Ballina Shire Council

Ballina Island and West Ballina Overland Flood Study and Flood Protection Feasibility Study and Plan

Draft Report - Appendices (Exhibition Version)

November 2021

Appendices

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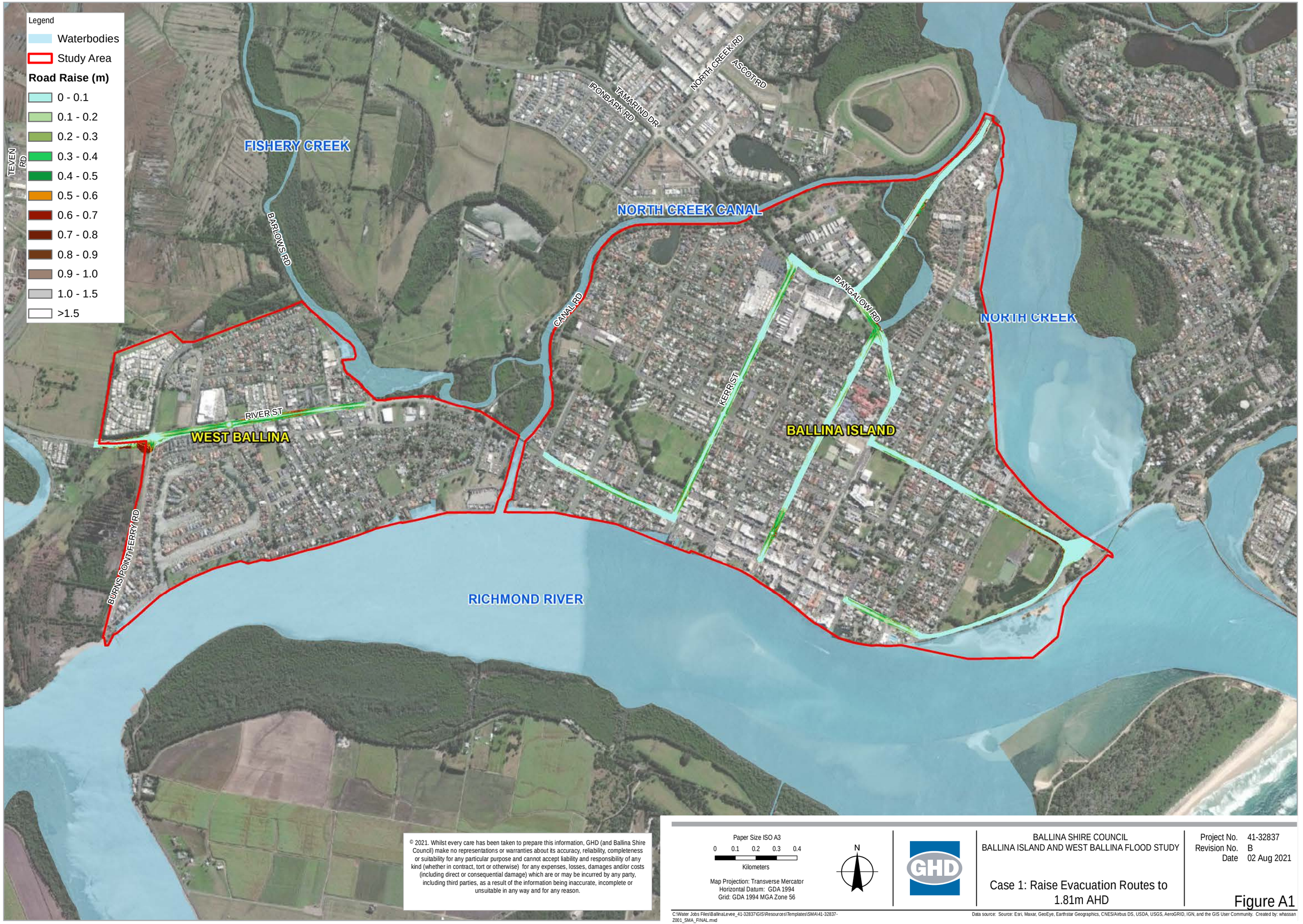
Appendices

Appendix A – Evacuation Route Raising Maps



Paper Size ISO A3

0 0.1 0.2 0.3 0.4

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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BALLINA SHIRE COUNCIL
BALLINA ISLAND AND WEST BALLINA FLOOD STUDY

Case 1: Raise Evacuation Routes to 1.81m AHD

Project No. 41-32837
Revision No. B
Date 02 Aug 2021

Figure A1

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Print date: 02 Aug 2021 - 13:34 (SMA record: 2)

Data source: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community. Created by: whassan

Legend

Waterbodies

Study Area

Road Raise (m)

- 0 - 0.1
- 0.1 - 0.2
- 0.2 - 0.3
- 0.3 - 0.4
- 0.4 - 0.5
- 0.5 - 0.6
- 0.6 - 0.7
- 0.7 - 0.8
- 0.8 - 0.9
- 0.9 - 1.0
- 1.0 - 1.5
- >1.5

FISHERY CREEK

NORTH CREEK CANAL

NORTH CREEK

WEST BALLINA

BALLINA ISLAND

RICHMOND RIVER

TEVEN RD

BARLOWS RD

IRONBARK RD

TAMARIND DR

NORTH CREEK RD

ASCOT RD

CANAL RD

BANGALOW RD

KERR ST

RIVER ST

BURNS POINT FERRY RD

Paper Size ISO A3

0 0.1 0.2 0.3 0.4

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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BALLINA SHIRE COUNCIL
BALLINA ISLAND AND WEST BALLINA FLOOD STUDY

Case 2: Raise Evacuation Routes to Level of Exiting Fill Policy (~1.9m AHD to 2.2m AHD)

Project No. 41-32837
Revision No. B
Date 02 Aug 2021

Figure A2

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Print date: 02 Aug 2021 - 13:34 (SMA record: 3)

Data source: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community. Created by: whassan

Legend

Waterbodies

Study Area

Road Raise (m)

- 0 - 0.1
- 0.1 - 0.2
- 0.2 - 0.3
- 0.3 - 0.4
- 0.4 - 0.5
- 0.5 - 0.6
- 0.6 - 0.7
- 0.7 - 0.8
- 0.8 - 0.9
- 0.9 - 1.0
- 1.0 - 1.5
- >1.5

FISHERY CREEK

NORTH CREEK CANAL

NORTH CREEK

WEST BALLINA

BALLINA ISLAND

RICHMOND RIVER

TEVEN RD

BARLOWS RD

IRONBARK RD

TAMARIND DR

NORTH CREEK RD

ASCOT RD

CANAL RD

BANGALOW RD

KERR ST

RIVER ST

BURNS POINT FERRY RD

Paper Size ISO A3

0 0.1 0.2 0.3 0.4

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

GHD

BALLINA SHIRE COUNCIL
BALLINA ISLAND AND WEST BALLINA FLOOD STUDY

Case 3: Raise Evacuation Routes to 1% AEP YR2050 Flood Level (~2.1m AHD to 2.3m AHD)

Project No. 41-32837
Revision No. B
Date 02 Aug 2021

Figure A3

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Print date: 02 Aug 2021 - 13:35 (SMA record: 4)

Data source: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community. Created by: whassan

Paper Size ISO A3

0 0.1 0.2 0.3 0.4

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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BALLINA SHIRE COUNCIL
BALLINA ISLAND AND WEST BALLINA FLOOD STUDY

Case 4: Raise Evacuation Routes to 1% AEP YR2100 Flood Level (~2.4m AHD to 2.7m AHD)

Project No. 41-32837
Revision No. B
Date 02 Aug 2021

Figure A4

C:\Water Jobs Files\BallinaLevee_41-32837\GIS\Resources\Templates\SMA\41-32837-Z001_SMA_FINAL.mxd
Print date: 02 Aug 2021 - 13:35 (SMA record: 5)

Data source: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community. Created by: whassan

Appendix B – Road Raising Unit Costs

Ballina Island and West Ballina Flood Protection Study
Road Reconstruction / Raising Costs

Road Type	Pavement width (lanes and shoulders)	Costs of road construction (less than 0.25m raising) / lineal metre of road														
		Provision for Traffic Management during construction	Clearing, stripping, remove existing, subgrade preparation	Pavements	Kerbed medians / intersection islands	K&C, incl SWD pits and pipes, and subsoil drains	Safety barriers	Footpaths / verge landscaping	Signs and lines	Traffic signals	Road lighting	Utility Services relocations	**Subtotal**	Planning, survey, investigations, design, supervision and administration / management (%)	Contingency Allowance (%)	**TOTAL**
4 lane arterial, dual carriageway, HD pavement	24m	$600	$1,800	$4,800	$300	$2,000	$100	$800	$0	$200	$0	$800	**$11,400**	$2,850.00	$7,125.00	$21,375.00
2 lane collector road	15m	$240	$1,125	$2,250	$150	$1,500	$0	$400	$0	$0	$0	$500	**$6,165**	$1,541.25	$3,853.13	$11,559.38
2 lane residential street	8m	$60	$600	$1,200	$50	$1,200	$0	$200	$0	$0	$0	$350	**$3,660**	$915.00	$2,287.50	$6,862.50

Road Type	Pavement width (lanes and shoulders)	Costs of road construction (less than 0.5m raising) / lineal metre of road														
		Provision for Traffic Management during construction	Clearing, stripping, remove existing, subgrade preparation	Pavements	Kerbed medians / intersection islands	K&C, incl SWD pits and pipes, and subsoil drains	Safety barriers	Footpaths / verge landscaping	Signs and lines	Traffic signals	Road lighting	Utility Services relocations	**Subtotal**	Planning, survey, investigations, design, supervision and administration / management (%)	Contingency Allowance (%)	**TOTAL**
4 lane arterial, dual carriageway, HD pavement	24m	$600	$1,200	$4,800	$300	$2,000	$100	$975	$50	$350	$400	$2,000	**$12,775**	$3,193.75	$7,984.38	$23,953.13
2 lane collector road	15m	$240	$750	$2,250	$150	$1,500	$0	$650	$30	$0	$200	$750	**$6,520**	$1,630.00	$4,075.00	$12,225.00
2 lane residential street	8m	$60	$400	$1,200	$50	$1,200	$0	$600	$10	$0	$100	$500	**$4,120**	$1,030.00	$2,575.00	$7,725.00

Road Type	Pavement width (lanes and shoulders)	Costs of road construction (up to 1.0m raising) / lineal metre of road																
		Provision for Traffic Management during construction	Clearing, stripping, remove existing, subgrade preparation	Pavements	Kerbed medians / intersection islands	K&C, incl SWD pits and pipes, and subsoil drains	Safety barriers	Footpaths / verge landscaping	Signs and lines	Traffic signals	Road lighting	Utility Services relocations	Retaining Walls	Earthworks	**Subtotal**	Planning, survey, investigations, design, supervision and administration / management (%)	Contingency Allowance (%)	**TOTAL**
4 lane arterial, dual carriageway, HD pavement	24m	$700	$2,400	$4,800	$300	$3,000	$100	$1,600	$50	$350	$400	$4,000	$1,100	$600	**$19,400**	$4,850.00	$12,125.00	$36,375.00
2 lane collector road	15m	$300	$1,500	$2,250	$150	$2,500	$0	$900	$30	$0	$200	$1,500	$550	$375	**$10,255**	$2,563.75	$6,409.38	$19,228.13
2 lane residential street	8m	$80	$800	$1,200	$50	$2,200	$0	$1,400	$10	$0	$100	$1,500	$550	$200	**$8,090**	$2,022.50	$5,056.25	$15,168.75

Road Type	Pavement width (lanes and shoulders)	Costs of road construction (up to 1.5m raising) / lineal metre of road																
		Provision for Traffic Management during construction	Clearing, stripping, remove existing, subgrade preparation	Pavements	Kerbed medians / intersection islands	K&C, incl SWD pits and pipes, and subsoil drains	Safety barriers	Footpaths / verge landscaping	Signs and lines	Traffic signals	Road lighting	Utility Services relocations	Retaining Walls	Earthworks	**Subtotal**	Planning, survey, investigations, design, supervision and administration / management (%)	Contingency Allowance (%)	**TOTAL**
4 lane arterial, dual carriageway, HD pavement	24m	$800	$3,600	$4,800	$600	$3,000	$100	$2,250	$50	$350	$400	$4,000	$2,200	$1,200	**$23,350**	$5,837.50	$14,593.75	$43,781.25
2 lane collector road	15m	$360	$2,700	$2,250	$150	$2,500	$0	$1,200	$30	$0	$200	$1,500	$1,100	$750	**$12,740**	$3,185.00	$7,962.50	$23,887.50
2 lane residential street	8m	$100	$2,000	$1,200	$50	$2,200	$0	$2,000	$10	$0	$100	$1,500	$1,100	$400	**$10,660**	$2,665.00	$6,662.50	$19,987.50

Road Type	Pavement width (lanes and shoulders)	Costs of road construction (up to 2.0m raising) / lineal metre of road																
		Provision for Traffic Management during construction	Clearing, stripping, remove existing, subgrade preparation	Pavements	Kerbed medians / intersection islands	K&C, incl SWD pits and pipes, and subsoil drains	Safety barriers	Footpaths / verge landscaping	Signs and lines	Traffic signals	Road lighting	Utility Services relocations	Retaining Walls	Earthworks	**Subtotal**	Planning, survey, investigations, design, supervision and administration / management (%)	Contingency Allowance (%)	**TOTAL**
4 lane arterial, dual carriageway, HD pavement	24m	$900	$4,800	$4,800	$600	$3,000	$100	$2,600	$50	$350	$400	$4,000	$3,300	$1,800	**$26,700**	$6,675.00	$16,687.50	$50,062.50
2 lane collector road	15m	$420	$3,900	$2,250	$150	$2,500	$0	$1,500	$30	$0	$200	$1,500	$1,650	$1,125	**$15,225**	$3,806.25	$9,515.63	$28,546.88
2 lane residential street	8m	$120	$3,200	$1,200	$50	$2,200	$0	$2,600	$10	$0	$100	$1,500	$1,650	$600	**$13,230**	$3,307.50	$8,268.75	$24,806.25

Assumptions:
No 'excavation' earthworks required
Property Resumptions not included (allow for some retaining walls)
Noise barriers not included
Bridges and major culverts not included (assume existing to remain)
Cost escalation not included (2021 dollars)

Disclaimer:
The information provided above is indicative only, intended to provide Council with cost sums for comparison of options. Figures are based on opinion / expectation of works required and associated costs. Actual / final costs may vary - GHD does not represent, warrant or guarantee that the works / project can or will be undertaken at a cost which is the same or less than that shown above.

Appendix C – Cost Estimate for Ballina Island Levee System

Figure C1. Ballina Island Levee (Levee Sub-Sections 1 to 13)

Table C1. Ballina Island Flood Levee Cost Estimate (AACE Class 5) Summary

Sub Section	**Estimated Cost**	
Sub Section 1: Raise River Street	$	58,490,842
Sub Section 2: Concrete Revetment Wall	$	3,050,928
Sub Section 3: Earth Levee	$	4,979,991
Sub Section 4: Concrete Revetment Wall	$	2,419,746
Sub Section 5: Concrete Revetment Wall	$	4,114,764
Sub Section 6: Earth Levee	$	3,436,598
Sub Section 7: Canal Flood Gate	$	6,458,587
Sub Section 8: Earth Levee	$	4,648,475
Sub Section 9: Concrete Revetment Wall	$	2,128,606
Sub Section 10: Earth Levee	$	2,511,947
Sub Section 11:Concrete Revetment Wall	$	688,909
Sub Section 12: Earth Levee	$	3,332,750
Sub Section 13: Concrete Revetment Wall	$	3,832,116
Total Barrier Works	$	100,094,259
Pump Infrastructure	$	2,100,000
Backflow prevention devices	$	665,000
Total Preliminary Estimate	**$**	**102,859,259**

Exclusions:

Marine and environmental approvals
Planning approvals
Geotechnical investigation
Land acquisition
Consultation
Latent Conditions
Management of ASS
Survey
Design of service relocations

BALLINA SHIRE COUNCIL
CONCEPT ESTIMATE - BALLINA ISLAND FLOOD LEVEE WORKS

Sub Section 1: Raise River Street

Item No	Description	Qty	Unit	Rate	Est Cost
1	Raise Road by Up to 0.25 m	292	m	21375	6241500
2	Raise road by 0.25 m to 0.5 m	889	m	23953	21294217
3	Raise road by 0.5 m	851	m	36375	30955125
	TOTAL ESTIMATE				$58,490,842
	(Note rates above include 50% contingency allowance)				

BALLINA SHIRE COUNCIL
CONCEPT ESTIMATE - BALLINA ISLAND FLOOD LEVEE WORKS

Sub Section 2: Concrete Revetment Wall

Item No	Description	Qty	Unit	Rate	Est Cost
1	Clearing	2404	m^2	11.4	27410
2	Excavation	342	m^3	16	5465
3	Concrete Footings	99	m^3	1100	108448
4	Concrete Wall	123	m^3	1800	221825
5	Environmental protection	1	Item	3631	3631
6	Design and documentation	1	Item	29052	29052
7	PUP relocations	1	Item	100000	100000
8	Sheet Piling Cutoff PROV	481	m	3500	1683098
9	Contingency (40%)				872000
	TOTAL ESTIMATE				$3,050,928

BALLINA SHIRE COUNCIL
CONCEPT ESTIMATE - BALLINA ISLAND FLOOD LEVEE WORKS

Sub Section 3: Earth Levee

Item No	Description	Qty	Unit	Rate	Est Cost
1	Clearing	8918	m^2	11.4	101662
2	Stripping	1550	m^3	16	24805
3	Embankment fill (Incl core)	2227	m^3	150	333993
4	Cut-off (extension of core into substrate)	1113	m^3	175	194829
5	Topsoiling	5685	m^2	13	73899
6	Vegetation of levee	5685	m^2	6	34107
7	Environmental protection	1	Item	7633	7633
8	Design and documentation	1	Item	61064	61064
9	PUP relocations	1	Item	100000	100000
10	Sheet Piling Cutoff PROV	750	m^2	3500	2625000
11	Contingency (40%)				1423000
	TOTAL ESTIMATE				$4,979,991

BALLINA SHIRE COUNCIL
CONCEPT ESTIMATE - BALLINA ISLAND FLOOD LEVEE WORKS

Sub Section 4:Concrete Revetment Wall

Item No	Description	Qty	Unit	Rate	Est Cost
1	Clearing	1975	m^2	11.4	22510
2	Excavation	238	m^3	16	3814
3	Concrete Footings	60	m^3	1100	65624
4	Concrete Wall	75	m^3	1800	134232
5	Environmental protection	1	Item	2262	2262
6	Design and documentation	1	Item	18094	18094
7	PUP relocations	1	Item	100000	100000
8	Sheet Piling Cutoff PROV	395	m^2	3500	1382210
9	Contingency (40%)				691000
	TOTAL ESTIMATE				$2,419,746

BALLINA SHIRE COUNCIL
CONCEPT ESTIMATE - BALLINA ISLAND FLOOD LEVEE WORKS

Sub Section 5:Concrete Revetment Wall

Item No	Description	Qty	Unit	Rate	Est Cost
1	Clearing	3180	m^2	11.4	36251
2	Excavation	392	m^3	16	6272
3	Concrete Footings	100	m^3	1100	110404
4	Concrete Wall	125	m^3	1800	225826
5	Environmental protection	1	Item	3788	3788
6	Design and documentation	1	Item	30300	30300
7	PUP relocations	1	Item	300000	300000
8	Sheet Piling Cutoff PROV	636	m^2	3500	2225923
9	Contingency (40%)				1176000
	TOTAL ESTIMATE				$4,114,764

BALLINA SHIRE COUNCIL
CONCEPT ESTIMATE - BALLINA ISLAND FLOOD LEVEE WORKS

Sub Section 6: Earth Levee

Item No	Description	Qty	Unit	Rate	Est Cost
1	Clearing	6188	m^2	11.4	70543
2	Stripping	1341	m^3	16	21451
3	Embankment fill (Incl core)	3666	m^3	150	549967
4	Cut-off (extension of core into substrate)	1833	m^3	175	320814
5	Topsoiling	4916	m^2	13	63905
6	Vegetation of levee	4916	m^2	6	29495
7	Environmental protection	1	Item	10562	10562
8	Design and documentation	1	Item	84494	84494
9	PUP relocations	1	Item	100000	100000
10	Sheet Piling Cutoff PROV	344	m^2	3500	1203367
11	Contingency (40%)				982000
	TOTAL ESTIMATE				$3,436,598

BALLINA SHIRE COUNCIL
CONCEPT ESTIMATE - BALLINA ISLAND FLOOD LEVEE WORKS

Sub Section 7: Canal Flood Gate

Item No	Description	Qty	Unit	Rate	Est Cost
1	Piled Concrete Structure with penstock and flap valve arrangement	171	m^2	27000	4613587
2	Contingency (40%)				1845000
	TOTAL ESTIMATE				$6,458,587

BALLINA SHIRE COUNCIL
CONCEPT ESTIMATE - BALLINA ISLAND FLOOD LEVEE WORKS

Sub Section 8: Earth Levee

Item No	Description	Qty	Unit	Rate	Est Cost
1	Clearing	8335	m^2	11.4	95016
2	Stripping	1779	m^3	16	28472
3	Embankment fill (Incl core)	4514	m^3	150	677094
4	Cut-off (extension of core into substrate)	2257	m^3	175	394972
5	Topsoiling	6525	m^2	13	84822
6	Vegetation of levee	6525	m^2	6	39148
7	Environmental protection	1	Item	13195	13195
8	Design and documentation	1	Item	105562	105562
9	PUP relocations	1	Item	200000	200000
10	Sheet Piling Cutoff PROV	481	m^2	3500	1682195
11	Contingency (40%)				1328000
	TOTAL ESTIMATE				$4,648,475

BALLINA SHIRE COUNCIL
CONCEPT ESTIMATE - BALLINA ISLAND FLOOD LEVEE WORKS

Sub Section 9:Concrete Revetment Wall

Item No	Description	Qty	Unit	Rate	Est Cost
1	Clearing	1468	m^2	11.4	16732
2	Excavation	292	m^3	16	4666
3	Concrete Footings	101	m^3	1100	111428
4	Concrete Wall	127	m^3	1800	227920
5	Environmental protection	1	Item	3607	3607
6	Design and documentation	1	Item	28860	28860
7	PUP relocations	1	Item	100000	100000
8	Sheet Piling Cutoff PROV	294	m^2	3500	1027394
9	Contingency (40%)				608000
	TOTAL ESTIMATE				$2,128,606

BALLINA SHIRE COUNCIL
CONCEPT ESTIMATE - BALLINA ISLAND FLOOD LEVEE WORKS

Sub Section 10: Earth Levee

Item No	Description	Qty	Unit	Rate	Est Cost
1	Clearing	4758	m^2	11.4	54238
2	Stripping	1061	m^3	16	16983
3	Embankment fill (Incl core)	2982	m^3	150	447322
4	Cut-off (extension of core into substrate)	1491	m^3	175	260938
5	Topsoiling	3892	m^2	13	50596
6	Vegetation of levee	3892	m^2	6	23352
7	Environmental protection	1	Item	8534	8534
8	Design and documentation	1	Item	68274	68274
9	PUP relocations	1	Item	10000	10000
10	Sheet Piling Cutoff PROV	244	m^2	3500	853710
11	Contingency (40%)				718000
	TOTAL ESTIMATE				$2,511,947

BALLINA SHIRE COUNCIL
CONCEPT ESTIMATE - BALLINA ISLAND FLOOD LEVEE WORKS

Sub Section 11:Concrete Revetment Wall

Item No	Description	Qty	Unit	Rate	Est Cost
1	Clearing	563	m^2	11.4	6413
2	Excavation	85	m^3	16	1353
3	Concrete Footings	25	m^3	1100	27459
4	Concrete Wall	31	m^3	1800	56167
5	Environmental protection	1	Item	914	914
6	Design and documentation	1	Item	850	850
7	PUP relocations	1	Item	5000	5000
8	Sheet Piling Cutoff PROV	113	m^2	3500	393754
9	Contingency (40%)				197000
	TOTAL ESTIMATE				$688,909

BALLINA SHIRE COUNCIL
CONCEPT ESTIMATE - BALLINA ISLAND FLOOD LEVEE WORKS

Sub Section 12: Earth Levee

Item No	Description	Qty	Unit	Rate	Est Cost
1	Clearing	6421	m^2	11.4	73200
2	Stripping	117	m^3	16	1872
3	Embankment fill (Incl core)	3060	m^3	150	458948
4	Cut-off (extension of core into substrate)	1530	m^3	175	267719
5	Topsoiling	4918	m^2	13	63936
6	Vegetation of levee	4918	m^2	6	29509
7	Environmental protection	1	Item	8952	8952
8	Design and documentation	1	Item	71615	71615
9	PUP relocations	1	Item	40000	40000
10	Sheet Piling Cutoff PROV	390	m^2	3500	1365000
11	Contingency (40%)				952000
	TOTAL ESTIMATE				$3,332,750

BALLINA SHIRE COUNCIL
CONCEPT ESTIMATE - BALLINA ISLAND FLOOD LEVEE WORKS

Sub Section 13: Concrete Revetment Wall

Item No	Description	Qty	Unit	Rate	Est Cost
1	Clearing	3206	m^2	11.4	36547
2	Excavation	383	m^3	16	6129
3	Concrete Footings	95	m^3	1100	104383
4	Concrete Wall	119	m^3	1800	213510
5	Environmental protection	1	Item	3606	3606
6	Design and documentation	1	Item	28846	28846
7	PUP relocations	1	Item	100000	100000
8	Sheet Piling Cutoff PROV	641	m^2	3500	2244095
9	Contingency (40%)				1095000
	TOTAL ESTIMATE				$3,832,116

BALLINA SHIRE COUNCIL
CONCEPT ESTIMATE - BALLINA ISLAND FLOOD LEVEE WORKS

Pump out facilities

Item No	Description	Qty	Unit	Rate		Est Cost
1	Supply of portable pump units (200 l/s)	10	no	110000	$	1,100,000.00
2	Construction of pump sumps/chambers	10	no	30000	$	300,000.00
3	Access Hardstands for pumping operation	10	no	10000	$	100,000.00
4	Contingency (40%)					600000
	TOTAL ESTIMATE					$2,100,000

Levee embankment costing basis

The levee embankment material quantity has been calculated based on the following:

- Levee to elevation shown on above figures
- Levee height above terrain based on supplied topography
- Cleared width of levee footprint + 5 m
- Top width of levee = 2 m
- Side slopes 1 on 4
- Stripping of 300 mm to levee foundation
- Use of additional cut-off key (below the foundation) equivalent to 50% of the levee volume above the foundation
- Topsoiling and vegetation of levee surface
- Notional allowances for:
    - Environmental protection during construction
    - Relocation of existing services
    - Backflow prevention devices to existing tidal outlets
    - Design costs (8%)
    - Provisional item for cut-off sheet piling where substrate conditions are not favourable (based on 10 m deep sheet piling)
    - 40% Contingency sum (excludes cost of provision of sheet piling)

Concrete barrier costing basis

The concrete barrier wall has been quantified based on:

- Wall heights calculated as per levees
- Cleared corridor of 5 metres width
- Cantilever footing with 80% of wall volume
- 300 mm cover over footing
- Average wall thickness varying between 160 mm to 250 mm
- Notional allowances for:
    - Environmental protection during construction
    - Relocation of existing services
    - Backflow prevention devices to existing tidal outlets
    - Design costs (8%)
    - Provisional item for cut-off sheet piling where substrate conditions are not favourable (based on 10 m deep sheet piling)
    - 40% Contingency sum (excludes cost of provision of sheet piling)

Rates applied to the estimates quantities are based on recent GHD project experience where applicable on similar works.

Flood gate costing basis

The flood gates proposed will vary in length and height and only a coarse assessment of these has been undertaken to date.

In order to provide an initial budget figure for the cost of providing these GHD have referred to actual costs ($3.22M) advised by Brisbane City Council for the construction of a major BPD at West Creek, Milton. The structure (overall area of 120 m^2) is a significant piled concrete superstructure with a number of sizeable flood flaps and penstock gates. The cost per square meter of the overall structure was calculated to be $26,800, and this rate has been applied to the estimated areas required for the flood gates included in the defend options.

Pump Infrastructure costing basis:

Pump cost estimates are based on the following assumptions:

* 10x 200L/s pumps required in Ballina Island at a cost of $110K per pump.
* 10x 200L/s pumps required in West Ballina at a cost of $110K per pump.
* $40K allowance for associated pump infrastructure including pump sumps/chambers and access hardstands for pump operations.
* 40% contingency .

It is noted that a detailed internal drainage study would be required to identify the location and number of pumps required to manage coincident local flooding within the protected area located behind levee systems.

Appendix D – Cost Estimate for West Ballina Levee System

Figure D1. West Ballina Flood Levee (Levee Sub-Sections 1 to 19)

Table D1. West Ballina Flood Levee Cost Estimate (Class AACE 5) Summary

Sub Section	Estimated Cost	
Sub Section 1: Earth Levee	$	881,989
Sub Section 2: Canal Flood Gate	$	6,251,502
Sub Section 3: Concrete Revetment Wall	$	6,947,512
Sub Section 4: Earth Levee	$	2,237,416
Sub Section 5: Concrete Revetment Wall	$	1,106,052
Sub Section 6: Concrete Revetment Wall	$	129,698
Sub Section 7: Concrete Revetment Wall	$	5,385,265
Sub Section 8: Earth Levee	$	2,316,604
Sub Section 9: Estruarine Flood Gate	$	2,368,825
Sub Section 10: Earth Levee	$	11,906,935
Sub Section 11: Canal Flood Gate	$	2,782,948
Sub Section 12: Foreshore Flood Gate	$	1,425,406
Sub Section 13:Concrete Revetment Wall	$	1,962,653
Sub Section 14: Earth Levee	$	5,484,596
Sub Section 15:Concrete Revetment Wall	$	1,547,009
Sub Section 17: Flood Gate	$	826,639
Sub Section 18: Foreshore Flood Gate	$	1,081,825
Sub Section 19: Earth Levee	$	2,096,684
Total Barrier Works	$	56,739,559
Pump infrastructure	$	2,100,000
Backflow prevention devices	$	190,000
Total Preliminary Estimate	**$**	**59,029,559**

Exclusions:

Marine and environmental approvals
Planning approvals
Geotechnical investigation
Land acquisition
Consultation
Latent Conditions
Management of ASS
Survey
Design of service relocations

BALLINA SHIRE COUNCIL
CONCEPT ESTIMATE - WEST BALLINA FLOOD LEVEE WORKS

Sub Section 1: Earth Levee

Item No	Description	Qty	Unit	Rate	Est Cost
1	Clearing	1681	m^2	11	19168
2	Stripping	339	m^3	16	5426
3	Embankment fill (Incl core)	721	m^3	150	108221
4	Cut-off (extension of core into substrate)	361	m^3	175	63129
5	Topsoiling	1243	m^2	13	16165
6	Vegetation of levee	1243	m^2	6	7461
7	Environmental protection	1	Item	2196	2196
8	Design and documentation	1	Item	17566	17566
9	PUP relocations	1	Item	5000	5000
10	Sheet Piling Cutoff PROV	110	m	3500	385658
11	Contingency (40%)				252000
	TOTAL ESTIMATE				$881,989

BALLINA SHIRE COUNCIL
CONCEPT ESTIMATE - WEST BALLINA FLOOD LEVEE WORKS

Sub Section 2: Canal Flood Gate

Item No	Description	Qty	Unit	Rate	Est Cost
1	Piled Concrete Structure with penstock and flap valve arrangement	165	m^2	27000	4465502
2	Contingency (40%)				1786000
	TOTAL ESTIMATE				$ 6,251,502.31

BALLINA SHIRE COUNCIL
CONCEPT ESTIMATE - WEST BALLINA FLOOD LEVEE WORKS

Sub Section 3: Concrete Revetment Wall

Item No	Description	Qty	Unit	Rate	Est Cost
1	Clearing	5630	m^2	11	64187
2	Excavation	852	m^3	16	13628
3	Concrete Footings	256	m^3	1100	281996
4	Concrete Wall	320	m^3	1800	576809
5	Environmental protection	1	Item	4683	4683
6	Design and documentation	1	Item	74930	74930
7	PUP relocations	1	Item	5000	5000
8	Sheet Piling Cutoff PROV	1126	m	3500	3941280
9	Contingency (40%)				1985000
	TOTAL ESTIMATE				$6,947,512

BALLINA SHIRE COUNCIL
CONCEPT ESTIMATE - WEST BALLINA FLOOD LEVEE WORKS

Sub Section 4: Earth Levee

Item No	Description	Qty	Unit	Rate	Est Cost
1	Clearing	4173	m^2	11	47573
2	Stripping	730	m^3	16	11685
3	Embankment fill (Incl core)	1101	m^3	150	165160
4	Cut-off (extension of core into substrate)	551	m^3	175	96343
5	Topsoiling	803	m^2	13	10443
6	Vegetation of levee	803	m^2	6	4820
7	Environmental protection	1	Item	3360	3360
8	Design and documentation	1	Item	26882	26882
9	PUP relocations	1	Item	15000	15000
10	Sheet Piling Cutoff PROV	348	m	3500	1217150
11	Contingency (40%)				639000
	TOTAL ESTIMATE				$2,237,416

BALLINA SHIRE COUNCIL
CONCEPT ESTIMATE - WEST BALLINA FLOOD LEVEE WORKS

Sub Section 5: Concrete Revetment Wall

Item No	Description	Qty	Unit	Rate	Est Cost
1	Clearing	888	m^2	11	10124
2	Excavation	123	m^3	16	1965
3	Concrete Footings	34	m^3	1100	37718
4	Concrete Wall	43	m^3	1800	77150
5	Environmental protection	1	Item	1270	1270
6	Design and documentation	1	Item	10157	10157
7	PUP relocations	1	Item	30000	30000
8	Sheet Piling Cutoff PROV	178	m	3500	621670
9	Contingency (40%)				316000
	TOTAL ESTIMATE				$1,106,052

BALLINA SHIRE COUNCIL
CONCEPT ESTIMATE - WEST BALLINA FLOOD LEVEE WORKS

Sub Section 6: Concrete Revetment Wall

Item No	Description	Qty	Unit	Rate	Est Cost
1	Clearing	104	m^2	11	1183
2	Excavation	12	m^3	16	198
3	Concrete Footings	4	m^3	1100	4084
4	Concrete Wall	5	m^3	1800	8353
5	Environmental protection	1	Item	138	138
6	Design and documentation	1	Item	1105	1105
7	PUP relocations	1	Item	5000	5000
8	Sheet Piling Cutoff PROV	21	m	3500	72635
9	Contingency (40%)				37000
	TOTAL ESTIMATE				$129,698

BALLINA SHIRE COUNCIL
CONCEPT ESTIMATE - WEST BALLINA FLOOD LEVEE WORKS

Sub Section 7: Concrete Revetment Wall

Item No	Description	Qty	Unit	Rate	Est Cost
1	Clearing	4453	m^2	11	50766
2	Excavation	605	m^3	16	9672
3	Concrete Footings	168	m^3	1100	184711
4	Concrete Wall	210	m^3	1800	377819
5	Environmental protection	1	Item	6230	6230
6	Design and documentation	1	Item	49837	49837
7	PUP relocations	1	Item	50000	50000
8	Sheet Piling Cutoff PROV	891	m	3500	3117230
9	Contingency (40%)				1539000
	TOTAL ESTIMATE				$5,385,265

BALLINA SHIRE COUNCIL
CONCEPT ESTIMATE - WEST BALLINA FLOOD LEVEE WORKS

Sub Section 8: Earth Levee

Item No	Description	Qty	Unit	Rate	Est Cost
1	Clearing	4148	m^2	11	47282
2	Stripping	861	m^3	16	13781
3	Embankment fill (Incl core)	2391	m^3	150	358704
4	Cut-off (extension of core into substrate)	1196	m^3	175	209244
5	Topsoiling	3158	m^2	13	41055
6	Vegetation of levee	3158	m^2	6	18949
7	Environmental protection	1	Item	6890	6890
8	Design and documentation	1	Item	55121	55121
9	PUP relocations	1	Item	10000	10000
10	Sheet Piling Cutoff PROV	255	m	3500	893578
11	Contingency (40%)				662000
	TOTAL ESTIMATE				$2,316,604

BALLINA SHIRE COUNCIL
CONCEPT ESTIMATE - WEST BALLINA FLOOD LEVEE WORKS

Sub Section 9: Estruarine Flood Gate

Item No	Description	Qty	Unit	Rate	Est Cost
1	Piled Concrete Structure with penstock and flap valve arrangement	63	m^2	27000	1691825.114
2	Contingency (40%)				677000
	TOTAL ESTIMATE				$ 2,368,825.11

BALLINA SHIRE COUNCIL
CONCEPT ESTIMATE - WEST BALLINA FLOOD LEVEE WORKS

Sub Section 10: Earth Levee

Item No	Description	Qty	Unit	Rate	Est Cost
1	Clearing	21931	m^2	11	250014
2	Stripping	4769	m^3	16	76311
3	Embankment fill (Incl core)	13381	m^3	150	2007148
4	Cut-off (extension of core into substrate)	6690	m^3	175	1170836
5	Topsoiling	17488	m^2	13	227342
6	Vegetation of levee	17488	m^2	6	104927
7	Environmental protection	1	Item	38366	38366
8	Design and documentation	1	Item	306926	306926
9	PUP relocations	1	Item	100000	100000
10	Sheet Piling Cutoff PROV	1207	m	3500	4223065
11	Contingency (40%)				3402000
	TOTAL ESTIMATE				$11,906,935

BALLINA SHIRE COUNCIL
CONCEPT ESTIMATE - WEST BALLINA FLOOD LEVEE WORKS

Sub Section 11: Canal Flood Gate

Item No	Description	Qty	Unit	Rate	Est Cost
1	Piled Concrete Structure with penstock and flap valve arrangement	74	m^2	27000	1987948.397
2	Contingency (40%)				795000
	TOTAL ESTIMATE				$ 2,782,948.40

BALLINA SHIRE COUNCIL
CONCEPT ESTIMATE - WEST BALLINA FLOOD LEVEE WORKS

Sub Section 12: Foreshore Flood Gate

Item No	Description	Qty	Unit	Rate	Est Cost
1	Piled Concrete Structure with penstock and flap valve arrangement	38	m^2	26824	1018406.17
2	Contingency (40%)				407000
	TOTAL ESTIMATE				$1,425,406

BALLINA SHIRE COUNCIL
CONCEPT ESTIMATE - WEST BALLINA FLOOD LEVEE WORKS

Sub Section 13:Concrete Revetment Wall

Item No	Description	Qty	Unit	Rate	Est Cost
1	Clearing	1448	m^2	11	16508
2	Excavation	179	m^3	16	2869
3	Concrete Footings	46	m^3	1100	50265
4	Concrete Wall	57	m^3	1800	102816
5	Environmental protection	1	Item	1725	1725
6	Design and documentation	1	Item	13797	13797
7	PUP relocations	1	Item	200000	200000
8	Sheet Piling Cutoff PROV	290	m	3500	1013674
9	Contingency (40%)				561000
	TOTAL ESTIMATE				$1,962,653

BALLINA SHIRE COUNCIL
CONCEPT ESTIMATE - WEST BALLINA FLOOD LEVEE WORKS

Sub Section 14: Earth Levee

Item No	Description	Qty	Unit	Rate	Est Cost
1	Clearing	9715	m^2	11	110747
2	Stripping	1997	m^3	16	31954
3	Embankment fill (Incl core)	4906	m^3	150	735877
4	Cut-off (extension of core into substrate)	2453	m^3	175	429262
5	Topsoiling	7323	m^2	13	95195
6	Vegetation of levee	7323	m^2	6	43936
7	Environmental protection	1	Item	14470	14470
8	Design and documentation	1	Item	115758	115758
9	PUP relocations	1	Item	200000	200000
10	Sheet Piling Cutoff PROV	612	m	3500	2140397
11	Contingency (40%)				1567000
	TOTAL ESTIMATE				$5,484,596

BALLINA SHIRE COUNCIL
CONCEPT ESTIMATE - WEST BALLINA FLOOD LEVEE WORKS

Sub Section 15:Concrete Revetment Wall

Item No	Description	Qty	Unit	Rate	Est Cost
1	Clearing	1366	m^2	11	15567
2	Excavation	134	m^3	16	2137
3	Concrete Footings	30	m^3	1100	33091
4	Concrete Wall	38	m^3	1800	67687
5	Environmental protection	1	Item	1185	1185
6	Design and documentation	1	Item	9479	9479
7	PUP relocations	1	Item	20000	20000
8	Sheet Piling Cutoff PROV	273	m	3500	955864
9	Contingency (40%)				442000
	TOTAL ESTIMATE				$1,547,009

BALLINA SHIRE COUNCIL
CONCEPT ESTIMATE - WEST BALLINA FLOOD LEVEE WORKS

Sub Section 17: Flood Gate

Item No	Description	Qty	Unit	Rate	Est Cost
1	Piled Concrete Structure with penstock and flap valve arrangement	22	m^2	27000	590639.33
2	Contingency (40%)				236000
	TOTAL ESTIMATE				$ 826,639.33

BALLINA SHIRE COUNCIL
CONCEPT ESTIMATE - WEST BALLINA FLOOD LEVEE WORKS

Sub Section 18: Foreshore Flood Gate

Item No	Description	Qty	Unit	Rate	Est Cost
1	Piled Concrete Structure with penstock and flap valve arrangement	29	m^2	27000	772824.7976
2	Contingency (40%)				309000
	TOTAL ESTIMATE				$ 1,081,824.80

BALLINA SHIRE COUNCIL
CONCEPT ESTIMATE - WEST BALLINA FLOOD LEVEE WORKS

Sub Section 19: Earth Levee

Item No	Description	Qty	Unit	Rate	Est Cost
1	Clearing	4015	m^2	11	45774
2	Stripping	826	m^3	16	13222
3	Embankment fill (Incl core)	1847	m^3	150	277073
4	Cut-off (extension of core into substrate)	924	m^3	175	161626
5	Topsoiling	3030	m^2	13	39391
6	Vegetation of levee	3030	m^2	6	18180
7	Environmental protection	1	Item	5553	5553
8	Design and documentation	1	Item	44421	44421
9	PUP relocations	1	Item	10000	10000
10	Sheet Piling Cutoff PROV	252	m	3500	882445
11	Contingency (40%)				599000
	TOTAL ESTIMATE				$2,096,684

BALLINA SHIRE COUNCIL
CONCEPT ESTIMATE - WEST BALLINA FLOOD LEVEE WORKS

Pumping infrastructure

Item No	Description	Qty	Unit	Rate	Est Cost
1	Supply of pump units (200 l/s)	10	no	110000	$ 1,100,000.00
2	Construction of pump sumps/chambers	10	no	30000	$ 300,000.00
3	Access Hardstands for pumping operation	10	no	10000	$ 100,000.00
4	Contingency (40%)				600000
	TOTAL ESTIMATE				$2,100,000

Levee embankment costing basis

The levee embankment material quantity has been calculated based on the following:

- Levee to elevation shown on above figures
- Levee height above terrain based on supplied topography
- Cleared width of levee footprint + 5 m
- Top width of levee = 2 m
- Side slopes 1 on 4
- Stripping of 300 mm to levee foundation
- Use of additional cut-off key (below the foundation) equivalent to 50% of the levee volume above the foundation
- Topsoiling and vegetation of levee surface
- Notional allowances for:
    - Environmental protection during construction
    - Relocation of existing services
    - Backflow prevention devices to existing tidal outlets
    - Design costs (8%)
    - Provisional item for cut-off sheet piling where substrate conditions are not favourable (based on 10 m deep sheet piling)
    - 40% Contingency sum (excludes cost of provision of sheet piling)

Concrete barrier costing basis

The concrete barrier wall has been quantified based on:

- Wall heights calculated as per levees
- Cleared corridor of 5 metres width
- Cantilever footing with 80% of wall volume
- 300 mm cover over footing
- Average wall thickness varying between 160 mm to 250 mm
- Notional allowances for:
    - Environmental protection during construction
    - Relocation of existing services
    - Backflow prevention devices to existing tidal outlets
    - Design costs (8%)
    - Provisional item for cut-off sheet piling where substrate conditions are not favourable (based on 10 m deep sheet piling)
    - 40% Contingency sum (excludes cost of provision of sheet piling)

Rates applied to the estimates quantities are based on recent GHD project experience where applicable on similar works.

Flood gate costing basis

The flood gates proposed will vary in length and height and only a coarse assessment of these has been undertaken to date.

In order to provide an initial budget figure for the cost of providing these GHD have referred to actual costs ($3.22M) advised by Brisbane City Council for the construction of a major BPD at West Creek, Milton. The structure (overall area of 120 m^2) is a significant piled concrete superstructure with a number of sizeable flood flaps and penstock gates. The cost per square meter of the overall structure was calculated to be $26,800, and this rate has been applied to the estimated areas required for the flood gates included in the defend options.

Pump Infrastructure costing basis:

Pump cost estimates are based on the following assumptions:

* 10x 200L/s pumps required in Ballina Island at a cost of $110K per pump.
* 10x 200L/s pumps required in West Ballina at a cost of $110K per pump.
* $40K allowance for associated pump infrastructure including pump sumps/chambers and access hardstands for pump operations.
* 40% contingency .

It is noted that a detailed internal drainage study would be required to identify the location and number of pumps required to manage coincident local flooding within the protected area located behind levee systems.

Appendix E – Private Property Fill Maps

Paper Size ISO A3

0 0.1 0.2 0.3 0.4

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

BALLINA SHIRE COUNCIL

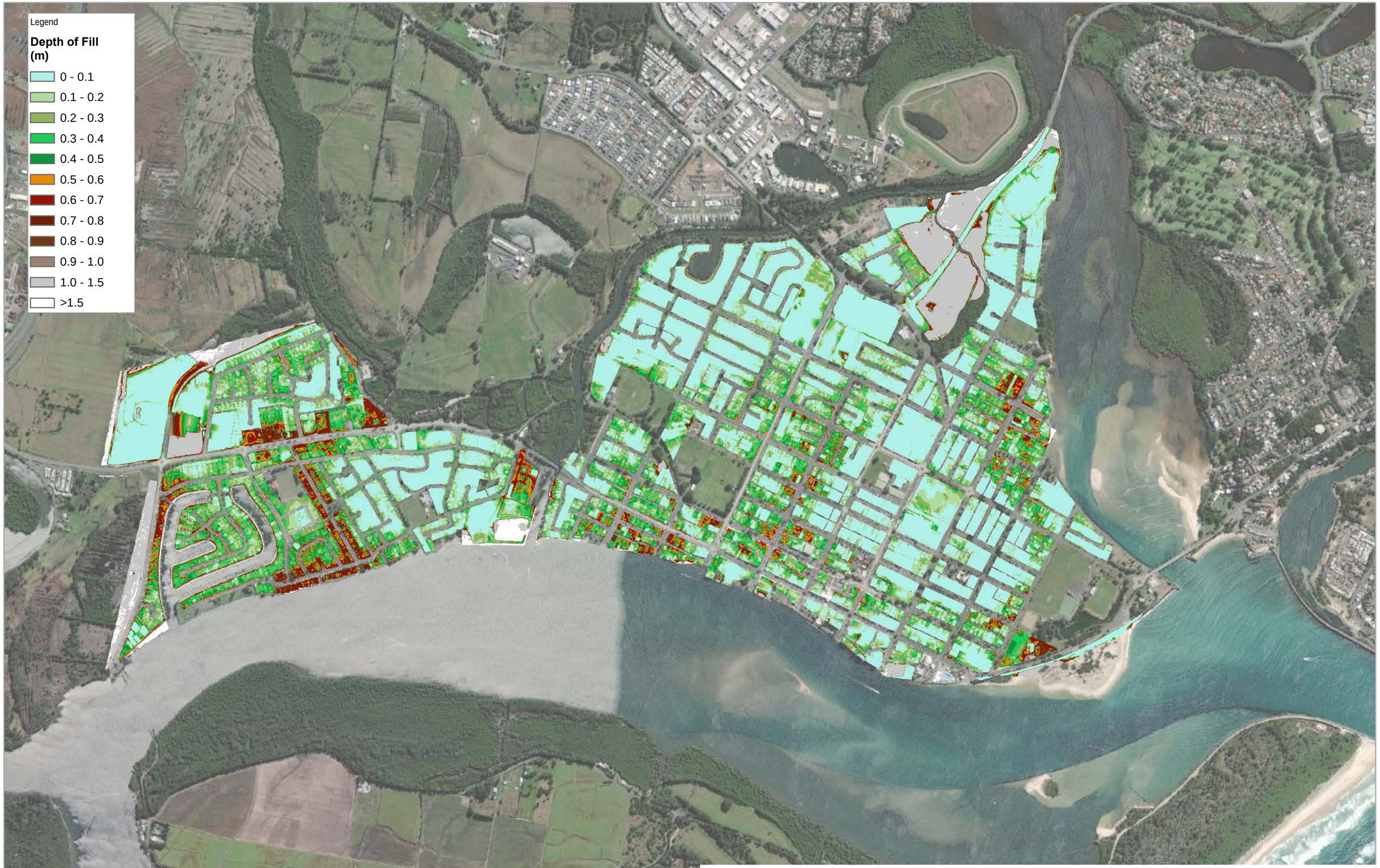
Case 1: Raise Property Levels to 1.81m AHD

Project No. 41-32837
Revision No. A
Date 30 Jun 2021

Figure **E1**

C:\Water Jobs Files\BallinaLevee_41-32837\GIS\Resources\Templates\SMA\41-32837-Z001_SMA_FINAL.mxd
Print date: 30 Jun 2021 - 17:26 (SMA record: 12)

Data source: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community. Created by: whassan



Paper Size ISO A3

0 0.1 0.2 0.3 0.4

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

BALLINA SHIRE COUNCIL

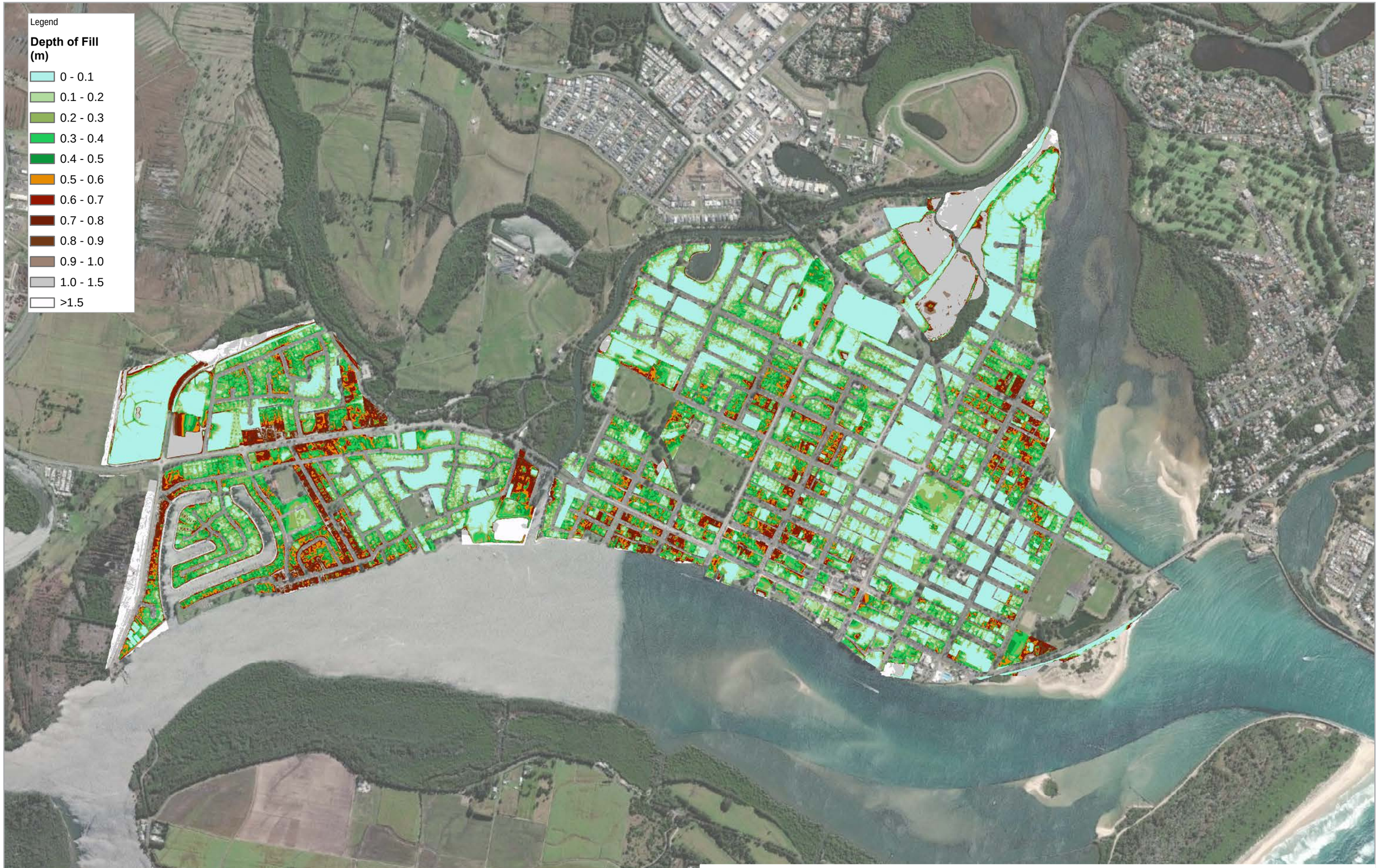
Case 2: Raise Properties to **Level of Existing Fill Policy (~1.9m AHD to 2.2m AHD)**

Project No. 41-32837
Revision No. A
Date 30 Jun 2021

Figure **E2**

C:\Water Jobs Files\BallinaLevee_41-32837\GIS\Resources\Templates\SMA\41-32837-Z001_SMA_FINAL.mxd
Print date: 30 Jun 2021 - 17:26 (SMA record: 15)

Data source: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community. Created by: whassan



Paper Size ISO A3

0 0.1 0.2 0.3 0.4

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

BALLINA SHIRE COUNCIL

Case 3: Raise Property Levels to **1% AEP YR2050** Flood Level **(~2.1m AHD to 2.3m AHD)**

Project No. 41-32837
Revision No. A
Date 30 Jun 2021

Figure **E3**

C:\Water Jobs Files\BallinaLevee_41-32837\GIS\Resources\Templates\SMA\41-32837-Z001_SMA_FINAL.mxd
Print date: 30 Jun 2021 - 17:26 (SMA record: 13)

Data source: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community. Created by: whassan

Legend

Depth of Fill (m)

- 0 - 0.1
- 0.1 - 0.2
- 0.2 - 0.3
- 0.3 - 0.4
- 0.4 - 0.5
- 0.5 - 0.6
- 0.6 - 0.7
- 0.7 - 0.8
- 0.8 - 0.9
- 0.9 - 1.0
- 1.0 - 1.5
- >1.5

Paper Size ISO A3

0 0.1 0.2 0.3 0.4

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

BALLINA SHIRE COUNCIL

Case 4: Raise Property Levels to **1% AEP YR2**100 Flood Level **(~2.4m AHD to 2.7m AHD)**

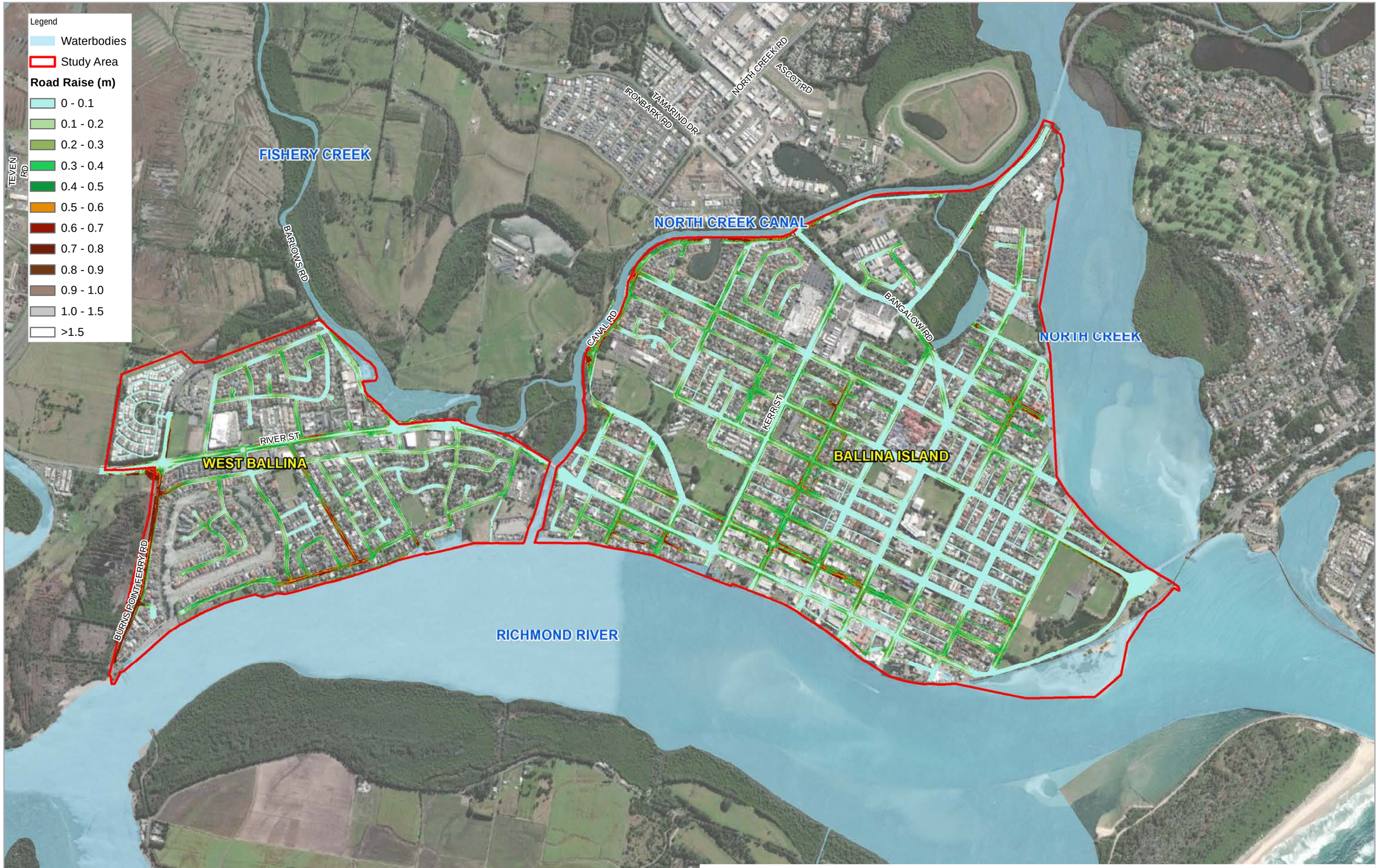
Project No. 41-32837
Revision No. A
Date 30 Jun 2021

Figure **E4**

C:\Water Jobs Files\BallinaLevee_41-32837\GIS\Resources\Templates\SMA\41-32837-Z001_SMA_FINAL.mxd
Print date: 30 Jun 2021 - 17:26 (SMA record: 14)

Data source: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community. Created by: whassan

Appendix F – Road Raise Maps



Paper Size ISO A3

0 0.1 0.2 0.3 0.4

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

BALLINA SHIRE COUNCIL
BALLINA ISLAND AND WEST BALLINA FLOOD STUDY

Raise Roads to 1.81m AHD

Project No. 41-32837
Revision No. B
Date 02 Aug 2021

Figure F1

C:\Water Jobs Files\BallinaLevee_41-32837\GIS\Resources\Templates\SMA\41-32837-2001_SMA_FINAL.mxd
Print date: 02 Aug 2021 - 13:35 (SMA record: 6)

Data source: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community. Created by: whassan

Paper Size ISO A3

0 0.1 0.2 0.3 0.4

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

BALLINA SHIRE COUNCIL
BALLINA ISLAND AND WEST BALLINA FLOOD STUDY

Raise Roads to
Level of Existing Fill Policy
(~1.9m AHD to 2.2m AHD)

Project No. 41-32837
Revision No. B
Date 02 Aug 2021

Figure F2

C:\Water Jobs Files\BallinaLevee_41-32837\GIS\Resources\Templates\SMA\41-32837-Z001_SMA_FINAL.mxd
Print date: 02 Aug 2021 - 13:35 (SMA record: 7)

Data source: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community. Created by: whassan

Paper Size ISO A3

0 0.1 0.2 0.3 0.4

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

BALLINA SHIRE COUNCIL
BALLINA ISLAND AND WEST BALLINA FLOOD STUDY

Raise Roads to
1% AEP YR2050 Flood Level
(~2.1m AHD to 2.3m AHD)

Project No. 41-32837
Revision No. B
Date 02 Aug 2021

Figure F3

C:\Water Jobs Files\BallinaLevee_41-32837\GIS\Resources\Templates\SMA\41-32837-Z001_SMA_FINAL.mxd
Print date: 02 Aug 2021 - 13:35 (SMA record: 8)

Data source: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community. Created by: whassan

Legend

Waterbodies

Study Area

Road Raise (m)

- 0 - 0.1
- 0.1 - 0.2
- 0.2 - 0.3
- 0.3 - 0.4
- 0.4 - 0.5
- 0.5 - 0.6
- 0.6 - 0.7
- 0.7 - 0.8
- 0.8 - 0.9
- 0.9 - 1.0
- 1.0 - 1.5
- >1.5

FISHERY CREEK

NORTH CREEK CANAL

NORTH CREEK

WEST BALLINA

BALLINA ISLAND

RICHMOND RIVER

TEVEN RD

BARLOWS RD

IRONBARK RD

TAMARIND DR

NORTH CREEK RD

ASCOT RD

CANAL RD

BANGALOW RD

KERR ST

RIVER ST

BURNS POINT FERRY RD

Paper Size ISO A3

0 0.1 0.2 0.3 0.4

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

GHD

BALLINA SHIRE COUNCIL
BALLINA ISLAND AND WEST BALLINA FLOOD STUDY

Raise Roads to 1%AEP YR2100 Flood Level (~2.4m AHD to 2.7m AHD)

Project No. 41-32837
Revision No. B
Date 02 Aug 2021

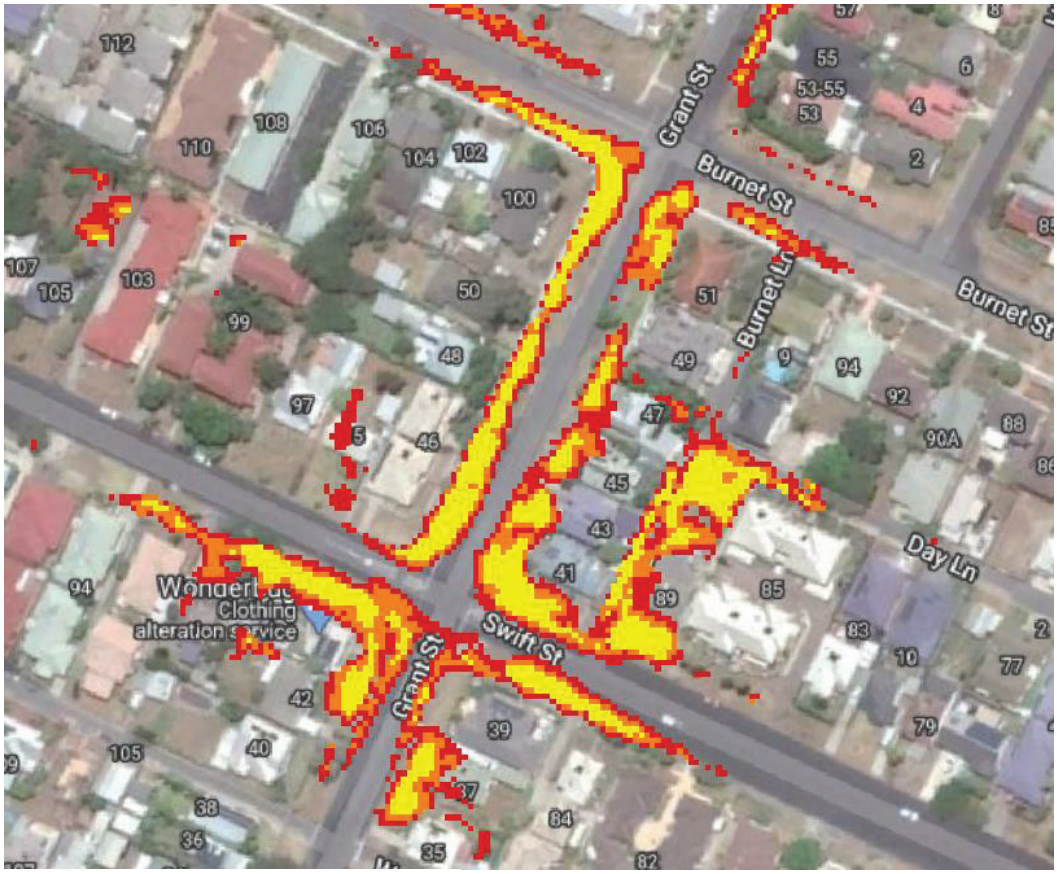
Figure F4

C:\Water Jobs Files\BallinaLevee_41-32837\GIS\Resources\Templates\SMA\41-32837-Z001_SMA_FINAL.mxd
Print date: 02 Aug 2021 - 13:35 (SMA record: 9)

Data source: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community. Created by: whassan

Appendix G – Overland Flooding Hotspots

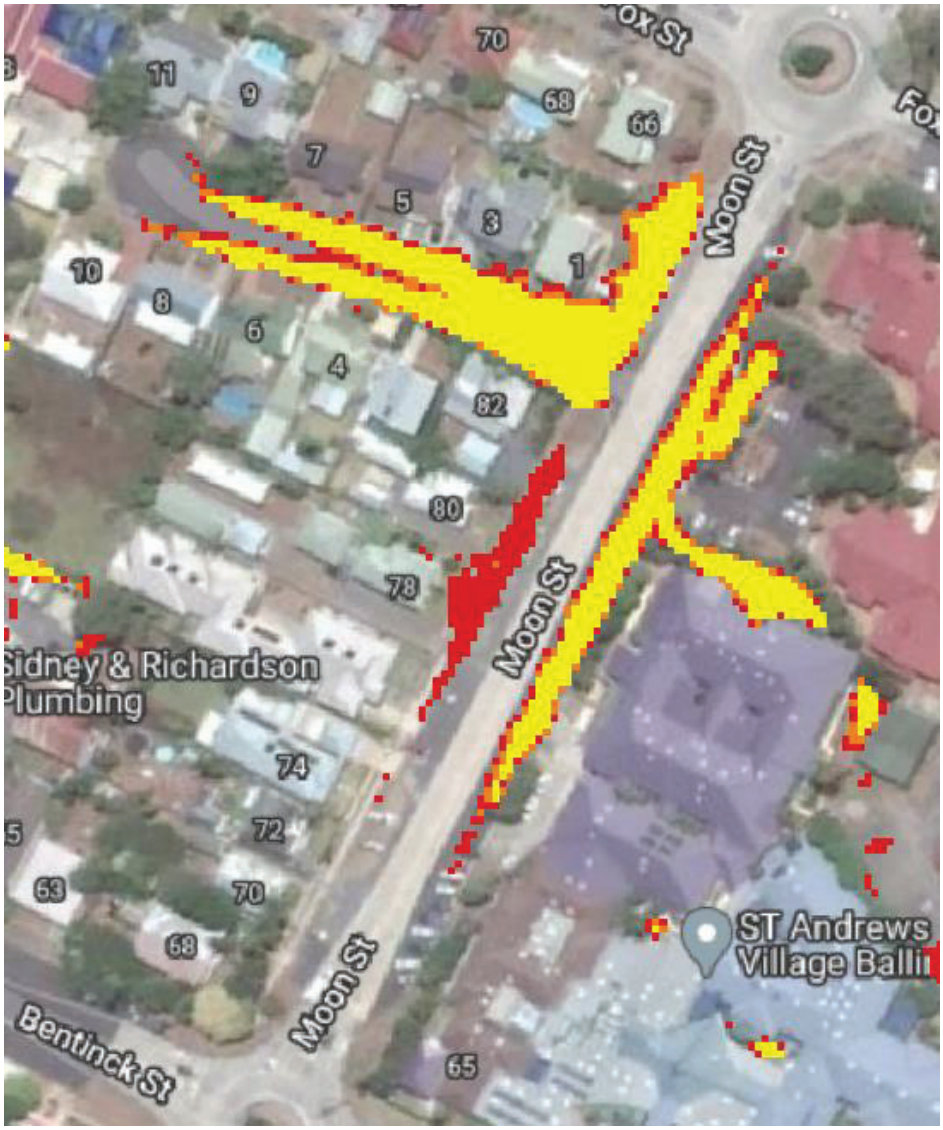
Flooding hotspot #1: Grant St



d > 0.2 m in 20% AEP
d > 0.2 m in 5% AEP
d > 0.2 m in 1% AEP

d = flood depth

Flooding hotspot #2: Moon St and Acacia Pl



d > 0.2 m in 20% AEP
d > 0.2 m in 5% AEP
d > 0.2 m in 1% AEP

d = flood depth

Flooding hotspot #3: Russell St

d > 0.2 m in 20% AEP
d > 0.2 m in 5% AEP
d > 0.2 m in 1% AEP

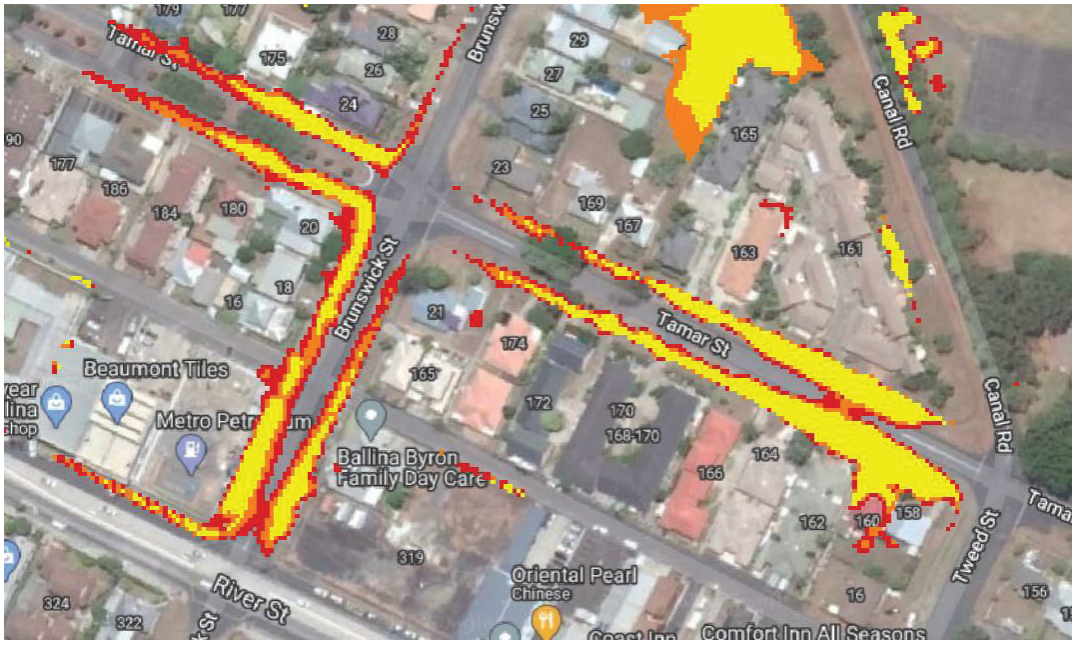
d = flood depth

Flooding hotspot #4: TAFE NSW

d > 0.2 m in 20% AEP
d > 0.2 m in 5% AEP
d > 0.2 m in 1% AEP

d = flood depth

Flooding hotspot #5: Tamar St & Brunswick St



d > 0.2 m in 20% AEP
d > 0.2 m in 5% AEP
d > 0.2 m in 1% AEP

d = flood depth

Flooding hotspot #6: Newland St and Westland Pl

- d > 0.2 m in 20% AEP
- d > 0.2 m in 5% AEP
- d > 0.2 m in 1% AEP

d = flood depth

Flooding hotspot #7: River St

d > 0.2 m in 20% AEP
d > 0.2 m in 5% AEP
d > 0.2 m in 1% AEP

d = flood depth

Flooding hotspot #8: Kalinga St

d > 0.2 m in 20% AEP
d > 0.2 m in 5% AEP
d > 0.2 m in 1% AEP

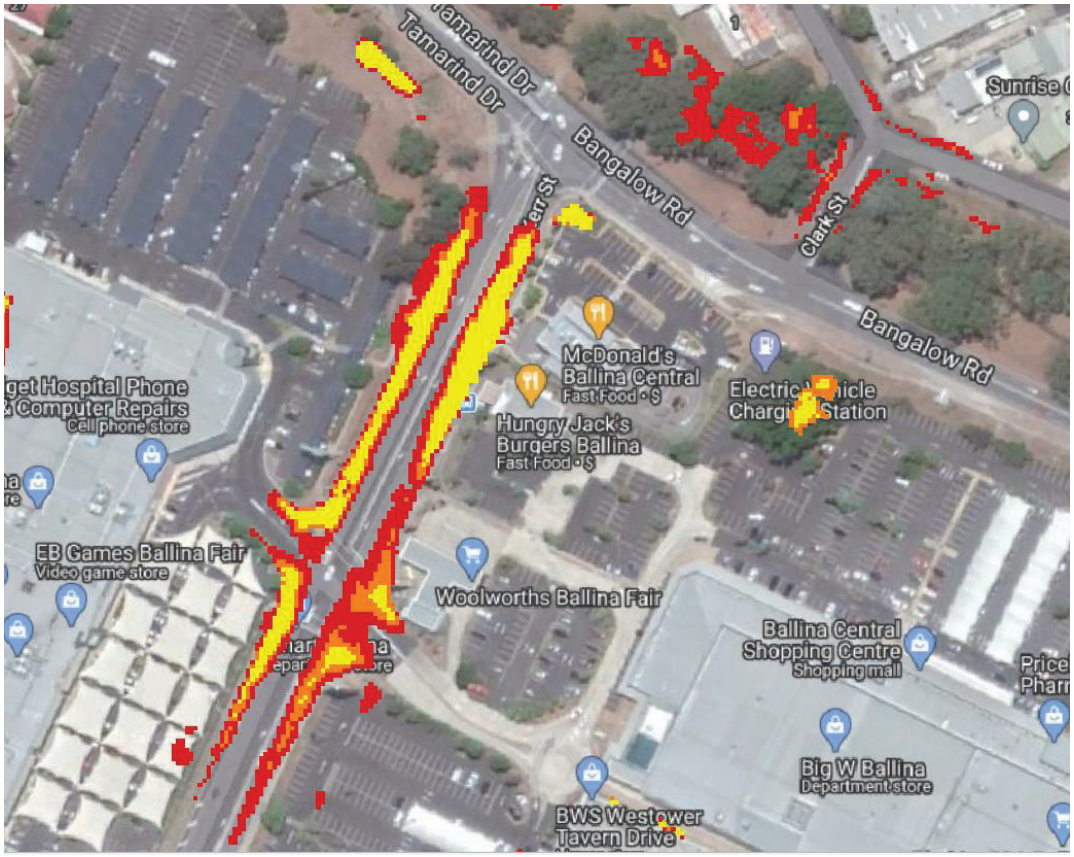
d = flood depth

Flooding hotspot #9: Waterview Ct

d > 0.2 m in 20% AEP
d > 0.2 m in 5% AEP
d > 0.2 m in 1% AEP

d = flood depth

Flooding hotspot #10: Kerr St



- d > 0.2 m in 20% AEP
- d > 0.2 m in 5% AEP
- d > 0.2 m in 1% AEP

d = flood depth

Flooding hotspot #11: Grant St and Tamar St

Area flooded by January 2018 King Tide with no local rainfall event

Flooding hotspot #12: Skinner St and Martin St

Area flooded by January 2018 King Tide with no local rainfall event

Flooding hotspot #13: Riverside Dr

Area flooded by January 2018 King Tide with no local rainfall event

Appendix H – Overland Flood Mitigation Measures

Flooding hotspot #1: Grant St, Swift St, Burnet St

- Install Backflow prevention device at the pipe outlet on Richmond River at the end of Grant Street

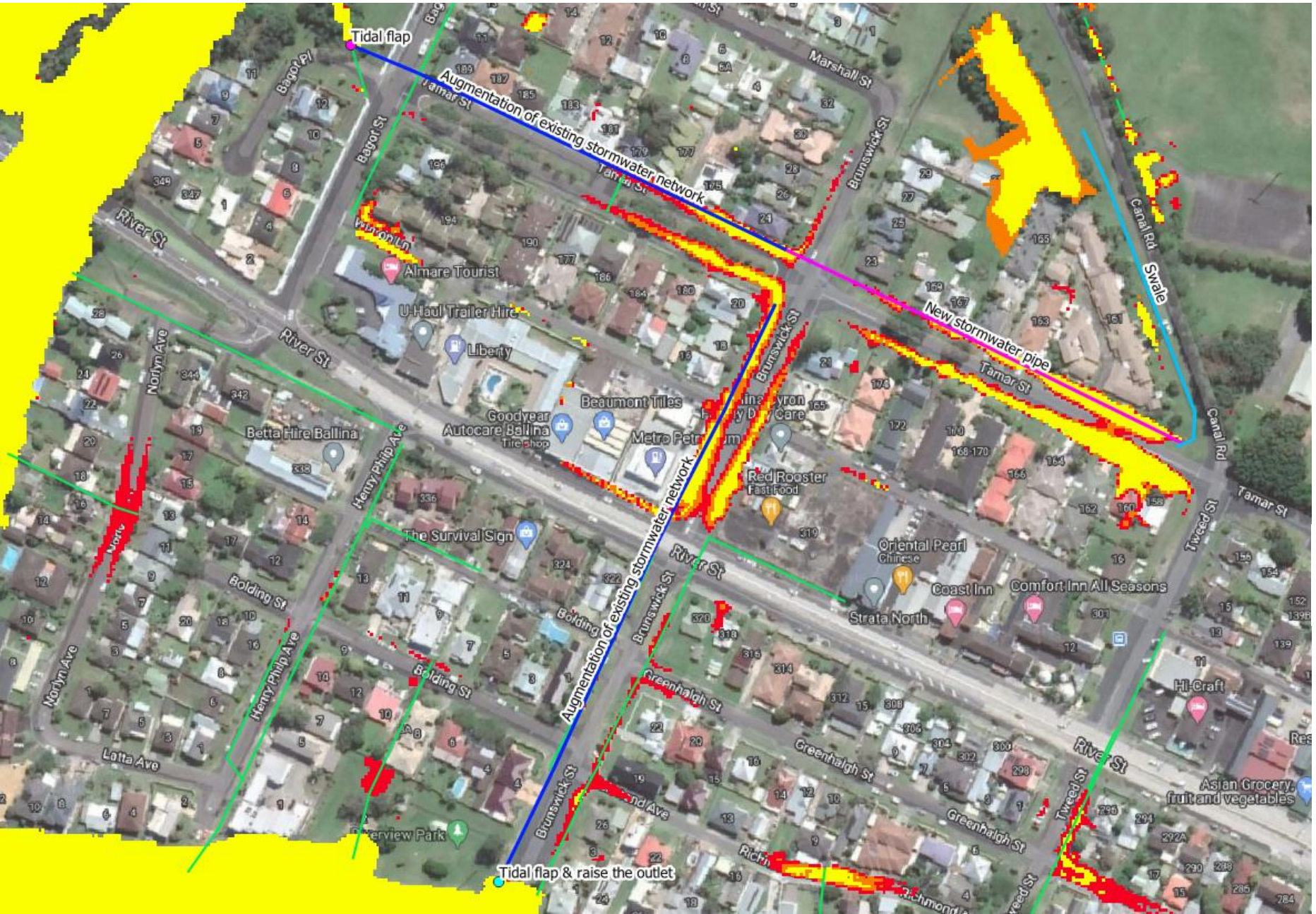
Flood depth:

- d > 0.2 m in 20% AEP
- d > 0.2 m in 5% AEP
- d > 0.2 m in 1% AEP

Mitigation options:

- Tidal flap
- Tidal flap & raise the outlet

Flooding hotspot #5: Tamar St and Brunswick St



- Augmentation of stormwater drainage pipe along Brunswick St
- Install backflow prevention device at the pipe outlet on Richmond River at the end of Brunswick St

Flood depth:

- d > 0.2 m in 20% AEP
- d > 0.2 m in 5% AEP
- d > 0.2 m in 1% AEP

Mitigation options:

- Augmentation of existing stormwater network
- New stormwater pipe
- Swale
- Tidal flap
- Tidal flap & raise the outlet

Flooding hotspot #7: River St between Sunset Ave and Ronan Pl

Flood depth:

- d > 0.2 m in 20% AEP
- d > 0.2 m in 5% AEP
- d > 0.2 m in 1% AEP

Mitigation options:

- Augmentation of existing stormwater network
- New stormwater pipe
- Swale
- Tidal flap
- Tidal flap & raise the outlet

- Install backflow prevention device at the pipe outlet on Fishery Creek at the end of River St
- Excavation of swale to facilitate conveyance of flows into stormwater pipes and provide temporary additional water storage
- Augmentation of existing pipe network along River St

Flooding hotspot #11: Grant St and Tamar St

- Install backflow prevention device at the pipe outlet on Richmond River at the end of Grant St
- Augmentation of existing pipe network along Tamar St to convey flows into stormwater network located along Grant St and Cherry St

Mitigation options:

- Augmentation of existing stormwater network
- Tidal flap & raise the outlet

Area flooded by January 2018 King Tide with no local rainfall event

Flooding hotspot #12: Skinner St and Martin St

- Install backflow prevention device at the pipe outlet on North Creek at the end of Skinner St

Area flooded by January 2018 King Tide with no local rainfall event

Mitigation options:

- Tidal flap & raise the outlet

Appendix I – Overland Flood Mitigation Cost Estimates

Summary of Cost Estimates for Overland Flood Mitigation Measures

Area	Estimated Cost	
Hotspot #1: Grant St, Swift St, Burnet St	$	156,500
Hotspot #5: Tamar St and Brunswick St	$	1,295,400
Hotspot #7: River St between Sunset Ave and Roman Pl.	$	691,760
Hotspot #11: Grant St and Tamar St	$	342,920
Hotspot #12: Skinner St and Martin St	$	66,000
Total Preliminary Estimate	**$**	**2,552,580**

Costing of pipe system augmentation has been undertaken on the following criteria

No current design standard or level of service has been identified or modelled,
Costing assumed to be indicative amount to assist as an initial guide with respect to cost/benefit considerations
Costing based on the mitigation work being the retention of existing assets with the addition of a relief system appoximately of >50% of the existing
Costing of drainage pipe installation based on 4 x pipe supply price
Costing of swales based on $80/lin.m
Feasability of swale locations to be confirmed, unsuitable areas will require extension of underground drainage (i.e. along River Street)

BALLINA SHIRE COUNCIL
BALLINA ISLAND AND WEST BALLINA FLOOD STUDY
CONCEPT ESTIMATE - FLOOD HOTSPOT MITIGATION WORKS

Hotspot #1: Grant St, Swift St, Burnet St

Item No	Description	Qty	Unit	Rate	Est Cost
1	Retrofit Backflow Prevention Devices to existing pipe outlets:				
	600 dia	1	ea	13500	13500
	750 dia	2	ea	18000	36000
	900 dia	1	ea	22000	22000
2	Modifications to existing outlets for rertro-fit	4	ea	10000	40000
	Contingency Sum (40%)				45000
	TOTAL ESTIMATE #1				***$156,500***

BALLINA SHIRE COUNCIL
BALLINA ISLAND AND WEST BALLINA FLOOD STUDY
CONCEPT ESTIMATE - FLOOD HOTSPOT MITIGATION WORKS

Hotspot #5: Tamar St and Brunswick St

Item No	Description	Qty	Unit	Rate	Est Cost
1	Retrofit Backflow Prevention Devices to existing pipe outlets:				
	600 dia	2	ea	13500	27000
2	Modifications to existing outlets for rertro-fit	2	ea	10000	20000
3	Fit Backflow prevention Devices to new pipe outlet:				
	375 dia	1	ea	8000	8000
	525 dia	1	ea	11000	11000
4	New Drainage Pipes:				
	375 dia	400	m	320	128000
	450 dia	500	m	480	240000
	525 dia	400	m	600	240000
5	Drainage structures (Pits/MH's/outlets)	30	No	4000	120000
6	Swale	300	m	80	24000
7	Services investigation and relocation (20% of pipe and structure value)		Item		150400
8	Contingency Sum (40%)				327000
	TOTAL ESTIMATE #5				***$1,295,400***

BALLINA SHIRE COUNCIL
BALLINA ISLAND AND WEST BALLINA FLOOD STUDY
CONCEPT ESTIMATE - FLOOD HOTSPOT MITIGATION WORKS

Hotspot #7: River St between Sunset Ave and Roman Pl.

Item No	Description	Qty	Unit	Rate	Est Cost
1	Retrofit Backflow Prevention Devices to existing pipe outlets:				
	900 dia	1	ea	22000	22000
2	Fit Backflow prevention Devices to additional pipe outlet:				
	750 dia	1	ea	18000	18000
3	Modifications to existing outlets for rertro-fit	1	ea	10000	10000
4	New Drainage Pipes				
	450 dia	550	m	480	264000
	525 dia	160	m	600	96000
	600 dia	40	m	720	28800
	750 dia	60	m	1100	66000
5	Drainage structures (Pits/MH's/outlets)	20	No	4000	80000
6	Services investigation and relocation (20% of pipe and structure value)		Item		106960
7	Contingency Sum (40%)				277000
	TOTAL ESTIMATE #7				***$691,760***

BALLINA SHIRE COUNCIL
BALLINA ISLAND AND WEST BALLINA FLOOD STUDY
CONCEPT ESTIMATE - FLOOD HOTSPOT MITIGATION WORKS

Hotspot #11: Grant St and Tamar St

Item No	Description	Qty	Unit	Rate	Est Cost
1	Retrofit Backflow Prevention Devices to existing pipe outlets:				
	1200 dia	1	ea	29000	29000
2	Modifications to existing outlets for rertro-fit	1	ea	10000	10000
3	New Drainage Pipes				
	375 dia	120	m	480	57600
	450 dia	150	m	600	90000
4	Drainage structures (Pits/MH's/outlets)	6	No	4000	24000
5	Services investigation and relocation (20% of pipe and structure value)		Item		34320
6	Contingency Sum (40%)				98000
	TOTAL ESTIMATE #11				***$342,920***

BALLINA SHIRE COUNCIL
BALLINA ISLAND AND WEST BALLINA FLOOD STUDY
CONCEPT ESTIMATE - FLOOD HOTSPOT MITIGATION WORKS

Hotspot #12: Skinner St and Martin St

Item No	Description	Qty	Unit	Rate	Est Cost
1	Retrofit Backflow Prevention Devices to existing pipe outlets: 600 dia	2	ea	13500	27000
2	Modifications to existing outlets for rertro-fit	2	ea	10000	20000
3	Contingency Sum (40%)				19000
	TOTAL ESTIMATE #12				***$66,000***

Appendix J – Conceptual Plans of Indicative Evacuation Road Raise Drainage Works

Legend

- New Stormwater Pits
- Install New Tidal Flaps
- New Stormwater Pipes
- Existing Stormwater Pipes
- Flood Evacuation Route Raise
- Property Lots

Note:
This map is showing the location of new pipes and flap gate locations associated with the evacuation route raise

Construct new DN425 pipes

Construct new DN375 pipes

RIVER ST

BARLOWS RD

Paper Size ISO A3

0 0.015 0.03 0.045 0.06

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

GHD

Conceptual plans of indicative evacuation road raise drainage works

1 of 3

Project No. 41-32837
Revision No. A
Date 06 Oct 2021

Figure J-1

C:\Water Jobs Files\BallinaLevee_41-32837\GIS\Resources\Templates\SMA\41-32837-Z001_SMA_FINAL_v2.mxd
Print date: 06 Oct 2021 - 19:25 (SMA record: 34)

Note:
This map is showing the location of new pipes and flap gate locations associated with the emergency road raise option

Legend

- New Stormwater Pits
- Install New Tidal Flaps
- New Stormwater Pipes
- Existing Stormwater Pipes
- Flood Evacuation Route Raise
- Property Lots

Note:
This map is showing the location of new pipes and flap gate locations associated with the evacuation route raise

Construct new DN900 pipe

Construct new DN1050 pipes

TAMARIND DR

BANGALOW RD

KERR ST

Paper Size ISO A3

0 0.01 0.02 0.03 0.04

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

GHD

Conceptual plans of indicative evacuation road raise drainage works
2 of 3

Project No. 41-32837
Revision No. A
Date 06 Oct 2021

Figure J-2

C:\Water Jobs Files\BallinaLevee_41-32837\GIS\Resources\Templates\SMA\41-32837-Z001_SMA_FINAL_v2.mxd
Print date: 06 Oct 2021 - 19:25 (SMA record: 35)

Note:
This map is showing the location of new pipes and flap gate locations associated with the emergency road raise option

Legend

- New Stormwater Pits
- Install New Tidal Flaps
- New Stormwater Pipes
- Existing Stormwater Pipes
- Flood Evacuation Route Raise
- Property Lots

Note:
This map is showing the location of new pipes and flap gate locations associated with the evacuation route raise

New tide flaps

Construct new DN900 pipes

Construct new DN600 pipes

BANGALOW RD

Paper Size ISO A3

0 0.015 0.03 0.045 0.06

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

GHD

Conceptual plans of indicative evacuation road raise drainage works
3 of 3

Project No. 41-32837
Revision No. A
Date 06 Oct 2021

Figure J-3

C:\Water Jobs Files\BallinaLevee_41-32837\GIS\Resources\Templates\SMA\41-32837-Z001_SMA_FINAL_v2.mxd
Print date: 06 Oct 2021 - 19:25 (SMA record: 36)

Note:
This map is showing the location of new pipes and flap gate locations associated with the emergency road raise option

Appendix K – Conceptual Plans of Overland Flooding Hotspot Mitigation Works

Legend

- New Stormwater Pits
- Existing Tide Flaps
- Install New Tidal Flaps
- Upsize Existing Stormwater Pipes
- New Stormwater Pipes
- Existing Stormwater Pipes
- Property Lots

Note:
This map is showing the location of new pipes, dimensions and flap gate locations associated with mitigation measures

BARLOWS RD

RIVER ST

New tide flaps

Upsize existing DN600 pipes to DN900

Paper Size ISO A3

0 0.01 0.02 0.03 0.04

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

GHD

Conceptual plans of overland flooding hotspot mitigation works 1 of 4

Project No. 41-32837
Revision No. A
Date 06 Oct 2021

Figure K-1

C:\Water Jobs Files\BallinaLevee_41-32837\GIS\Resources\Templates\SMA\41-32837-Z001_SMA_FINAL_v2.mxd
Print date: 06 Oct 2021 - 19:25 (SMA record: 37)

Note:
This map is showing the location of new pipes, dimensions and flap gate locations associated with mitigation measures

Legend

- New Stormwater Pits
- Existing Tide Flaps
- Install New Tidal Flaps
- Upsize Existing Stormwater Pipes
- New Stormwater Pipes
- Existing Stormwater Pipes
- Property Lots

Note:
This map is showing the location of new pipes, dimensions and flap gate locations associated with mitigation measures

Upsize existing DN425 pipes to DN600

Construct new DN600 pipes

New tide flaps

CANAL RD

RIVER ST

KERR ST

Paper Size ISO A3

0 0.02 0.04 0.06 0.08

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

GHD

Conceptual plans of overland flooding hotspot mitigation works 2 of 4

Project No. 41-32837
Revision No. A
Date 06 Oct 2021

Figure K-2

C:\Water Jobs Files\BallinaLevee_41-32837\GIS\Resources\Templates\SMA\41-32837-Z001_SMA_FINAL_v2.mxd
Print date: 06 Oct 2021 - 19:25 (SMA record: 38)

Note:
This map is showing the location of new pipes, dimensions and flap gate locations associated with mitigation measures

Legend

- New Stormwater Pits
- Existing Tide Flaps
- Install New Tidal Flaps
- Upsize Existing Stormwater Pipes
- New Stormwater Pipes
- Existing Stormwater Pipes
- Property Lots

Note:
This map is showing the location of new pipes, dimensions and flap gate locations associated with mitigation measures

Upsize existing DN600 pipes to DN900

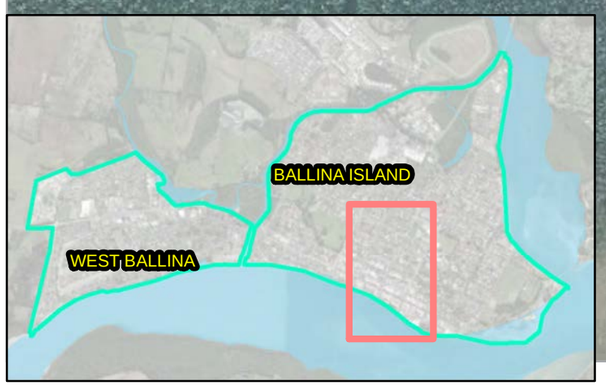
Upsize existing DN600 pipes to DN900

New tide flaps

Construct new DN600 pipes

KERR ST

RIVER ST



Paper Size ISO A3

0 0.025 0.05 0.075 0.1

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

GHD

Conceptual plans of overland flooding hotspot mitigation works
3 of 4

Project No. 41-32837
Revision No. A
Date 06 Oct 2021

Figure K-3

C:\Water Jobs Files\BallinaLevee_41-32837\GIS\Resources\Templates\SMA\41-32837-Z001_SMA_FINAL_v2.mxd
Print date: 06 Oct 2021 - 19:26 (SMA record: 39)

Note:
This map is showing the location of new pipes, dimensions and flap gate locations associated with mitigation measures

Legend

- New Stormwater Pits
- Existing Tide Flaps
- Install New Tidal Flaps
- Upsize Existing Stormwater Pipes
- New Stormwater Pipes
- Existing Stormwater Pipes
- Property Lots

Note:
This map is showing the location of new pipes, dimensions and flap gate locations associated with mitigation measures

New tide flaps

Paper Size ISO A3

0 0.015 0.03 0.045 0.06

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

GHD

Conceptual plans of overland flooding hotspot mitigation works 4 of 4

Project No. 41-32837
Revision No. A
Date 06 Oct 2021

Figure K-4

C:\Water Jobs Files\BallinaLevee_41-32837\GIS\Resources\Templates\SMA\41-32837-Z001_SMA_FINAL_v2.mxd
Print date: 06 Oct 2021 - 19:26 (SMA record: 40)

Note:
This map is showing the location of new pipes, dimensions and flap gate locations associated with mitigation measures

GHD

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G:\41\32837\WP\2021.11.01 DRAFT Exhibition Version of Flood Protection Feasibility Study and Plan\4132837-REP-1-Draft Flood Protection Feasibility Study and Plan Exhibition Version.docx

Document Status

Revision	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
0	LS, RB, WH, BR	Paul Priebbenow		Paul Priebbenow		07/10/2021
1	LS, RB, WH, BR	Paul Priebbenow		Paul Priebbenow		01/11/2021

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