

Burnett River Floodplain Action Plan

Options Assessment

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Introduction

- Today I'm presenting the 2nd phase of Floodplain Action Plan which is the **Options Assessment**. (In September last year we presented the 1st phase of the Floodplain Action Plan which was the **Flood Study**.)
- The Options Assessment has been undertaken by my company - GHD and has been undertaken independently of Council.
- The Options Assessment is based on best practice scientific and engineering methods including **best practice floodplain management principles**.
- The Options Assessment has been fast tracked – we've worked hard to deliver it in 6 months (usually take 1 year).
- What we are trying to achieve for the community is to find the **most sensible options** in which to invest **public funds**.
- **Best 'Bang for Buck'**



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Presentation (50 minutes):

- 2013 Event Flood Behaviour
- Floodplain Action Plan Overview
- Flood Modelling
- Identification of Options
- Options Assessment Process
- Recommendations
(Preferred Options, Non-viable Options, Future Work)

Focus

Questions & Answers (10 minutes)

1. 2013 Event Flood Behaviour



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2013 Flood Animation



2013 Flood

**Flow Rate of 2013 Event
=16,500 m³/s**

**Flow Rate Across North
Bundy = 4,000 m³/s**

**Volume of 2013 Flood
= 3,000 GL
(1GL = 1,000,000,000 L)**

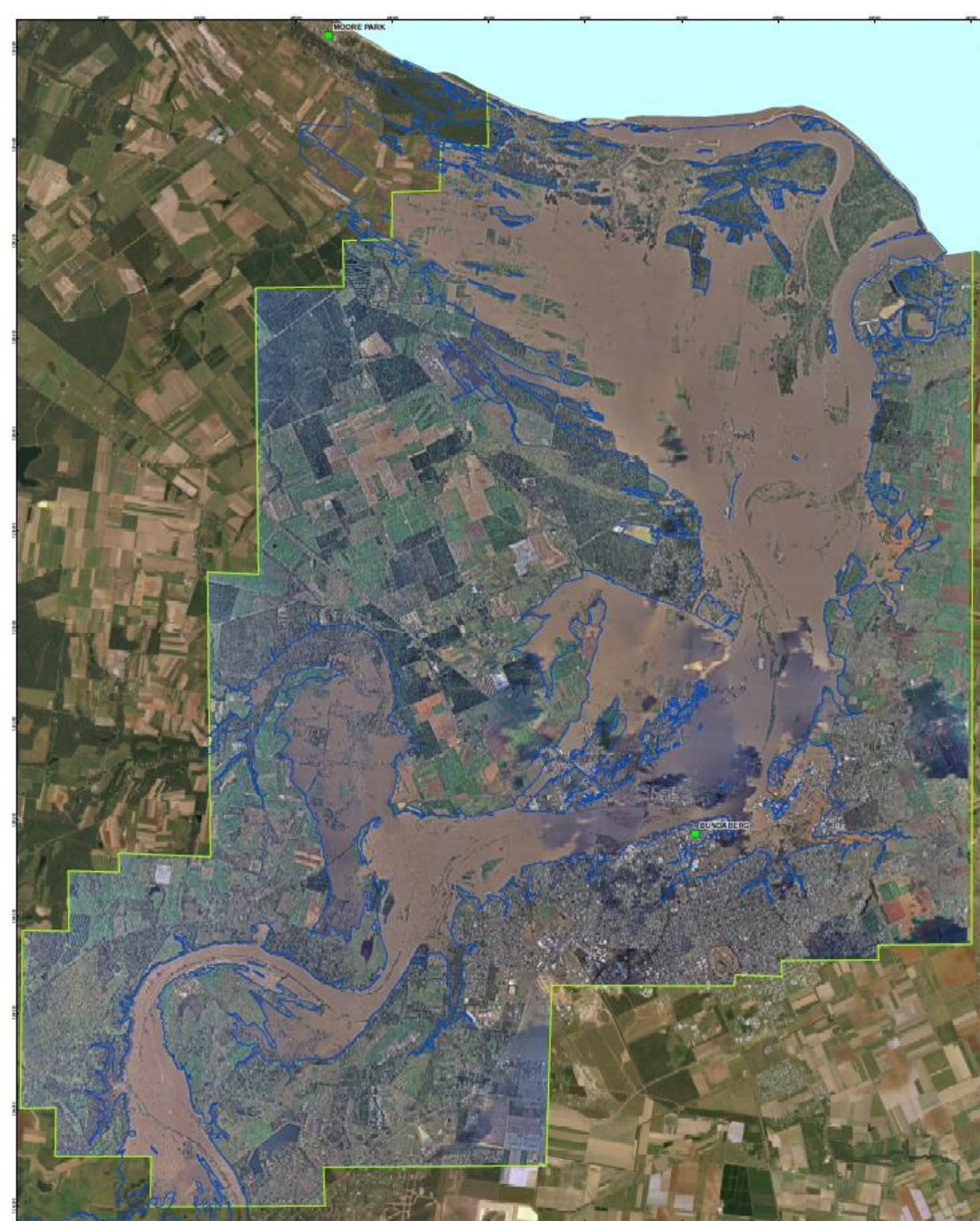
**Volume of 2013 Flood
= 1.3 million Olympic Swimming Pools**

**Volume of 2013 Flood
= 10 x Volume of Paradise Dam
(*Dam fills & Overtops in hours*)**

**Volume of 2013 Flood
= 5 x Volume Sydney Harbour**

Notes:

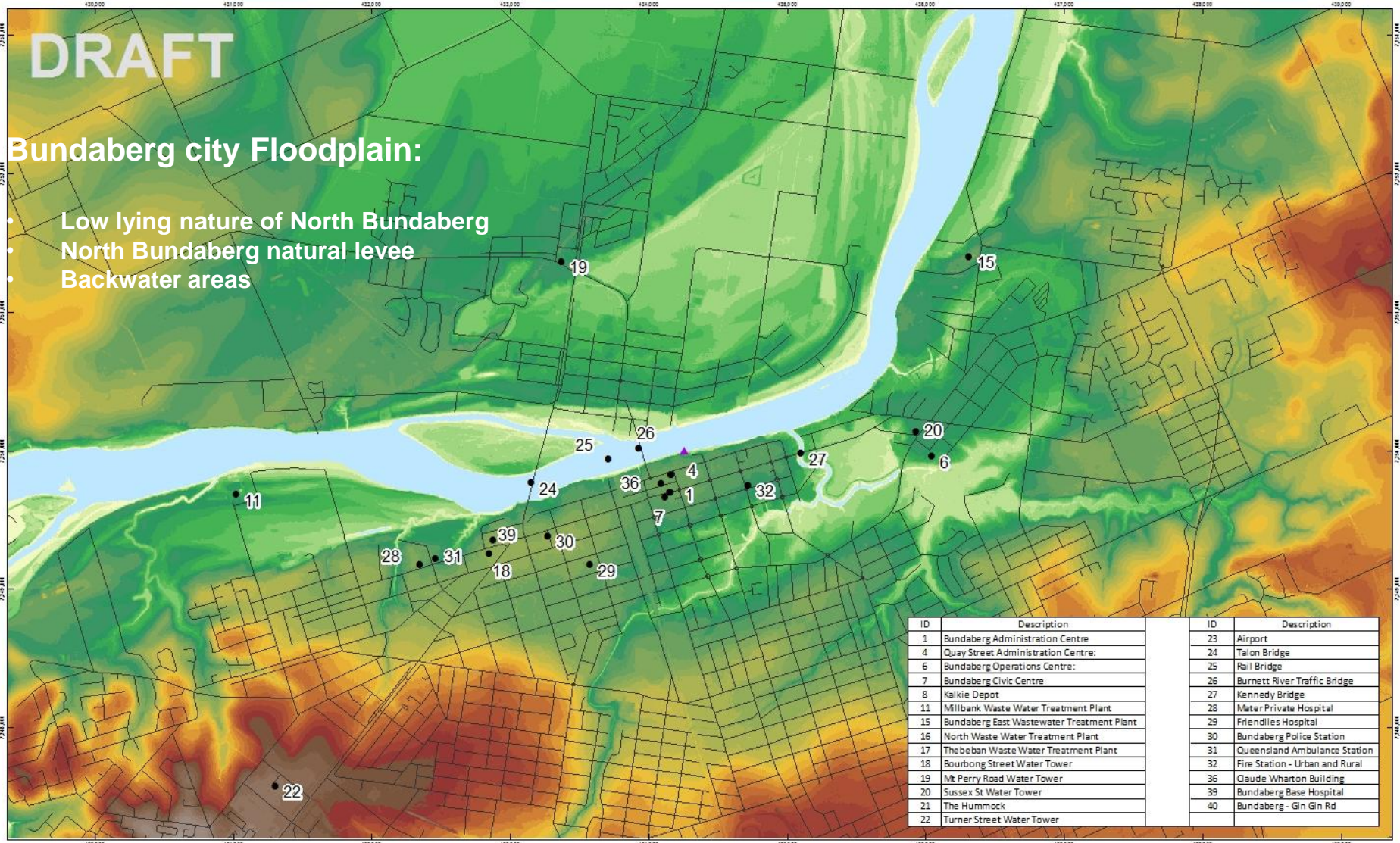
- Volume of Paradise Dam = 300GL
- Volume of Sydney Harbour = 560GL



DRAFT

Bundaberg city Floodplain:

- Low lying nature of North Bundaberg
- North Bundaberg natural levee
- Backwater areas



ID	Description	ID	Description
1	Bundaberg Administration Centre	23	Airport
4	Quay Street Administration Centre	24	Talon Bridge
6	Bundaberg Operations Centre	25	Rail Bridge
7	Bundaberg Civic Centre	26	Burnett River Traffic Bridge
8	Kalkie Depot	27	Kennedy Bridge
11	Millbank Waste Water Treatment Plant	28	Mater Private Hospital
15	Bundaberg East Wastewater Treatment Plant	29	Friendlies Hospital
16	North Waste Water Treatment Plant	30	Bundaberg Police Station
17	Theban Waste Water Treatment Plant	31	Queensland Ambulance Station
18	Bourbon Street Water Tower	32	Fire Station - Urban and Rural
19	Mt Perry Road Water Tower	36	Claude Wharton Building
20	Sussex St Water Tower	39	Bundaberg Base Hospital
21	The Hummock	40	Bundaberg - Gin Gin Rd
22	Turner Street Water Tower		



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



LEGEND

- ▲ Targo Street Stream Gauge
- Critical Infrastructure



Bundaberg Regional Council
Burnett River Flood Study

Job Number 41-24728
Revision A
Date 24 Jul 2013

Burnett River Ground Elevations

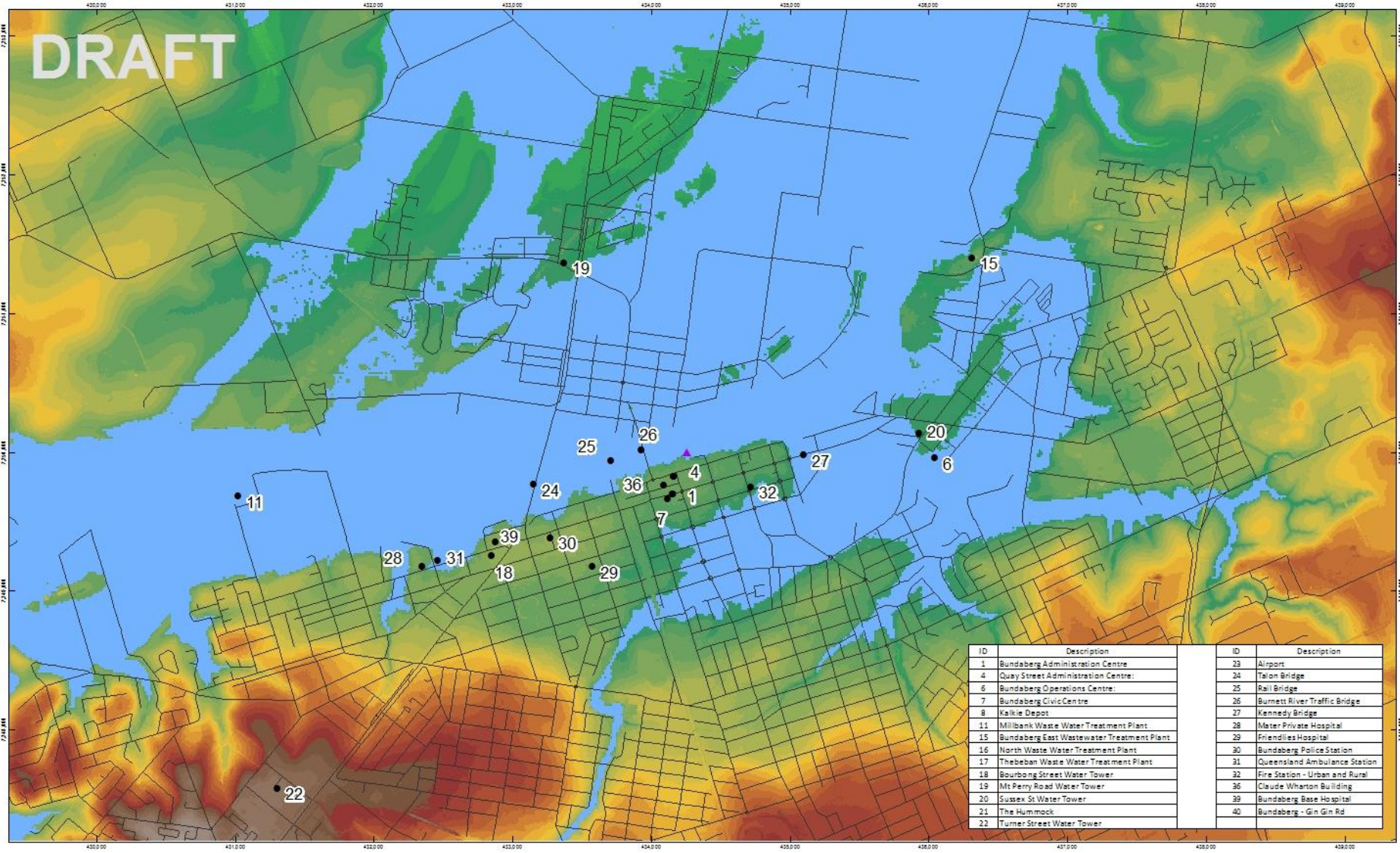
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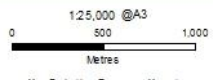
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Data source: GHD Flood Safety 2013, Critical Infrastructure 2013, DWRM Catchment 2012, Locality 2005.

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Map Projection: Transverse Mercator
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LEGEND

- Targo Street Stream Gauge
- Critical Infrastructure



Bundaberg Regional Council
 Burnett River Flood Study

Job Number 41-24728
 Revision A
 Date 24 Jul 2013

Burnett River Ground Elevations and 100 year Flooding

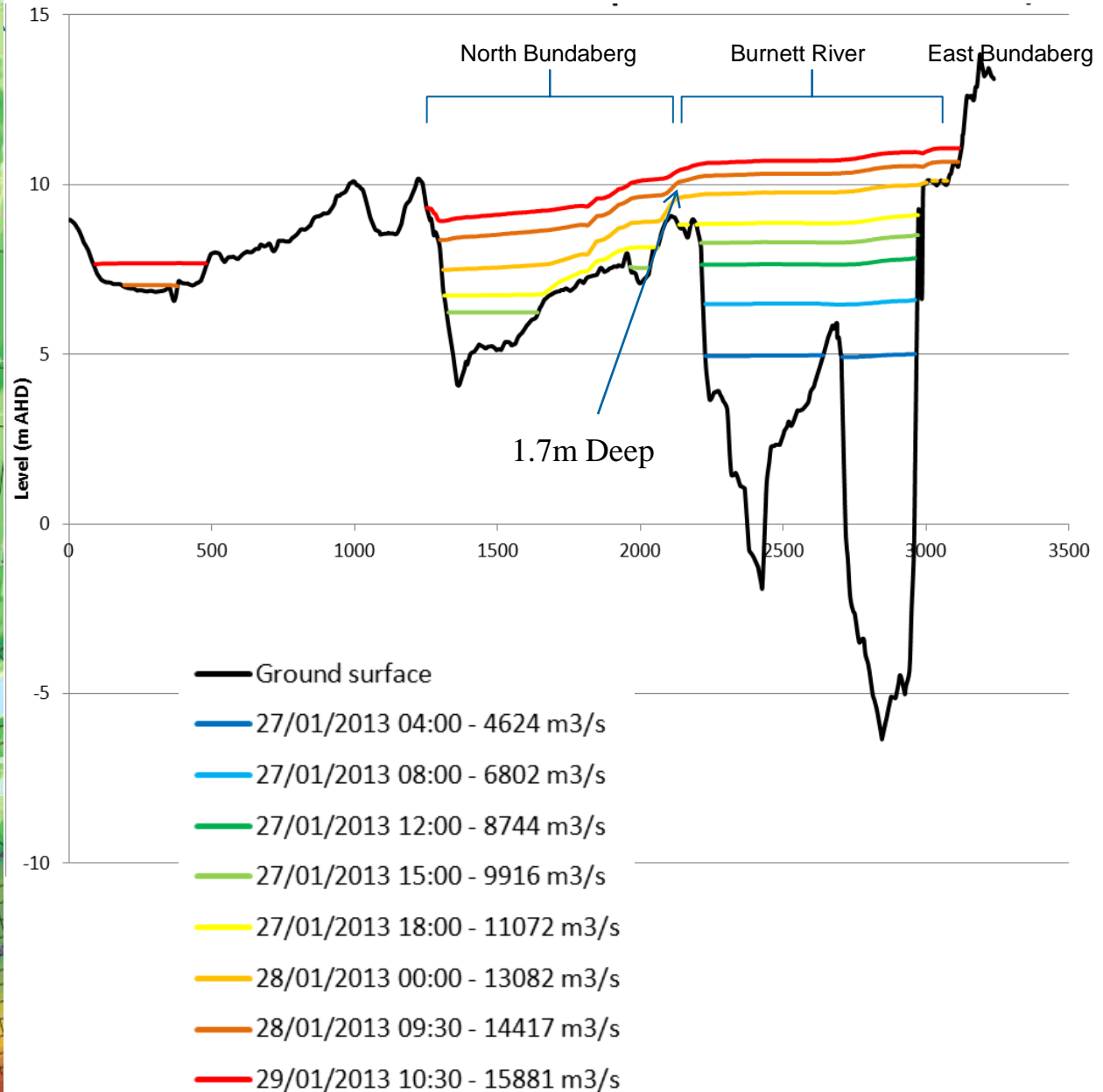
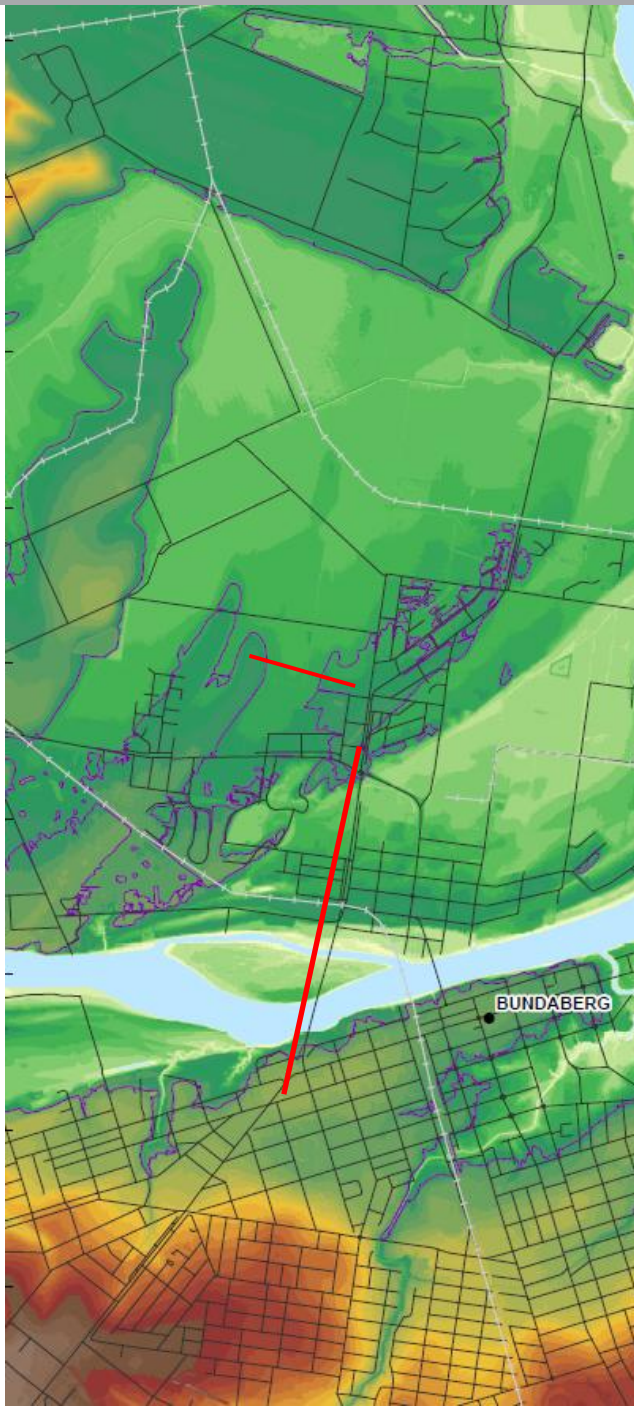
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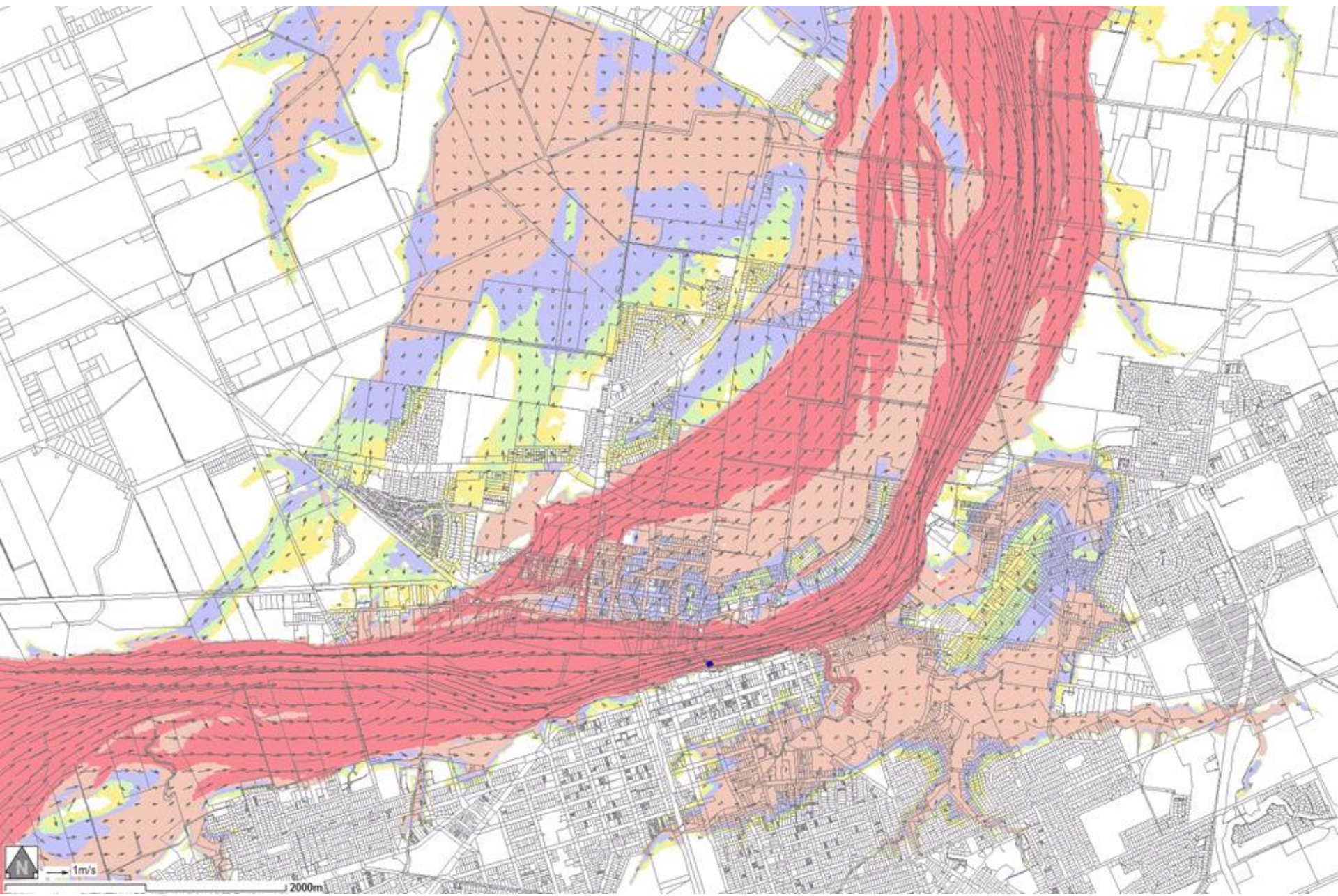
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2013 Flood Cross Section



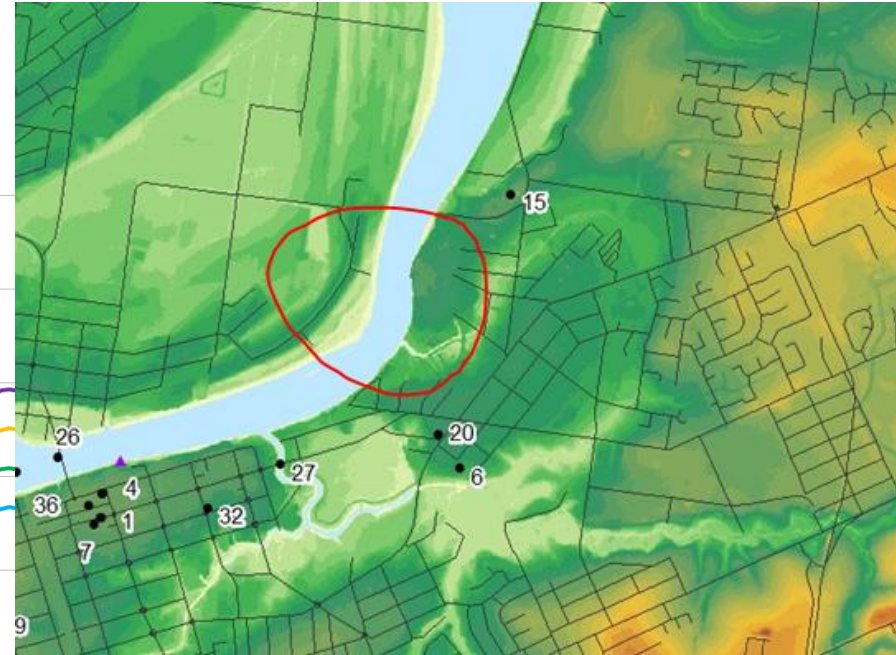
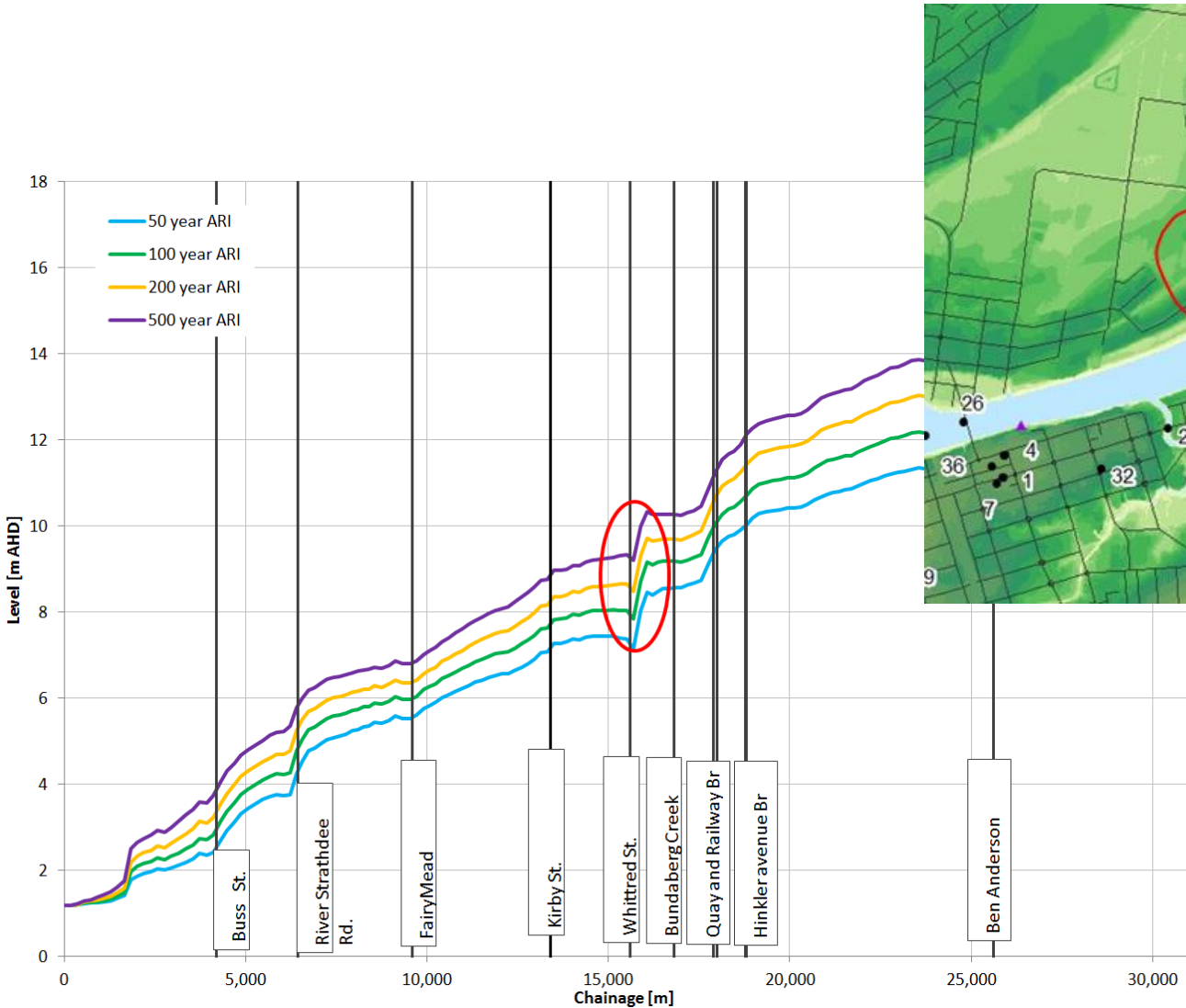


2013 Event Flood Vectors



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Longitudinal Flood Profile (Millaquin Bend Constriction)

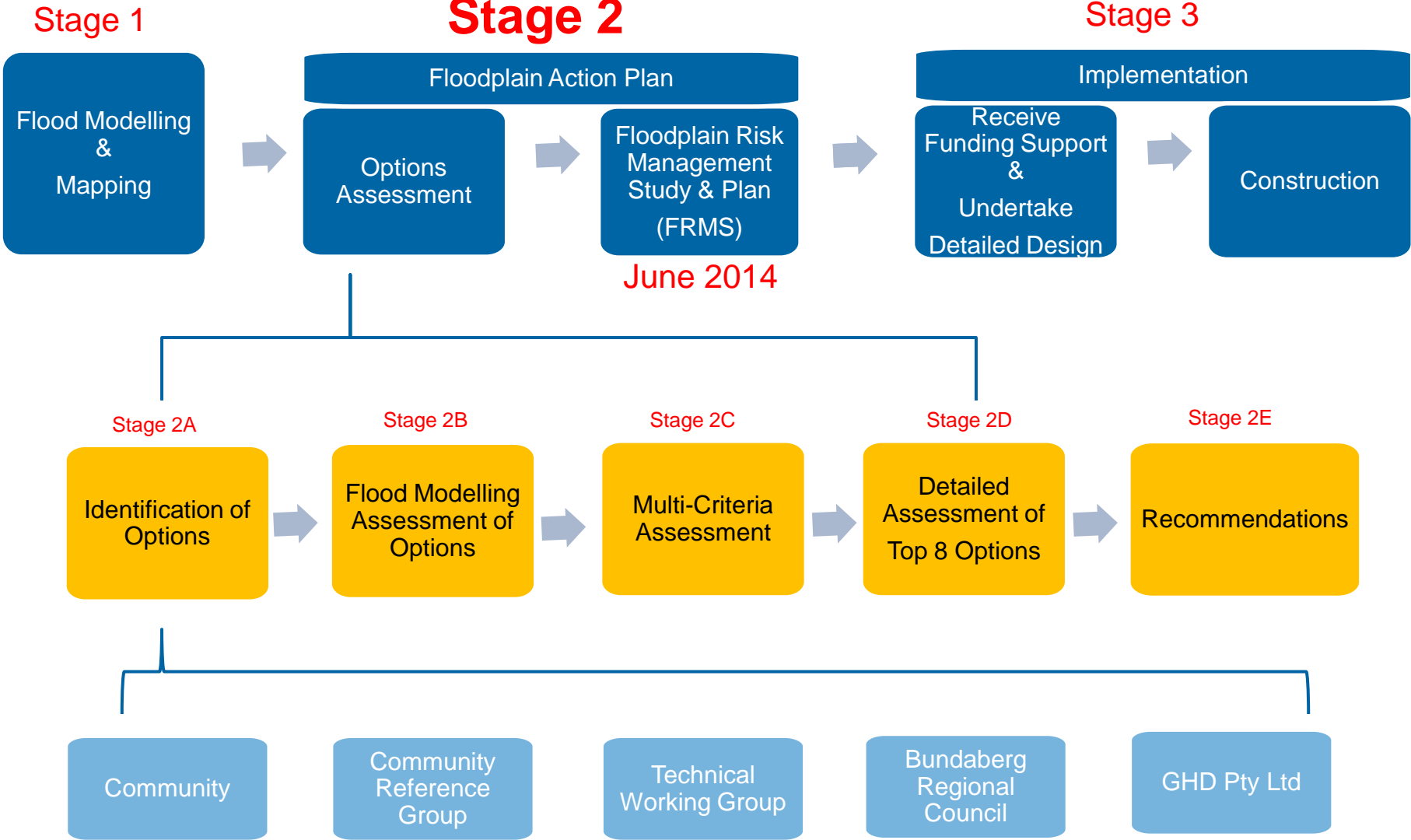


1. Floodplain Action Plan Overview



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Floodplain Action Plan - The Process





Outcomes: Floodplain Management Measures

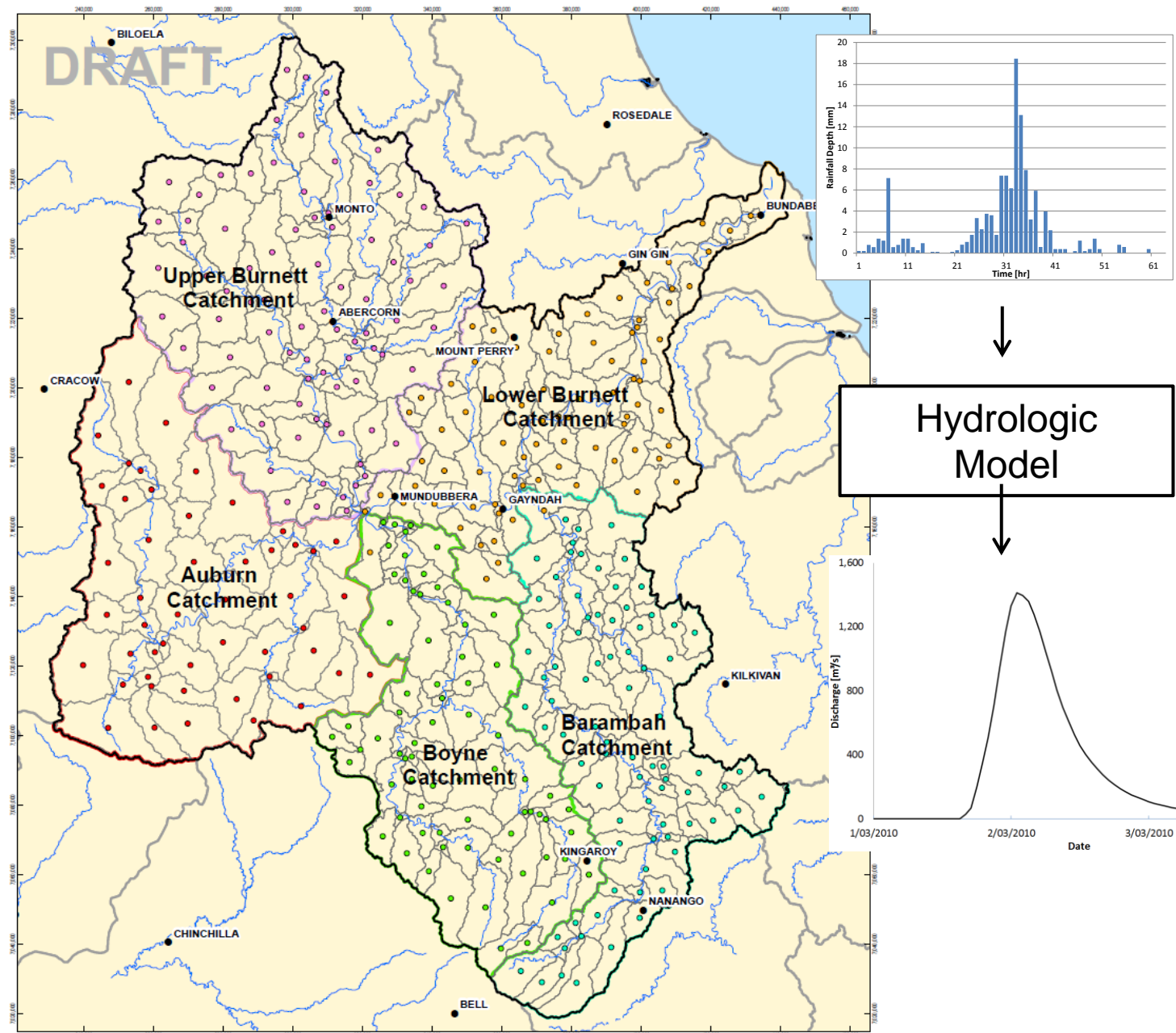
Theme/category	Types of measures, ideas , options
1. Flood prevention modifications	Designing measures to alter the behaviour of the flood itself by reducing flood levels and/or velocities or by excluding flood waters from areas at risk. Options may include, but is not limited to, levees, river dredging and vegetation removal.
2. Property modifications	Modifications to existing buildings to reduce flooding impacts. Options may include measures to improve property resilience and house raising.
3. Development controls	Reviewing building and planning codes such as setting minimum floor heights and changed land uses to reduce the risk of flood impacts.
4. Response modifications	Increasing the ability of people to respond appropriately in times of flood and/or enhancing the flood warning and evacuation procedures in an area. Options may include, but is not limited to, improving community awareness, improving flood warning systems, and updating local flood and evacuation plans.

Stage 1. Flood Modelling & Mapping (Stage 1 of Floodplain Action Plan)



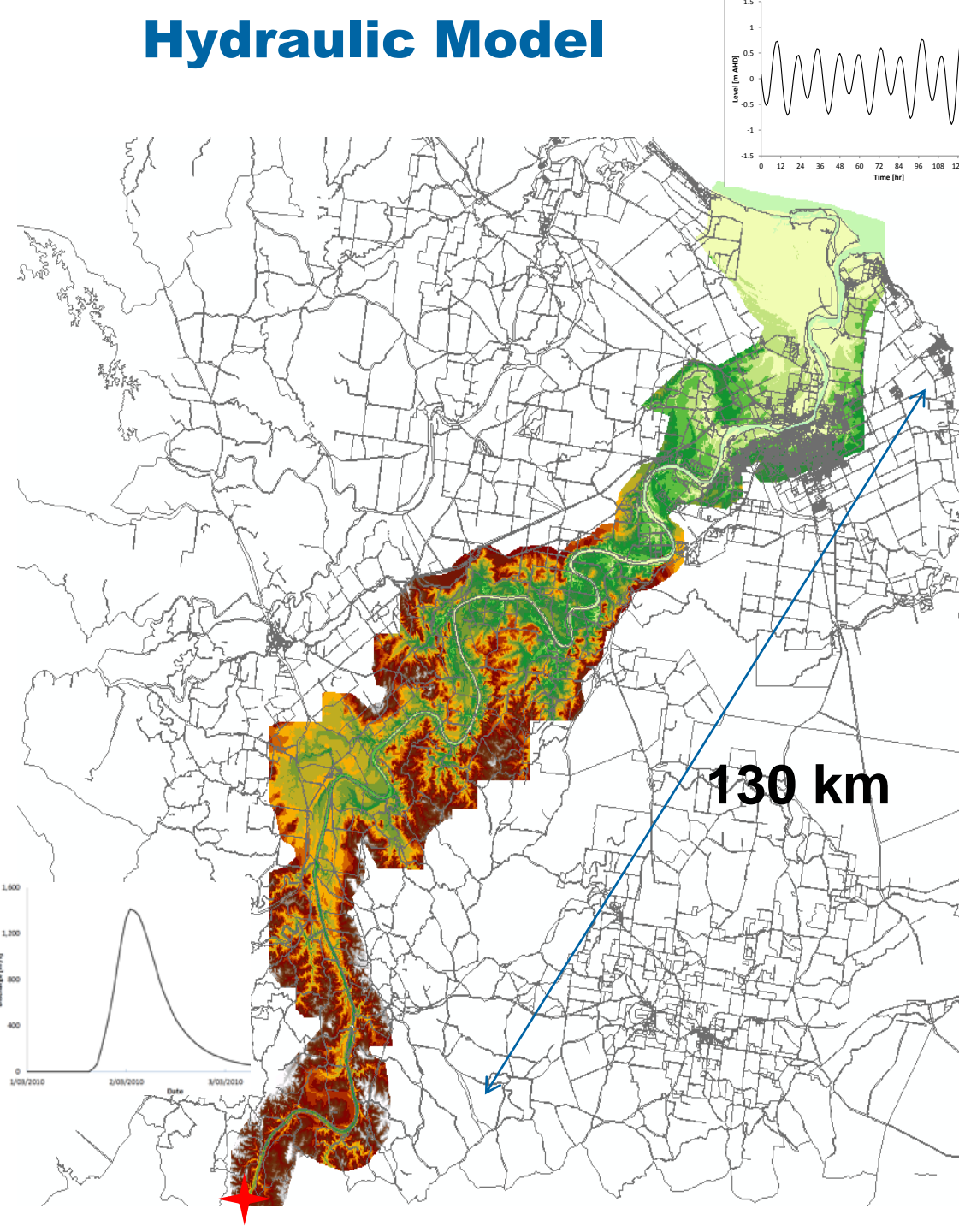
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Hydrological Model



- 300 sub-catchments
- Each sub-catchment defined by:
 - Area, Slope, Roughness, soil conditions
- Spatial & Temporal Rainfall Pattern
- Rainfall-in
↓
Flow Rate-out

Hydraulic Model



- 2 dimensional dynamic hydraulic model
- 3D DEM represented by a 15 m grid cell
- Upstream boundary uses inflow hydrograph from hydrological model
- Downstream tidal boundary
- Flood characteristic such as flood level, velocity & hazard in the 2D model area are determined numerically at each time step
- Nested Model

Identification of Options (Stage 2A)



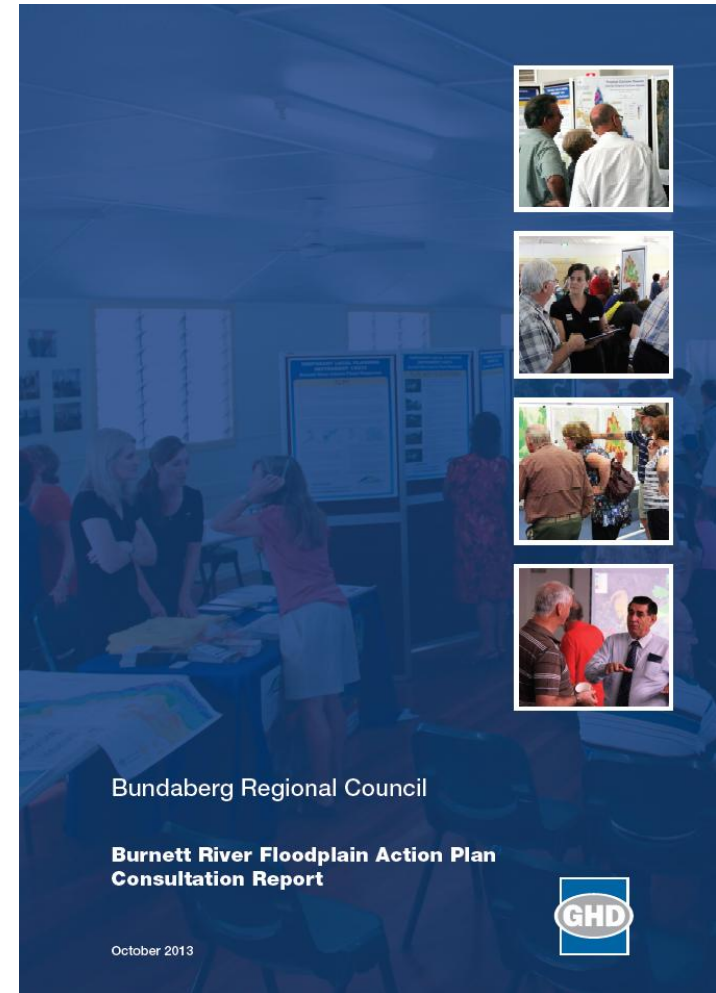
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Consultative Process

- **10 Community Information Sessions (280 people attended)**
- **Council Website & Suggestion box**
- **Community Reference Group**
- **Total of 328 ideas and suggestions were received (plus ideas direct to CRG)**
- **These Ideas were fed into the Options Assessment Process**
- **Options Assessment Report on Council's Website**



3. Options Assessment (Stage 2B and 2C)



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Options Assessment (Stage 2B & 2C)

Identification of 328 Ideas by Community, Council & GHD

Initial Filter

40 Options (CRG)

Flood Modelling of 40 Options

Multi-Criteria Assessment (MCA) of 20 Options

Detailed Assessment of Top 8 Options

Recommend 7 Projects

Types of Options Identified & Modelled:

Increase River Capacity

- Dredging Whole River
- Dredging Parts of River
- River Widening Options
- Mangrove Removal
- Remove Islands and blockages (e.g. Harriot)

Reduce Floodplain Inundation

- North Bundaberg Levee Options
- East Bundaberg Levee Options
- Levees in regional areas (e.g. Wallaville)

Divert Flows

- North Bundaberg Diversion Channels
- Upstream & Downstream Diversion Channels

Other Options

- House Raising & Land-use planning
- Evacuation Route upgrades
- Dams & Barrages

Multi Criteria Assessment:

- Flood Behaviour
- Social Considerations
- Environmental Considerations
- Economic Considerations

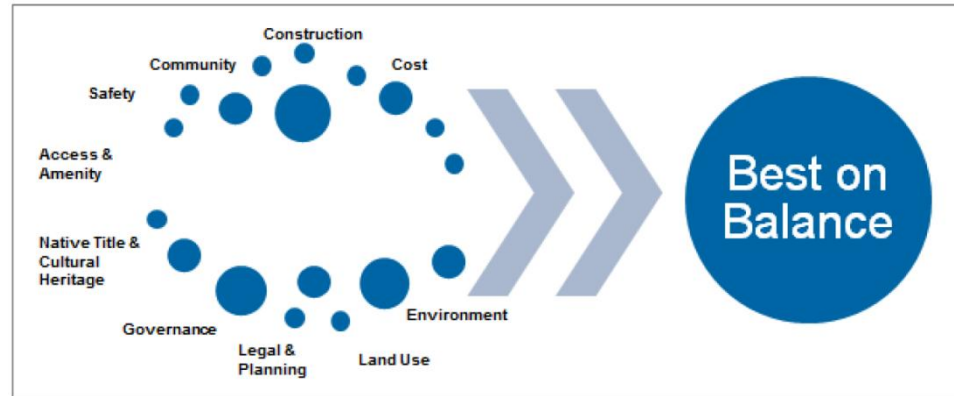
Recommend 7 Projects:

- East Levee & Floodgate
- Selective Dredging & Widening at Millaquin Bend
- Hinkler Avenue Upgrade
- Perry River Bridge Upgrade
- Pine Creek, Givelda and Electra evacuation route upgrades
- Mount Perry Rd & Fairymead Rd evacuation route upgrades
- Barthold Drive Evacuation Route



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Multi Criteria Analysis



- Tool to highlight potentially viable options for detailed assessment
- 20 projects and 20 assessment criteria (social, environmental, economic)
- Criteria weightings determined by CRG
- Each project given a relative score from 1 – 100 against each criteria
- Ranking based on cumulative weighted scores across all criteria

Score	Descriptor
100	Highly beneficial / desirable
90	Very beneficial / desirable
70	Moderately beneficial / desirable
50	Neutral (i.e. no significant positive or negative impact)
20	Moderately constrained / detrimental
10	Highly constrained / detrimental
1	Fatal flaw / prohibitive



MCA criteria

Social Criteria	Environmental Criteria	Economic Criteria
Communication / notification during a flood event	Impact on terrestrial environment (flora / fauna)	Overall cost-benefit
Flood warning time	Impact on aquatic / riparian environment (flora / fauna)	Cost of implementation
Frequency and duration of flooding or isolation / effects of isolation	Difficulty of environmental approvals	Cost of maintenance / upkeep
Impact on direct exposure to flood hazard / safety	Impact on river stability / sedimentation	Inundation of agriculture land
Visual amenity	Erosion / scour to floodplain	Impact on local business / commercial land
Cultural heritage		Impact on residential properties
Impact on community infrastructure		Impact on municipal infrastructure / utilities
Impact on evacuation routes		Impact on fisheries
Impact on recovery / accommodating the displaced victims of a flood		Impact on tourism
		Impact on developable land

MCA results

Option Number	Description	Viability
2	East Levee & Floodgate	V
38	Regional Bridge Upgrades	V
39	Bundaberg North Evacuation Route Upgrades	V
40	Funding for house raising / restumping	V
1	North Levee	V
23	Town Reach Dredging	V
10	Low Level North Bundaberg Levees	V
31	Millaquin Bend widening (north bank)	V
12	Wallaville Levee	MV
25	Selective dredging at foundry, Miliquin Bend and Fairymead Bend	MV
31	Town reach widening (north bank)	MV
24	Barrage to Port Dredging	MV
11	Port of Bundaberg Levee	MV
19	Gardens Channel 2	MV
29	Removal of sediment from north bank and Harriet Island	MV
26	Removal of Fairymead Levees	UV
27	Removal of mangroves from town reach	UV
30	Reopen Skyringville Passage	UV
20	Rubyanna Bypass Channel	UV
41	Fairymead Diversion Channel 3	UV

4. Detailed Assessment of Top 8 Options from MCA (Stage 2D)



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Detailed Assessment of Top 8 Options

- **Develop concept designs for each option**
- **Undertook additional detailed hydraulic modelling where appropriate**
- **Feasibility and risk assessments**
- **High level Environmental Impact Assessment**
- **Assessment of the number of properties benefitted and adversely affected**
- **Assessment of the reduction in flood damage costs**
- **Cost Estimates for each Option**
- **Cost-benefit analysis**

5. Recommendations (Stage 2E)

Discussion of:

- Preferred Options &
- Options not taken forward



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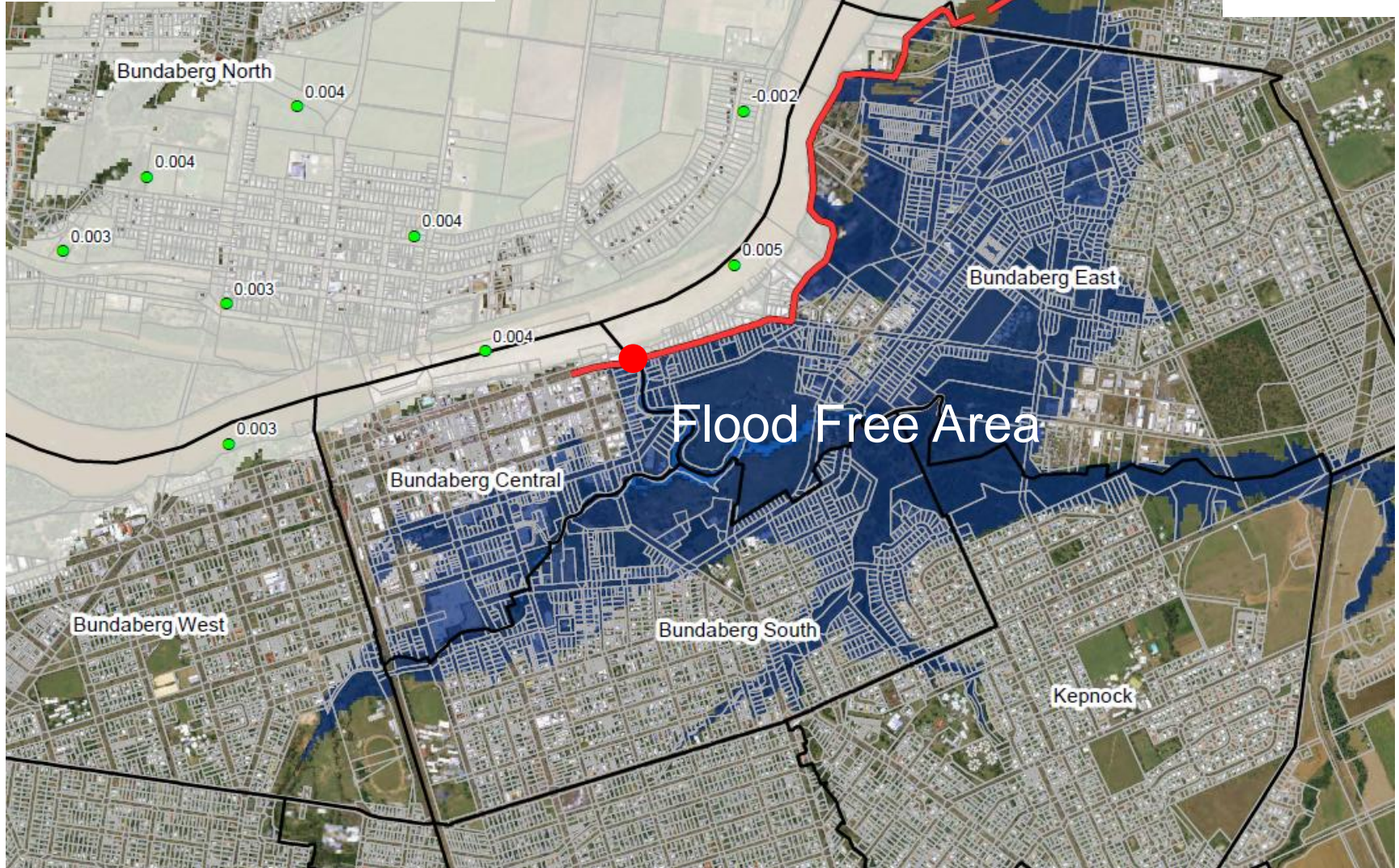
Preferred Options



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East Bundaberg Levee
\$71M
Approx. 1 to 5m high

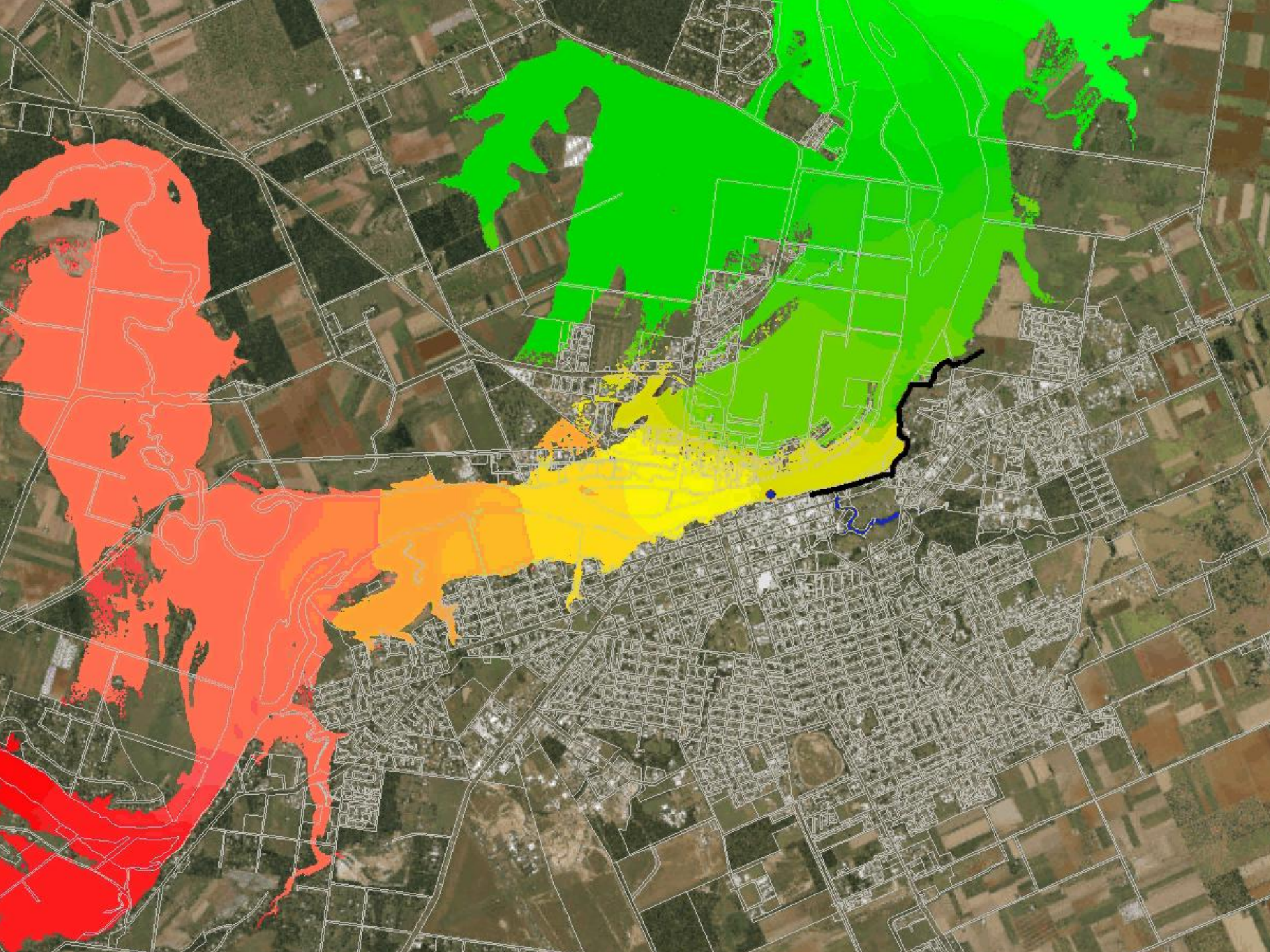
Flood Gate
3 x 8m H x 8m W gates





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East Bundaberg Levee Flood Animation





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East Bundaberg Levee and Floodgate

DESIGN

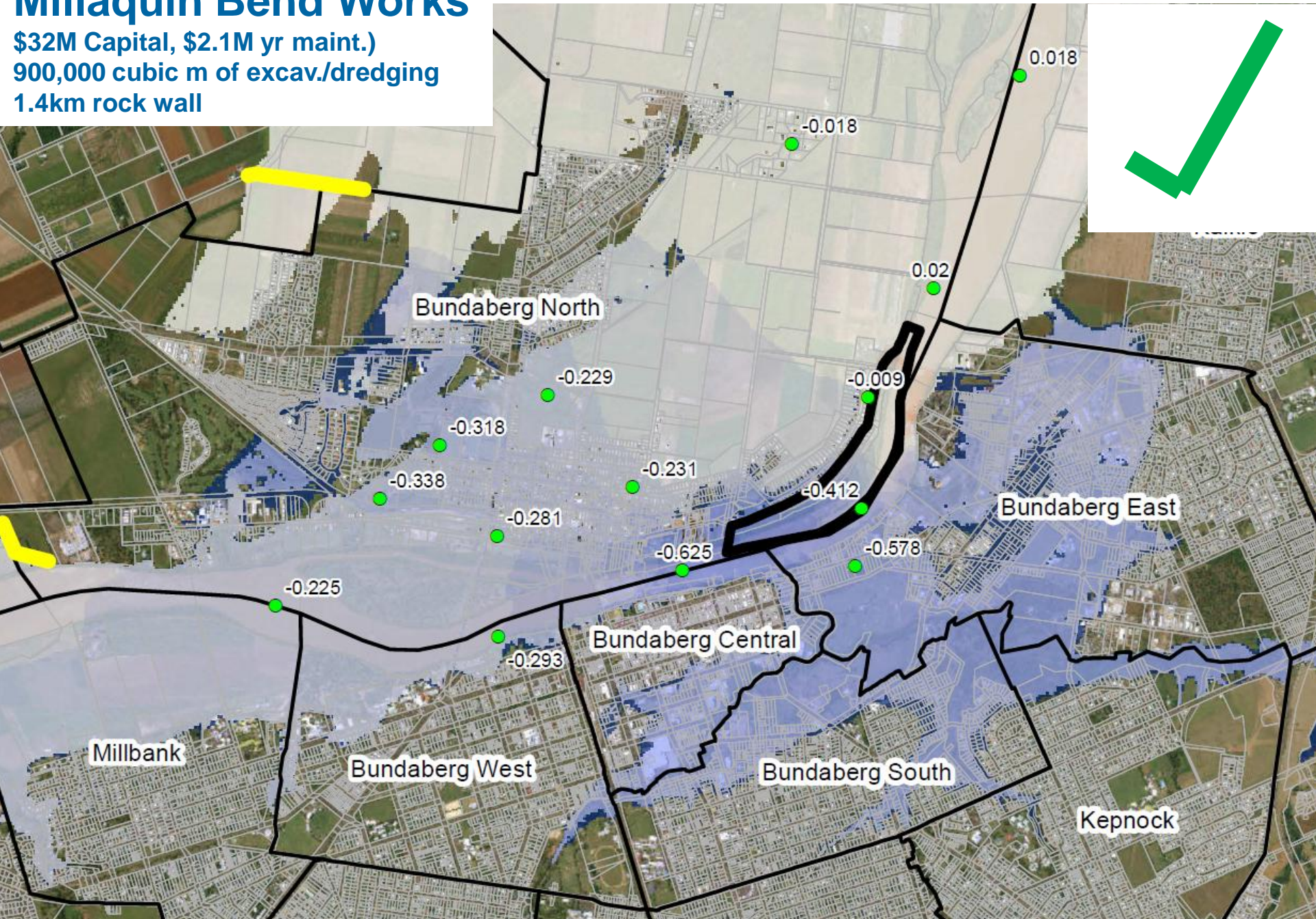
- Initial design based on 0.5% AEP flood plus 0.6 m freeboard (to be reviewed)
- Combination of construction techniques (earth and concrete)
- Large flood gate over Bundaberg Creek

BENEFITS

- Protects large area of South, Central & East Bundaberg (800 properties benefitted)
- Reduce above floor flooding on 740 properties (in Jan 2013 like event)
- Unlike North Bundaberg Levees – no significant impact on other properties
- Impacts / resumptions on a number of properties (to be confirmed in detailed design)
- \$71M cost estimate
- Benefit – cost ratio of 0.77

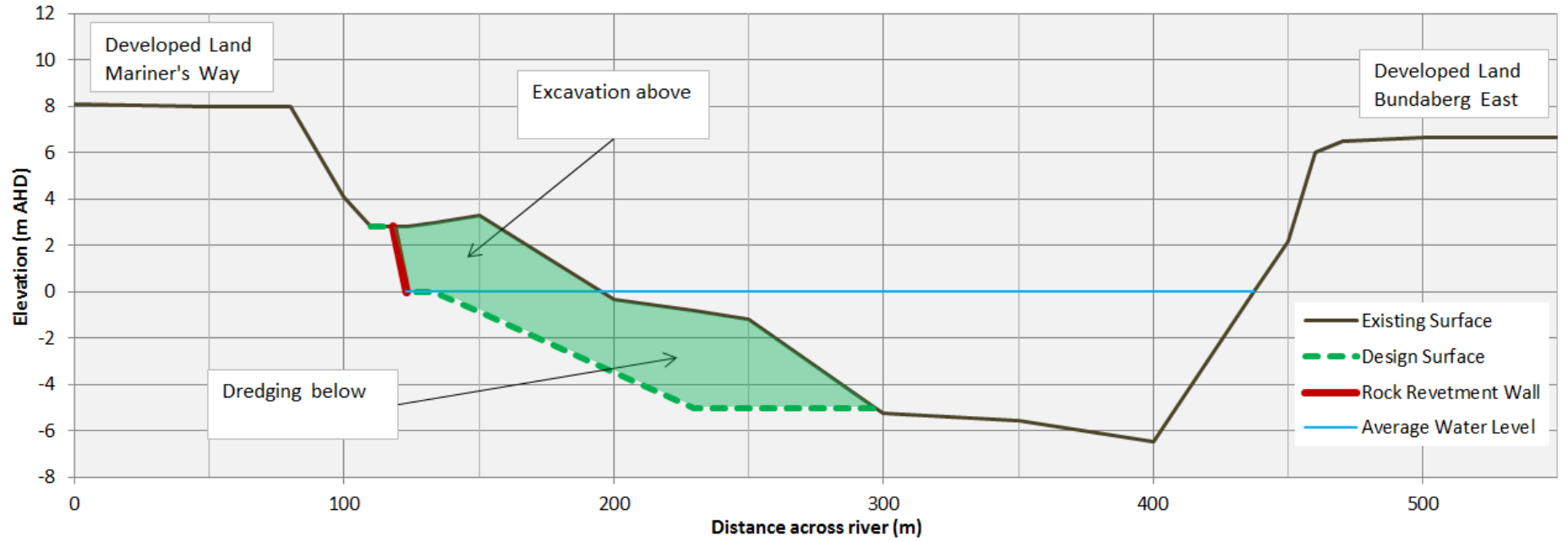
Millaquin Bend Works

\$32M Capital, \$2.1M yr maint.)
900,000 cubic m of excav./dredging
1.4km rock wall



Millaquin Bend Works

\$32M Capital, \$2.1M yr maint.)
900,000 cubic m of excav./dredging
1.4km rock wall
Removal of Mangroves





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Millaquin bend dredging & widening works

DESIGN

- Excavation on the northern side of Millaquin bend opposite the mill / distillery
- Involves both river widening (excavation on land) and dredging
- Includes engineered rock revetment wall
- Removal of mangroves

BENEFITS

- Reduces flood levels by approximately 0.5 m in East Bundaberg and by 0.3 m in North Bundaberg
- Reduce above floor flooding on 436 properties (Jan 2013 like event)
- \$32.1M capital cost, \$2.1M/yr on-going maintenance estimate
- Benefit – cost ratio of 0.5



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Goodnight Scrub Evacuation Route Upgrade (Perry River Bridge upgrade or alternative evac. route)

- New bridge 8m higher than existing bridge across Perry River
- Provide Approx. 10% AEP (10 year ARI) flood immunity
- Improved from < 20% AEP immunity under existing conditions to match immunity of St Agnes Creek bridge crossing
- \$17.3M cost estimate

Alternative Option Decided By Council:

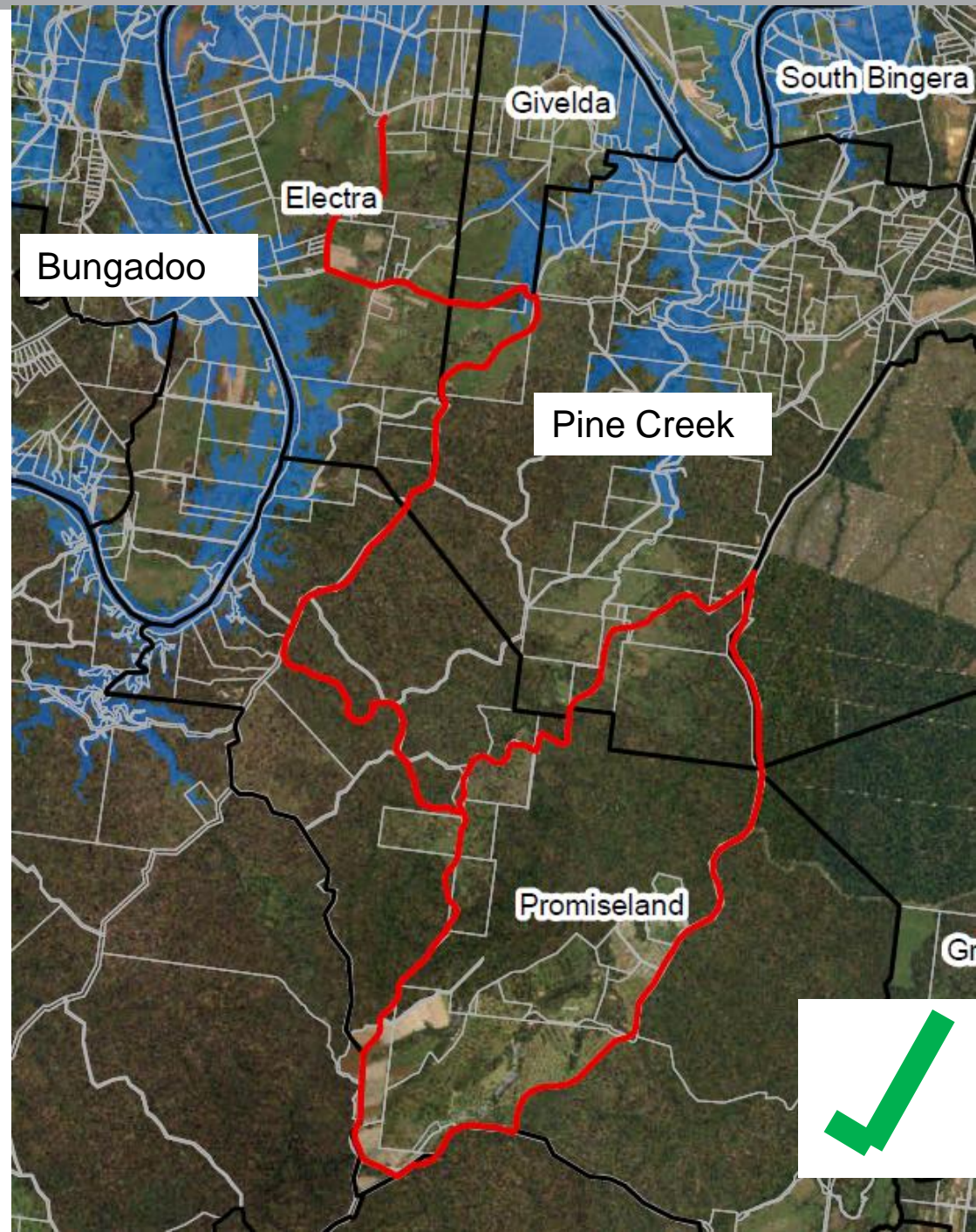
- An alternative evacuation route – through Goodnight Scrub NP along Kalliwa Rd to Gayndah-Mount Perry Rd
- Requires local road and drainage works



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Pine Creek, Givelda and Electra evacuation route upgrades

- Alternative Route to Pine Ck Road
- “All-weather” evacuation route through private property and state forest (red line)
- Maximum cost of \$1M to secure two routes
- Requires local road and drainage works





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Hinkler Avenue Upgrade

- New raised road on piers (viaduct) from Tallon Bridge to North School Hill Roundabout (0.8 km)
- Would improve existing road immunity from 10% AEP (10 year ARI) to 0.5% AEP (200 year ARI)
- Increases the evacuation time available across the river
- \$104M estimated costs
- Further investigations required in consultation with DTMR





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Mount Perry Rd & Fairymead Rd evacuation route upgrades

- Raise low lying section of existing roads to an elevation that will provide flood immune evacuation routes
- Would improve existing immunity from 2% AEP (50 year ARI) to 0.5% AEP (200 year ARI). Would remain open in a January 2013 scale flood event.
- \$7.4M estimated costs for 3 km of roads





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Summary of recommended large-scale mitigation options

- East Bundaberg Levee & Floodgate (\$71M)
- Millaquin bend dredging & widening works (\$32.1M capital, \$2.1M/yr maintenance)
- Perry River bridge upgrade (\$17.3M for bridge) or **alternative route**
- Pine Creek, Givelda and Electra alternative routes (\$1M max)
- Hinkler Avenue upgrade (\$104M)
- Mount Perry Rd and Fairymead Rd upgrades (\$7.4M)

Options Not Taken Forward



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Discussion of Some Options Not Taken Forward

Reminder

- **Hydraulic Modelling Undertaken to Assess over 40 Floodplain Management Options**
- **Options Assessment Report on Councils Website**
- **FAQ Document on Councils Website**

Five Non-Feasible Options

- **Dredging Burnett River (Barrage to Mouth)**
- **Dredging Burnett River (Town Reach)**
- **Diversion Channels & Levees in North Bundaberg**
- **Large Upstream and Downstream Diversion Channels**
- **Re-opening Skyringville Passage**



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Large-Scale Dredging Burnett River

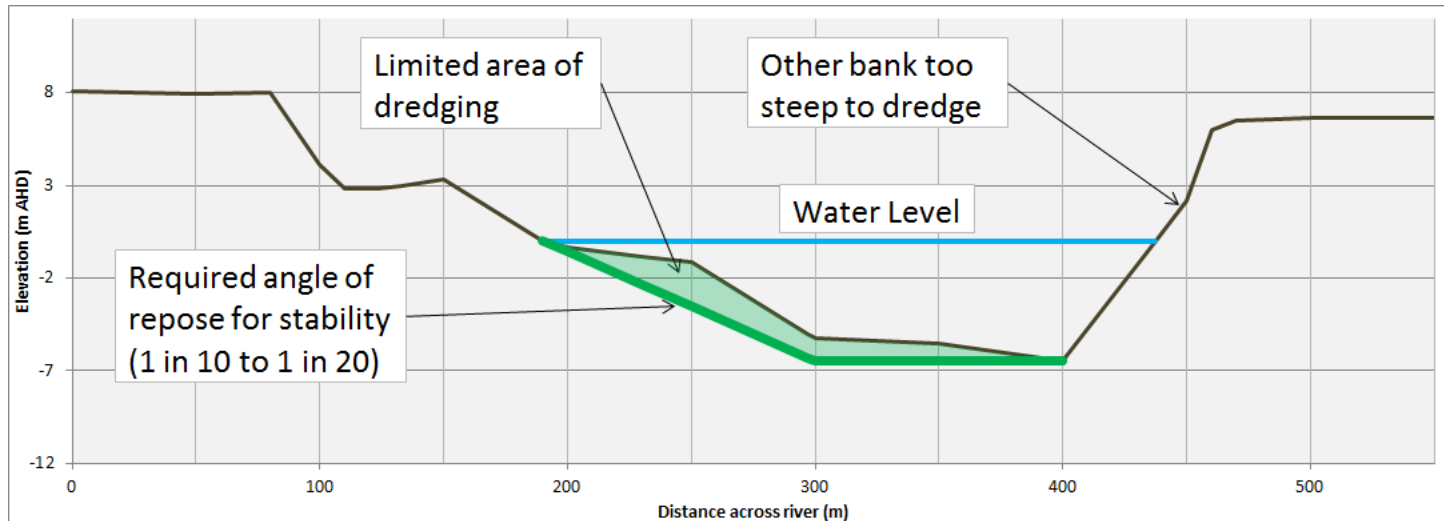
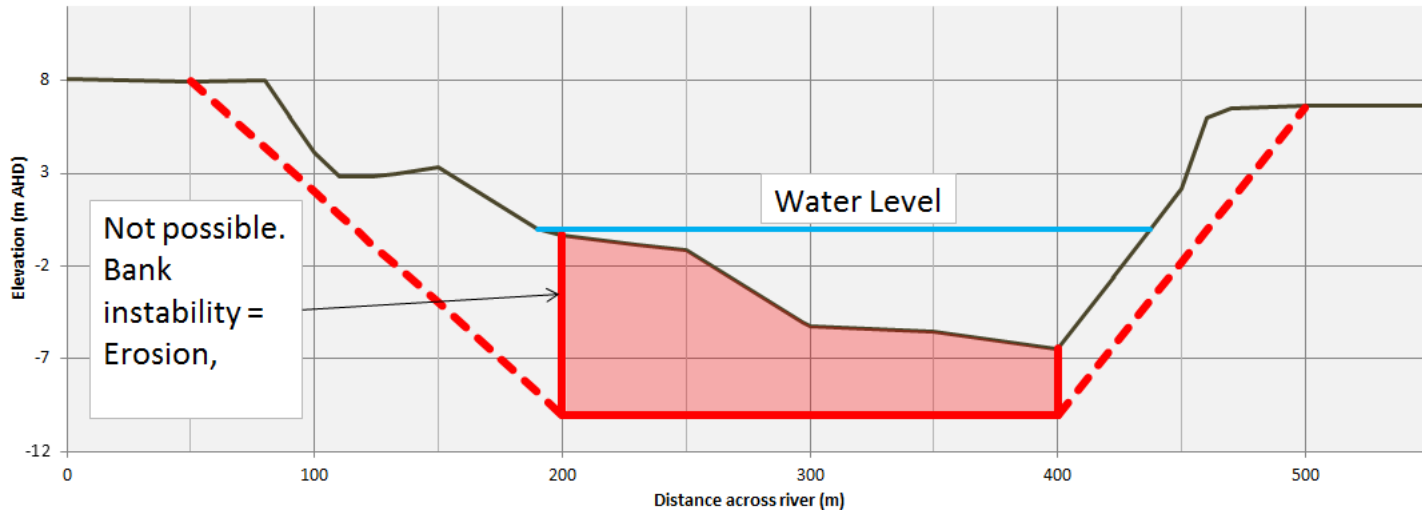
- Dredging Burnett River (Barrage to Mouth)
- Dredging Burnett River in Town Reach only

Bank Stability Issue:

- Appropriate bank slopes (angle of repose)
- Can't dredge where there is already steep banks
- Target Dredging in areas that are most suitable



Dredging Burnett River – Bank Stability Issues





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Dredging Burnett River (Barrage to Mouth)

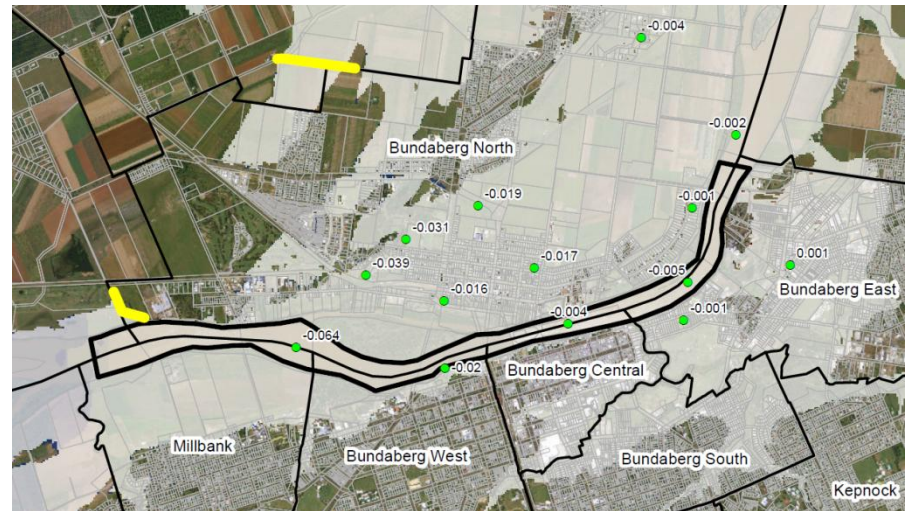
- Large volume of dredge material (7 million – 20 million cubic metres of spoil)
- Significant Cost (\$160M to \$700M)
- Significant ongoing and costly maintenance dredging required
- Relatively small reduction in flood levels compared to scale of project
- Very low Benefit – Cost Ratio

(Note: Volume of Dredging Volume associated with Abbot Point at GBRMP = 3 million cubic metres of dredge spoil)



Dredging Burnett River (Town Reach Only)

- Dredge depths ranging from 0 - 4m
- Design included maintaining stable bank slopes to avoid slumping (limits effectiveness)
- Large volume of dredge material (1.7 million – 2.6 million cubic metres of spoil)
- Significant Cost (\$85M to \$98M)
- Significant ongoing and costly maintenance dredging required
- Small reduction in flood levels compared to other options (< 100 mm).
- Very low Benefit – Cost Ratio of 0.05



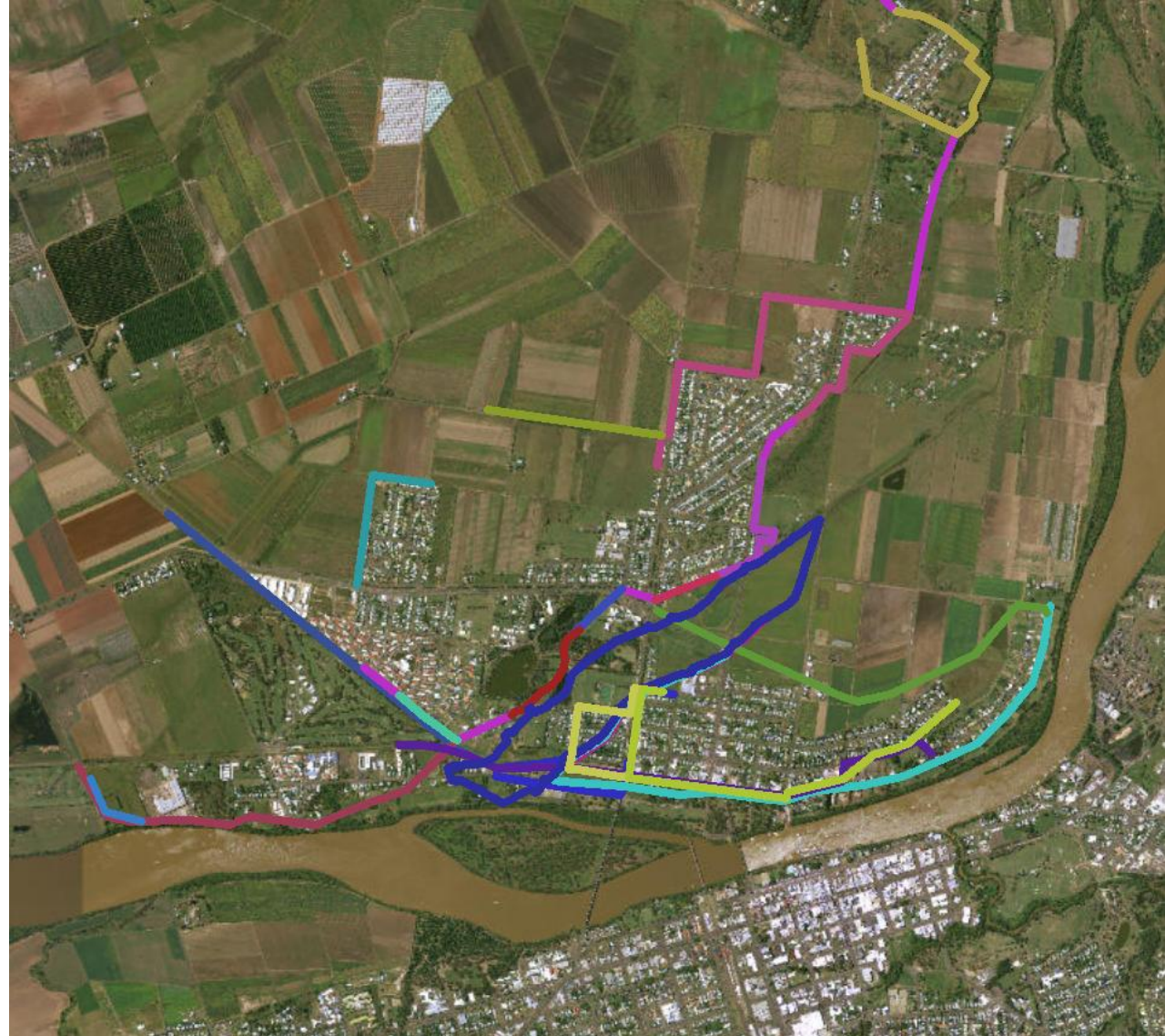


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North Bundaberg Options



- >15 Options Considered
- Focused on prevention of inundation in North Bundaberg
- Levees
- Diversion channels (e.g. Botanical gardens)





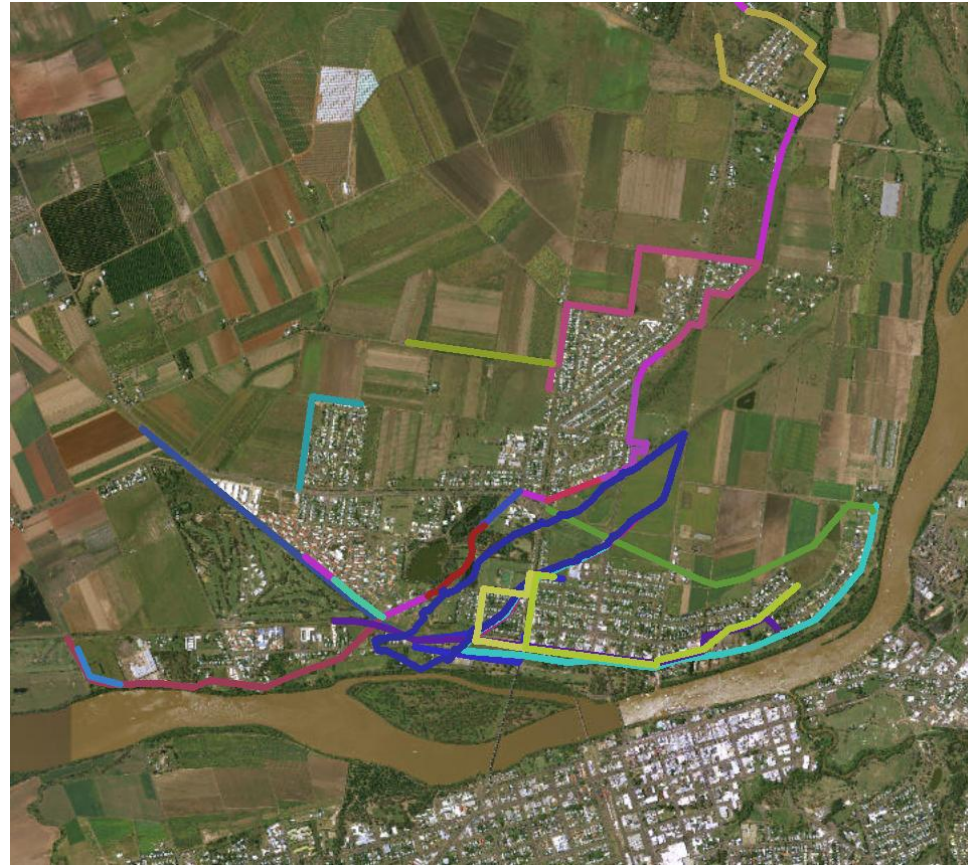
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Bundaberg North Levees and Channels

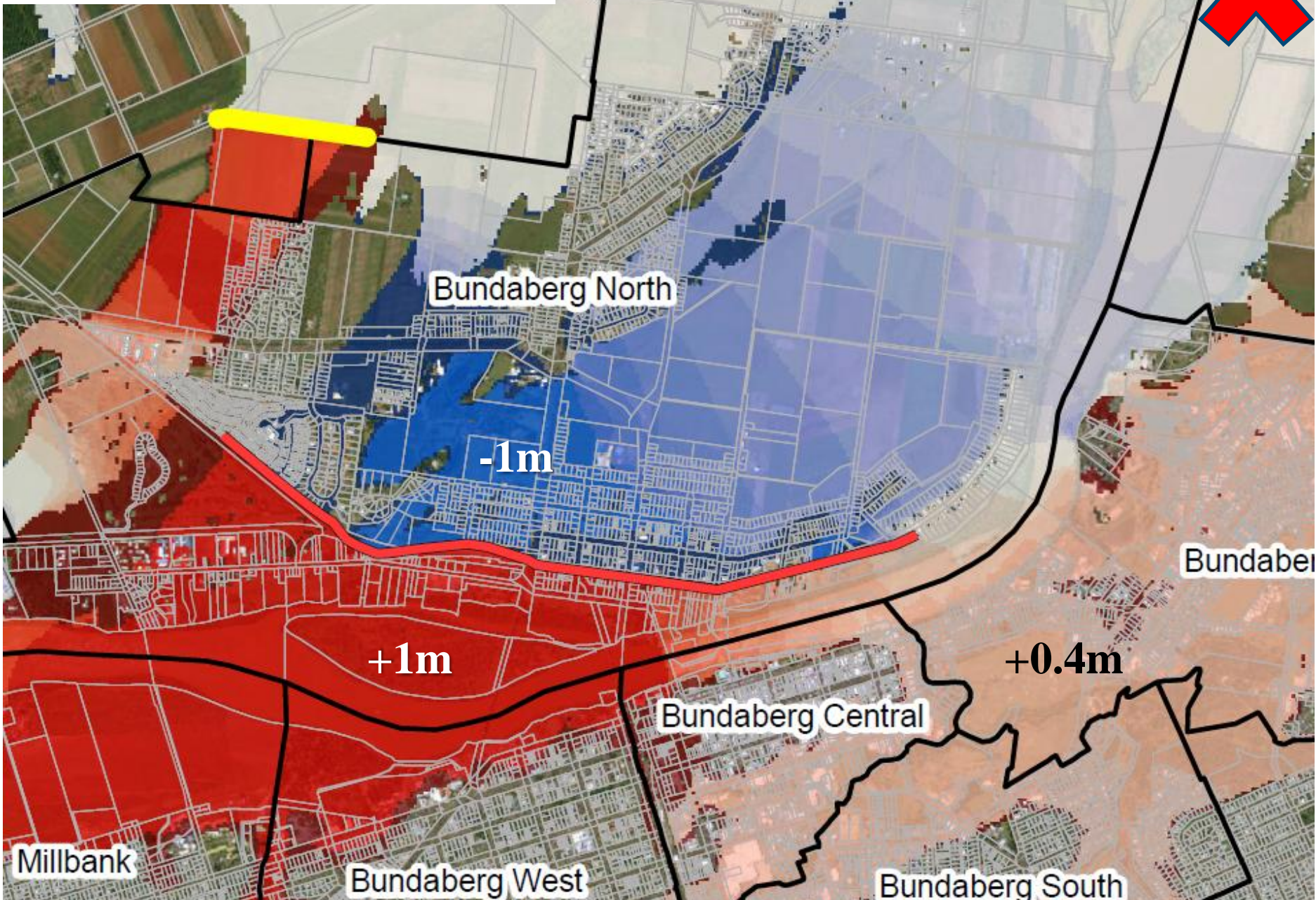
Major Issues:

- Bundaberg North is an active conveyance area
- High velocities
- 25% of Burnett River flow through Bundaberg North (January 2013)
- Most Options cause adverse impacts on adjacent properties & infrastructure (increased flood levels & velocities)

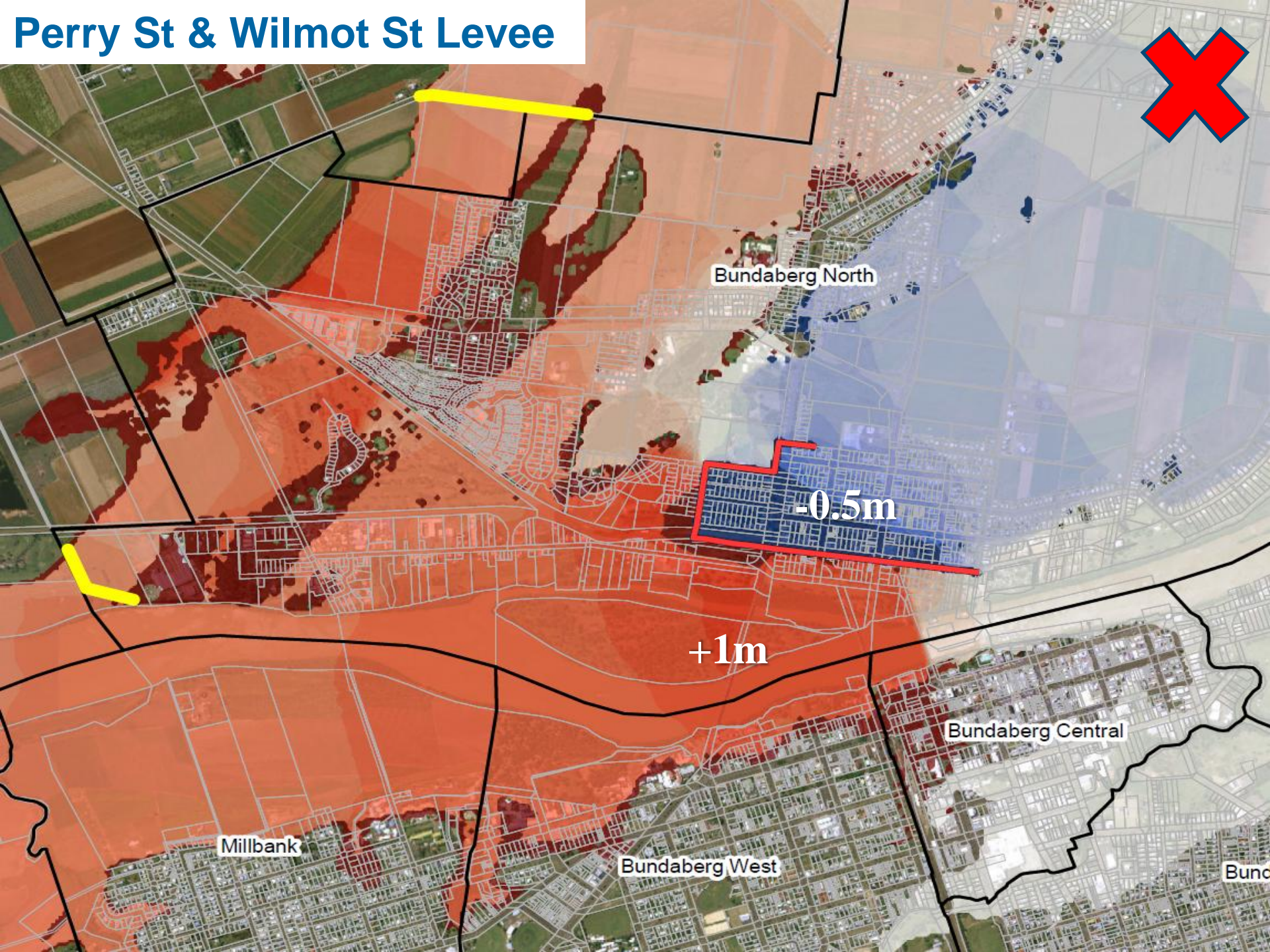


Perry Street Levee

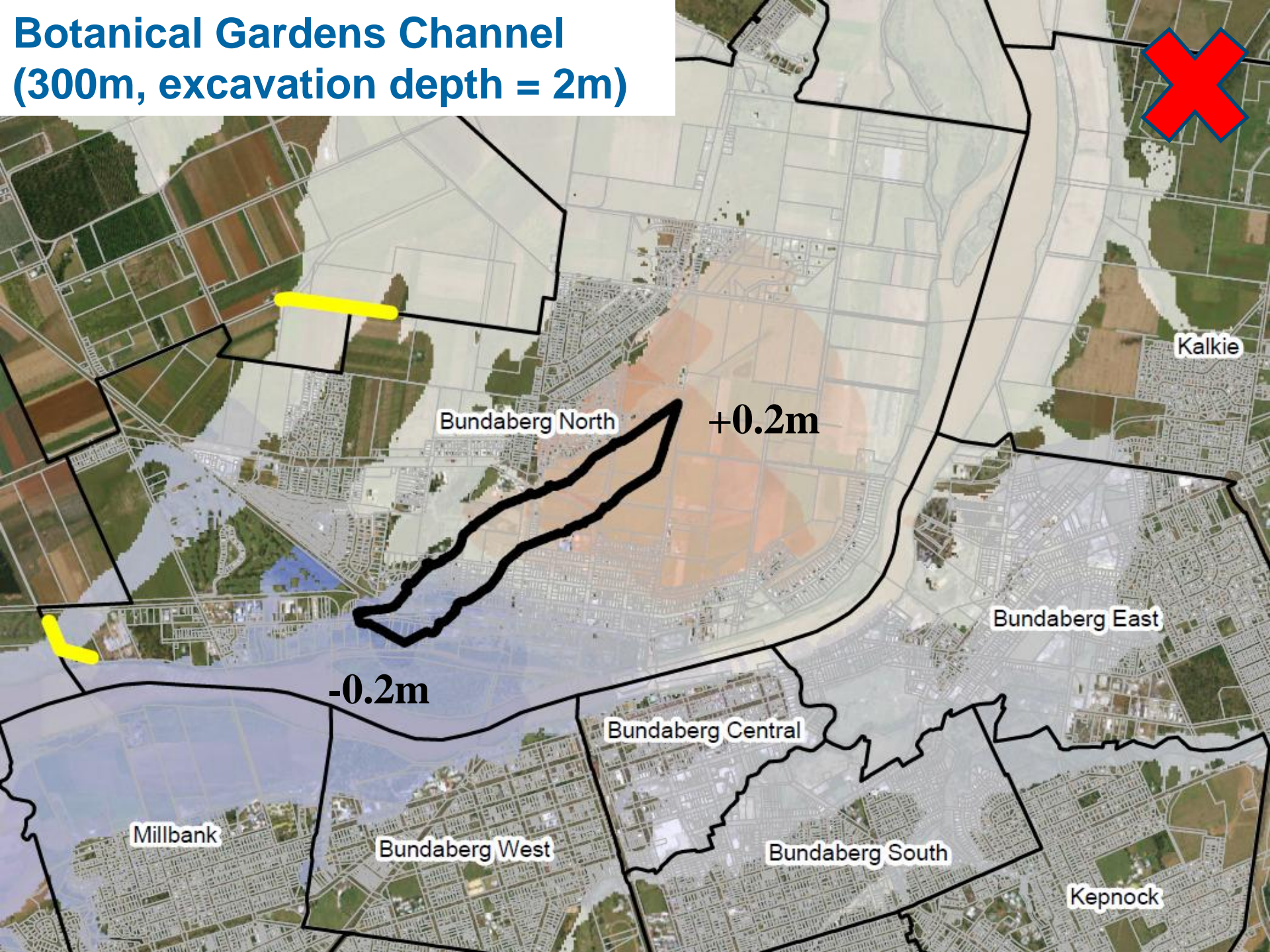
Red = Increase, Blue = Reduction



Perry St & Wilmot St Levee



Botanical Gardens Channel (300m, excavation depth = 2m)





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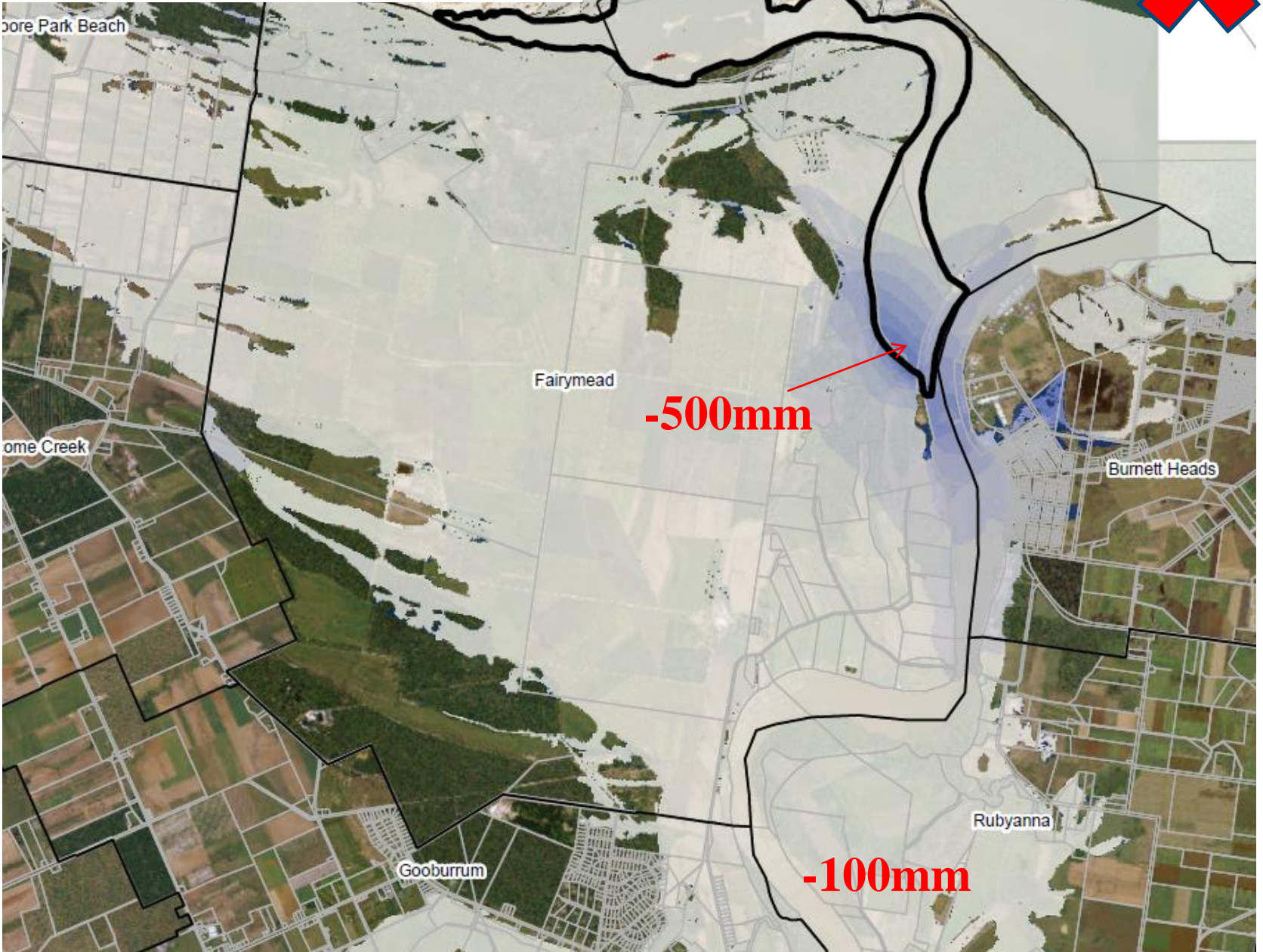
Diversion Channels & River Widening

- Including:
 - Town reach Works
 - Re-opening Skyringville Passage
 - Fairymead diversion channels
 - Rubyanna diversion
- Aim to reduce flood levels
- Increase river capacity or divert water elsewhere
- Relatively small flood level reductions
- Large scale and cost

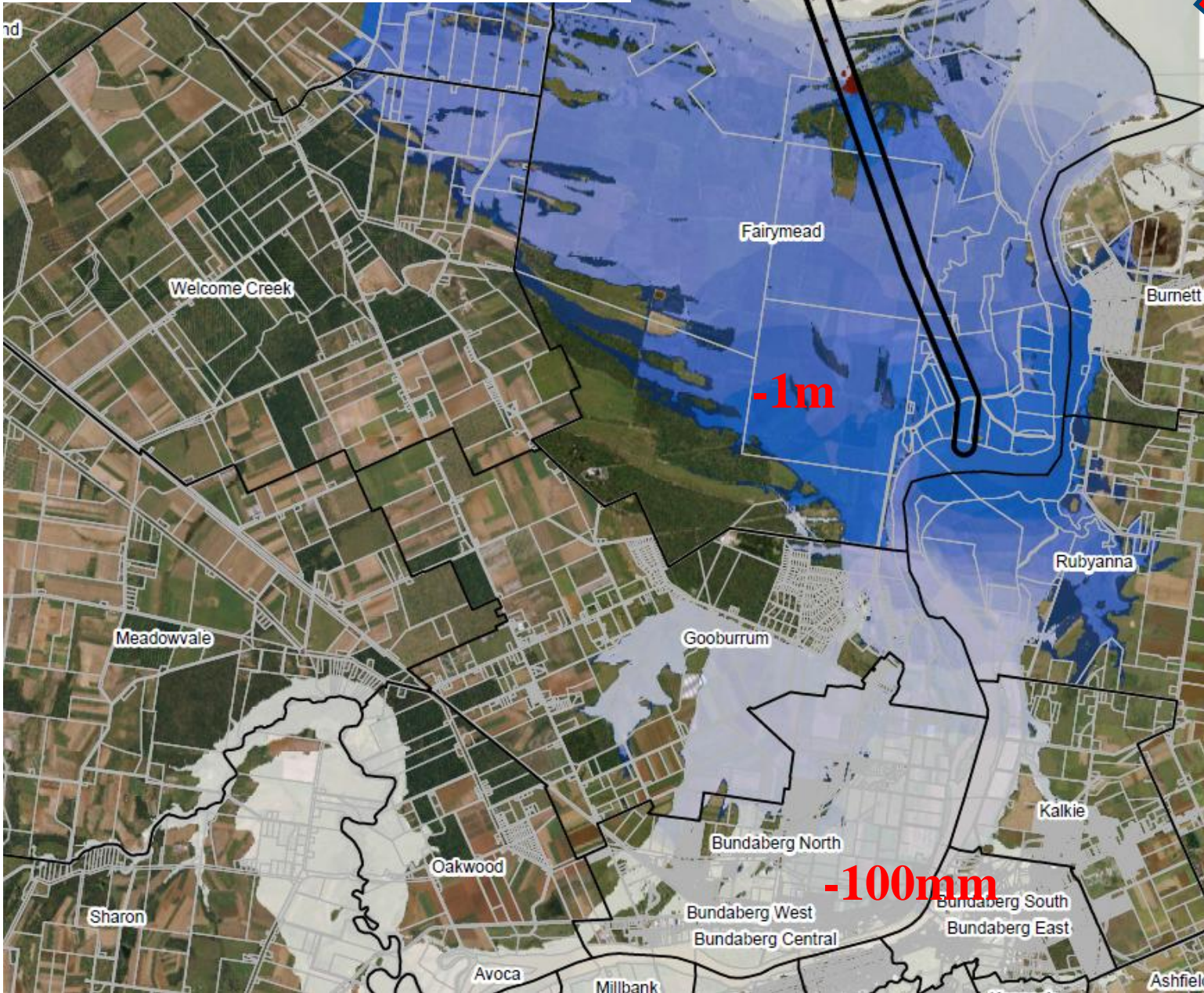
Note: Tens of millions of cubic m of excavation required for large diversion channel options for relatively small CBD flood level reductions.



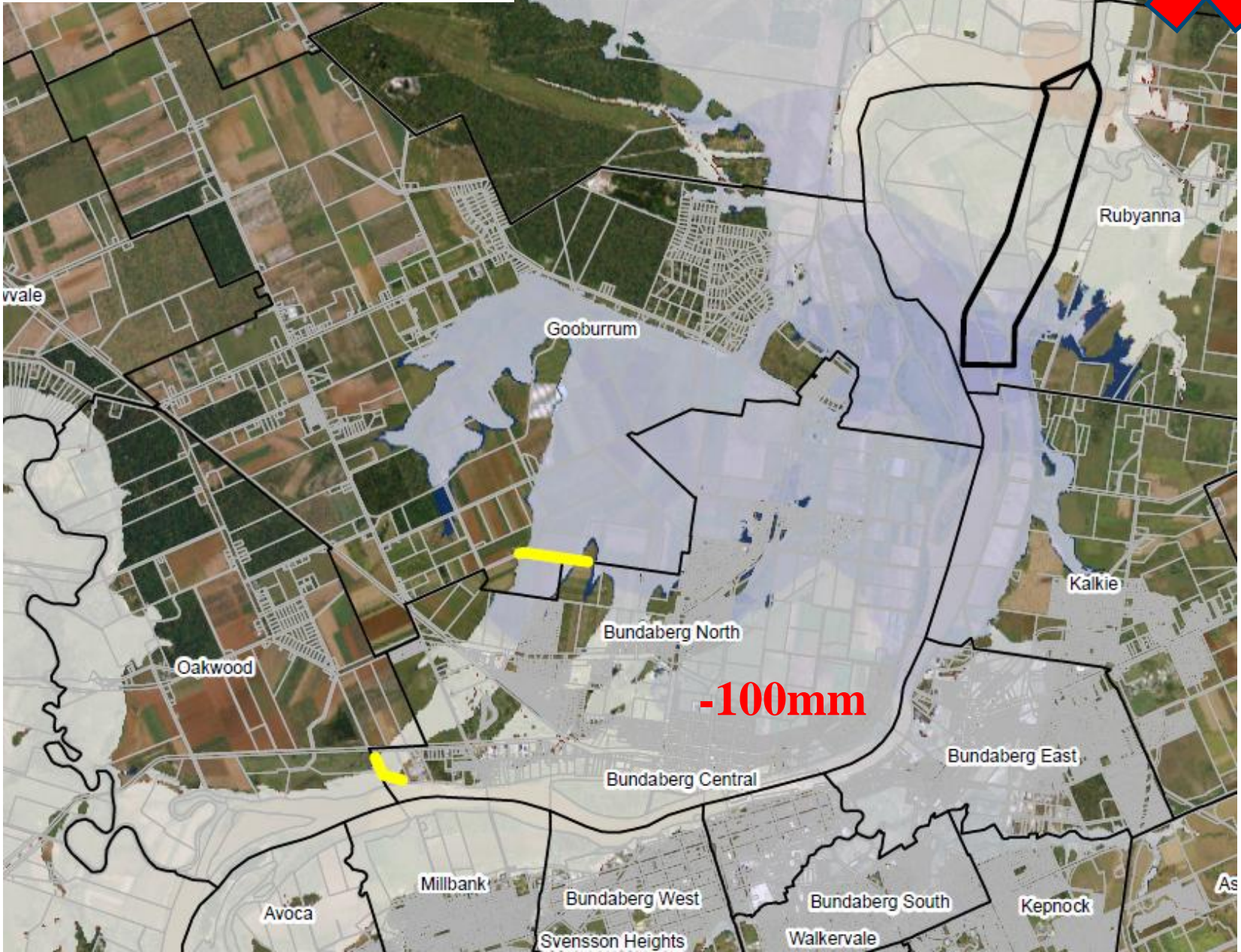
Re-open Skyringville Passage (excavate/dredge depth of 5m)



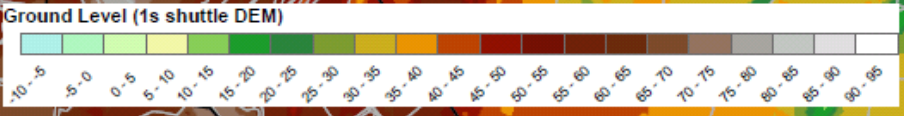
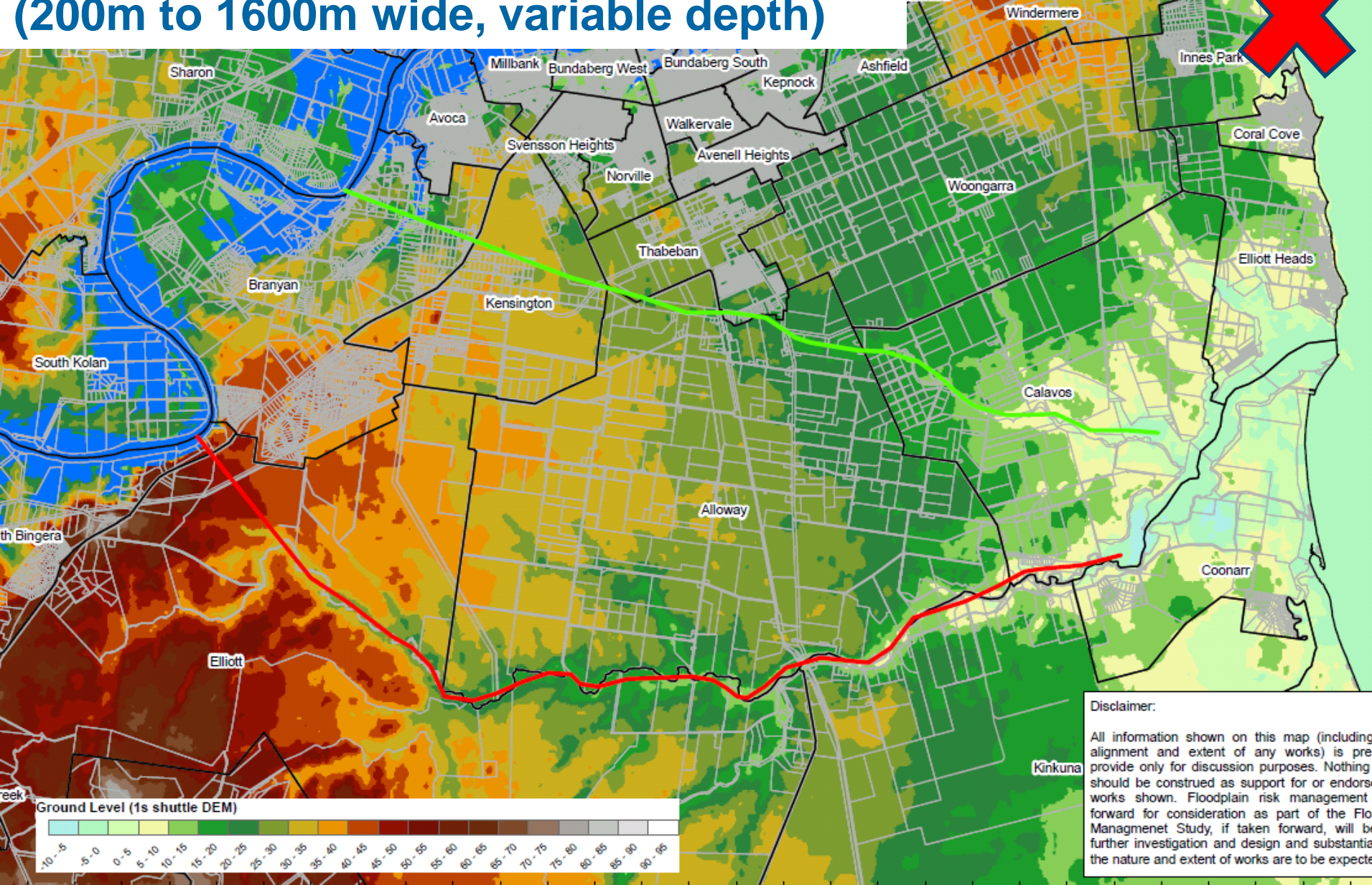
Fairymead Diversion Channel 1 (300m wide, -5m AHD)



Rubyanna Bypass Channel (500m wide, -2m AHD)



Large Diversion Channels to Elliot River (200m to 1600m wide, variable depth)



Disclaimer:
All information shown on this map (including alignment and extent of any works) is preliminary and should be construed as support for or endorsement of the works shown. Floodplain risk management works shown forward for consideration as part of the Flood Management Study, if taken forward, will require further investigation and design and substantial changes to the nature and extent of works are to be expected.



Large Diversion Channels to Elliot River

- Options proposed by the community
- Looked at two options for route and carrying capacity
- A (3,000m³/s) would reduce flooding in Bundaberg by 0.5m and B (10,000m³/s) by 4m

Option Details	Option 1 A	Option 1B	Option 2A	Option 2B
	Divert 3,000m ³ /s of floodwater from Burnett River (Ch 27km AMTD) to Elliot River	Divert 10,000m ³ /s of floodwater from Burnett River (Ch 27km AMTD) to Elliot River	Divert 3,000m ³ /s of floodwater from Burnett River (Ch 38km AMTD) to Elliot River	Divert 10,000m ³ /s of floodwater from Burnett River (Ch 38km AMTD) to Elliot River
Location of bypass channel entrance	Burnett River (Ch 27km AMTD)	Burnett River (Ch 27km AMTD)	Burnett River (Ch 38km AMTD)	Burnett River (Ch 38km AMTD)
Proposed bypass channel flow rate (m ³ /s)	3,000	10,000	3,000	10,000
Length of channel (m)	17,000	17,000	22,000	22,000
Top width of water surface (m)	195	520	505	1630
Maximum depth of excavation (m)	28	28	32	32
Approximate volume of excavation (m ³)	63,085,283	167,333,233	91,767,660	595,123,087
Excavation rate assumption (\$/m ³)	10	10	10	10
Approximate bulk earth works excavation costs (\$)	\$ 630,000,000	\$ 1,670,000,000	\$ 920,000,000	\$ 5,950,000,000

Floodplain Action Plan – Future Work



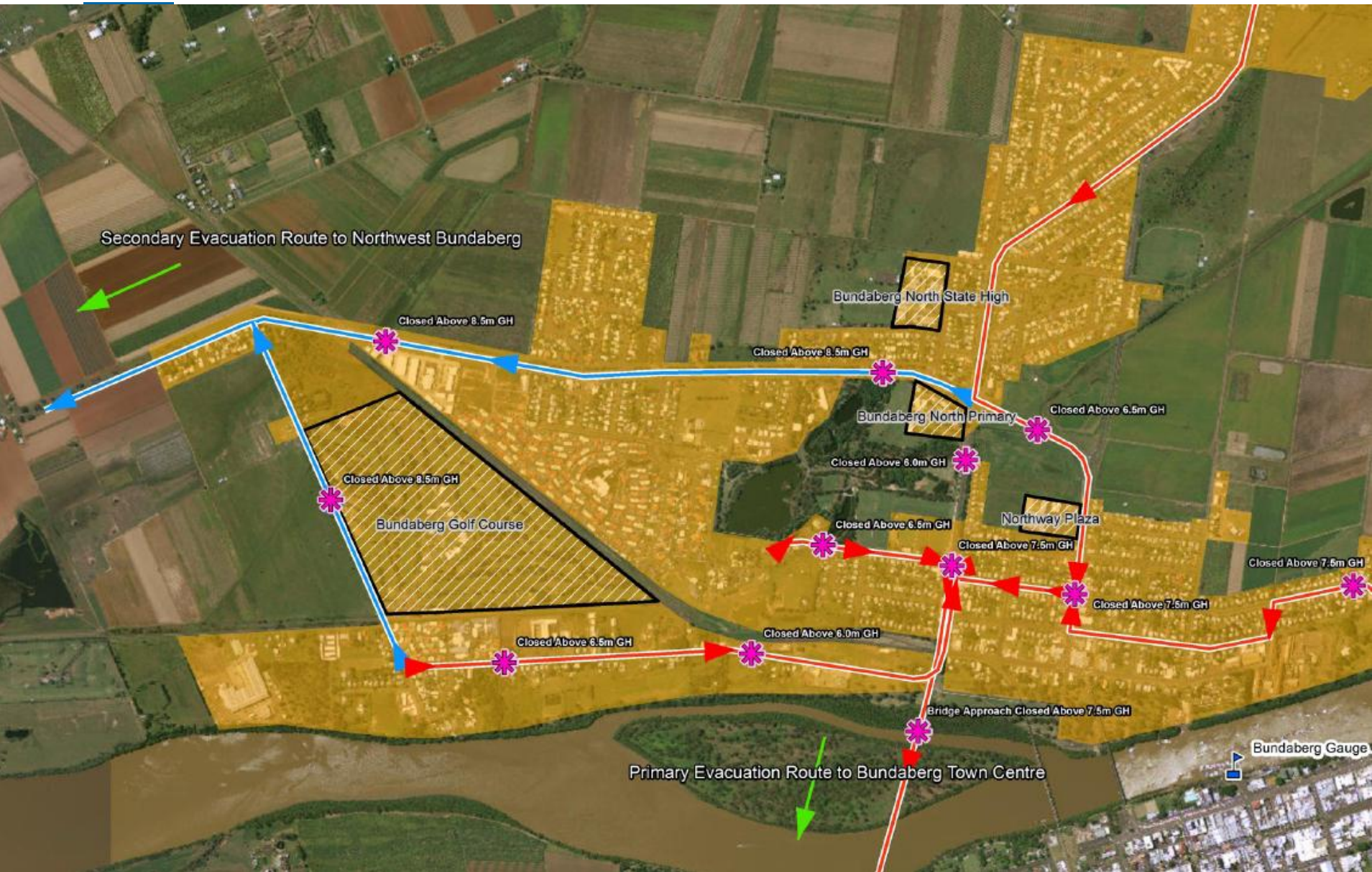
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Floodplain Action Plan – Future Work

- **Funding & Implementation**
- **Finalisation of BRC Flood Warning Mapping Portal**
- **Land Use Planning Recommendations**
- **Improved Disaster Management tools**
- **Finalisation of Evacuation Route Mapping**



Deputy Mayor David Batt to Introduce Mayor Mal Forman



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Council's Recommended Options

1. **Millaquin Bend Dredging & Widening Works**
2. **East Bundaberg Levee & Flood Gate**
3. **Hinkler Avenue Upgrade**
4. **Mt Perry Road and Fairymead Road Upgrades**
5. **Bartholdt Drive Alternative Evacuation Route**
6. **Pine Creek, Givelda & Electra evacuation route alternatives**
7. **Goodnight Scrub alternative evacuation routes**
8. **Various floodplain management measures**



Questions



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