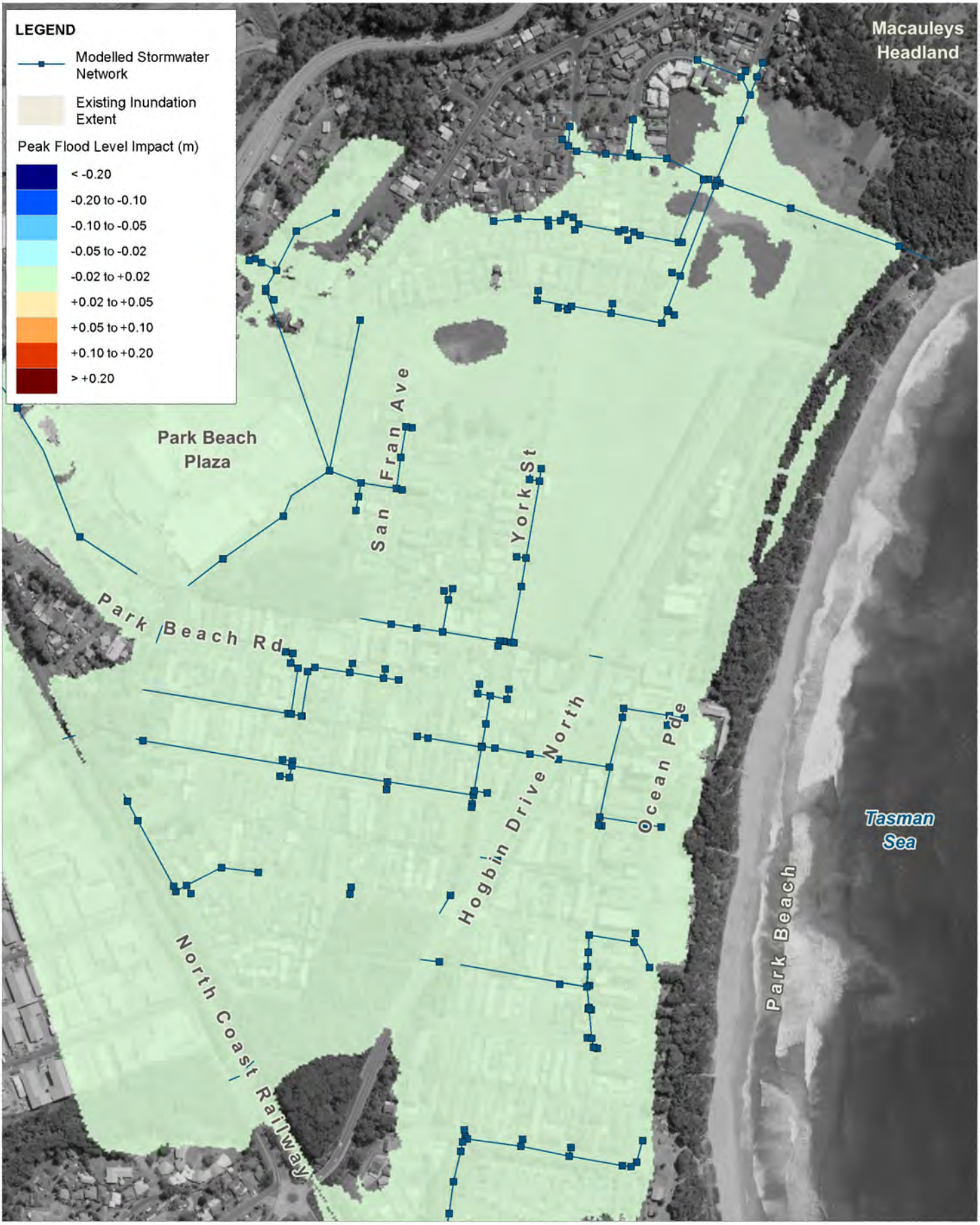

Title:

Railway Culvert (North Location) Upgrade
PMF Peak Flood Level Impact

Figure: C-12

Rev: A

N

0 125 250m

Approx. Scale

BMT WBM
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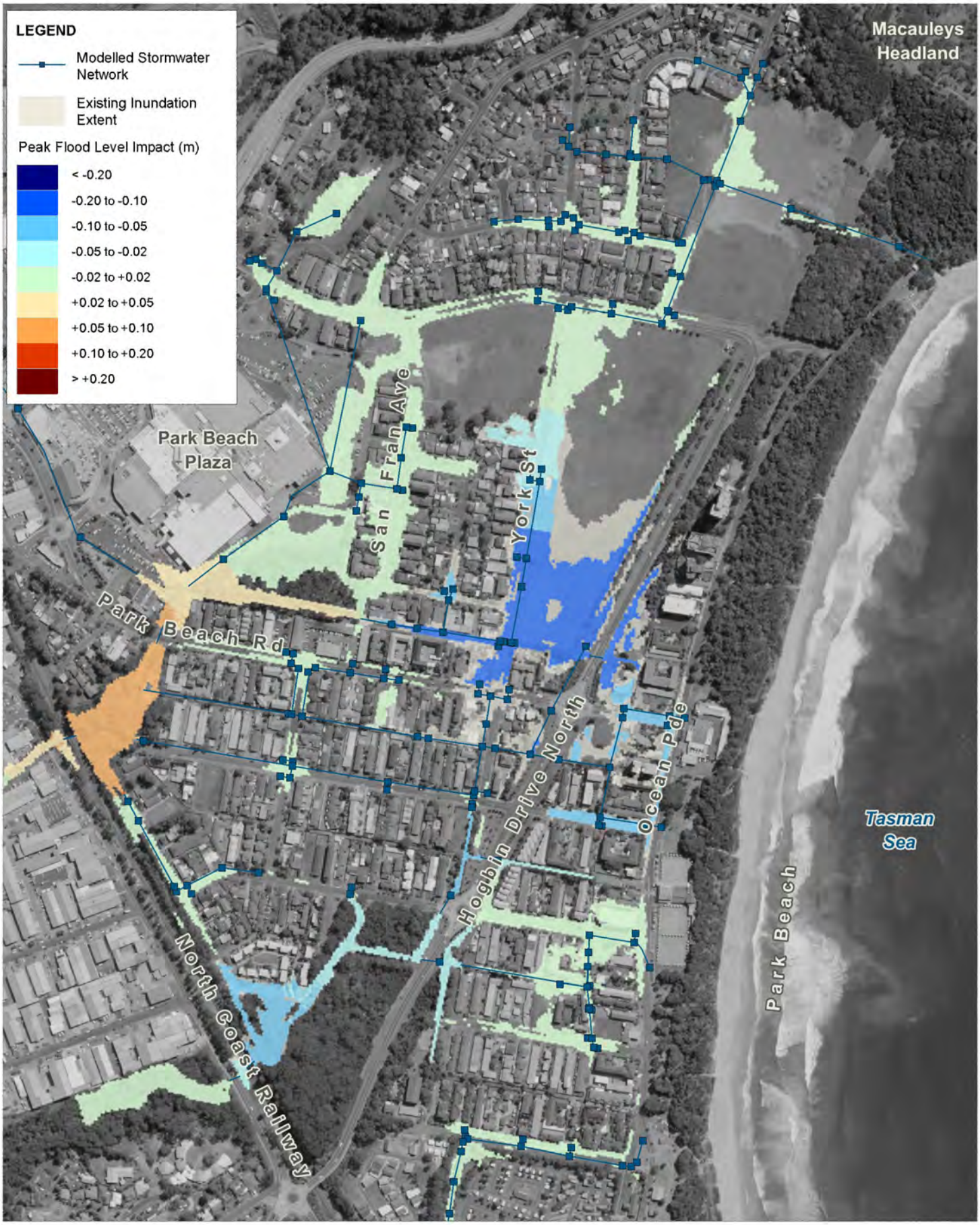


Title:

York St Oval Outlet Upgrade
5% AEP Peak Flood Level Impact

Figure: C-13

Rev: A

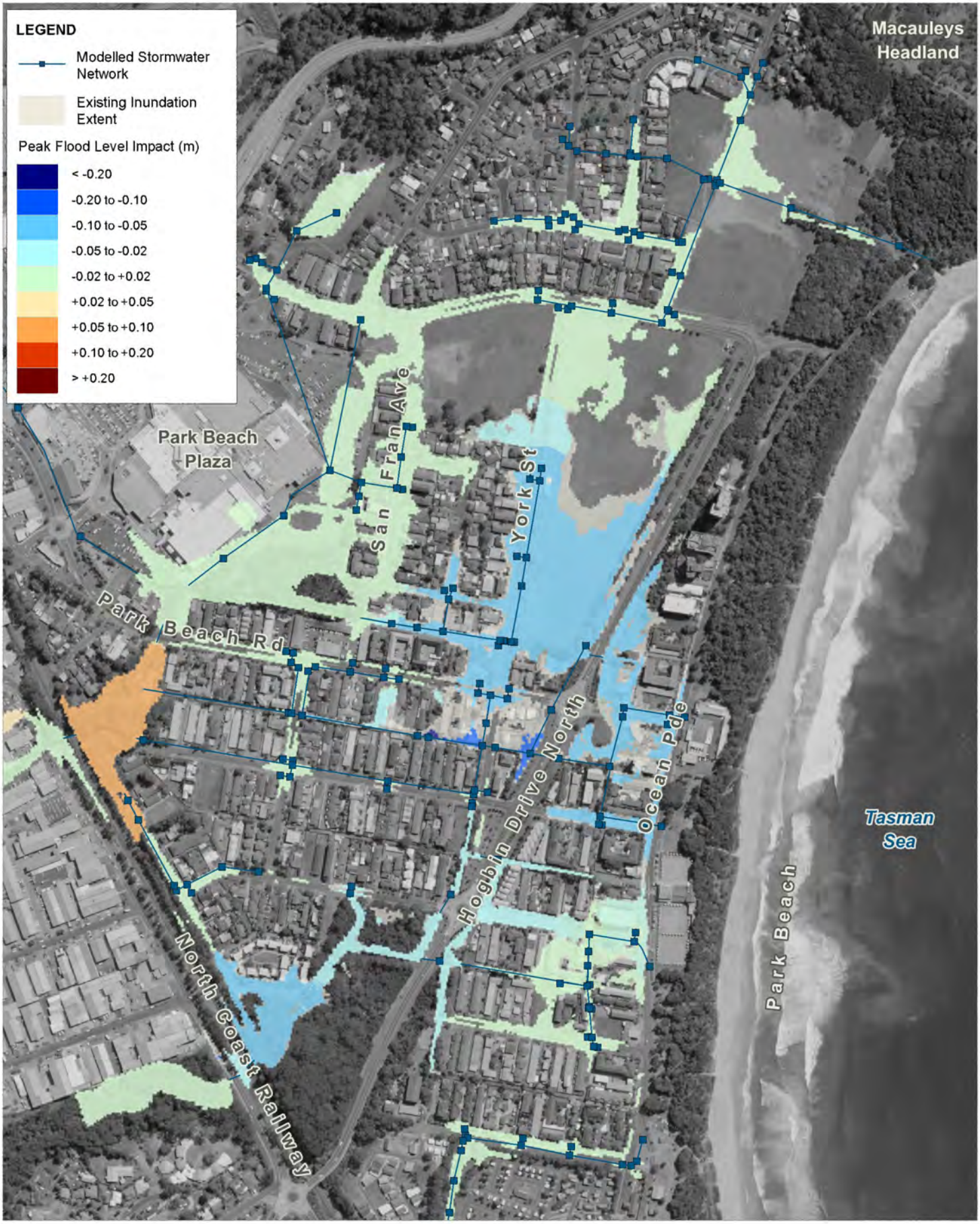
N

0 125 250m

Approx. Scale

BMT WBM
www.bmtwbm.com.au

Filepath : K:\N20327_Coffs_Creek\MapInfo\Workspaces\Figures\PB_FRMS\DRG_301_171004_PB_5%AEP_Opt11a_001.wor



Title:

York St Oval Outlet Upgrade
2% AEP Peak Flood Level Impact

Figure: C-14

Rev: A

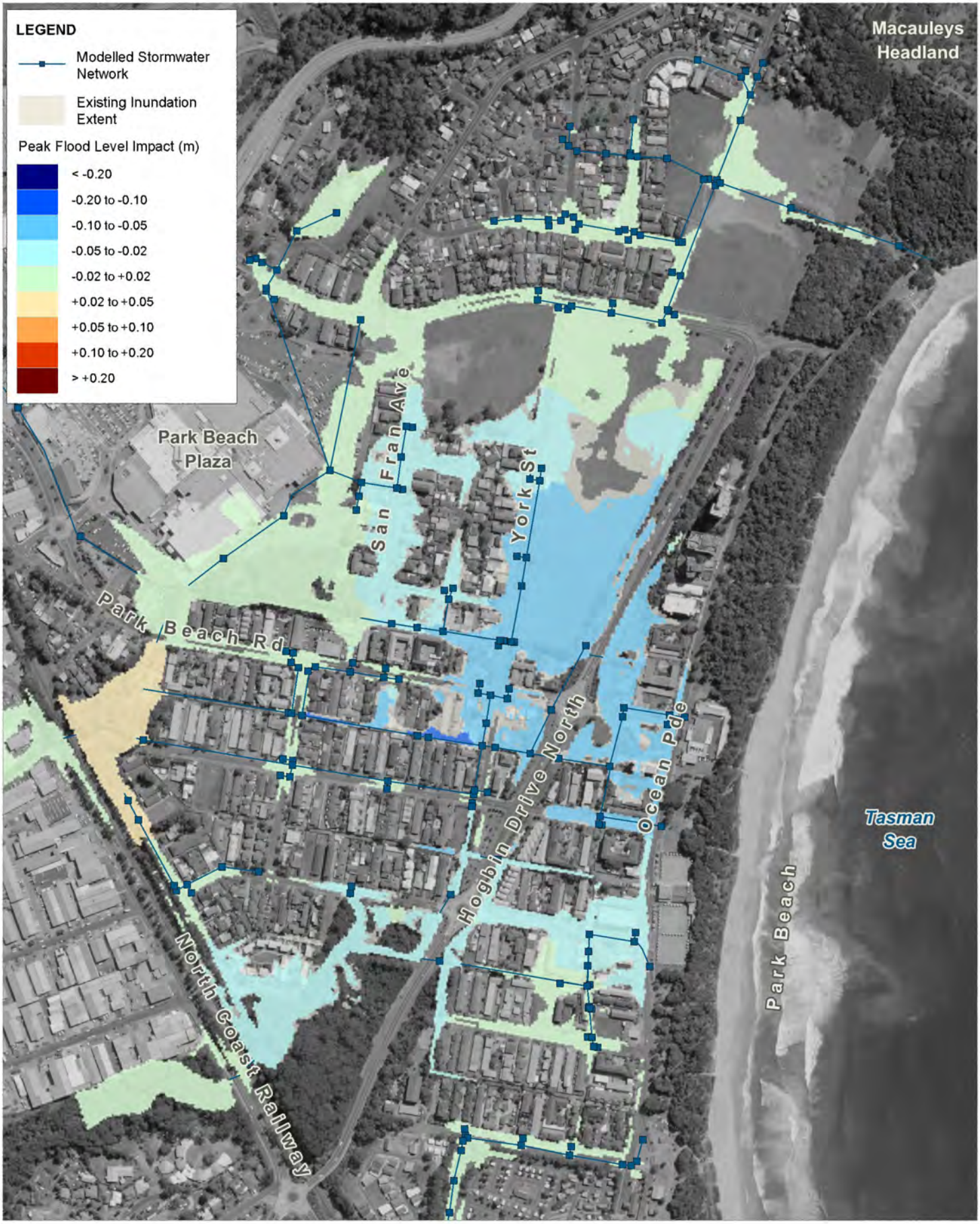
N

0 125 250m

Approx. Scale

BMT WBM
www.bmtwbm.com.au

Filepath : K:\N20327_Coffs_Creek\MapInfo\Workspaces\Figures\PB_FRMS\DRG_302_171004_PB_2%AEP_Opt11a_001.wor



Title:

York St Oval Outlet Upgrade
1% AEP Peak Flood Level Impact

Figure: C-15

Rev: A

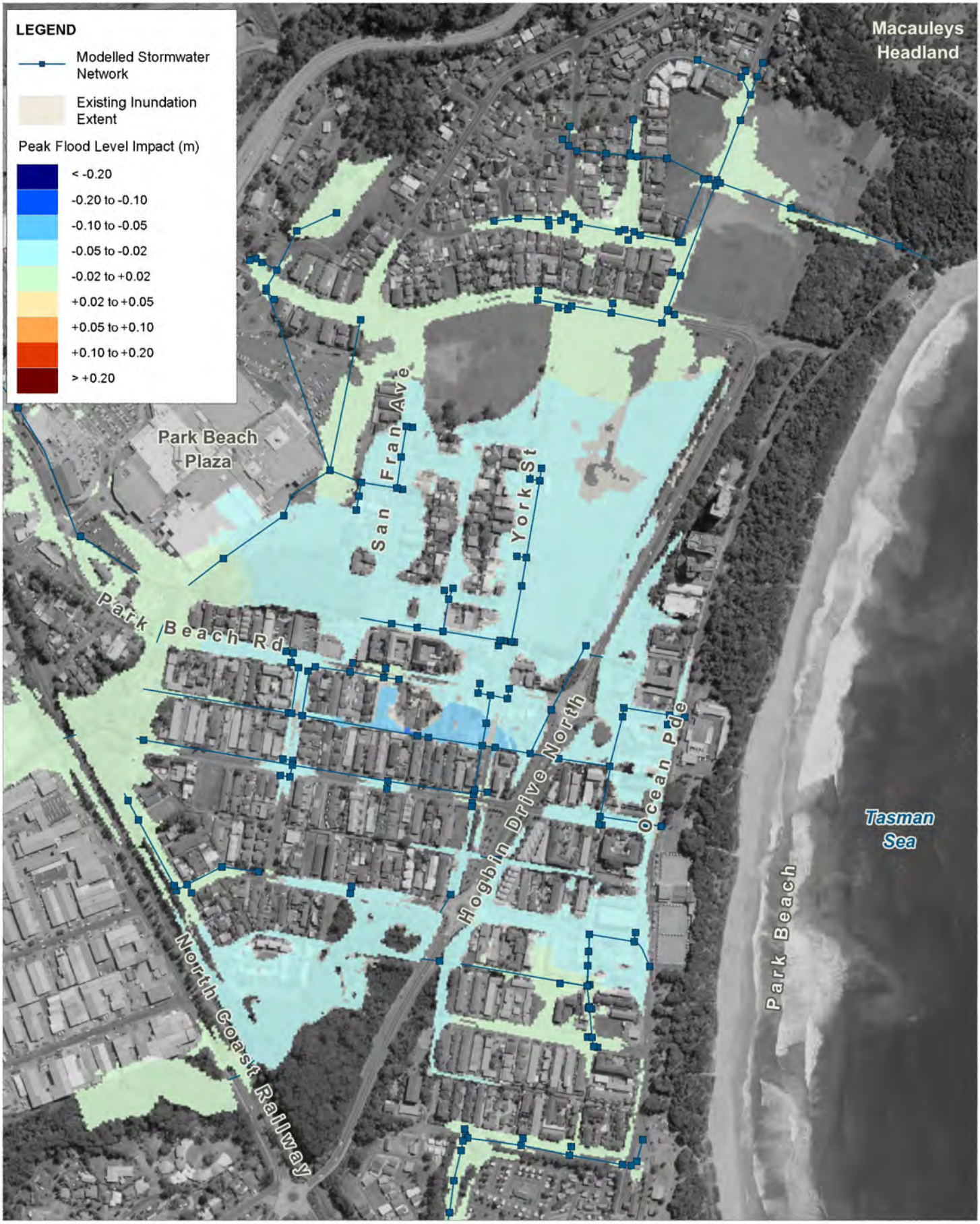
N

0 125 250m

Approx. Scale

BMT WBM
www.bmtwbm.com.au

Filepath : K:\N20327_Coffs_Creek\MapInfo\Workspaces\Figures\PB_FRMS\DRG_303_171004_PB_1%AEP_Opt11a_001.wor



Title:

York St Oval Outlet Upgrade
0.5% AEP Peak Flood Level Impact

Figure: C-16

Rev: A

N

0 125 250m

Approx. Scale

BMT WBM
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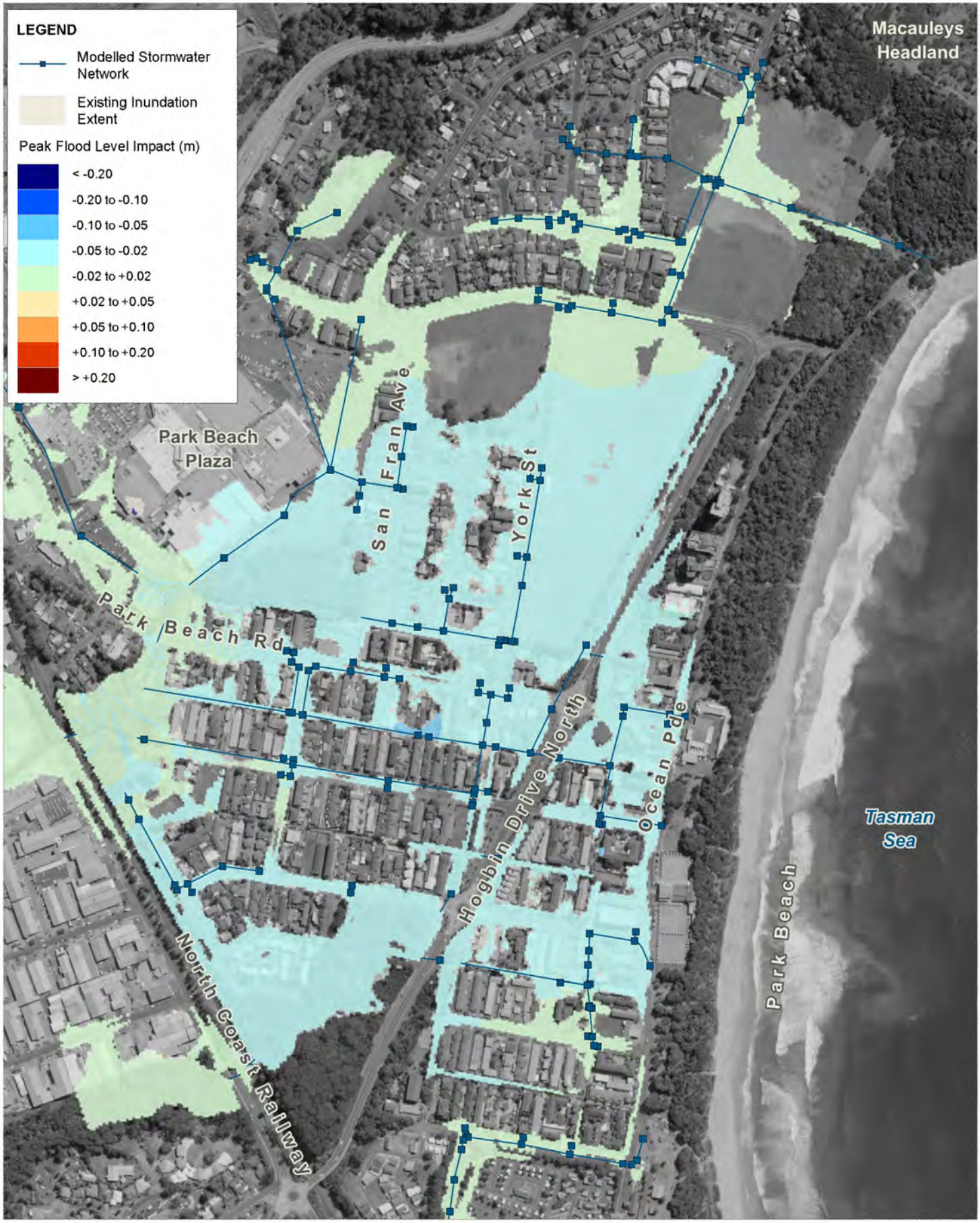
Filepath : K:\N20327_Coffs_Creek\MapInfo\Workspaces\Figures\PB_FRMS\DRG_304_171004_PB_0.5%AEP_Opt11a_001.wor



Title:

York St Oval Outlet Upgrade
0.2% AEP Peak Flood Level Impact

Figure: C-17

Rev: A

N

0 125 250m

Approx. Scale

BMT WBM
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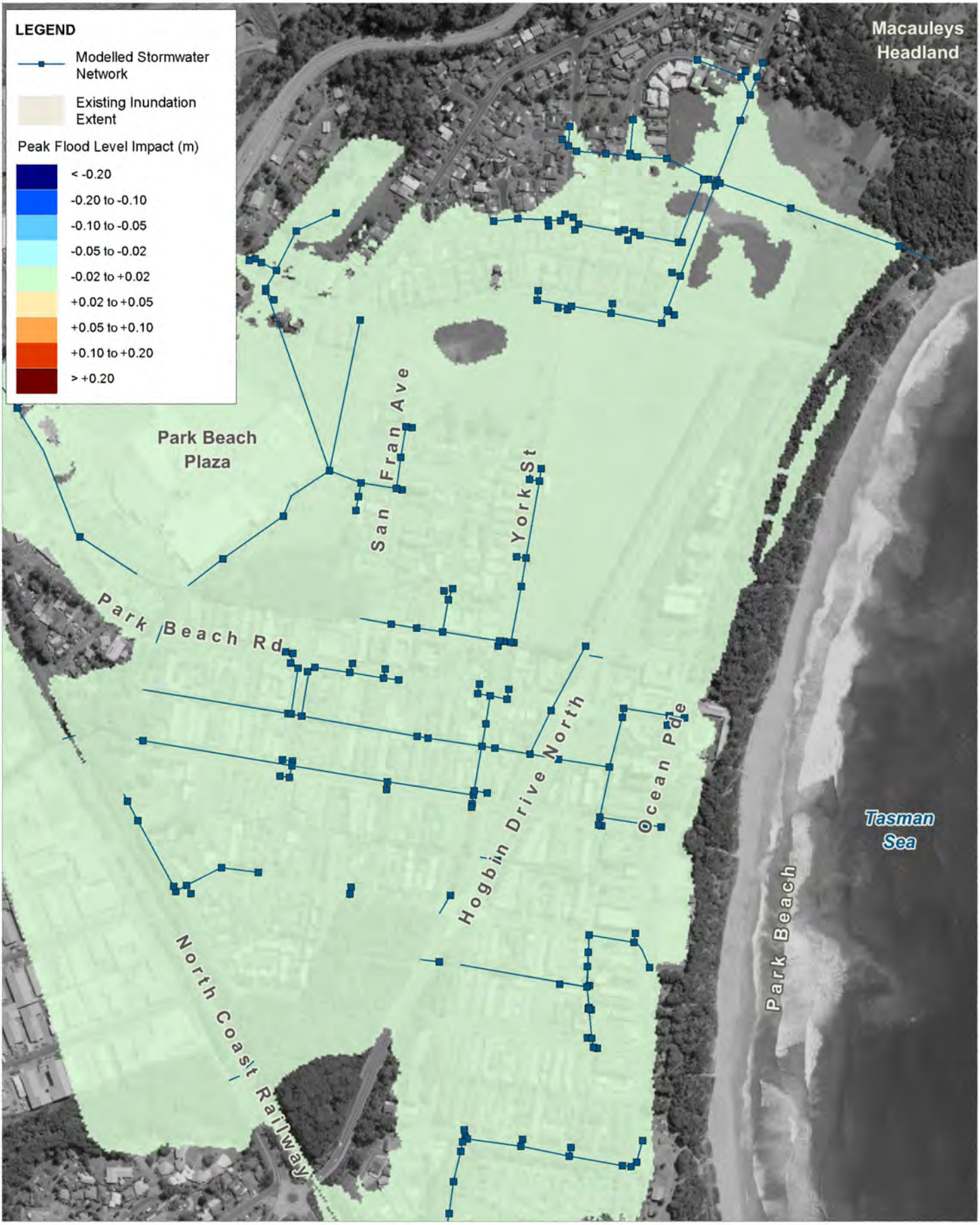

Title:

York St Oval Outlet Upgrade
PMF Peak Flood Level Impact

Figure: C-18

Rev: A

N

0 125 250m

Approx. Scale

BMT WBM
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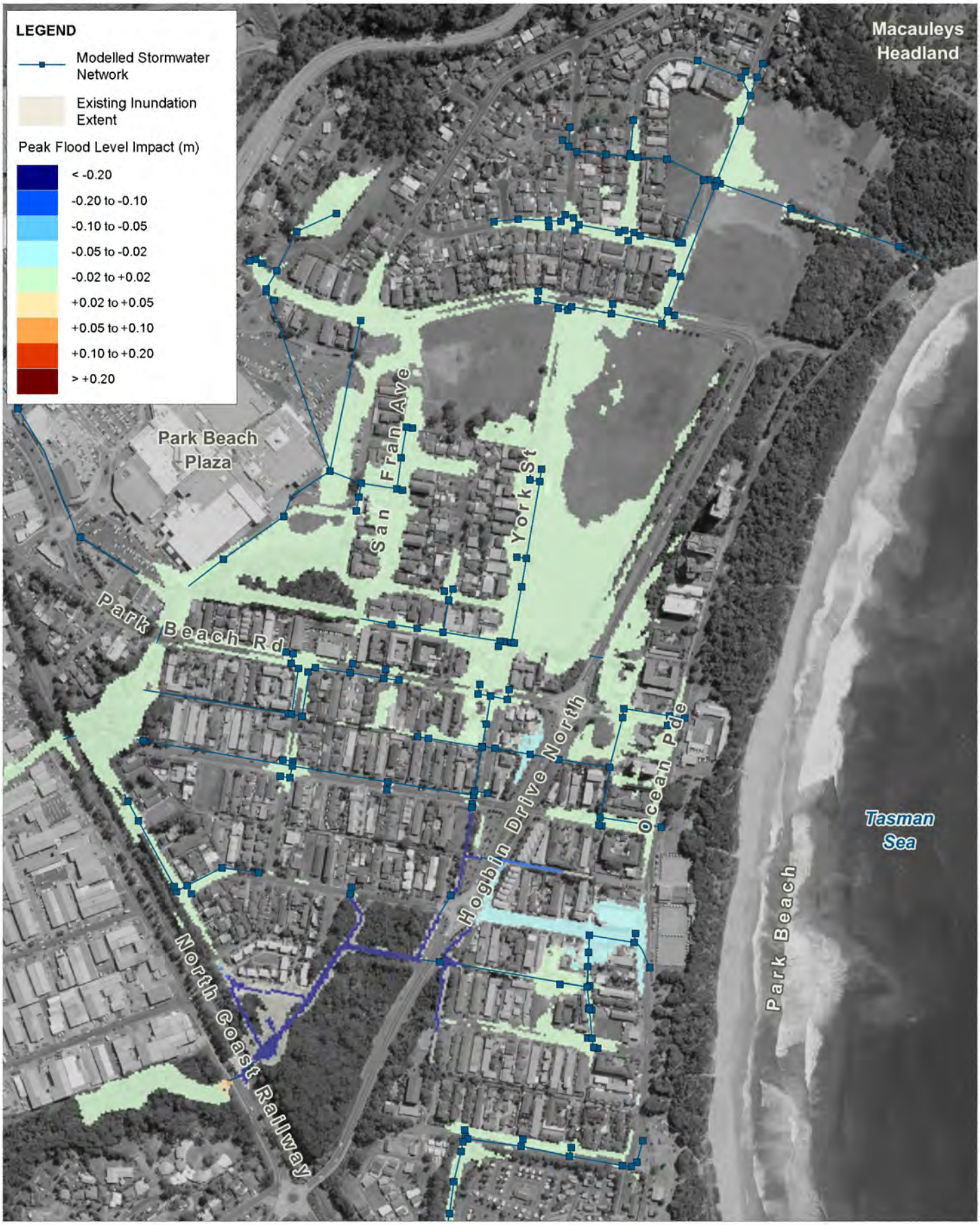


Title:

Railway Culvert (South) and Hogbin Drive Culvert Upgrade 5% AEP Peak Flood Level Impact

Figure: C-19

Rev: A

N

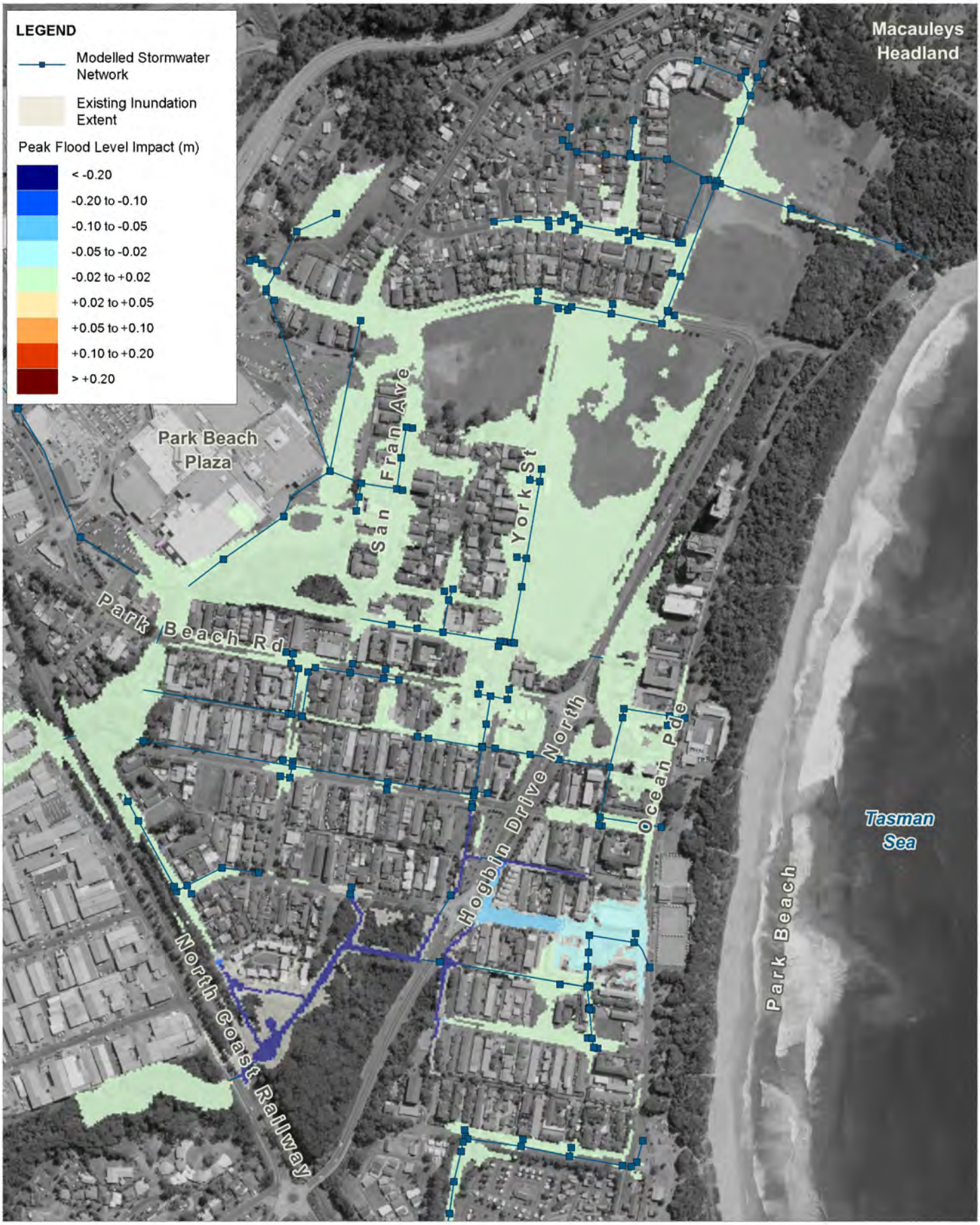
0 125 250m

Approx. Scale

BMT WBM

www.bmtwbm.com.au

Filepath : K:\N20327_Coffs_Creek\MapInfo\Workspaces\Figures\PB_FRMS\DRG_401_171004_PB_5%AEP_Opt12b_007.wor



Title:

Railway Culvert (South) and Hogbin Drive Culvert Upgrade 2% AEP Peak Flood Level Impact

Figure: C-20

Rev: A

N

0 125 250m

Approx. Scale

BMT WBM

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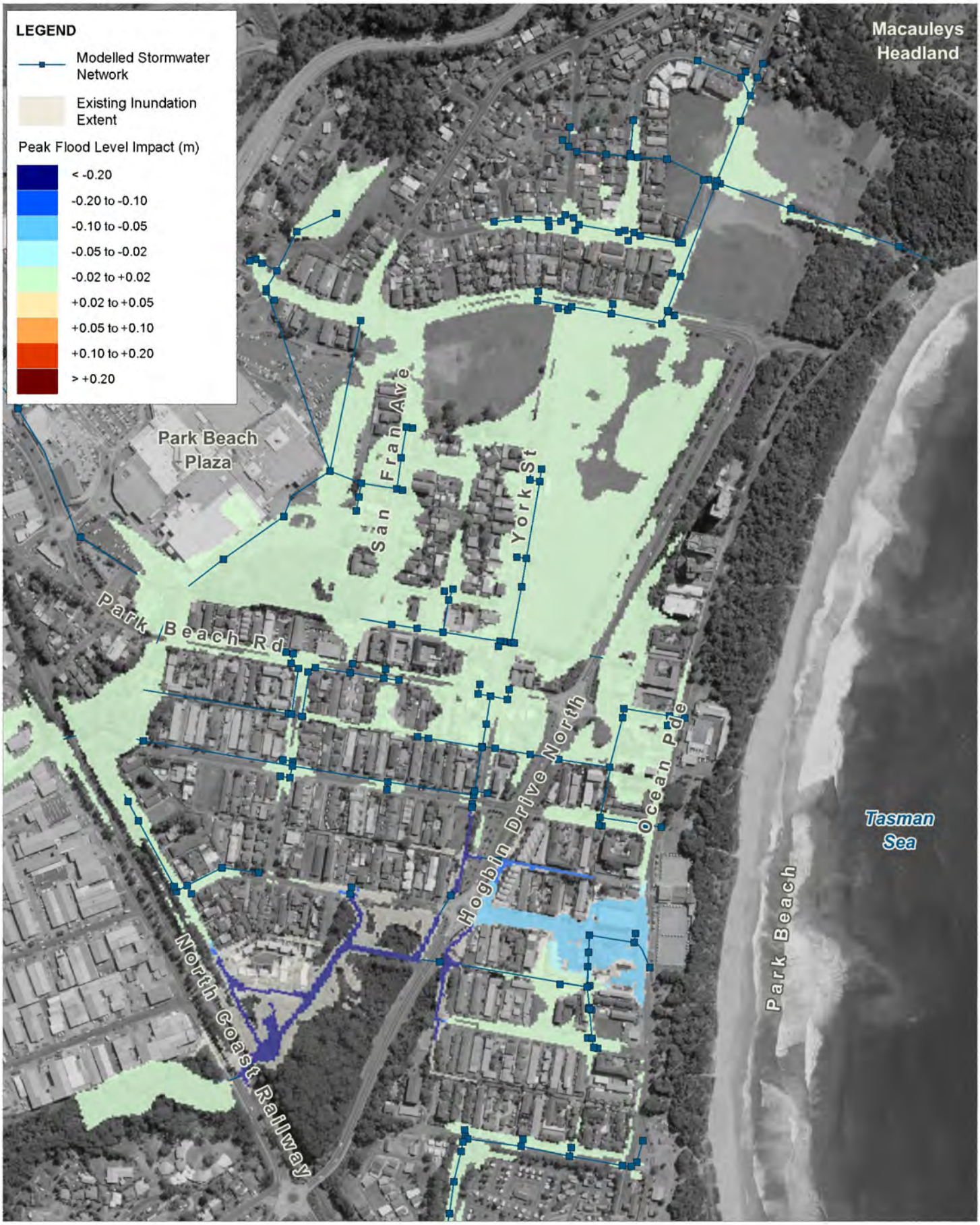
Filepath : K:\N20327_Coffs_Creek\MapInfo\Workspaces\Figures\PB_FRMS\DRG_402_171004_PB_2%AEP_Opt12b_007.wor



Title:

Railway Culvert (South) and Hogbin Drive Culvert Upgrade 1% AEP Peak Flood Level Impact

Figure: C-21

Rev: A

N

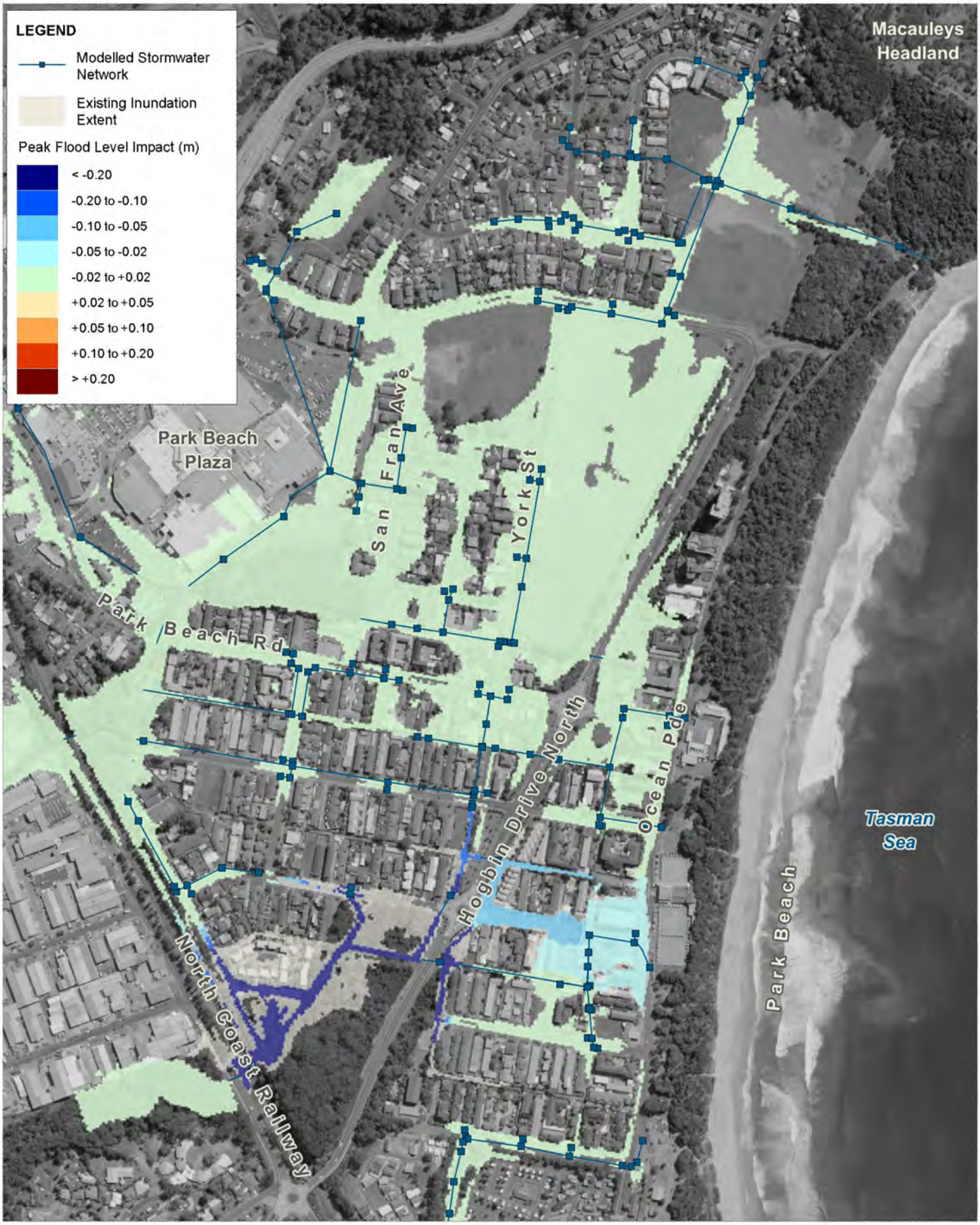
0 125 250m

Approx. Scale

BMT WBM

www.bmtwbm.com.au

Filepath : K:\N20327_Coffs_Creek\MapInfo\Workspaces\Figures\PB_FRMS\DRG_403_171004_PB_1%AEP_Opt12b_007.wor



Title:

Railway Culvert (South) and Hogbin Drive Culvert Upgrade 0.5% AEP Peak Flood Level Impact

Figure: C-22

Rev: A

N

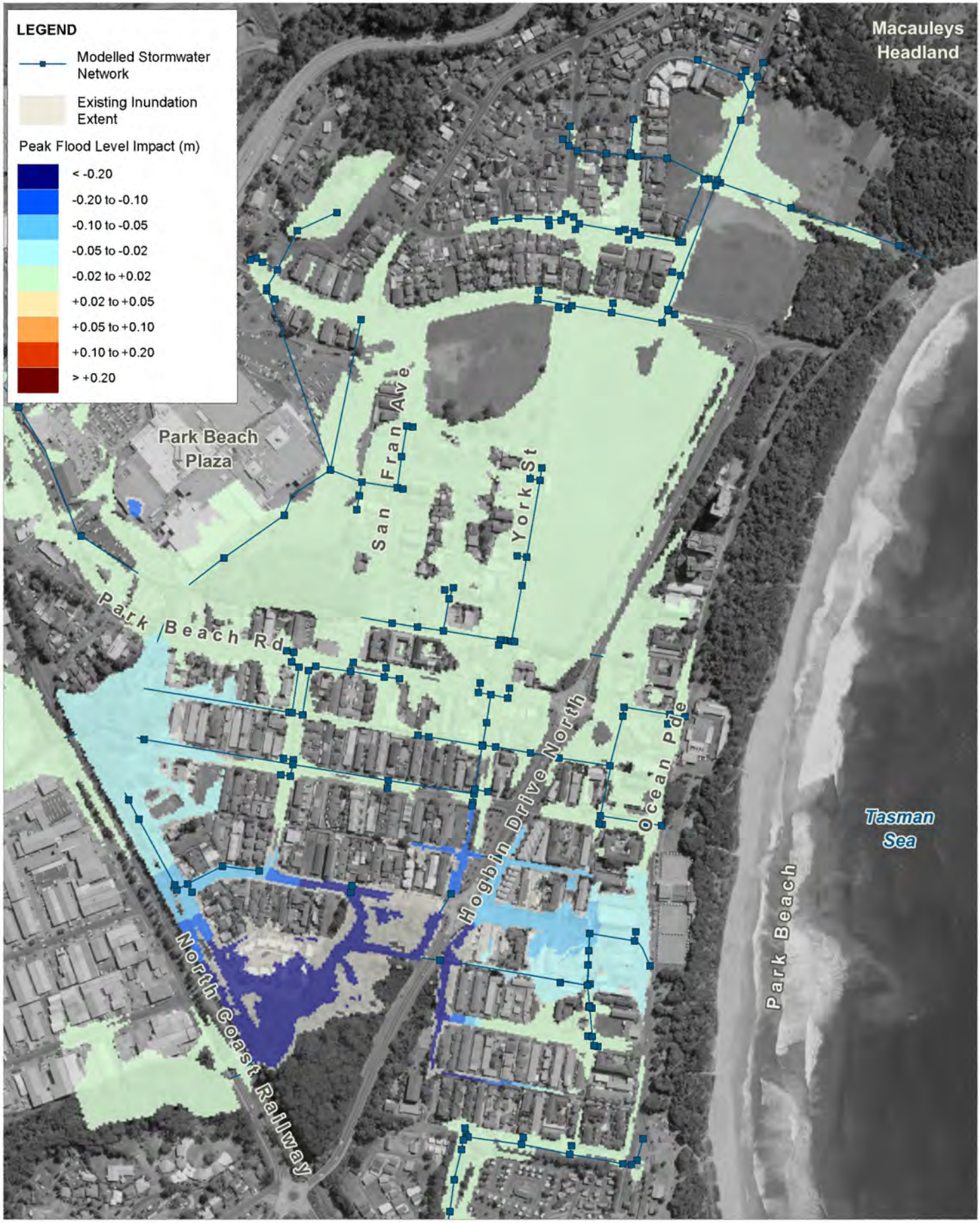
0 125 250m

Approx. Scale

BMT WBM

www.bmtwbm.com.au

Filepath : K:\N20327_Coffs_Creek\MapInfo\Workspaces\Figures\PB_FRMS\DRG_404_171004_PB_0.5%AEP_Opt12b_007.wor



Title:

Railway Culvert (South) and Hogbin Drive Culvert Upgrade 0.2% AEP Peak Flood Level Impact

Figure: C-23

Rev: A

N

0 125 250m

Approx. Scale

BMT WBM

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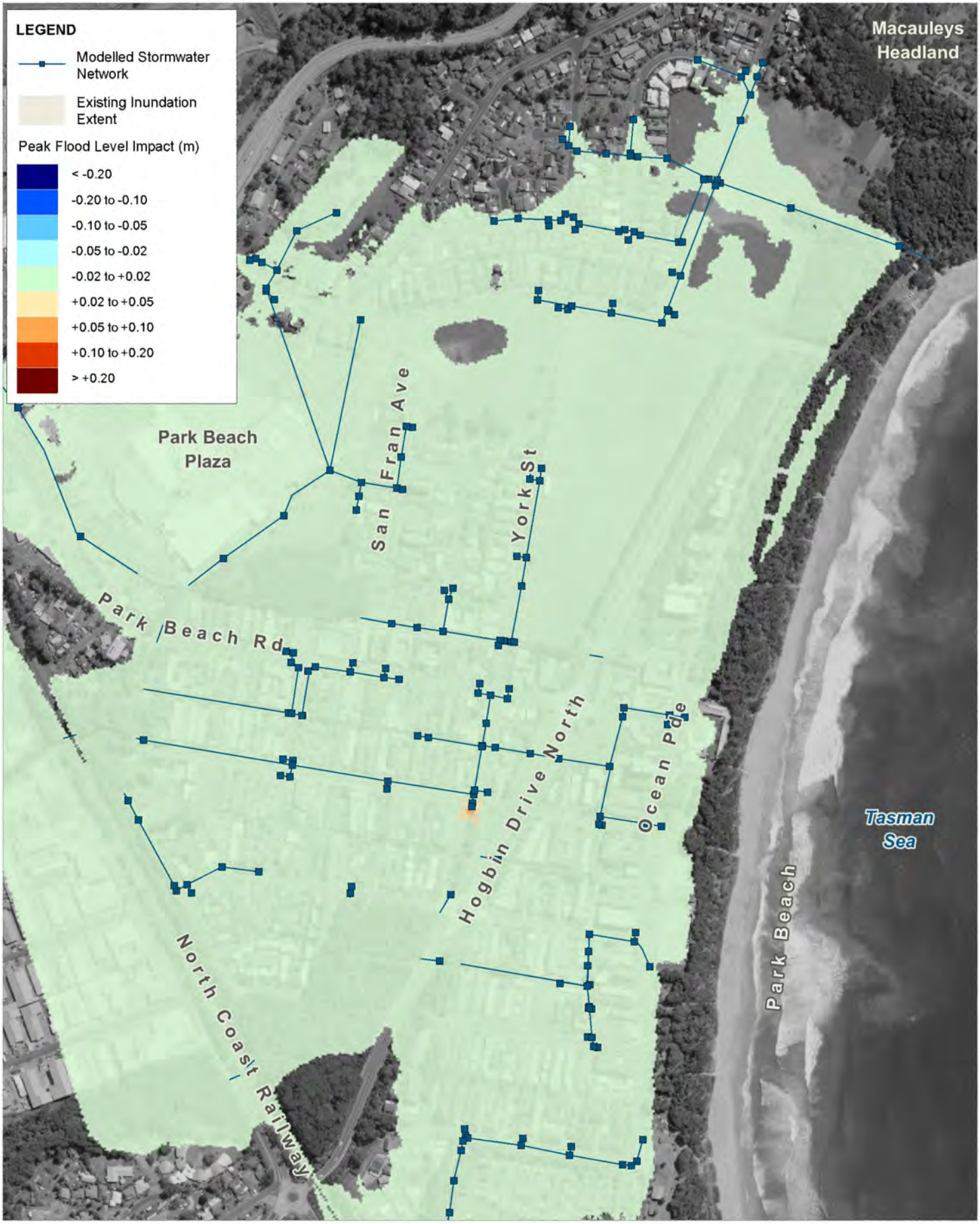
Filepath : K:\N20327_Coffs_Creek\MapInfo\Workspaces\Figures\PB_FRMS\DRG_405_171004_PB_0.2%AEP_Opt12b_007.wor



Title:

Railway Culvert (South) and Hogbin Drive Culvert Upgrade PMF Peak Flood Level Impact

Figure: C-24

Rev: A

N

0 125 250m

Approx. Scale

BMT WBM

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Appendix D Flood Modification Measures Cost Estimates

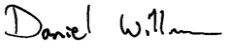
PARK BEACH FLOODPLAIN MANAGEMENT OPTIONS

BUDGETARY COST ESTIMATE

Macauleys Headland Outlet Upgrade (RCBCs)

ITEM No.	ITEM DESCRIPTION	QUANTITY	UNIT	RATE	AMOUNT
1	**SITE ESTABLISHMENT / DISESTABLISHMENT**				
	Erect temporary workers shed, provide temporary connections to services, erect fencing for plant compound, erect regulatory signs, provide complete work-as-executed drawings, and removal of above items at the conclusion of the works.	1	item	$5,000	$5,000
2	**SOIL AND WATER MANAGEMENT**				
	Construct standard sediment and erosion control devices in accordance with the "Blue Book", including mesh and gravel filters, vehicle shaker, watering of roads for dust control, barrier fencing, granular ground cover, mulching	1	item	$15,000	$15,000
3	**SITE CLEARANCE**				
	Clear site of vegetation, excavate to remove soil average 150 mm deep and spread and level on site	4680	m^2	$2	$9,360
	Cut existing turf into sods size 600 x 300mm, stack and keep watered for re-use	3060	m^2	$7	$21,420
	Demolish, remove and dispose existing road surface	150	m^2	$50	$7,500
	Break up amd remove reinforced concrete in trenches	720	m^3	$350	$252,000
4	**STORMWATER MANAGEMENT**				
	Excavate for new drainage pipes and structures in other than rock and dispose on site	9690	m^3	$55	$532,950
	1200mm RCP with RRJ (class2) to AS4058 1992	310	m	$1,000	$310,000
	Twin 2100mm x 1200mm box culvert	690	m	$3,500	$2,415,000
	Triple 2100mm x 1200mm box culvert	320	m	$5,250	$1,680,000
	Construct 900x900 junction pit	3	each	$2,500	$7,500
	Provide inlet pits (including connection to drainage line)	3	each	$5,000	$15,000
	Break into existing drainage lines and provide connections to new pits	4	each	$1,000	$4,000
	Reinforced concrete headwall foundation including excavation	6	m^3	$490	$2,940
	Reinforced concrete headwall 200mm thick including formwork	7	m^2	$410	$2,870
	Extra over for erosion protection	5.5	m^2	$220	$1,210
5	**REINSTATE SURFACES**				
	Level, grade, prepare and grass seed including fertilising and watering and maintaining for six months	3060	m^2	$8	$24,480
	Supply, place and compact new road pavement	150	m^2	$120	$18,000
6	**KERB AND MEDIAN CONSTRUCTION**				
	Construct standard kerb and gutter	20	m	$60	$1,200
7	**SIGNAGE AND LINEMARKING**				
	Miscellaneous	1	item	$1,000	$1,000
8	**OTHER ITEMS**				
	Consultants design fees (Planning, Survey, Roads, Drainage, Water Management, Geotechnical, Landscaping, Electrical, Sewer, Water, Telecommunications etc)	1	item	$400,000	$400,000
	Project Management fees	1	item	$270,000	$270,000
				SUB-TOTAL	**$5,996,000**
				Contingency (30%)	**$1,799,000**
				TOTAL	**$7,795,000**
	ITEMS NOT INCLUDED				
	Traffic Management Dewatering Service Relocation Management of Acid Sulfate Soils Authority Fees Legal commissions				

Prepared by: Daniel Williams
Company: BMT WBM
Position: NSW Flood Team Leader
Signed:



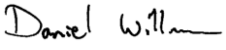
PARK BEACH FLOODPLAIN MANAGEMENT OPTIONS

BUDGETARY COST ESTIMATE

Macauleys Headland Outlet Upgrade (RCPs)

ITEM No.	ITEM DESCRIPTION	QUANTITY	UNIT	RATE	AMOUNT
1	**SITE ESTABLISHMENT / DISESTABLISHMENT**				
	Erect temporary workers shed, provide temporary connections to services, erect fencing for plant compound, erect regulatory signs, provide complete work-as-executed drawings, and removal of above items at the conclusion of the works.	1	item	$5,000	$5,000
2	**SOIL AND WATER MANAGEMENT**				
	Construct standard sediment and erosion control devices in accordance with the "Blue Book", including mesh and gravel filters, vehicle shaker, watering of roads for dust control, barrier fencing, granular ground cover, mulching	1	item	$15,000	$15,000
3	**SITE CLEARANCE**				
	Clear site of vegetation, excavate to remove soil average 150 mm deep and spread and level on site	5630	m^2	$2	$11,260
	Cut existing turf into sods size 600 x 300mm, stack and keep watered for re-use	2230	m^2	$7	$15,610
	Demolish, remove and dispose existing road surface	130	m^2	$50	$6,500
4	**STORMWATER MANAGEMENT**				
	Excavate for new drainage pipes and structures in other than rock and dispose on site	8200	m^3	$55	$451,000
	1200mm RCP with RRJ (class2) to AS4058 1992	2970	m	$1,000	$2,970,000
	Construct 900x900 junction pit	3	each	$2,500	$7,500
	Provide inlet pits (including connection to drainage line)	3	each	$5,000	$15,000
	Break into existing drainage lines and provide connections to new pits	4	each	$1,000	$4,000
	Reinforced concrete headwall foundation including excavation	5.1	m^3	$490	$2,499
	Reinforced concrete headwall 200mm thick including formwork	8	m^2	$410	$3,280
	Extra over for erosion protection	4.6	m^2	$220	$1,012
5	**REINSTATE SURFACES**				
	Level, grade, prepare and grass seed including fertilising and watering and maintaining for six months	3060	m^2	$8	$24,480
	Supply, place and compact new road pavement	150	m^2	$120	$18,000
6	**KERB AND MEDIAN CONSTRUCTION**				
	Construct standard kerb and gutter	20	m	$60	$1,200
7	**SIGNAGE AND LINEMARKING**				
	Miscellaneous	1	item	$1,000	$1,000
8	**OTHER ITEMS**				
	Consultants design fees (Planning, Survey, Roads, Drainage, Water Management, Geotechnical, Landscaping, Electrical, Sewer, Water, Telecommunications etc)	1	item	$270,000	$270,000
	Project Management fees	1	item	$180,000	$180,000
				SUB-TOTAL	**$4,002,000**
				Contingency (30%)	**$1,201,000**
				TOTAL	**$5,203,000**
	ITEMS NOT INCLUDED				
	Traffic Management				
	Dewatering				
	Service Relocation				
	Management of Acid Sulfate Soils				
	Authority Fees				
	Legal commissions				

Prepared by: Daniel Williams
Company: BMT WBM
Position: NSW Flood Team Leader
Signed:



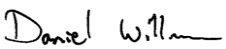
PARK BEACH FLOODPLAIN MANAGEMENT OPTIONS

BUDGETARY COST ESTIMATE

Railway Culvert Upgrade (North Location)

ITEM No.	ITEM DESCRIPTION	QUANTITY	UNIT	RATE	AMOUNT
1	**SITE ESTABLISHMENT / DISESTABLISHMENT**				
	Erect temporary workers shed, provide temporary connections to services, erect fencing for plant compound, erect regulatory signs, provide complete work-as-executed drawings, and removal of above items at the conclusion of the works.	1	item	$5,000	$5,000
2	**SOIL AND WATER MANAGEMENT**				
	Construct standard sediment and erosion control devices in accordance with the "Blue Book", including mesh and gravel filters, vehicle shaker, watering of roads for dust control, barrier fencing, granular ground cover, mulching	1	item	$15,000	$15,000
3	**STORMWATER MANAGEMENT**				
	Upgrade railway culvert to triple 3000mm x 2700mm RCBC (removal of existing culvert, cost of and instalation of new culvert, construction of apron slabs and wing-walls and repair of embankment including backfill and geo-textiles).	1	each	$502,700	$502,700
4	**OTHER ITEMS**				
	Consultants design fees (Planning, Survey, Roads, Drainage, Water Management, Geotechnical, Landscaping, Electrical, Sewer, Water, Telecommunications etc)	1	item	$40,000	$40,000
	Project Management fees	1	item	$30,000	$30,000
				SUB-TOTAL	**$593,000**
				Contingency (30%)	**$178,000**
				TOTAL	**$771,000**
	ITEMS NOT INCLUDED				
	Traffic Management Dewatering Service Relocation Management of Acid Sulfate Soils Authority Fees Legal commissions				

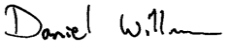
Prepared by: Daniel Williams
Company: BMT WBM
Position: NSW Flood Team Leader
Signed:



PARK BEACH FLOODPLAIN MANAGEMENT OPTIONS
BUDGETARY COST ESTIMATE
York St Oval Outlet

ITEM No.	ITEM DESCRIPTION	QUANTITY	UNIT	RATE	AMOUNT
1	**SITE ESTABLISHMENT / DISESTABLISHMENT**				
	Erect temporary workers shed, provide temporary connections to services, erect fencing for plant compound, erect regulatory signs, provide complete work-as-executed drawings, and removal of above items at the conclusion of the works.	1	item	$5,000	$5,000
2	**SOIL AND WATER MANAGEMENT**				
	Construct standard sediment and erosion control devices in accordance with the "Blue Book", including mesh and gravel filters, vehicle shaker, watering of roads for dust control, barrier fencing, granular ground cover, mulching	1	item	$15,000	$15,000
3	**SITE CLEARANCE**				
	Demolish, remove and dispose of existing garden beds	800	m^2	$50	$40,000
	Clear site of vegetation, excavate to remove soil average 150 mm deep and spread and level on site	560	m^2	$2	$1,120
	Cut existing turf into sods size 600 x 300mm, stack and keep watered for re-use	1320	m^2	$7	$9,240
	Demolish, remove and dispose existing road surface	820	m^2	$50	$41,000
	Break up amd remove reinforced concrete in trenches	200	m^3	$350	$70,000
4	**STORMWATER MANAGEMENT**				
	Excavate for new drainage pipes and structures in other than rock and dispose on site	3090	m^3	$55	$169,950
	2400mm x 1200mm box culvert	745	m	$2,750	$2,048,750
	Construct 900x900 junction pit	3	each	$2,500	$7,500
	Provide inlet pits (including connection to drainage line)	7	each	$5,000	$35,000
	Break into existing drainage lines and provide connections to new pits	5	each	$1,000	$5,000
	Reinforced concrete headwall foundation including excavation	3	m^3	$490	$1,470
	Reinforced concrete headwall 200mm thick including formwork	4.8	m^2	$410	$1,968
	Extra over for erosion protection	2.5	m^2	$220	$550
5	**REINSTATE SURFACES**				
	Existing landscaped areas	800	m^2	$5	$3,760
	Level, grade, prepare and grass seed including fertilising and watering and maintaining for six months	1320	m^2	$8	$10,560
	Supply, place and compact new road pavement	820	m^2	$120	$98,400
6	**KERB AND MEDIAN CONSTRUCTION**				
	Construct standard kerb and gutter	30	m	$60	$1,800
	Construct standard mountable kerb	10	m	$50	$500
7	**SIGNAGE AND LINEMARKING**				
	Miscellaneous	1	item	$1,000	$1,000
8	**OTHER ITEMS**				
	Consultants design fees (Planning, Survey, Roads, Drainage, Water Management, Geotechnical, Landscaping, Electrical, Sewer, Water, Telecommunications etc)	1	item	$190,000	$190,000
	Project Management fees	1	item	$130,000	$130,000
				SUB-TOTAL	**$2,888,000**
				Contingency (30%)	**$866,000**
				TOTAL	**$3,754,000**
	ITEMS NOT INCLUDED				
	Traffic Management				
	Dewatering				
	Service Relocation				
	Management of Acid Sulfate Soils				
	Authority Fees				
	Legal commissions				

Prepared by: Daniel Williams
Company: BMT WBM
Position: NSW Flood Team Leader
Signed:



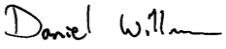
PARK BEACH FLOODPLAIN MANAGEMENT OPTIONS

BUDGETARY COST ESTIMATE

Railway Culvert Upgrade (South Location), Hogbin Drive Culvert Upgrade and Channel Works

ITEM No.	ITEM DESCRIPTION	QUANTITY	UNIT	RATE	AMOUNT
1	**SITE ESTABLISHMENT / DISESTABLISHMENT**				
	Erect temporary workers shed, provide temporary connections to services, erect fencing for plant compound, erect regulatory signs, provide complete work-as-executed drawings, and removal of above items at the conclusion of the works.	1	item	$5,000	$5,000
2	**SOIL AND WATER MANAGEMENT**				
	Construct standard sediment and erosion control devices in accordance with the "Blue Book", including mesh and gravel filters, vehicle shaker, watering of roads for dust control, barrier fencing, granular ground cover, mulching	1	item	$15,000	$15,000
3	**SITE CLEARANCE**				
	Clear site of vegetation, excavate to remove soil average 150 mm deep and spread and level on site	1920	m^2	$2	$3,840
	Demolish, remove and dispose existing road surface	260	m^2	$50	$13,000
4	**STORMWATER MANAGEMENT**				
	Excavate for new drainage pipes and structures in other than rock and dispose on site	2890	m^3	$55	$158,950
	Dewatering of excavated trenches	170	m^2	$60	$10,200
	Twin 1200mm RCP with RRJ (class2) to AS4058 1992	15	m	$1,600	$24,000
	Triple 1200mm RCP with RRJ (class2) to AS4058 1992	30	m	$2,400	$72,000
	Reinforced concrete headwall foundation including excavation	7.2	m^3	$490	$3,528
	Reinforced concrete headwall 200mm thick including formwork	12.5	m^2	$410	$5,125
	Extra over for erosion protection	6.2	m^2	$220	$1,364
	Upgrade railway culvert to triple 1200mm x 900m RCBC (removal of existing culvert, cost of and instalation of new culvert, construction of apron slabs and wing-walls and repair of embankment including backfill and geo-textiles).	1	each	$347,500	$347,500
5	**REINSTATE SURFACES**				
	Supply, place and compact new road pavement	260	m^2	$120	$31,200
6	**KERB AND MEDIAN CONSTRUCTION**				
	Construct standard kerb and gutter	20	m	$60	$1,200
7	**SIGNAGE AND LINEMARKING**				
	Miscellaneous	1	item	$1,000	$1,000
8	**OTHER ITEMS**				
	Consultants design fees (Planning, Survey, Roads, Drainage, Water Management, Geotechnical, Landscaping, Electrical, Sewer, Water, Telecommunications etc)	1	item	$50,000	$50,000
	Project Management fees	1	item	$30,000	$30,000
				SUB-TOTAL	**$773,000**
				Contingency (30%)	**$232,000**
				TOTAL	**$1,005,000**
	ITEMS NOT INCLUDED				
	Traffic Management Dewatering Service Relocation Management of Acid Sulfate Soils Authority Fees Legal commissions				

Prepared by: Daniel Williams
Company: BMT WBM
Position: NSW Flood Team Leader
Signed:



Appendix E Design Flood Mapping

Title:

Coffs Creek & Park Beach Flood Study
5% AEP Modelled Peak Flood Depths, Velocities & Water Levels

Figure: **E-1**

Rev: **A**

N

0 125 250m

Approx. Scale

BMT WBM
www.bmtwbm.com.au

Filepath : K:\N20327_Coffs_Creek\MapInfo\Workspaces\Mapping\PB_FRMS\DRG_A01_PB_5%AEP_Results.WOR

Title:

Coffs Creek & Park Beach Flood Study
2% AEP Modelled Peak Flood Depths, Velocities & Water Levels

Figure: **E-2**

Rev: **A**

N

0 125 250m

Approx. Scale

BMT WBM
www.bmtwbm.com.au

Filepath : K:\N20327_Coffs_Creek\MapInfo\Workspaces\Mapping\PB_FRMS\DRG_A02_PB_2%AEP_Results.WOR

Title:

Coffs Creek & Park Beach Flood Study
1% AEP Modelled Peak Flood Depths, Velocities & Water Levels

Figure: **E-3**

Rev: **A**

N

0 125 250m

Approx. Scale

BMT WBM
www.bmtwbm.com.au

Filepath : K:\N20327_Coffs_Creek\MapInfo\Workspaces\Mapping\PB_FRMS\DRG_A03_PB_1%AEP_Results.WOR

Title:

Coffs Creek & Park Beach Flood Study
0.5% AEP Modelled Peak Flood Depths, Velocities & Water Levels

Figure: **E-4**

Rev: **A**

N

0 125 250m

Approx. Scale

BMT WBM
www.bmtwbm.com.au

Filepath : K:\N20327_Coffs_Creek\MapInfo\Workspaces\Mapping\PB_FRMS\DRG_A04_PB_0.5%AEP_Results.WOR

Title:

Coffs Creek & Park Beach Flood Study
0.2% AEP Modelled Peak Flood Depths, Velocities & Water Levels

Figure: **E-5**

Rev: **A**

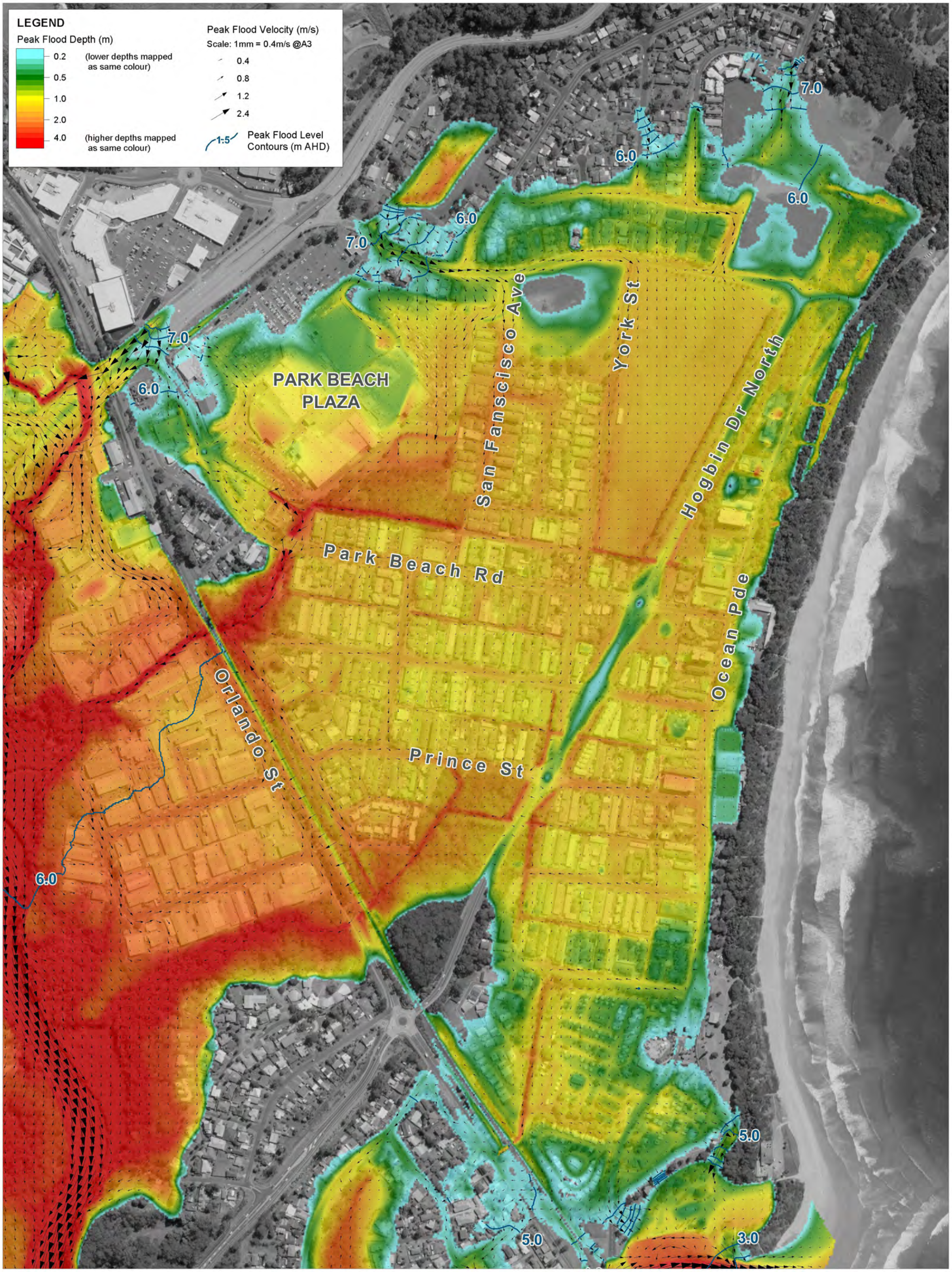
N

0 125 250m

Approx. Scale

BMT WBM
www.bmtwbm.com.au

Filepath : K:\N20327_Coffs_Creek\MapInfo\Workspaces\Mapping\PB_FRMS\DRG_A05_PB_0.2%AEP_Results.WOR



Title:

Coffs Creek & Park Beach Flood Study
PMF Modelled Peak Flood Depths, Velocities & Water Levels

Figure: E-6

Rev: A

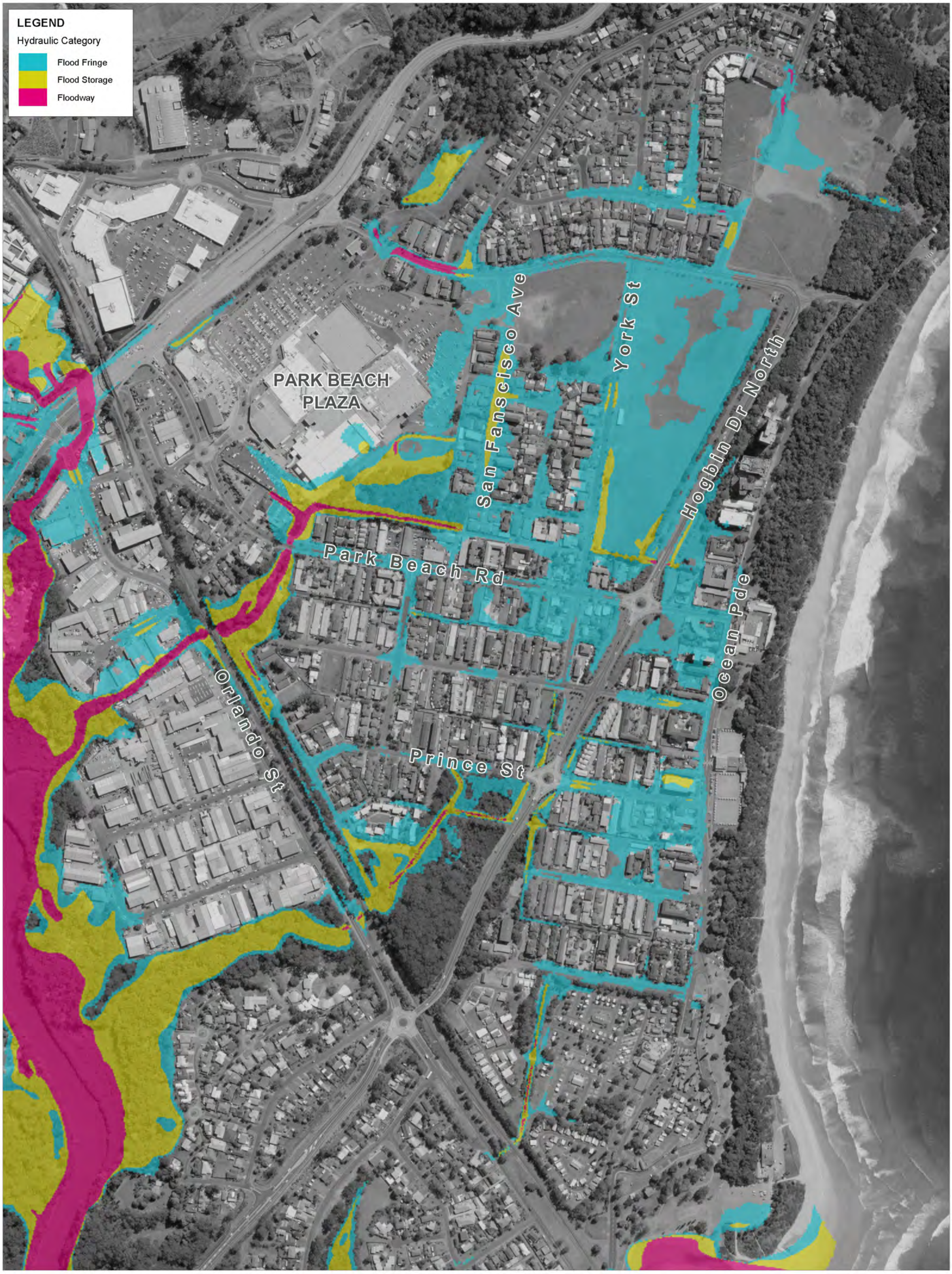
N

0 125 250m

Approx. Scale

BMT WBM
www.bmtwbm.com.au

Filepath : K:\N20327_Coffs_Creek\MapInfo\Workspaces\Mapping\PB_FRMS\DRG_A06_PB_PMF_Results.WOR



Title:

Coffs Creek & Park Beach Flood Study
Hydraulic Categorisation

Figure: E-7

Rev: A

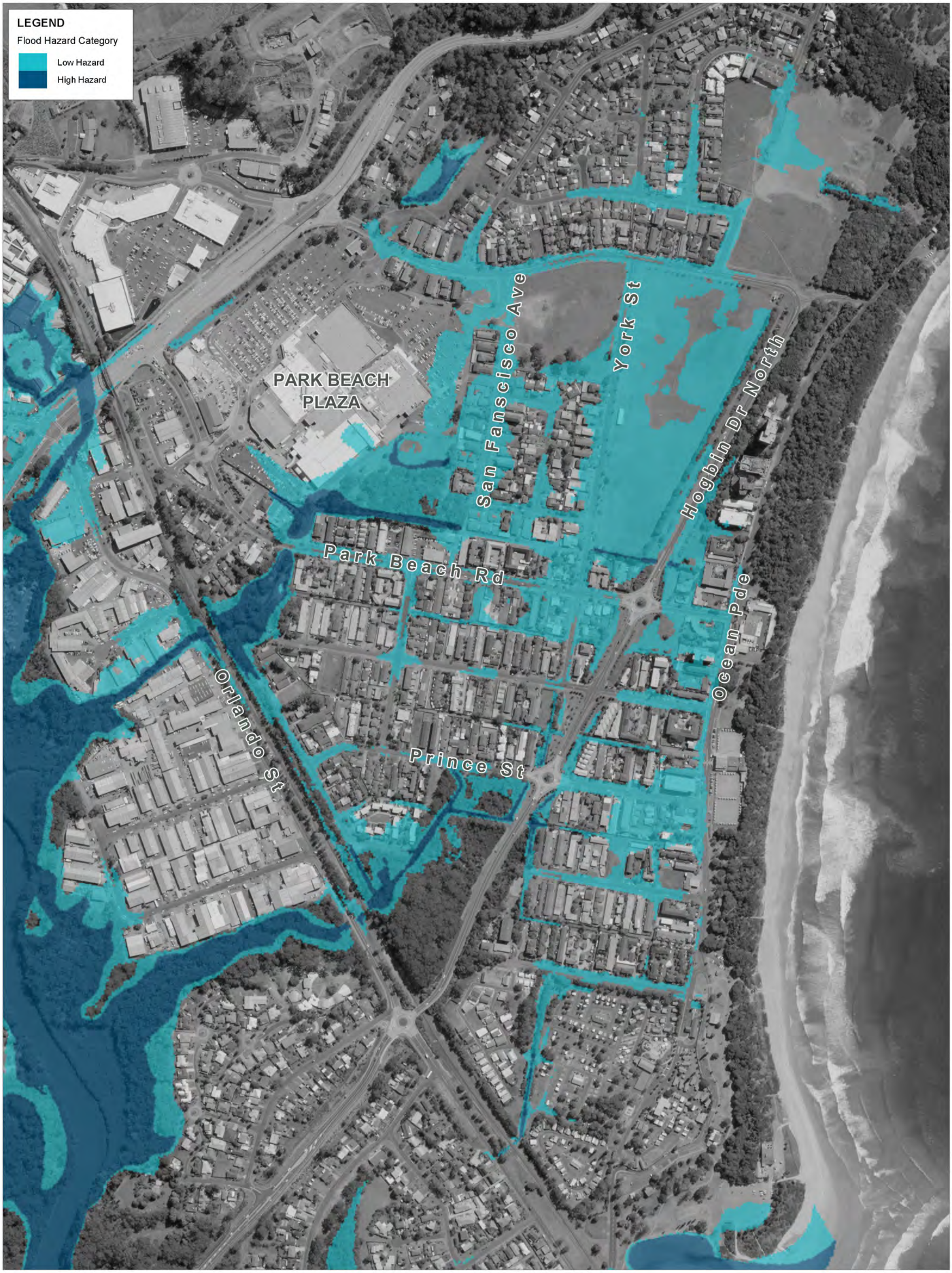
N

0 125 250m

Approx. Scale

BMT WBM
www.bmtwbm.com.au

Filepath : K:\N20327_Coffs_Creek\MapInfo\Workspaces\Mapping\PB_FRMS\DRG_A07_PB_1%AEP_HydCat.WOR



Title:

Coffs Creek & Park Beach Flood Study
Provisional Flood Hazard

Figure: **E-8**

Rev: **A**

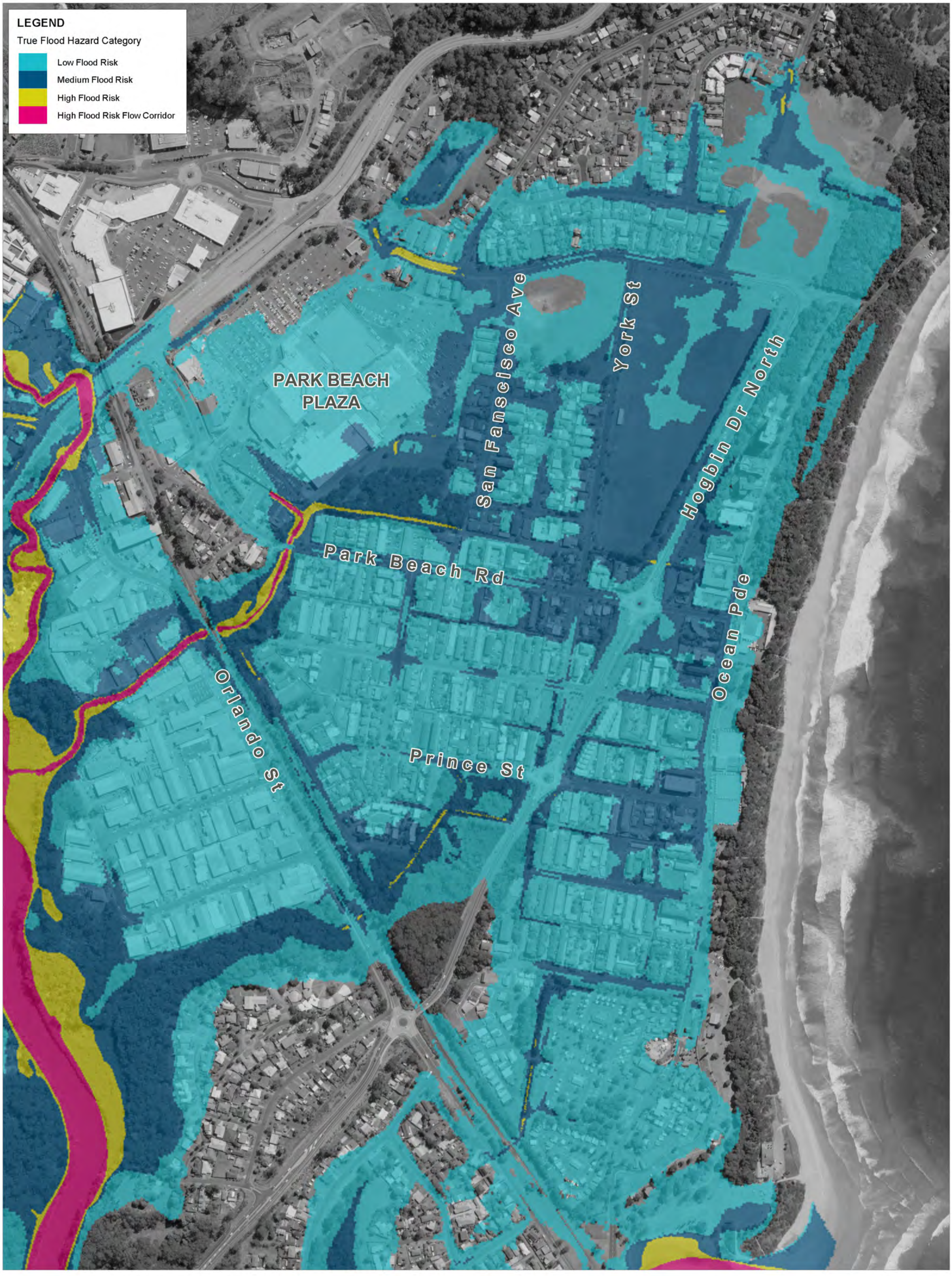
N

0 125 250m

Approx. Scale

BMT WBM
www.bmtwbm.com.au

Filepath : K:\N20327_Coffs_Creek\MapInfo\Workspaces\Mapping\PB_FRMS\DRG_A08_PB_1%AEP_Hazard.WOR



Title:

Coffs Creek & Park Beach Flood Study
True Flood Hazard

Figure: **E-9**

Rev: **A**

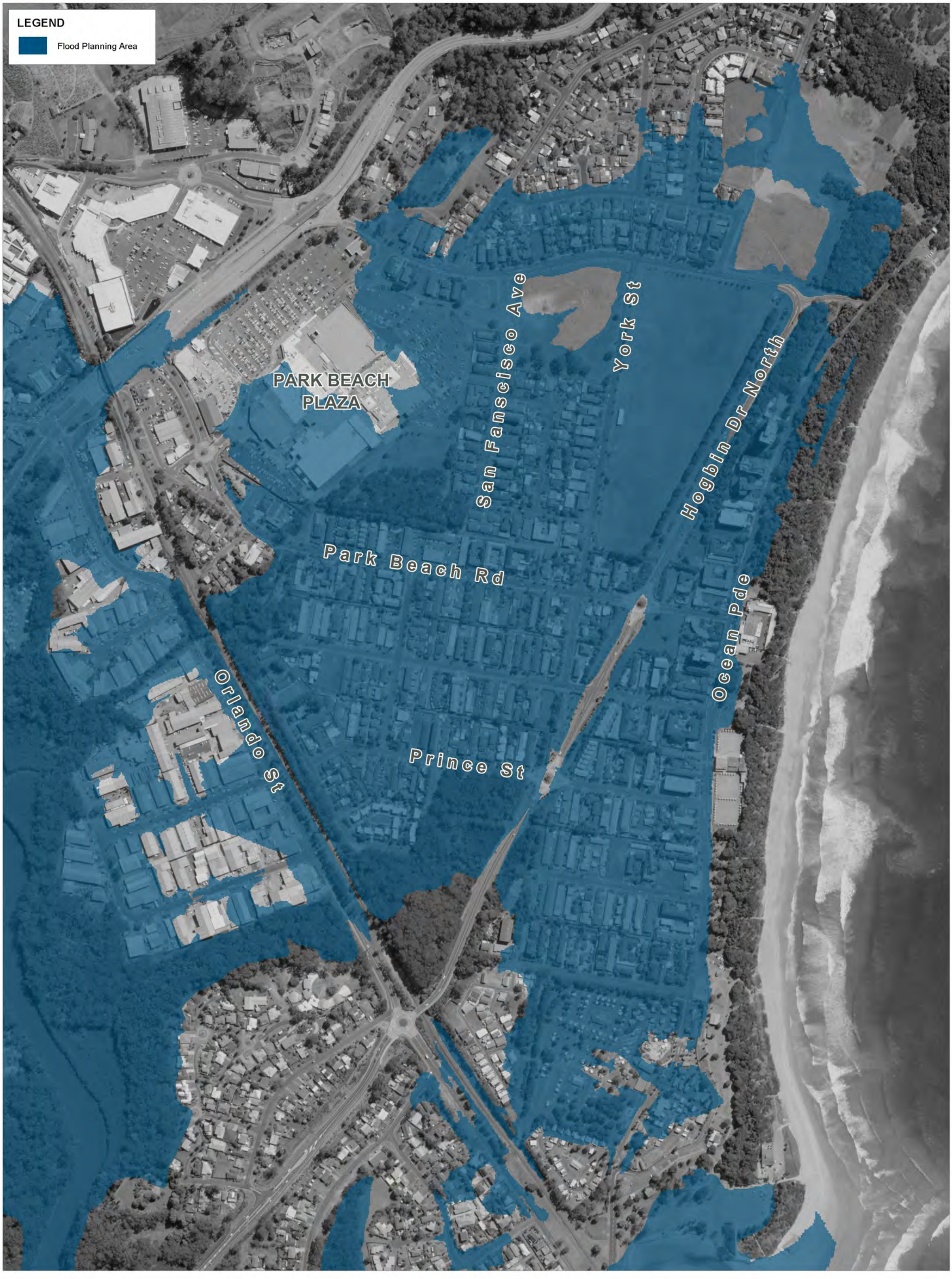
N

0 125 250m

Approx. Scale

BMT WBM
www.bmtwbm.com.au

Filepath : K:\N20327_Coffs_Creek\MapInfo\Workspaces\Mapping\PB_FRMS\DRG_A09_PB_TrueHazard.WOR



Title:

Coffs Creek & Park Beach Flood Study
Flood Planning Area

Figure: **E-10**

Rev: **A**

N

0 125 250m

Approx. Scale

BMT WBM
www.bmtwbm.com.au

Filepath : K:\N20327_Coffs_Creek\MapInfo\Workspaces\Mapping\PB_FRMS\DRG_A10_PB_1%AEP_FPA.WOR

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