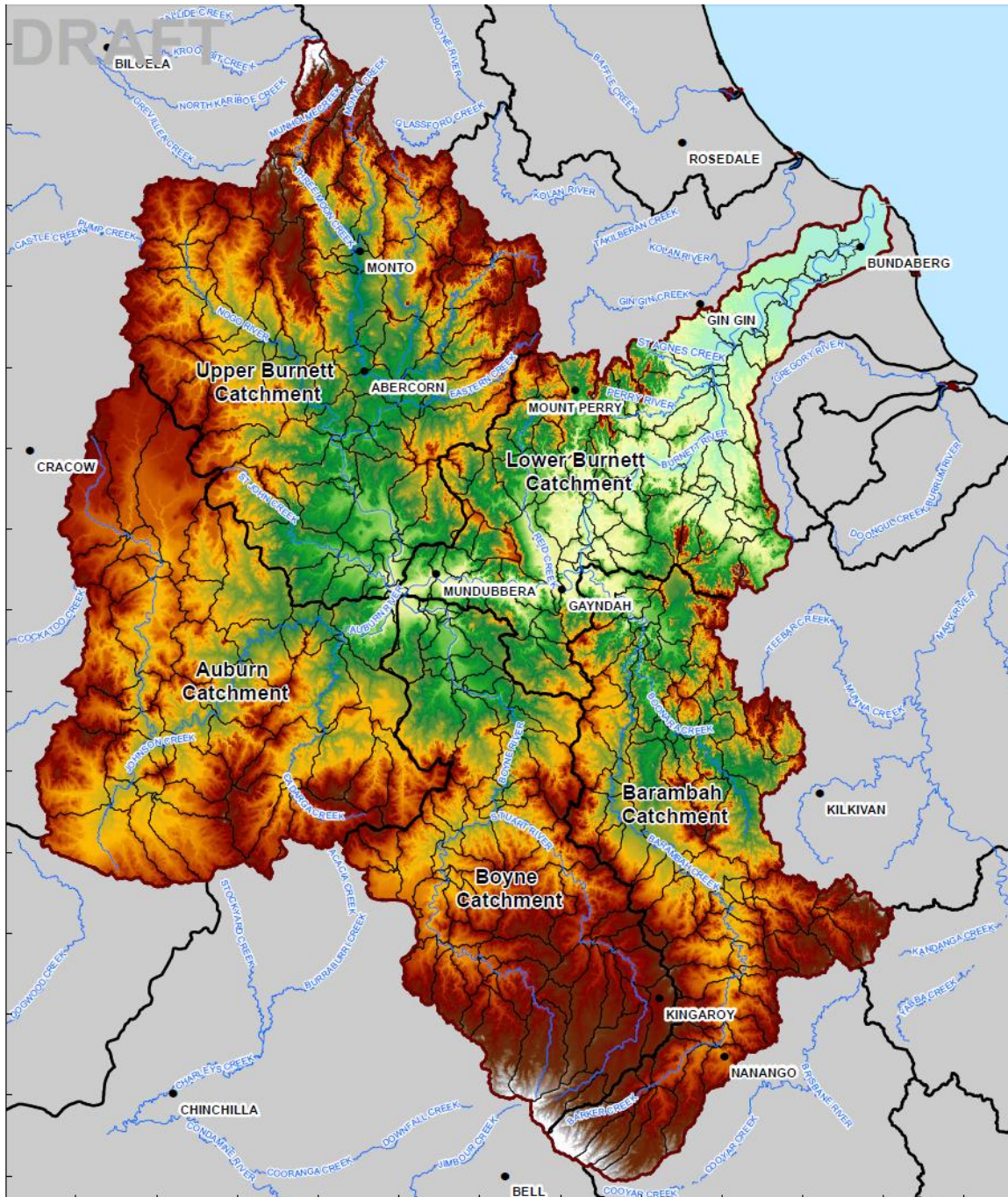


1. Catchment Overview

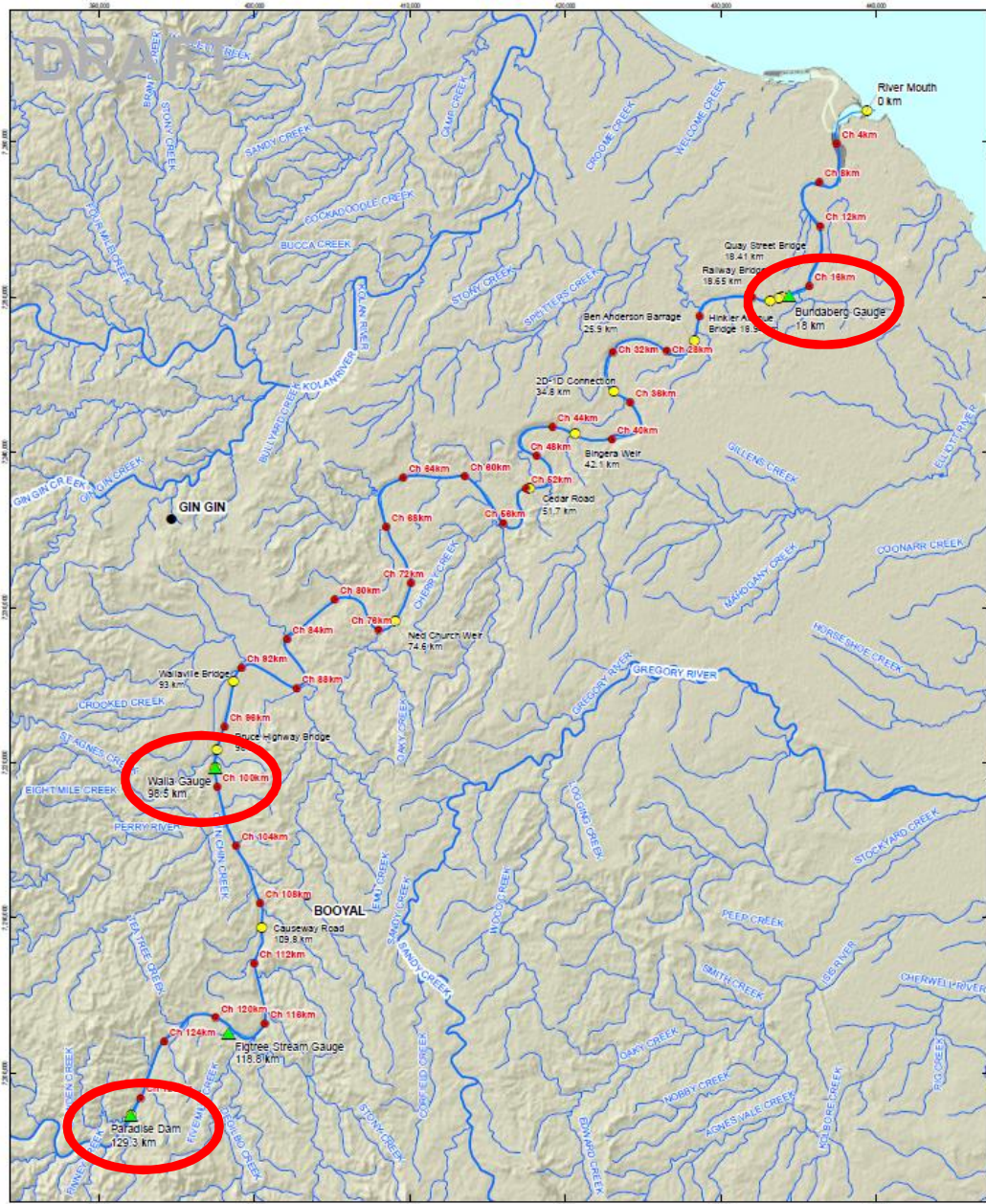


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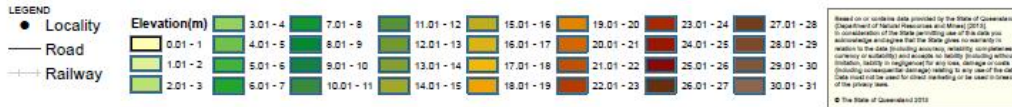
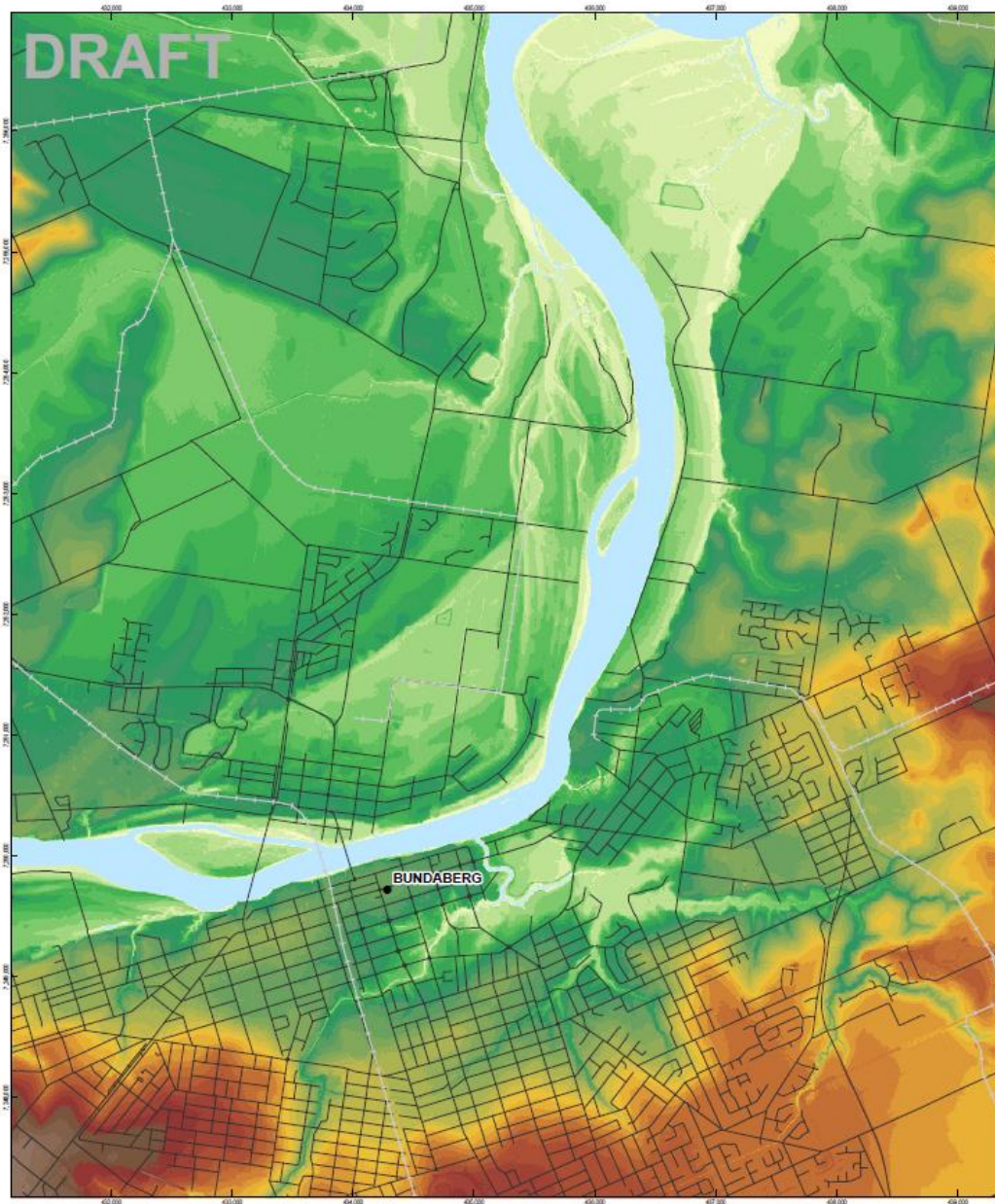
Catchment Overview

- $A=33,000\text{km}^2$
- 5 major sub-catchments
- Major rivers:
 - Burnett River
 - Auburn River
 - Boyne River
 - Nogo River &
 - Barambah Creek
- <5% of catchment downstream of Paradise Dam
- Storage capacity of Paradise Dam relatively small (<10%) compared to flood runoff volume in 2013 event
- Cumulative impact of dams on natural catchment (pre-dam) conditions flow rates during large events <10%



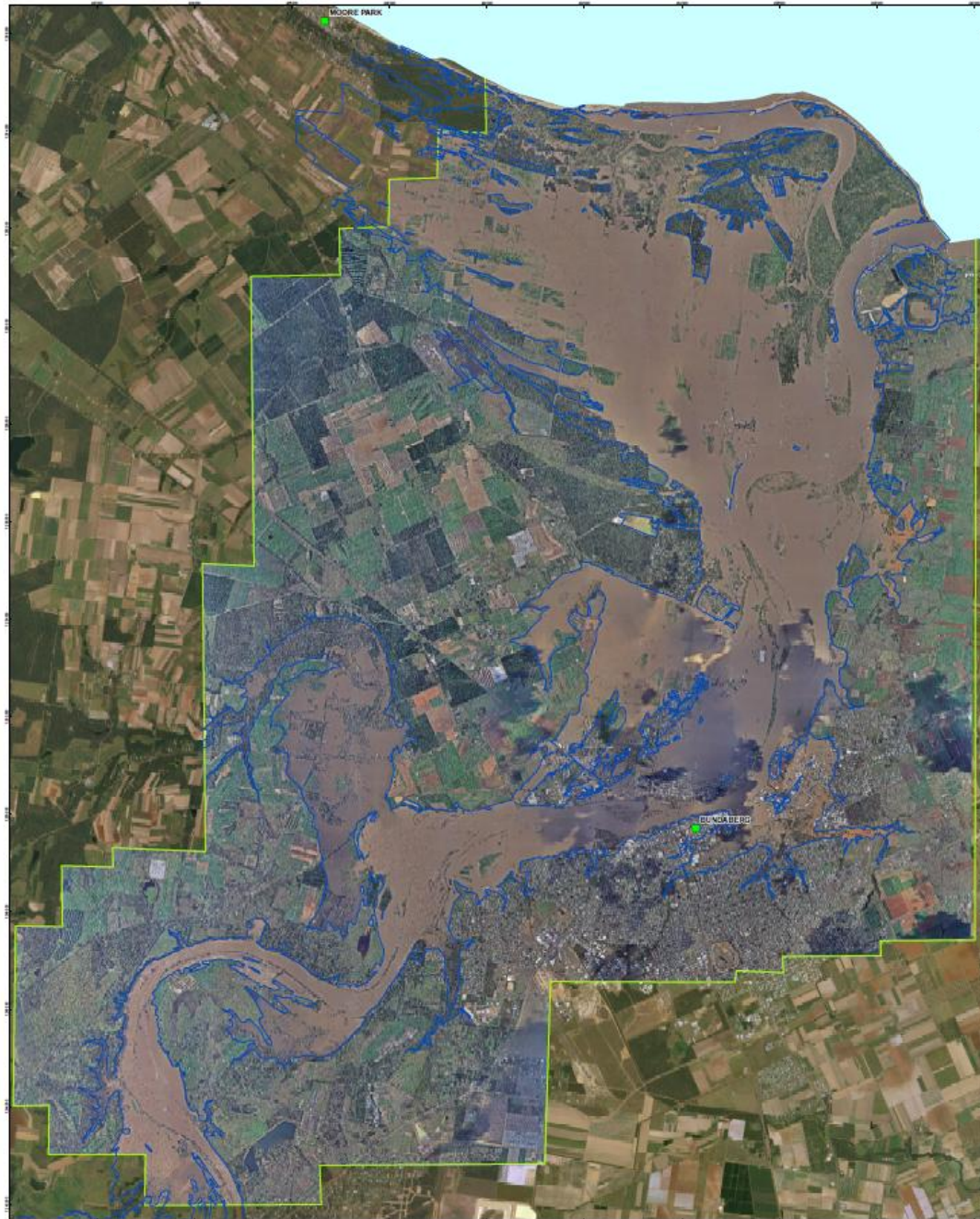
Key Features:

- Paradise Dam
- Walla stream gauge
- Figtree stream gauge
- Bundaberg stream gauge
- St Agnes Creek & Perry River



Bundaberg city Floodplain:

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



2013 Flood Extent

- **Conveyance Areas**
- **Backwater Areas**



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Size of Jan 2013 Flood

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

**(Approximately 1/4 of this through
North Bundaberg)**

**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**

**Volume of 2013 Flood
= 3 to 5 x Volume Sydney Harbour**

Notes:

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

2. Flood Study & Mapping Project



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Flood Modelling and Mapping Study Objectives:

- Develop calibrated flood models of the Burnett River system (Paradise Dam to River Mouth)
- Assess design flood events (e.g. the 1 in 50yr to 1 in 500yr events)
- Prepare flood level, depth, velocity, hazard and emergency maps;
- Sensitivity Analysis.

How did we model the Burnett catchment ?

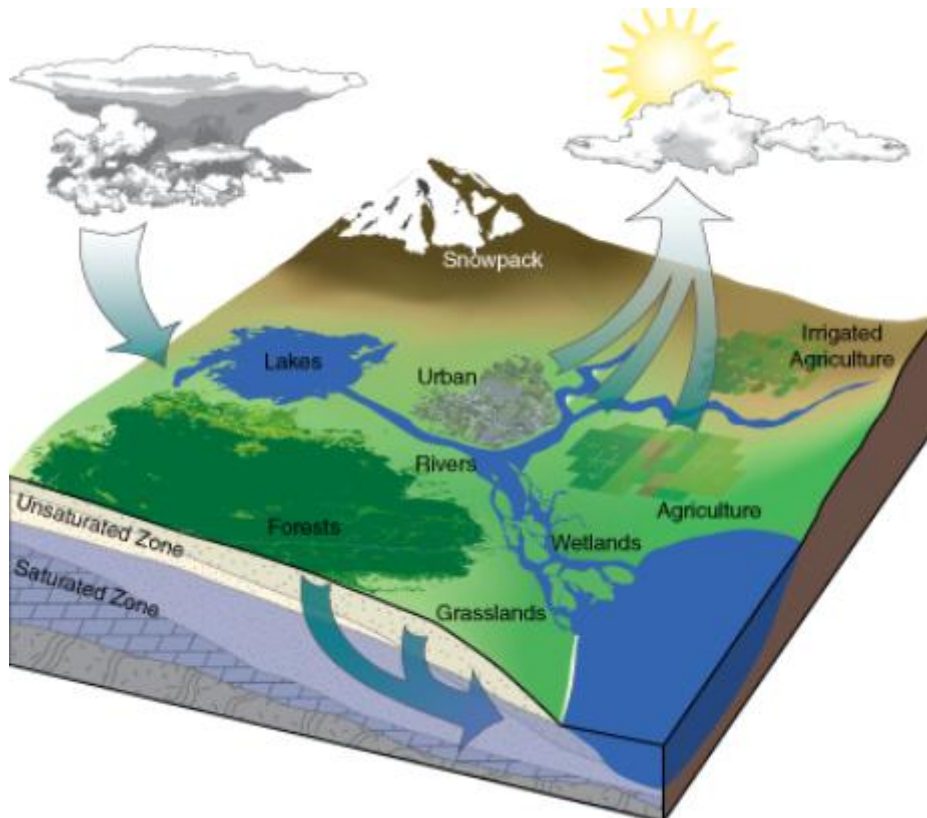
2 different types of numerical models were developed:

- A hydrologic model: used to estimate the rainfall runoff process. Outputs: flow rate hydrographs.
- A hydraulic model: used to simulate the dynamic propagation of flood flows across a floodplain. Outputs: Flood extents, levels, depths and velocities.

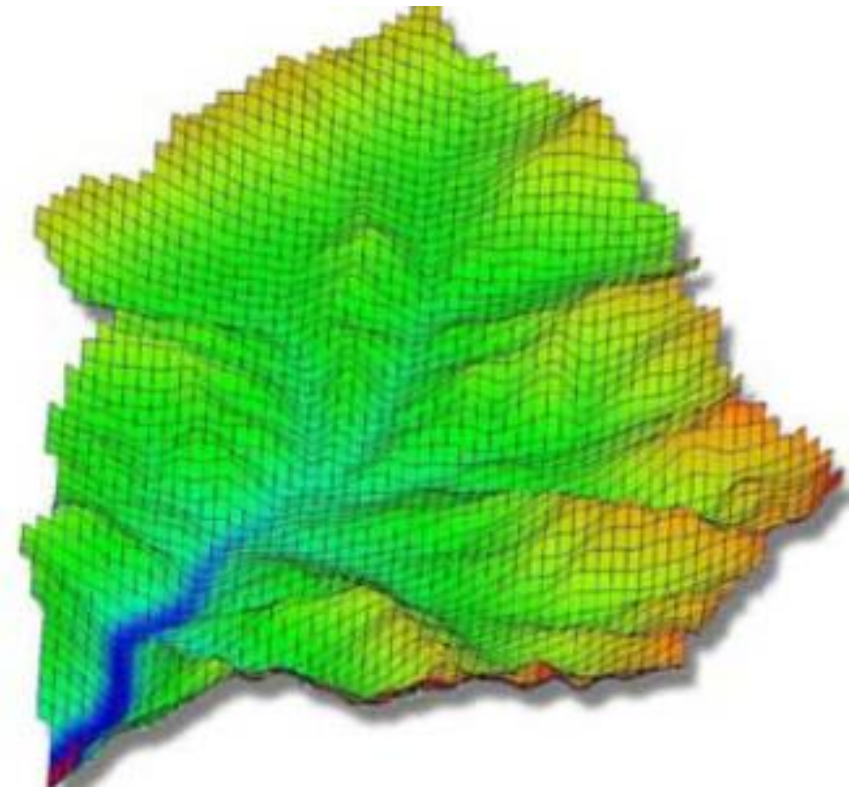


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Flood Models



Hydrologic Model
(Flows)

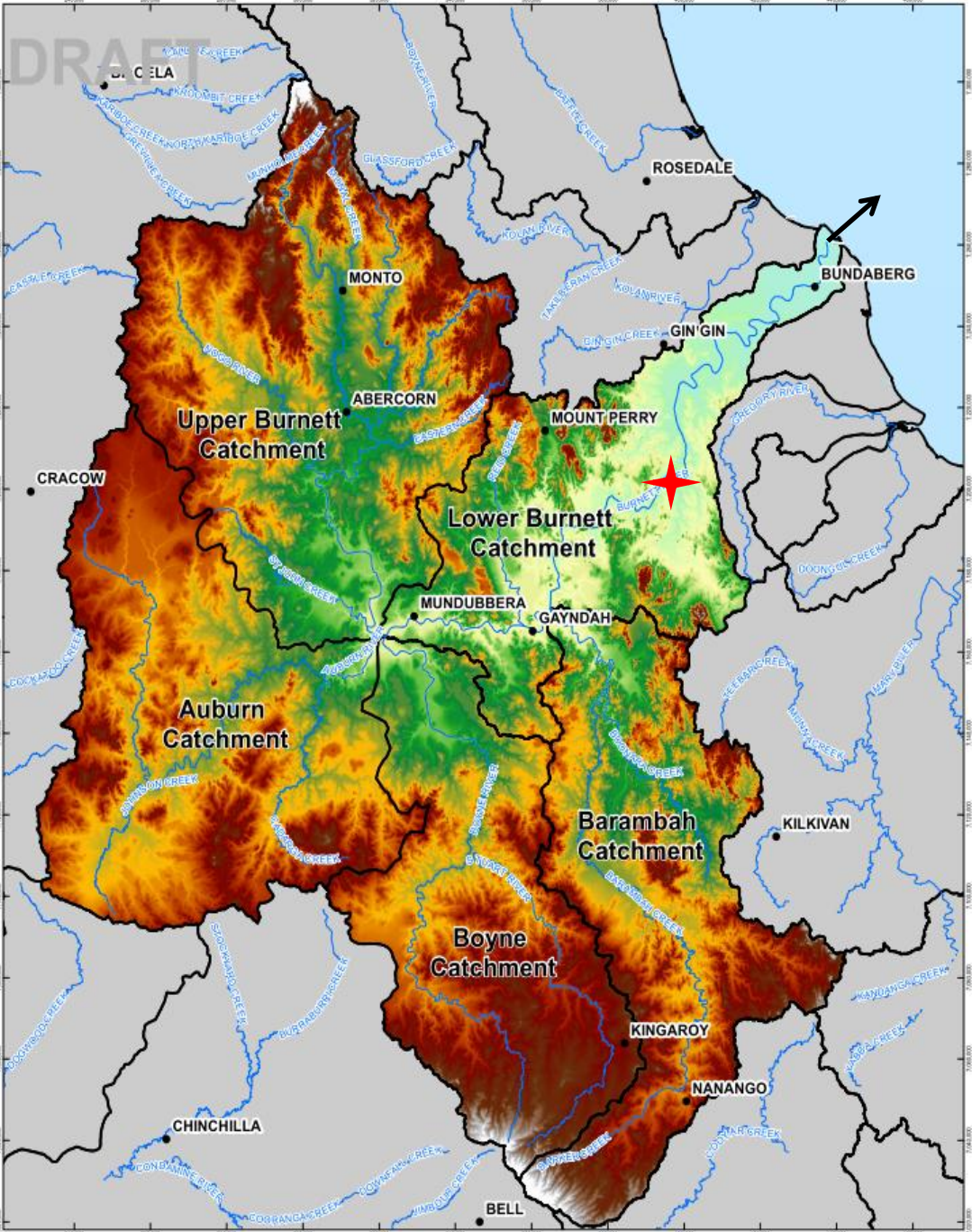


Hydraulic Model
(Levels, Extents, Depths
Velocities, Hazard)



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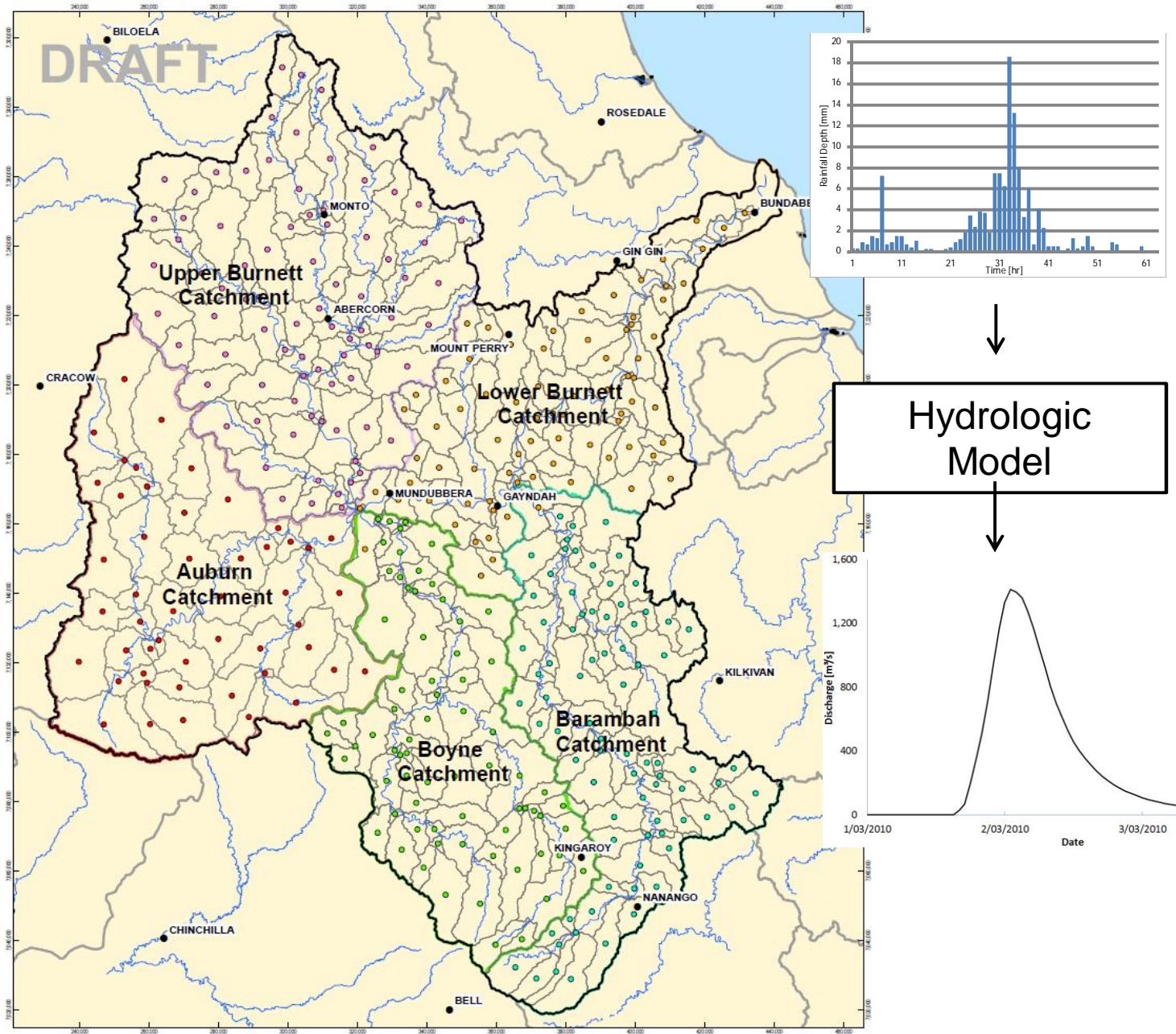
Hydrologic Modelling



Hydrologic Model

Hydrologic Model

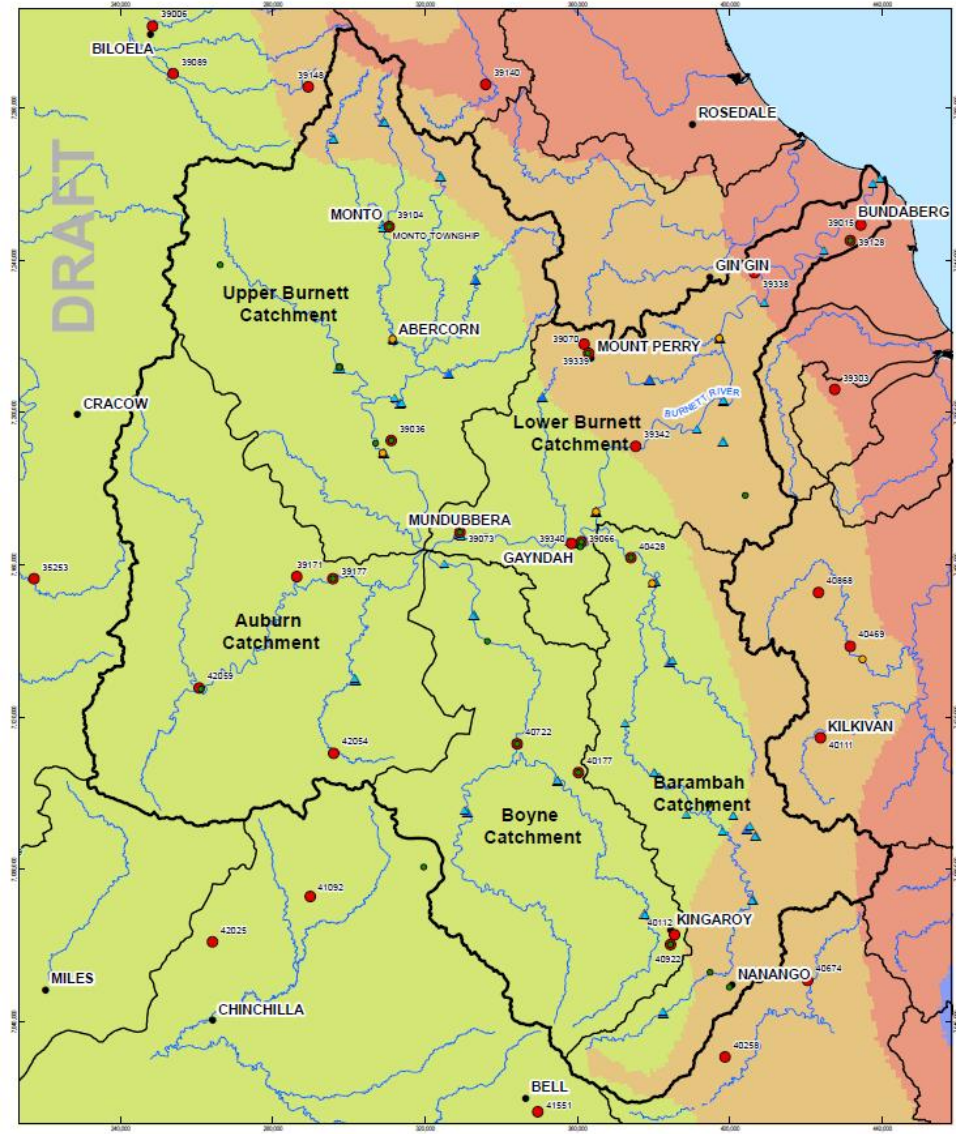
- 300 sub-catchments
- Each sub-catchment defined by:
 - Area, Slope, Roughness, soil conditions
- Spatial & Temporal Rainfall Pattern
- Rainfall-in
↓
Flow Rate-out





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Rainfall Gauges



LEGEND

- BOM Daily Rainfall Station
- DNRM Rainfall Station
- BOM Pluviograph Station
- ▲ DNRM Stream Gauge
- ▲ BOM Stream Gauge
- Locality
- Watercourse
- ▭ Sub Catchment Basin
- ▭ Burnett Catchment

Average Annual Rainfall (mm)

- 600
- 800
- 1000
- 1200
- 1600

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Scale: 1:875,000 (at A3)

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1984
GNS: GDA 1984 MGA Zone 58

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Bundaberg Regional Council
Burnett River Flood Study

Job Number: 41-24728
Revision: D
Date: 23 Jul 2013

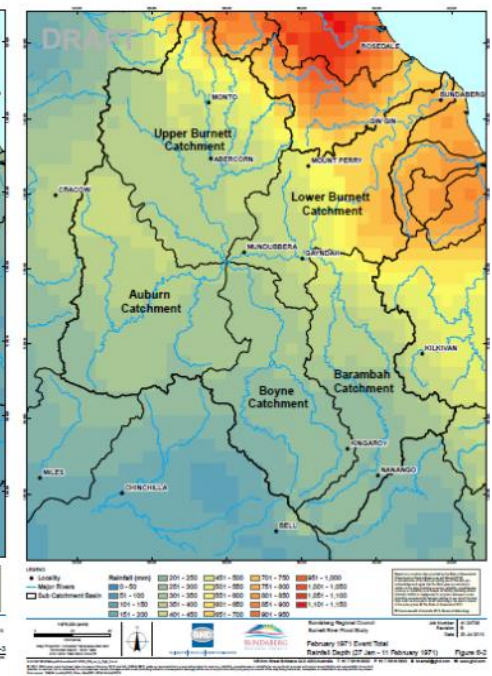
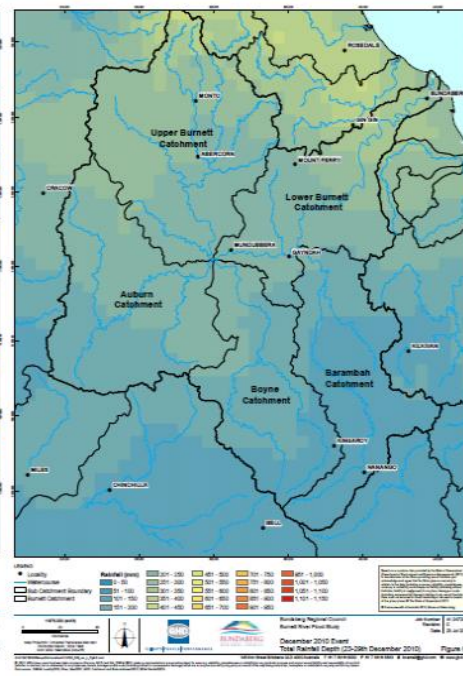
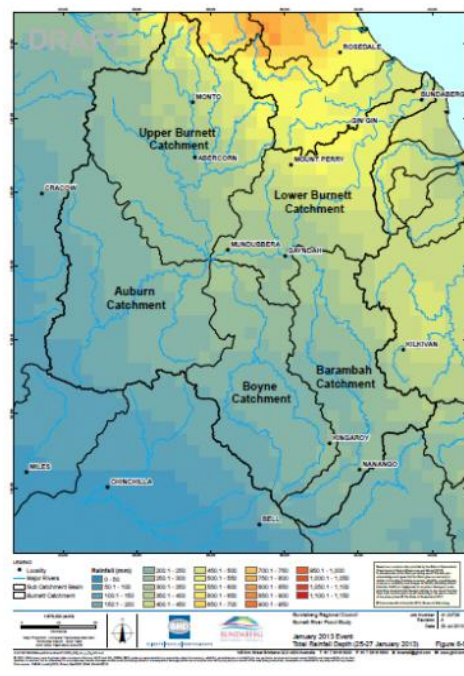
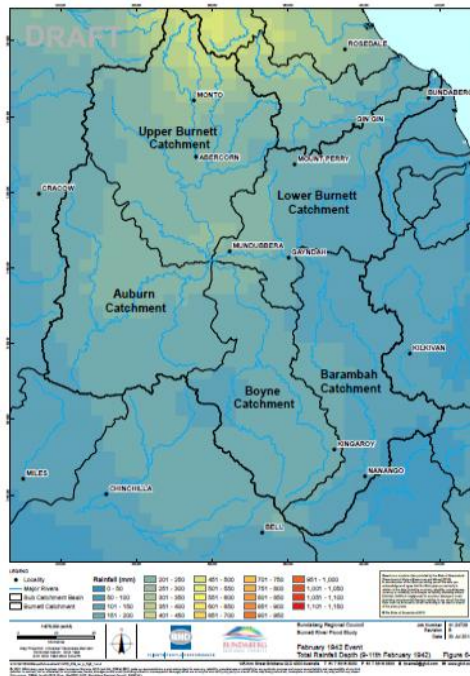
Annual Rainfall **Figure 2-4**

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Calibration to Historical Events



&
Jan 2011

Calibration to Historical Events

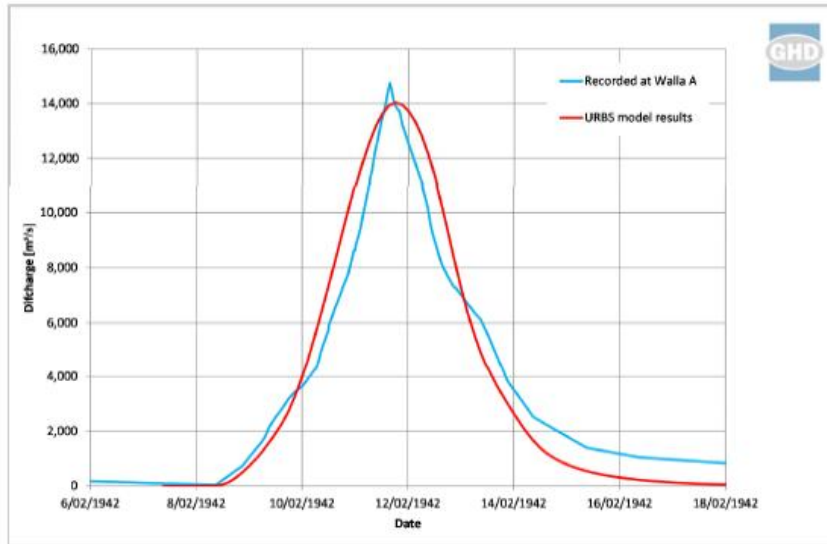


Figure 6-6 Comparison of Recorded and Modelled Flow Hydrographs at Walla, February 1942

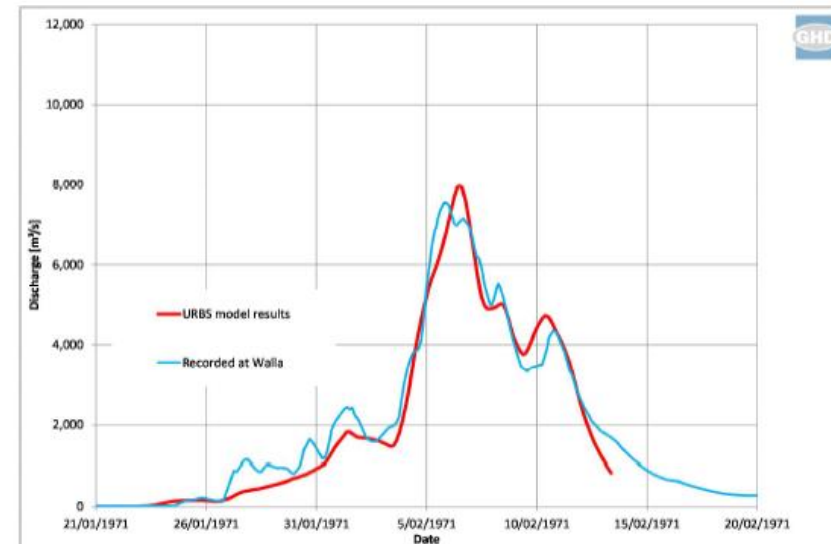


Figure 6-7 Comparison of Recorded and Modelled Flow Hydrographs at Walla, February 1971

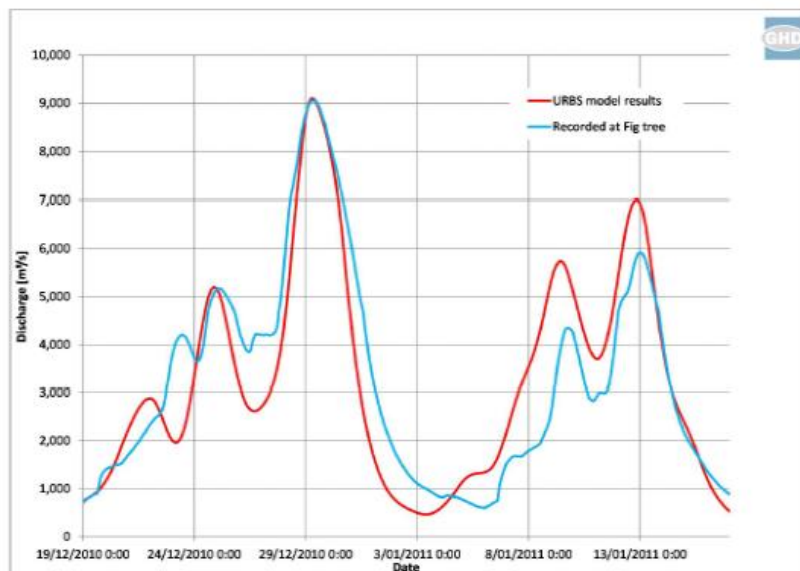


Figure 6-8 Comparison of Recorded and Modelled Flow Hydrographs at Figtree, December 2010-January 2011

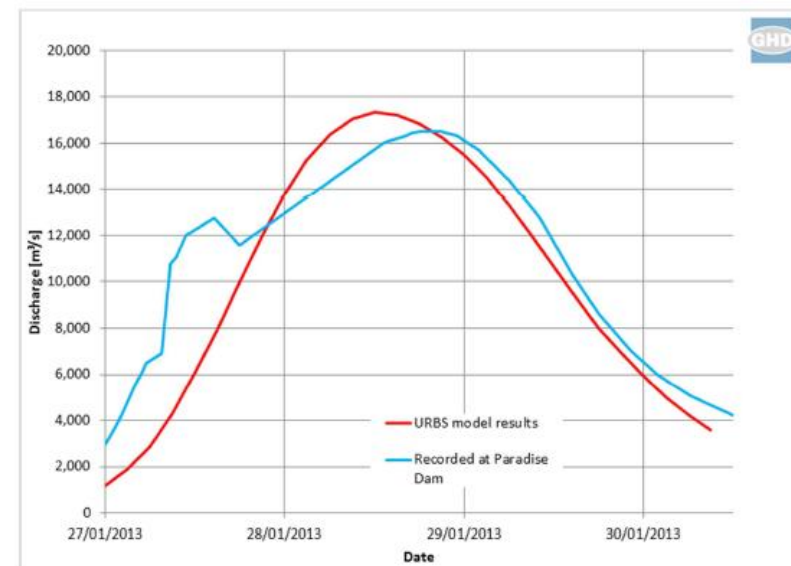


Figure 6-9 Comparison of Recorded and Modelled Flow Hydrographs at Paradise Dam, January 2013

Design Event Analysis

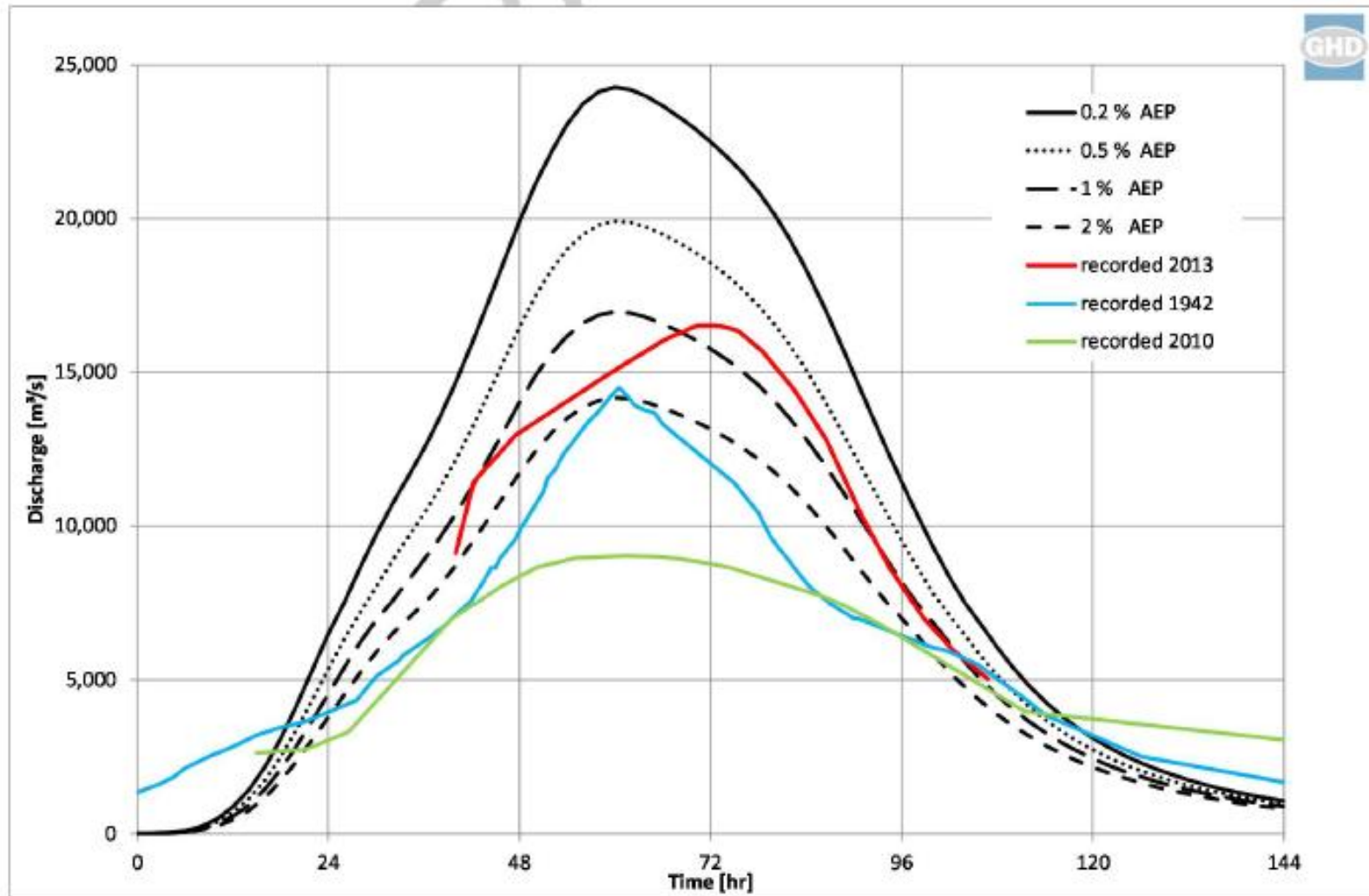


Figure 9-2 Adopted Design Event Hydrographs

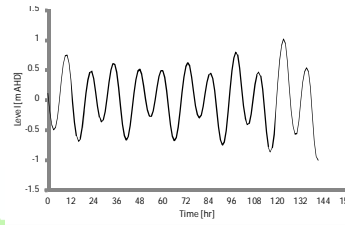




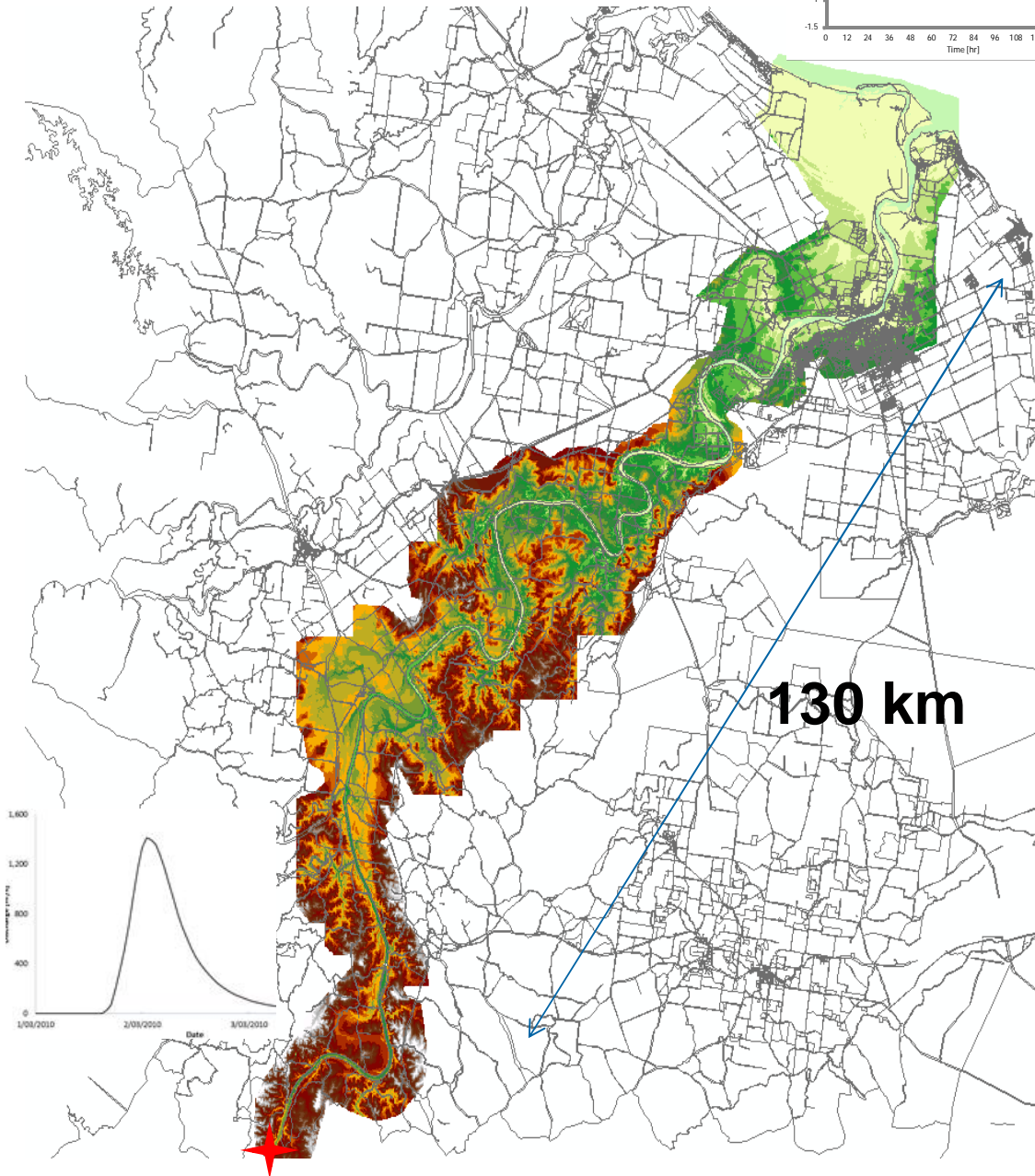
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Hydraulic Modelling

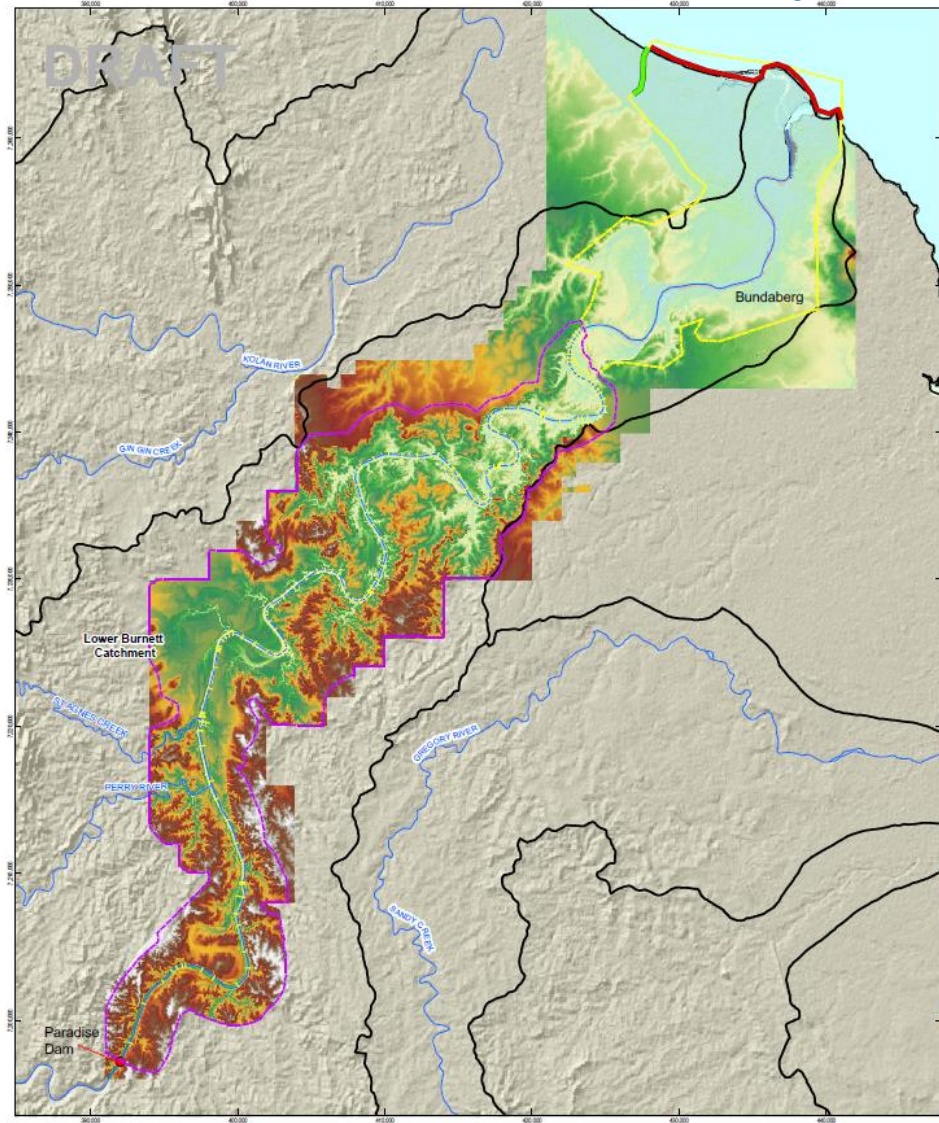
Hydraulic Model



- 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



River & Ground Levels (from survey)



LEGEND

- Upstream Inflow Boundary
- 1D Embedded Cross Section
- Watercourse
- HQ Boundary
- Tidal Boundary
- Sub Catchment Basin
- Model Extent (15m grid size)
- Model Extent (30m grid size)

Lidar DEM (m) AHD

- High: 184.185
- Low: -1.40349

Based on onshore data provided by the State of Queensland Department of Natural Resources and Water (2012), Bundaberg Regional Council and Bundaberg Regional Council. The data is provided as a service to the Bundaberg Regional Council and is not intended to be used for any other purpose. The data is provided as a service to the Bundaberg Regional Council and is not intended to be used for any other purpose. The data is provided as a service to the Bundaberg Regional Council and is not intended to be used for any other purpose.

Scale: 1:225,000 (at A3)

Map Projection: Universal Transverse Mercator
Geoid Datum: GDA 1984
Grid: GDA 1984 MGA Zone 55

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Burnett River Flood Study

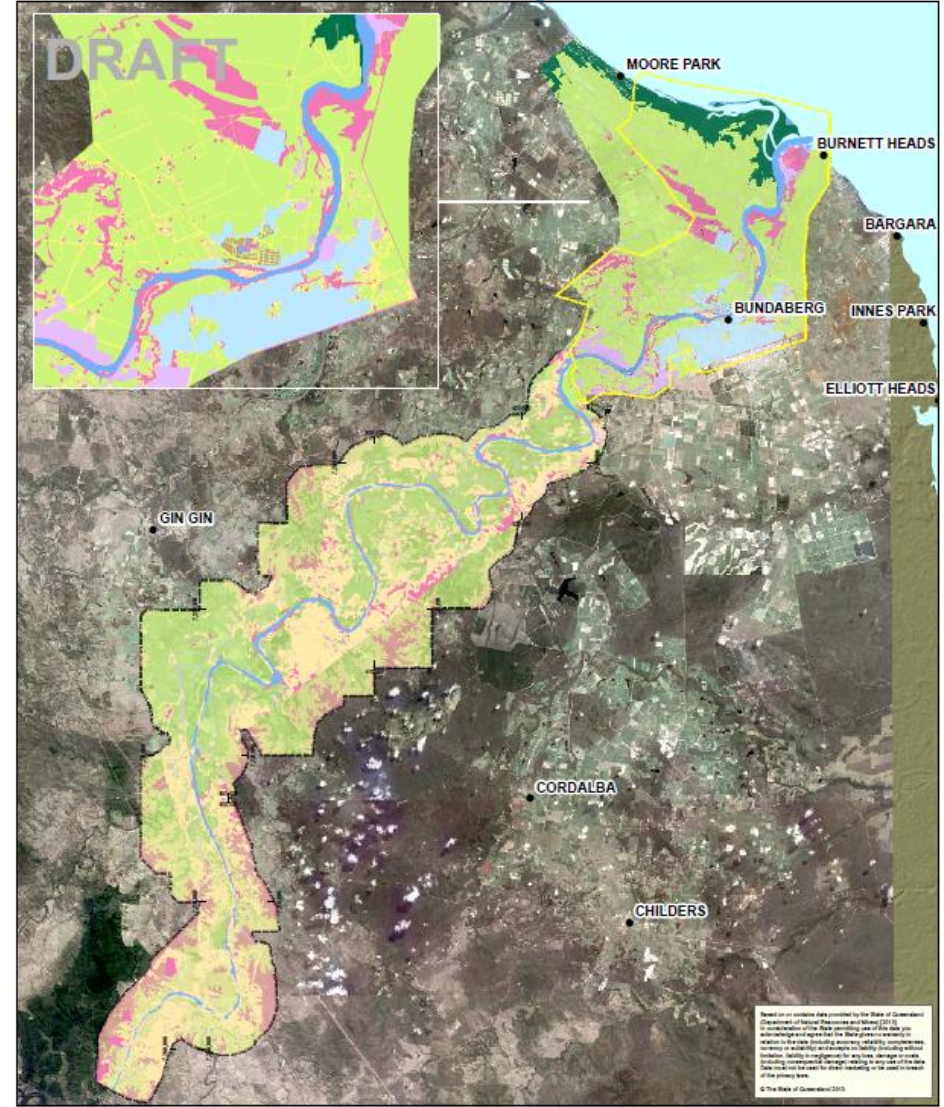
Burnett River
TUFLOW Model Setup

Job Number: 41-24728
Revision: C
Date: 01 Aug 2013

Figure 7-1

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Ground Roughness



LEGEND

- Locality
- Hydraulic Roughness
- Agricultural (n = 0.065)
- Forest (n = 0.08)
- Low-density Residential (n = 0.07)
- Open Woodland (n = 0.077)
- Burnett River Bed (n = 0.028 to n = 0.035)
- Road and Rail (n = 0.032)
- Urban (n = 0.08)
- Dense Vegetation (n = 0.12)
- Model Extent (30m Grid Size)
- Model Extent (15m Grid Size)

Based on onshore data provided by the State of Queensland Department of Natural Resources and Water (2012), Bundaberg Regional Council and Bundaberg Regional Council. The data is provided as a service to the Bundaberg Regional Council and is not intended to be used for any other purpose. The data is provided as a service to the Bundaberg Regional Council and is not intended to be used for any other purpose. The data is provided as a service to the Bundaberg Regional Council and is not intended to be used for any other purpose.

Scale: 1:225,000 (at A3)

Map Projection: Universal Transverse Mercator
Geoid Datum: GDA 1984
Grid: GDA 1984 MGA Zone 55

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Bundaberg Regional Council
Burnett River Flood Study

TUFLOW Roughness Map

Job Number: 41-24728
Revision: C
Date: 01 Aug 2013

Figure 7-2

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1942 Event

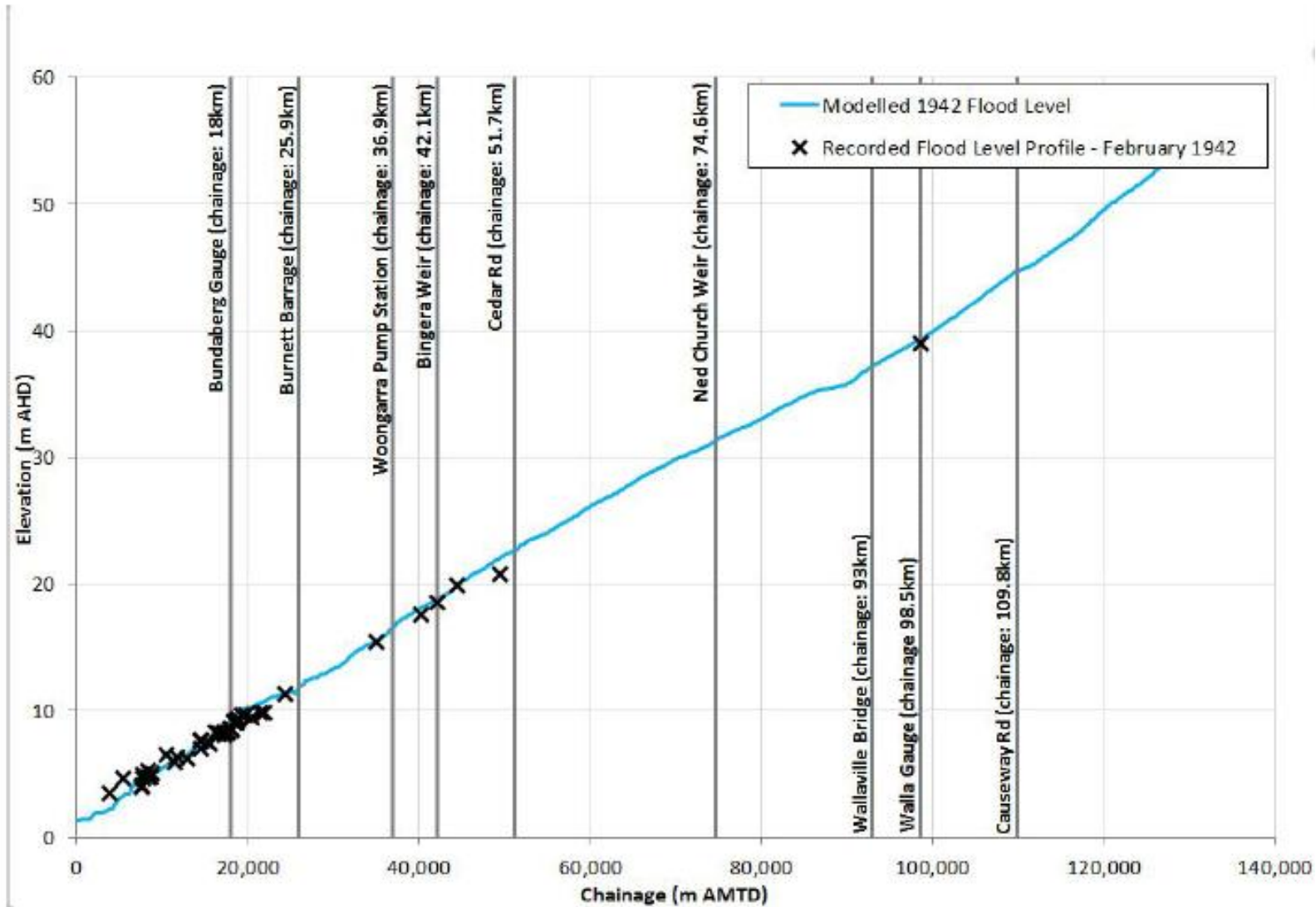


Figure 8-10 Longitudinal Flood Profile, February 1942



1971 Event

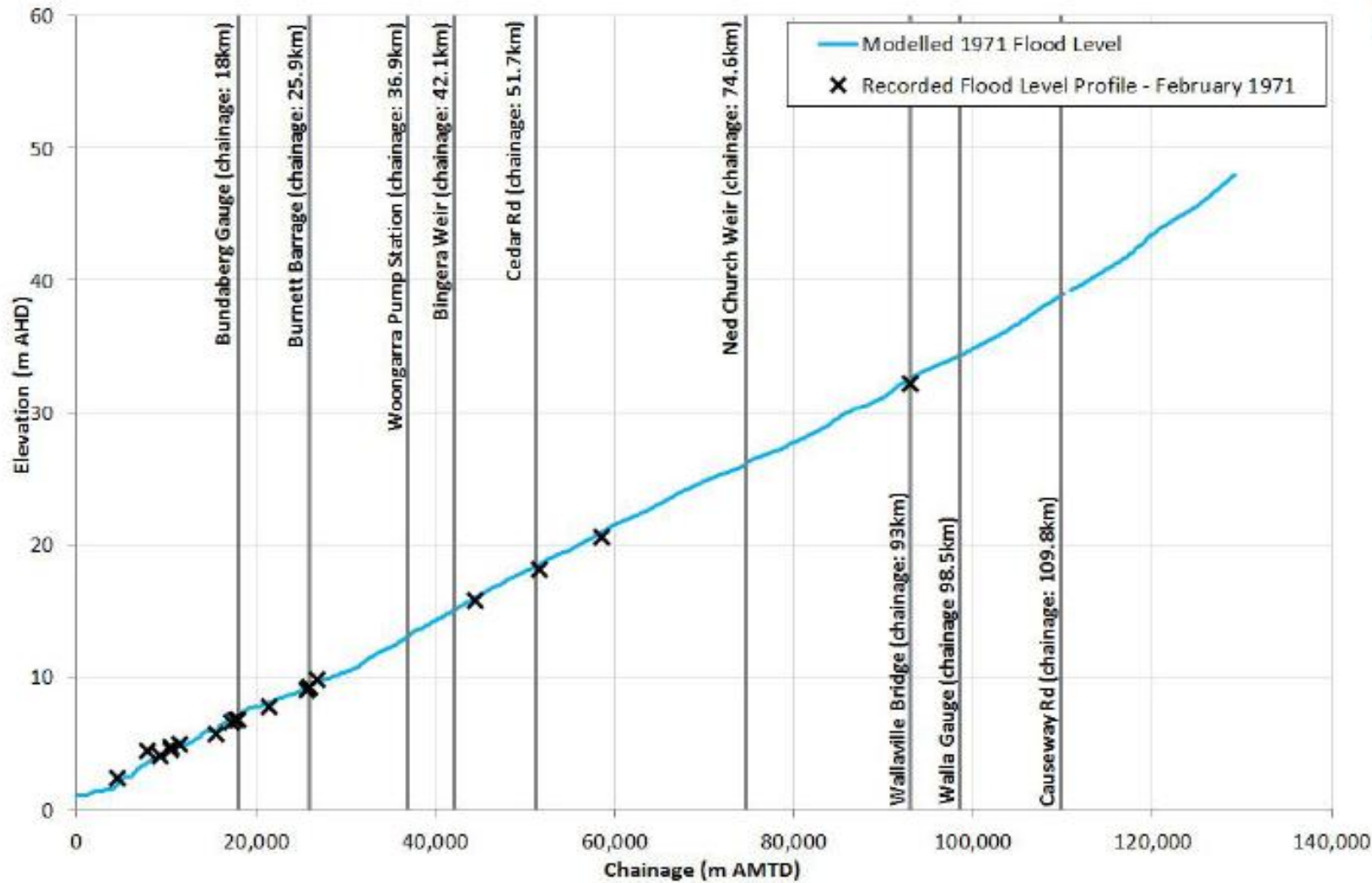


Figure 8-4 Longitudinal Flood Profile, February 1971



2010 Event

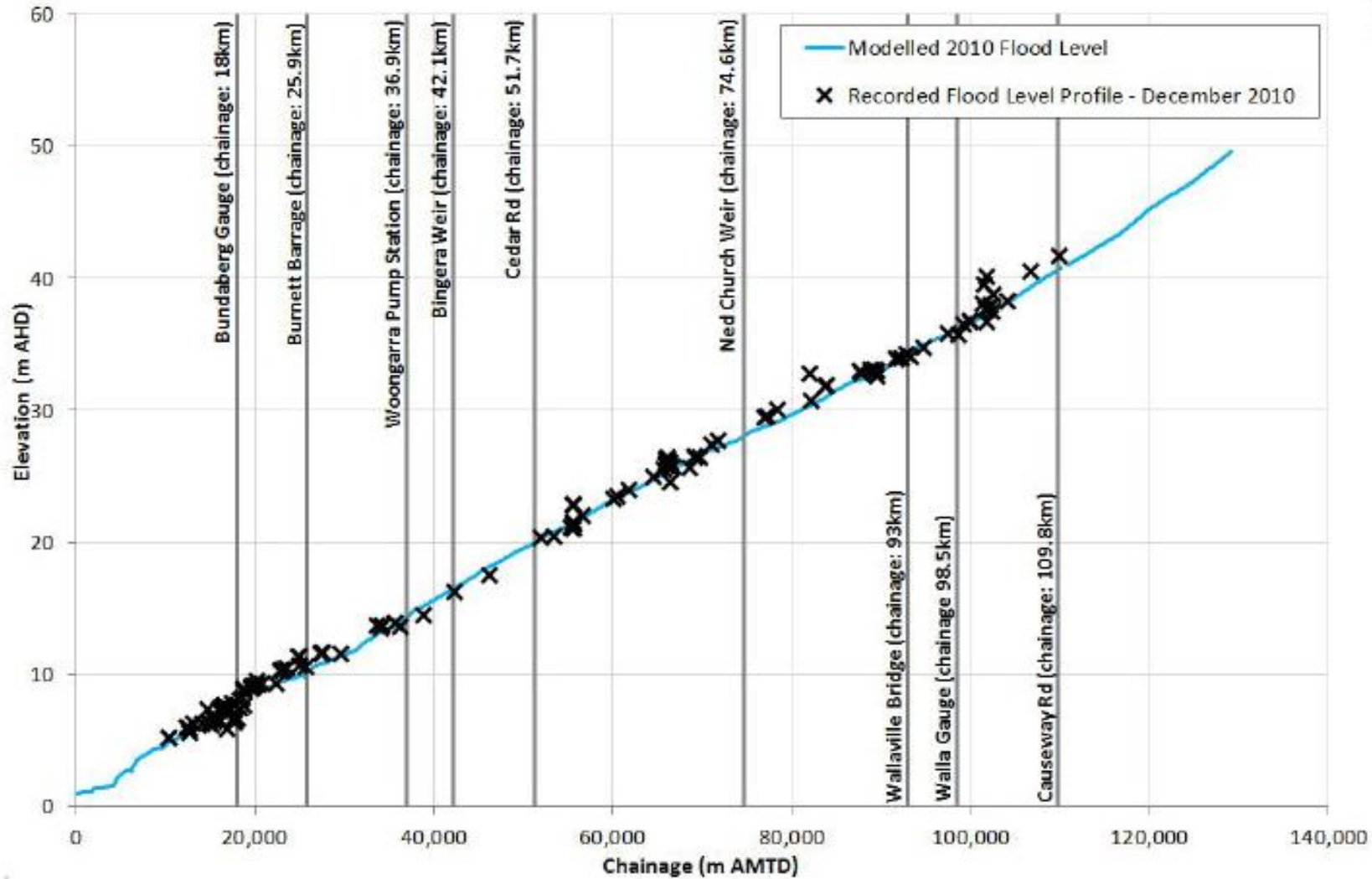


Figure 8-6 Longitudinal Flood Profile, December 2010



2013 Event

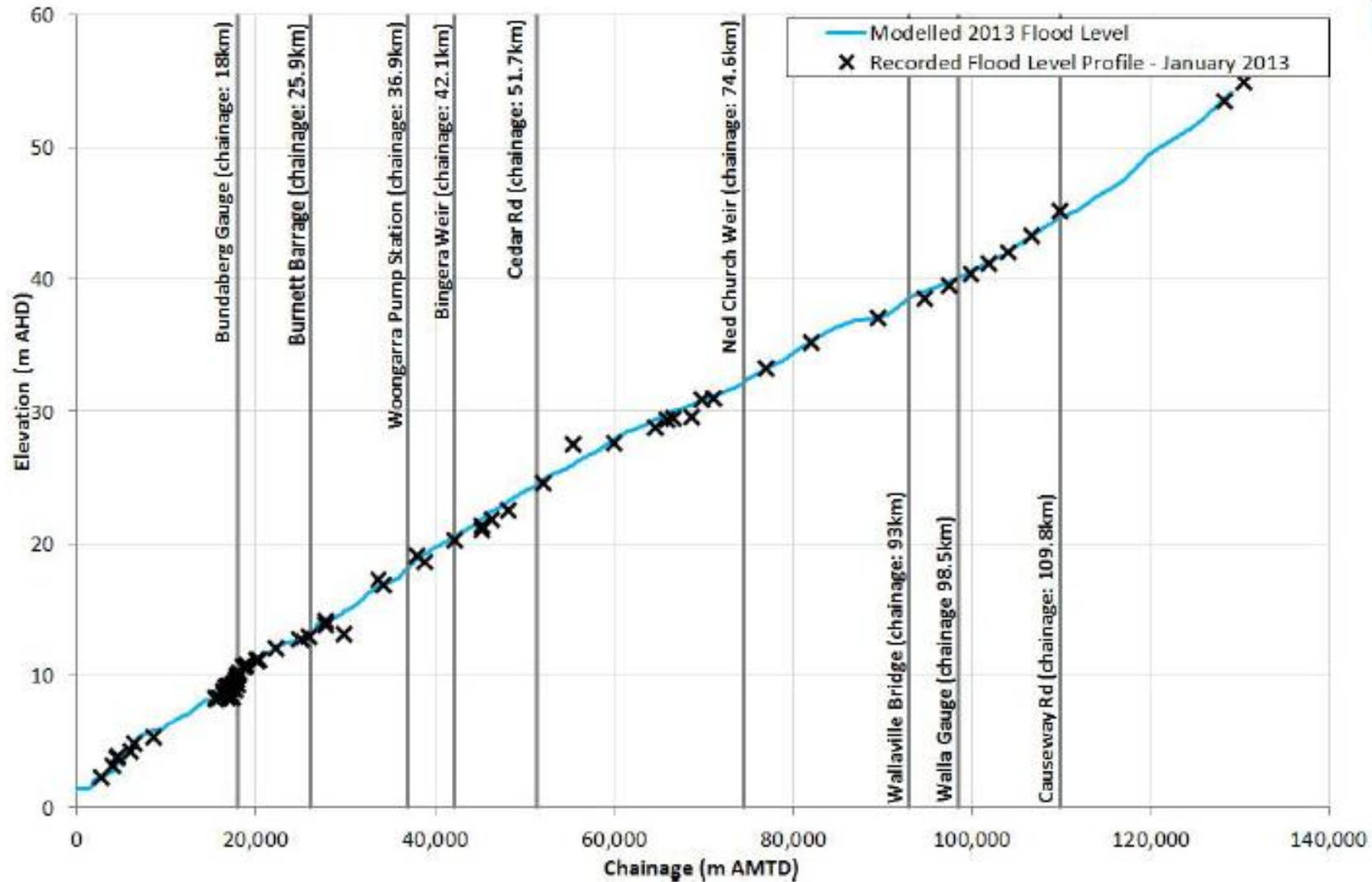
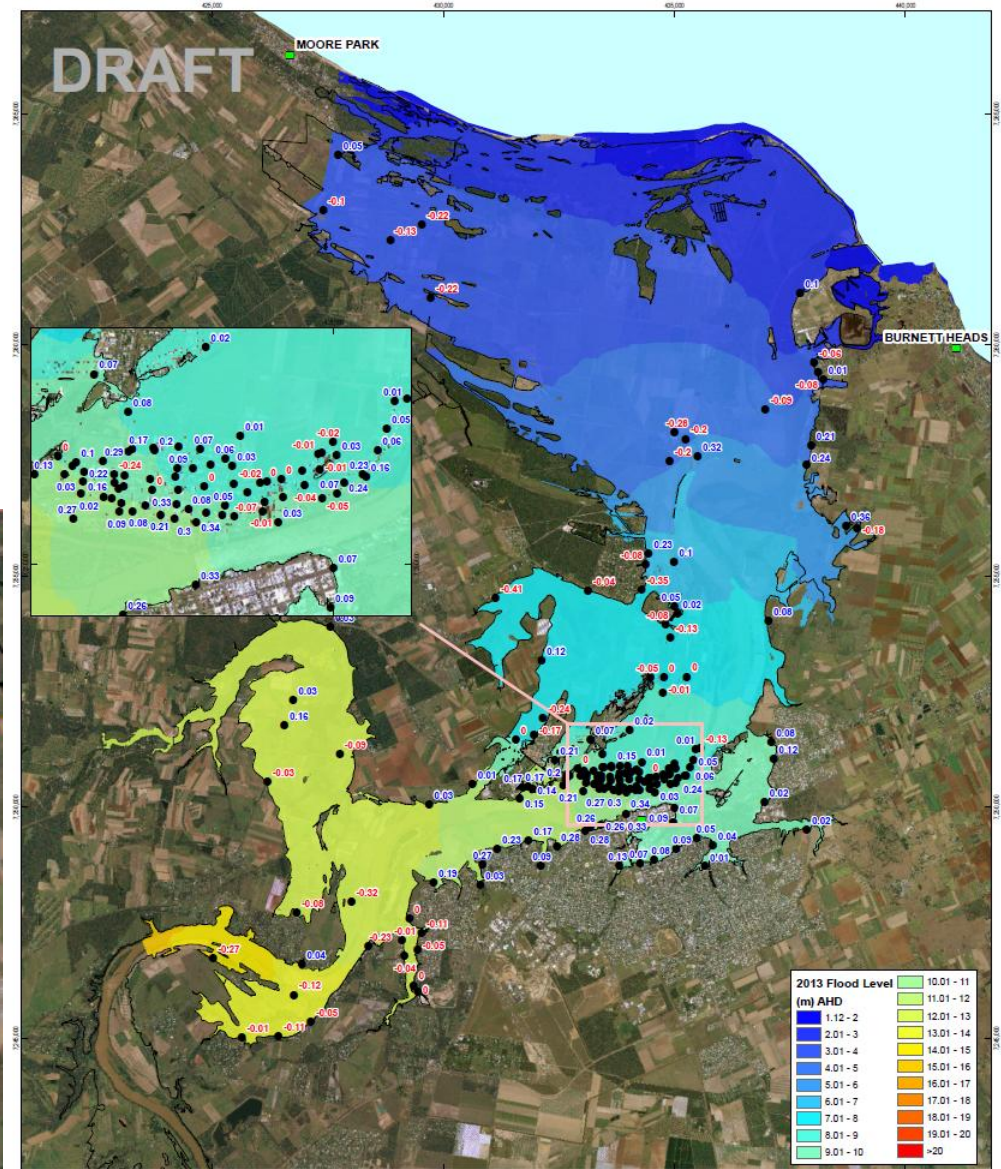
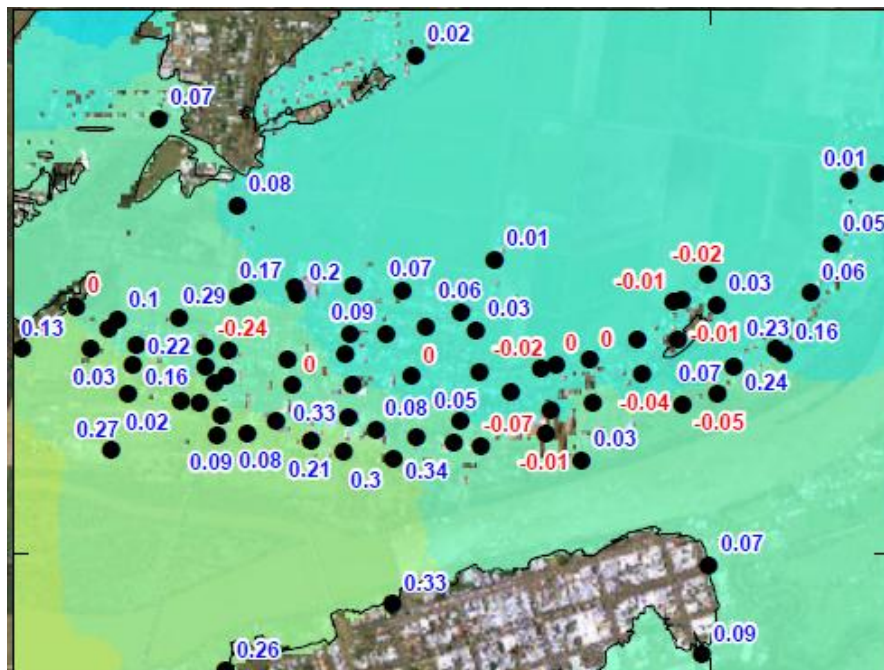


Figure 8-2 Longitudinal Flood Profile, January 2013



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2013 Event Flood Level Differences







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2013 Flood Animation



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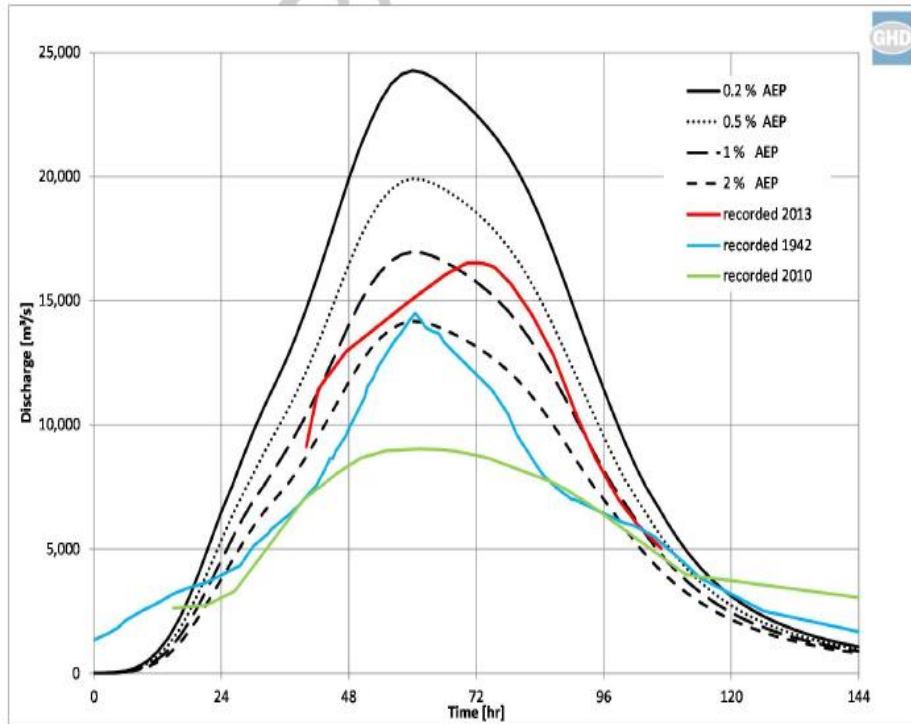
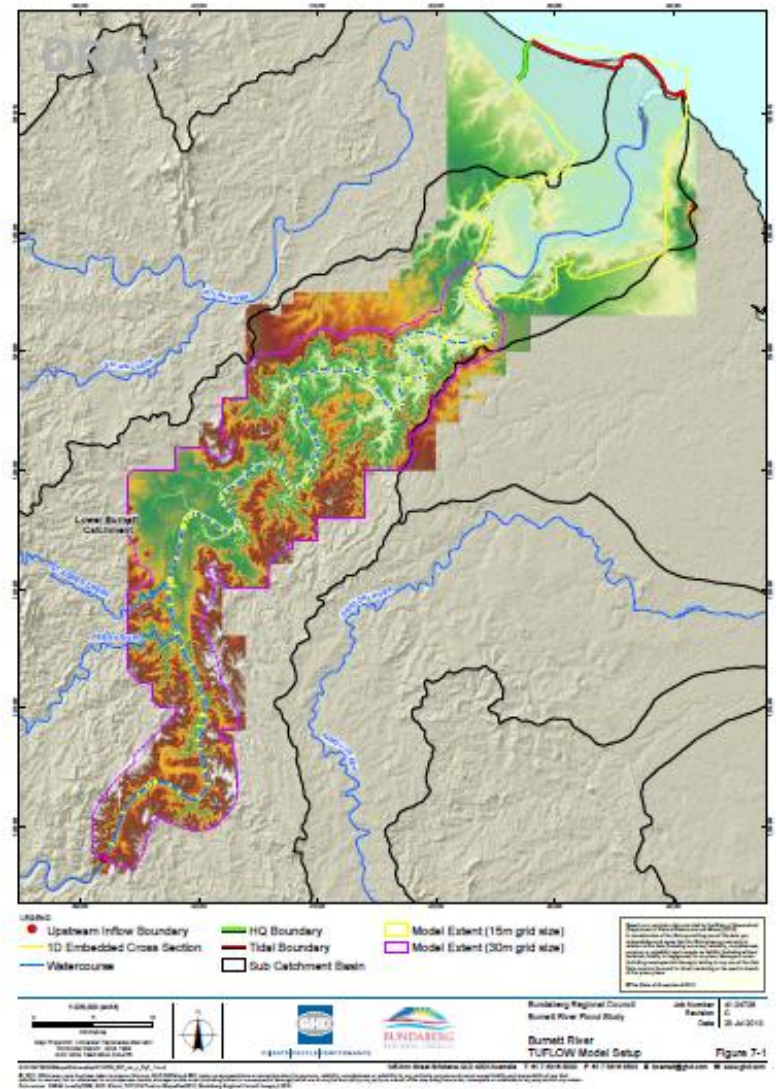


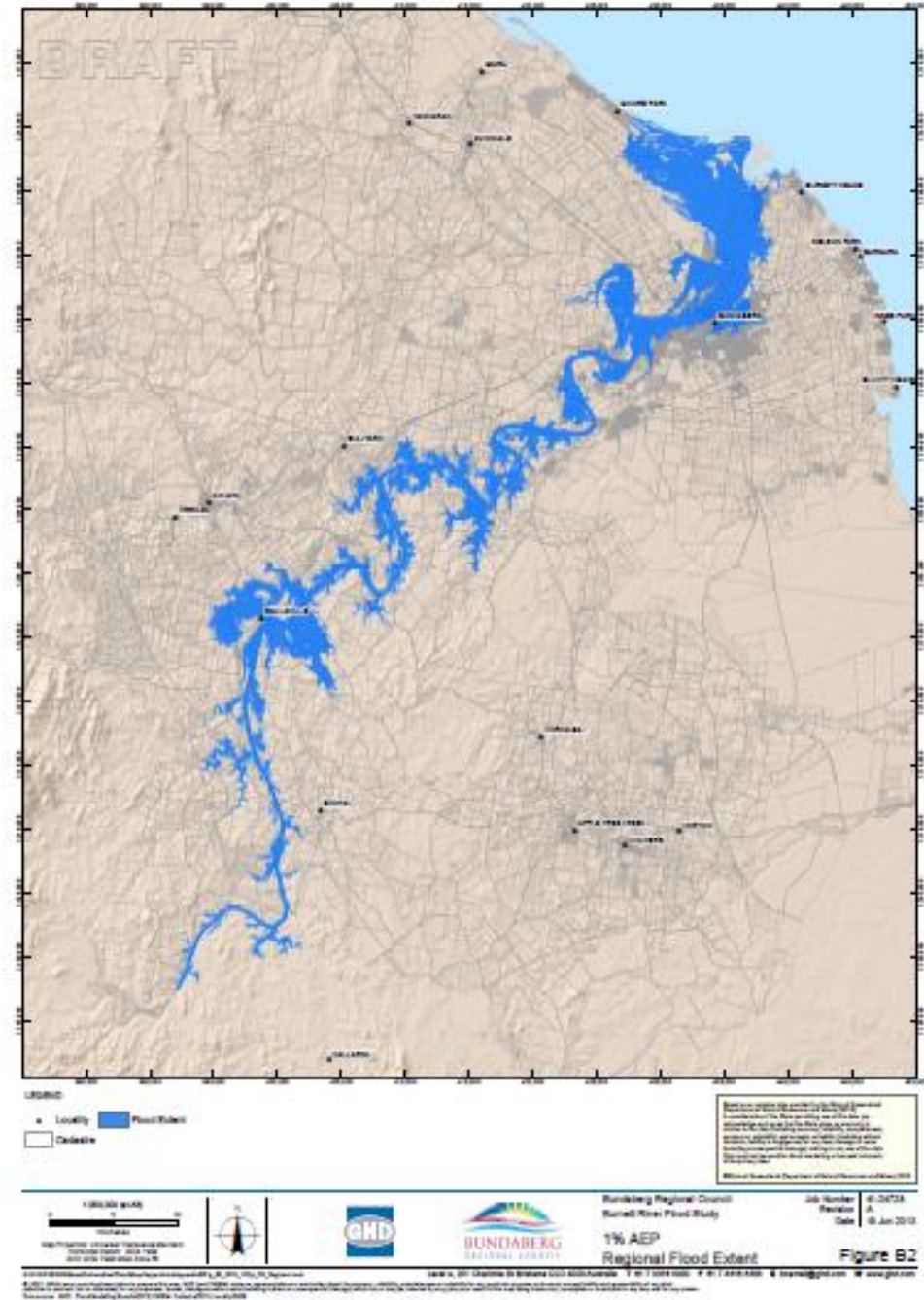
Figure 9-2 Adopted Design Event Hydrographs

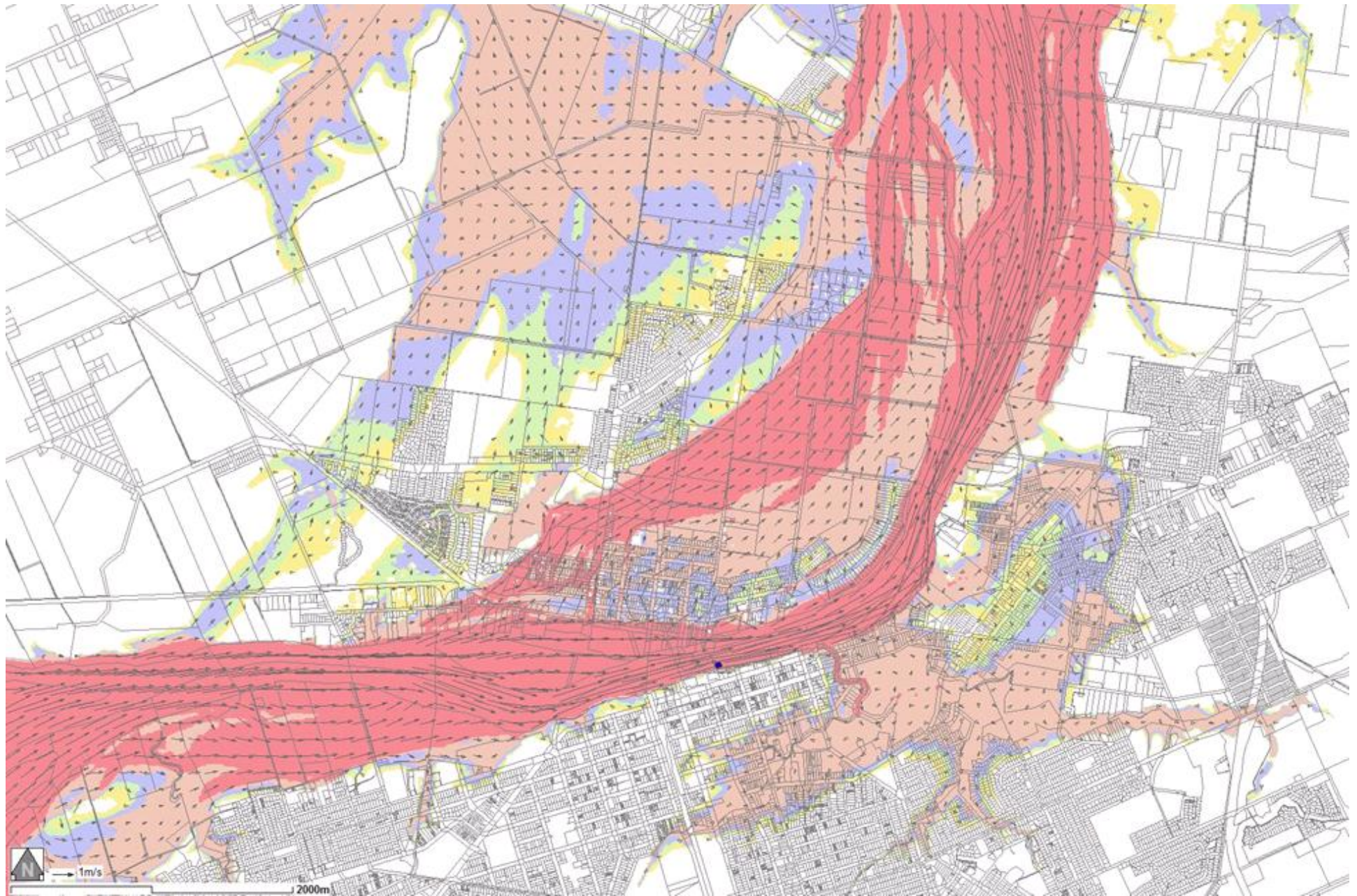




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- Design Event
- Flood Extents,
- Flood Levels
- Flood Depths
- Flood Velocities
- Flood Hazard



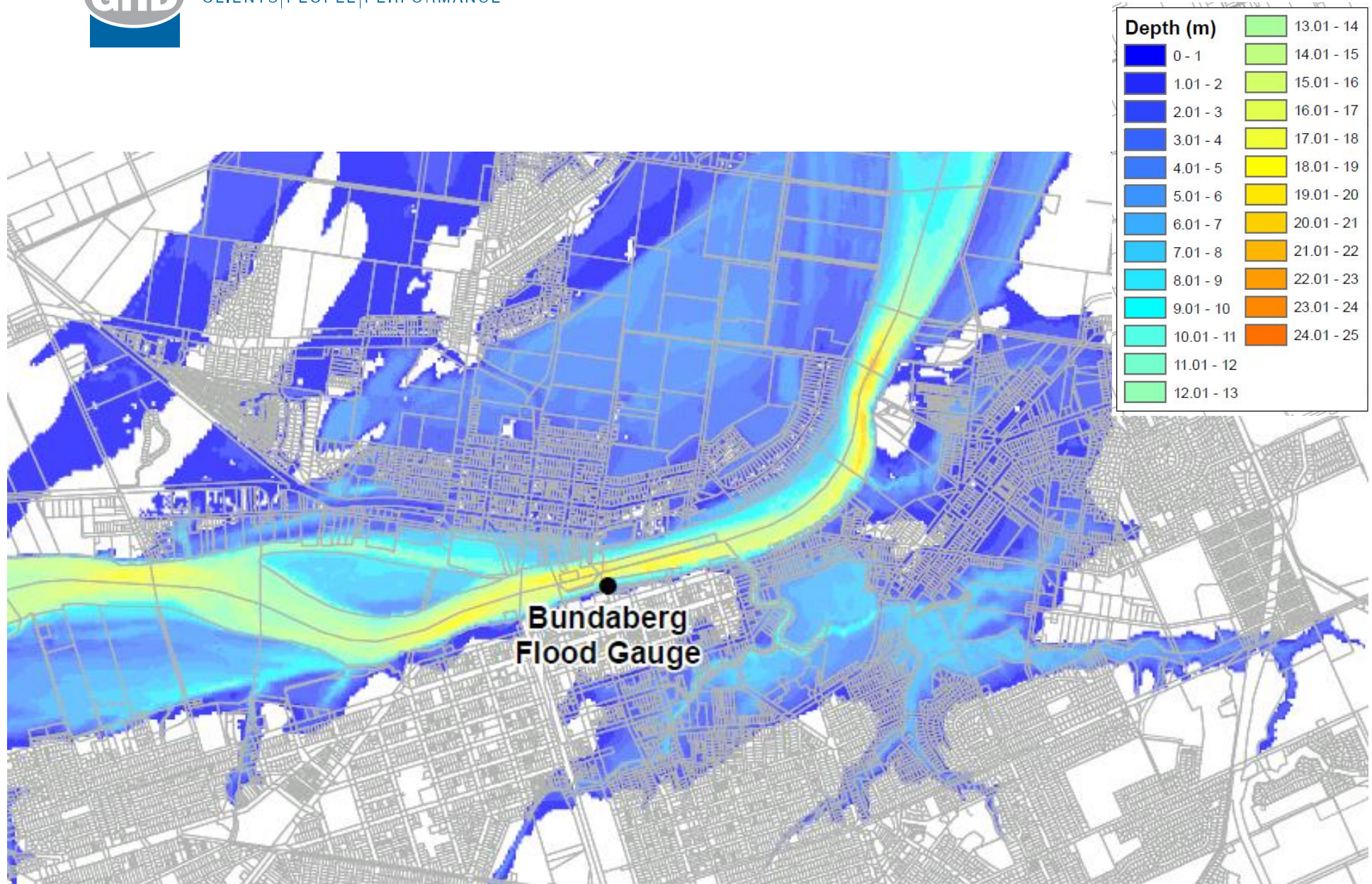


1% AEP Design Event Flood Vectors



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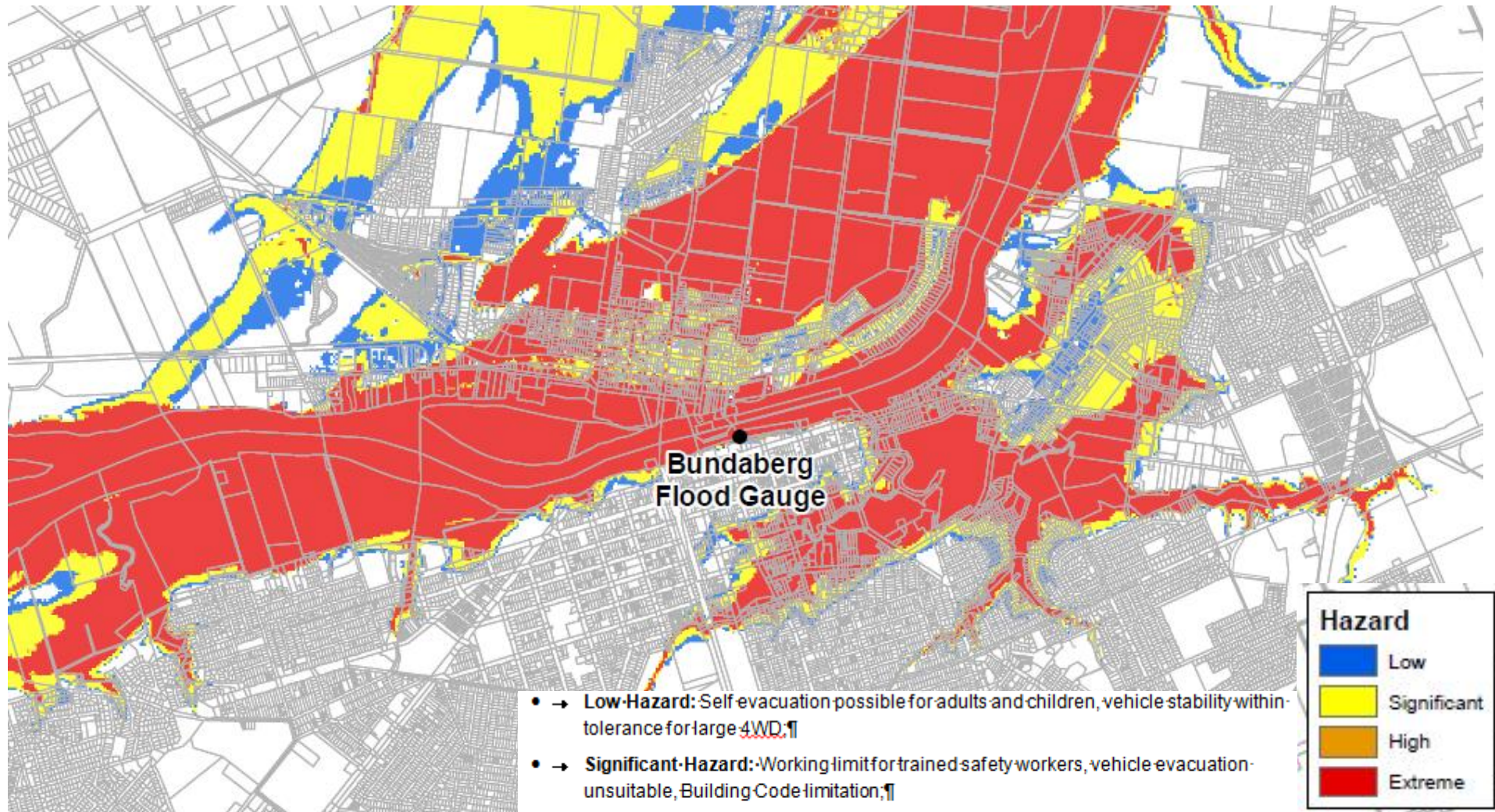
1% AEP Flood Depths





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2013 Like Event Design Event Flood Hazard



- → **Low Hazard:** Self evacuation possible for adults and children, vehicle stability within tolerance for large 4WD. ¶
- → **Significant Hazard:** Working limit for trained safety workers, vehicle evacuation unsuitable, Building Code limitation. ¶
- → **High Hazard:** Limit of uncompromised stability for adults (dangerous to most); and ¶
- → **Extreme Hazard:** In excess of known stability limits. ¶

Hazard	
Blue	Low
Yellow	Significant
Orange	High
Red	Extreme



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Sensitivity Analysis

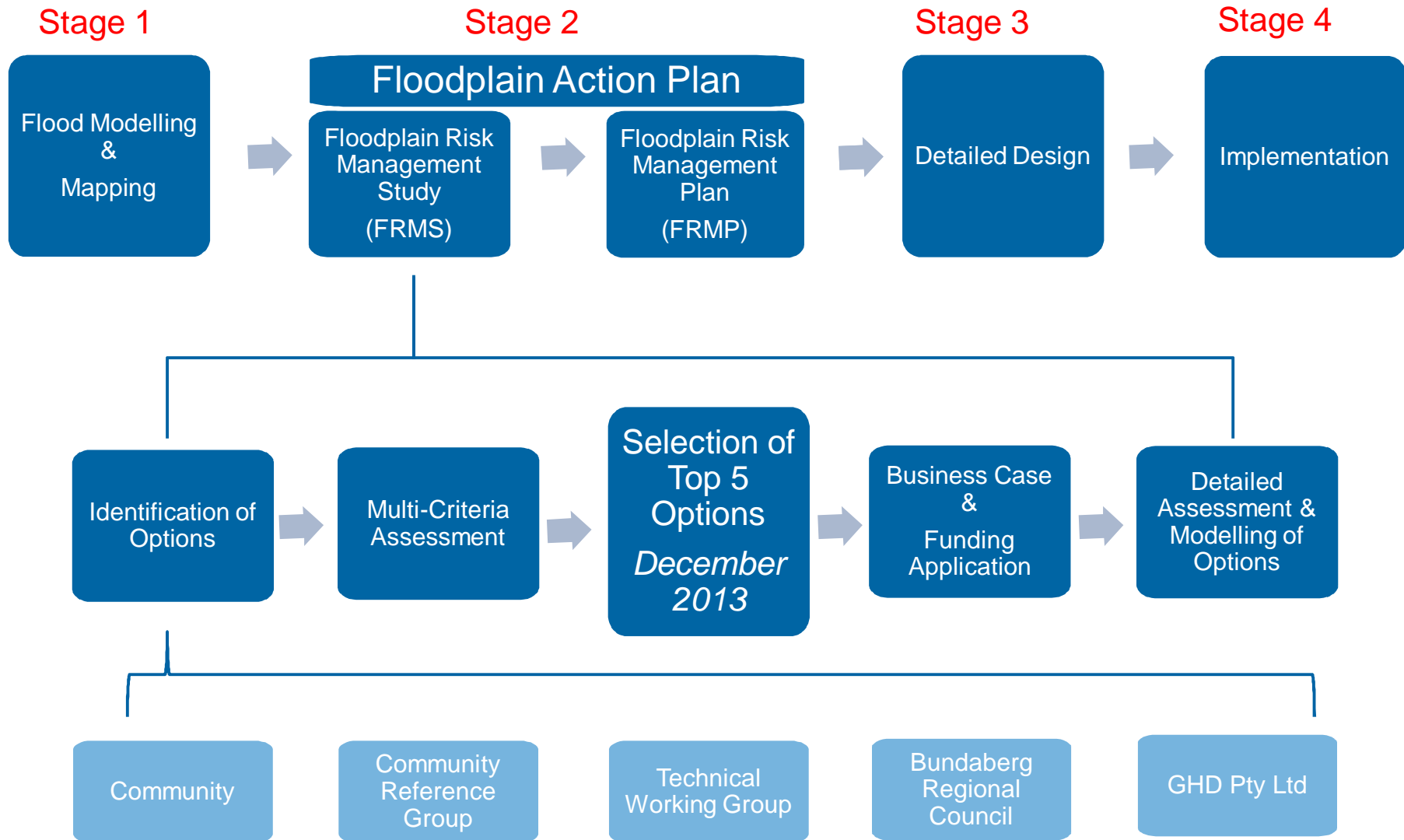
- Rainfall Patterns
 - Soil Loss Rates
 - Dam Levels
 - River Bed Levels
 - Tide
 - Climate Change
-
- Floodplain Management Measures
(e.g. levees, dredging etc)

3. Floodplain Action Plan



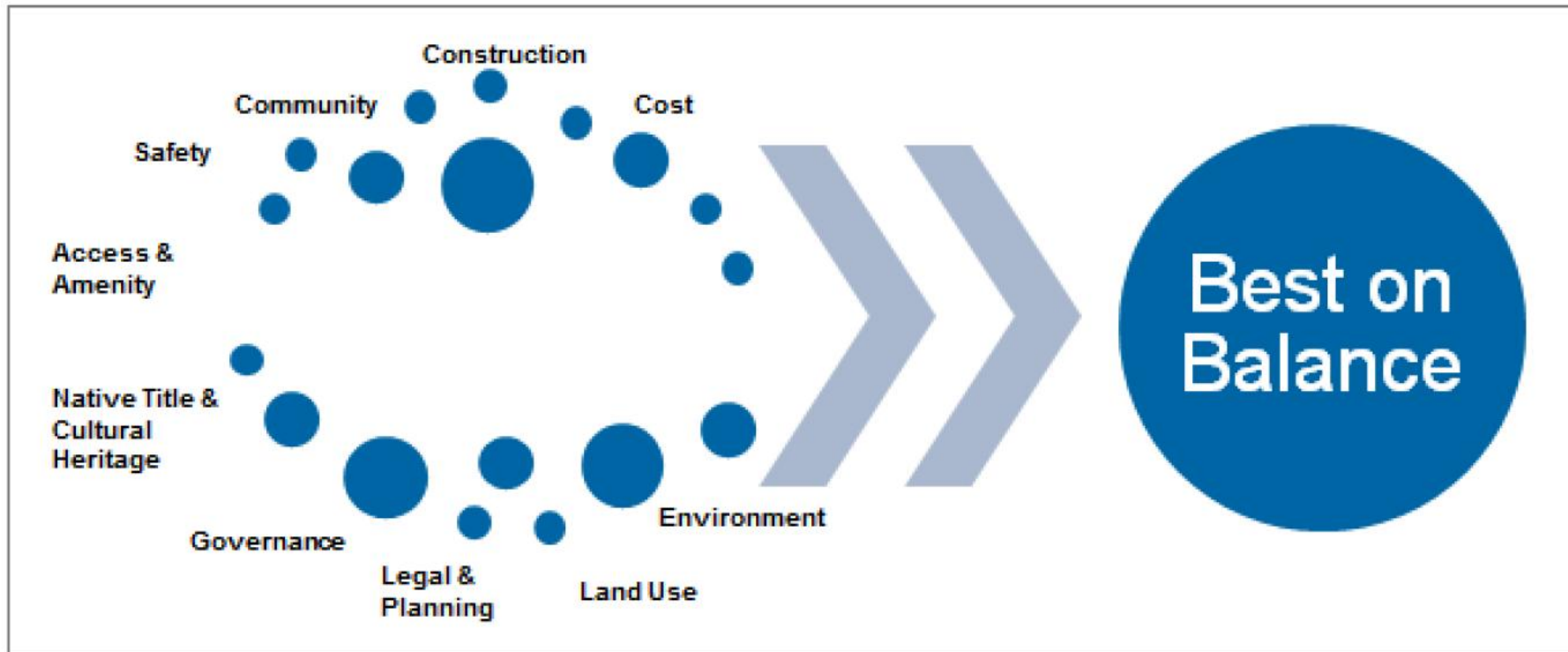
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Floodplain Action Plan - The Process



Multi Criteria Analysis (MCA) Process

A process for a non-biased rigorous assessment of floodplain management options.





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Floodplain Management Measures

Floodplain Management Measure	Aim
Land Use Planning Controls	Keeping people away from water
Structural Mitigation	Keeping water away from people
Development and Building Controls	Reducing the risk of inundation and amount of damage when the DFE event is exceeded
Flood Emergency Measures	Improving Flood Warning Systems Teaching people what to do

Best Practice Recommendations

The completion of a FRMS and development of a FRMP is consistent with a number of recommendations in the recent **Queensland Flood Commission of Inquiry** including:

Recommendation 2.12 Councils in floodplain areas should, resources allowing, develop comprehensive floodplain management plans that accord as closely as practicable with best practice principles;

The undertaking of such a comprehensive FRMS and FRMP is also consistent with the best practice floodplain management philosophies inherent in the following guidelines:

Floodplain Management Australia: Best Practice Principles, Standing Committee on Agriculture and Resource Management (SCARM Report 73, 2000);

The draft guideline produced by the Queensland Reconstruction Authority *Planning for stronger, more resilient floodplains: Part 2; Managing the Floodplain*, Emergency Management Australia Manual 19, Attorney-General's Department, 1999.

Natural Hazards in Australia: Identifying Risk Analysis Requirements, National Flood Risk Advisory Group, 2007.

NSW Floodplain Development Manual: The management of flood liable land, NSW Department of Infrastructure, Planning and Natural Resources April 2005

4. Key Outputs



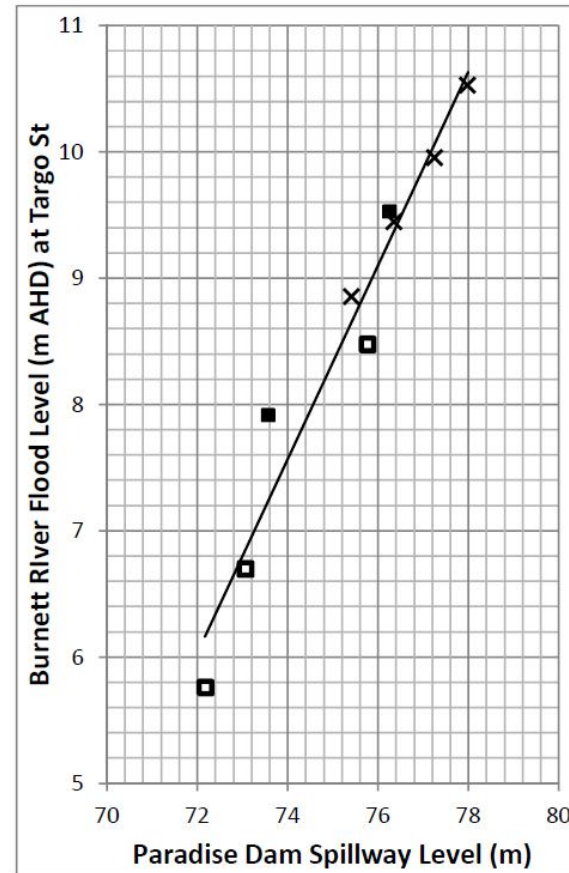
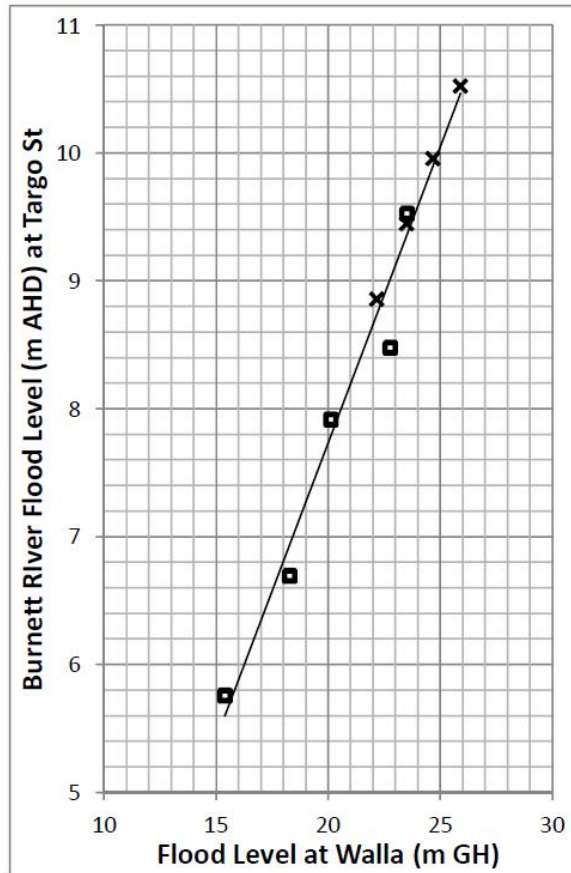
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Key Outputs

In addition to determining the Top 5 Options:

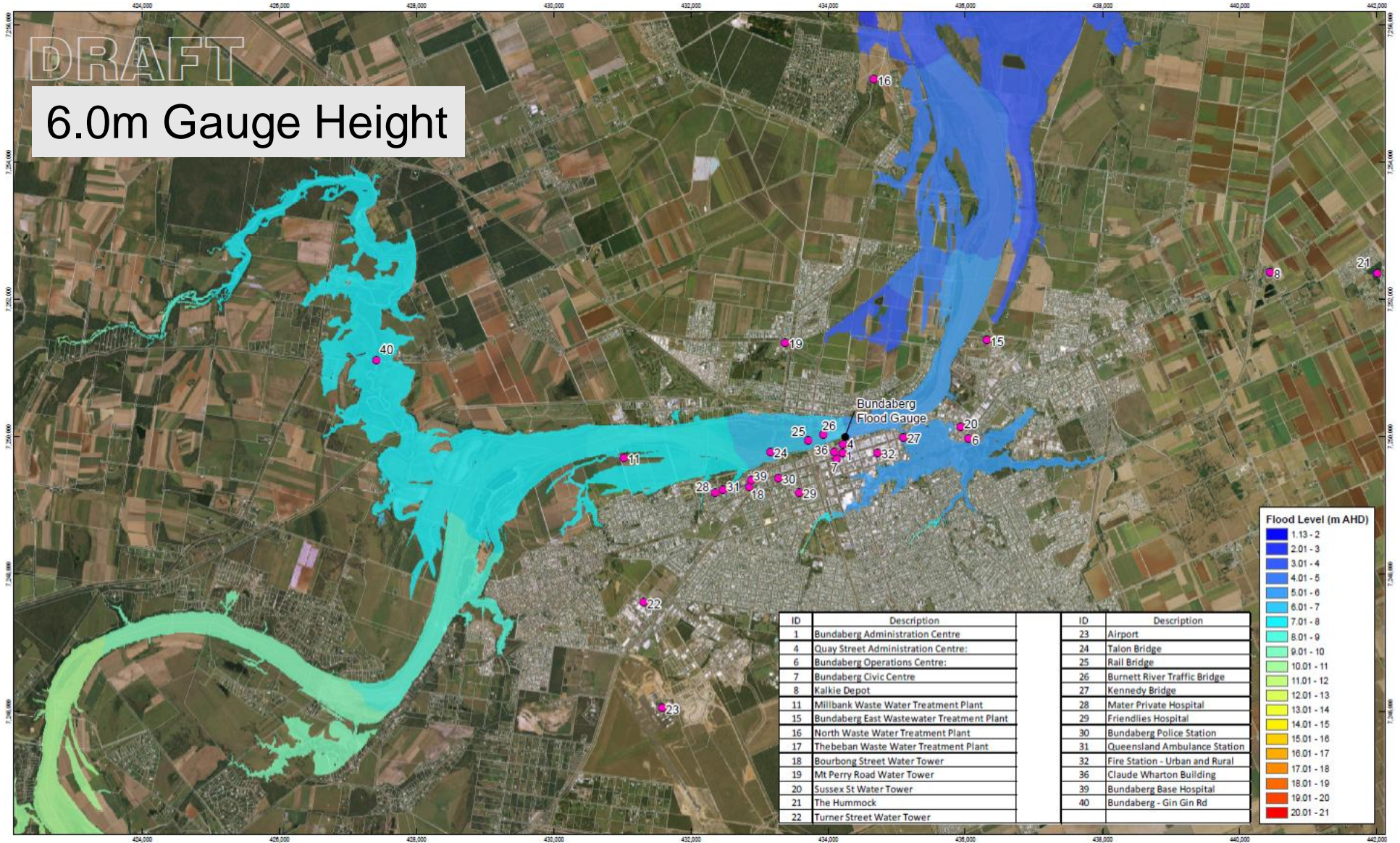
- Flood Models to test floodplain management options, future developments etc
- Flood Level (& Depth) Warning Maps (at Incremental Gauge Heights) & Fact Sheet
- Flood Time to Peak Maps and Graphs;
- Evacuation Maps (illustrating main evacuation routes)
- Flood Risk Maps (illustrating areas with different levels of flood hazard)
- Improved Property Flood Search Database
- Guidelines for mitigating flood induced scour on dwellings

Flood Warning Maps - Gauge Relationships



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6.0m Gauge Height



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	Thebanan Waste Water Treatment Plant	31	Queensland Ambulance Station
18	Bourbong 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		

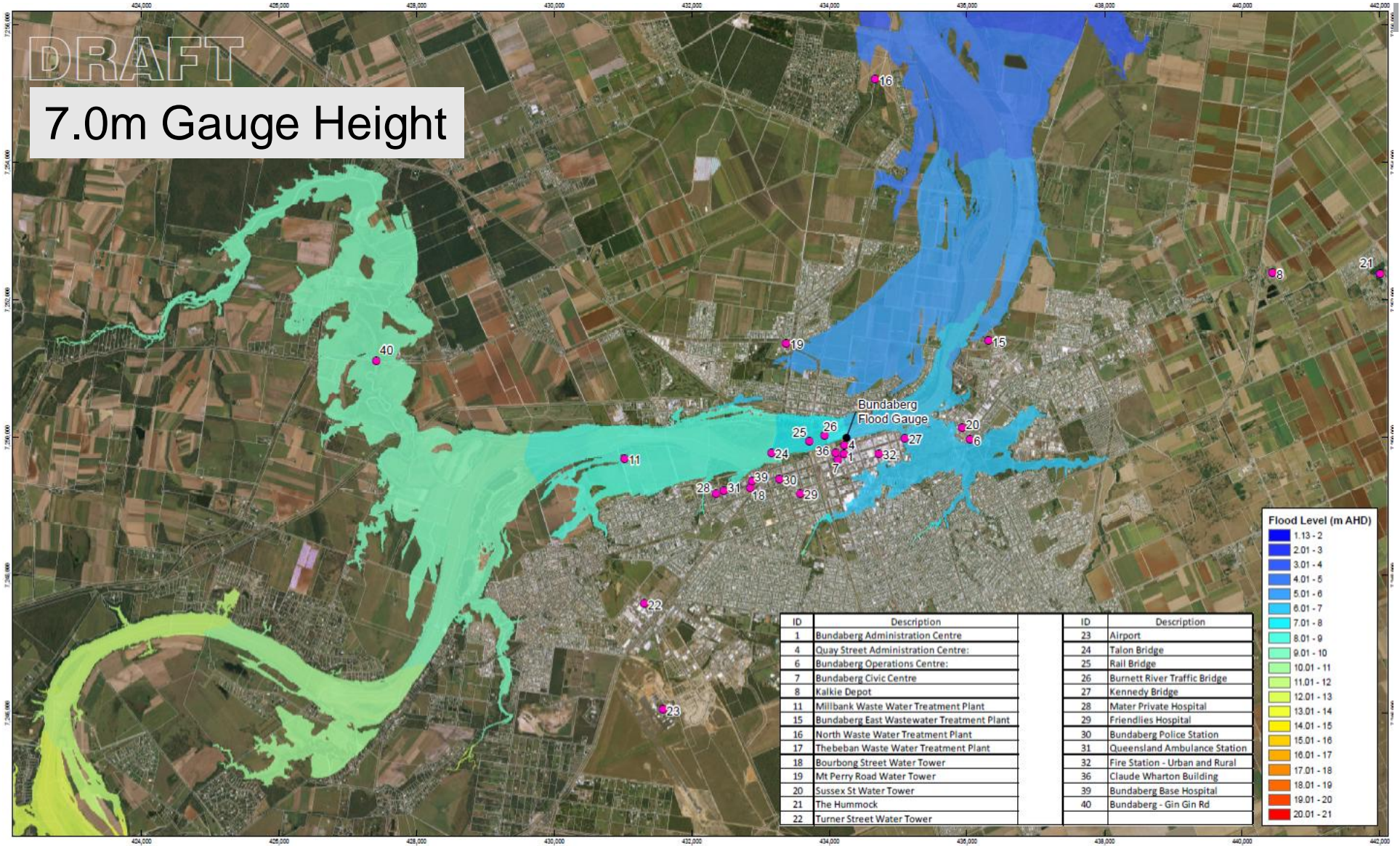


OUR COASTAL SPIRIT



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7.0m Gauge Height

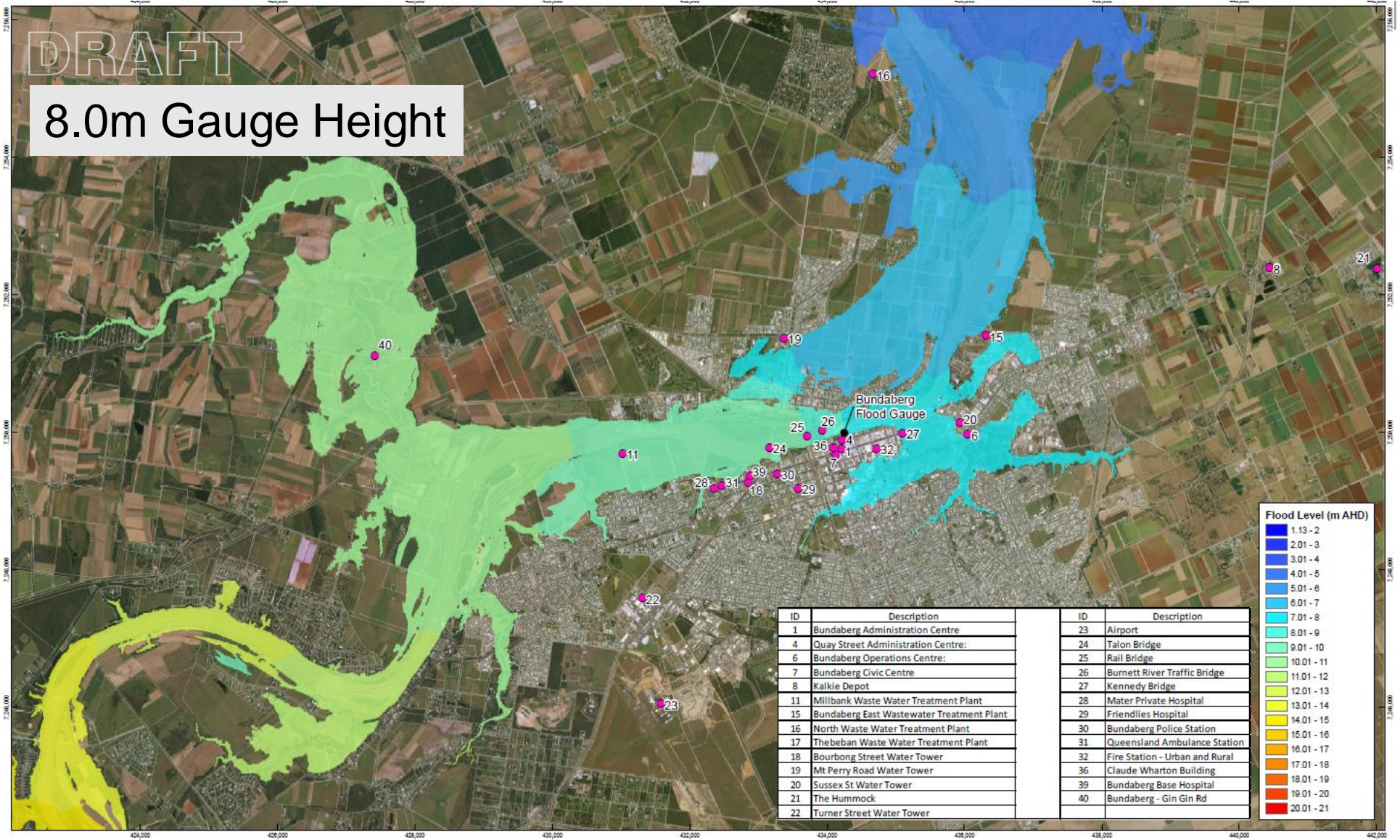


OUR COASTAL SPIRIT



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8.0m Gauge Height

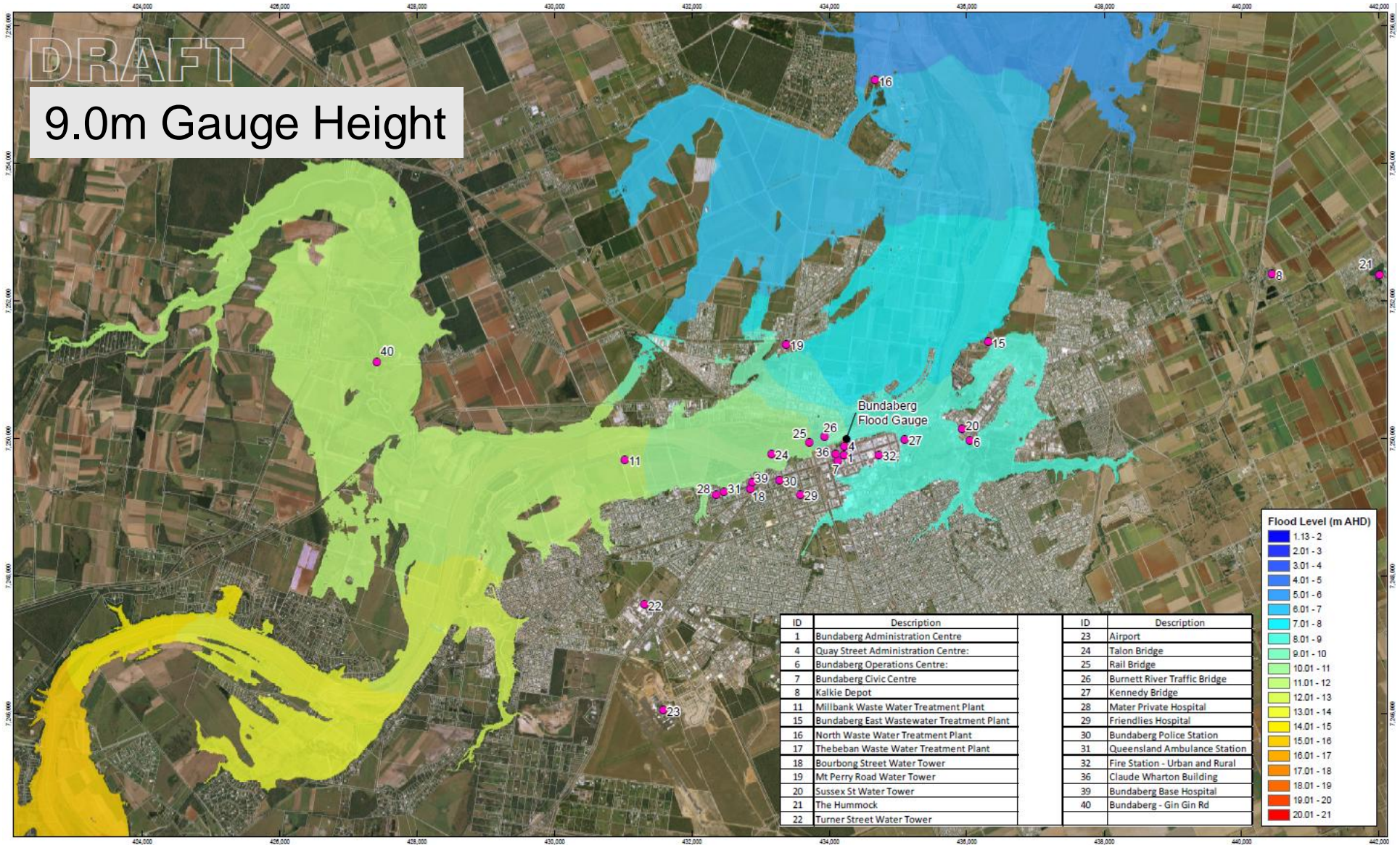


OUR COASTAL SPIRIT

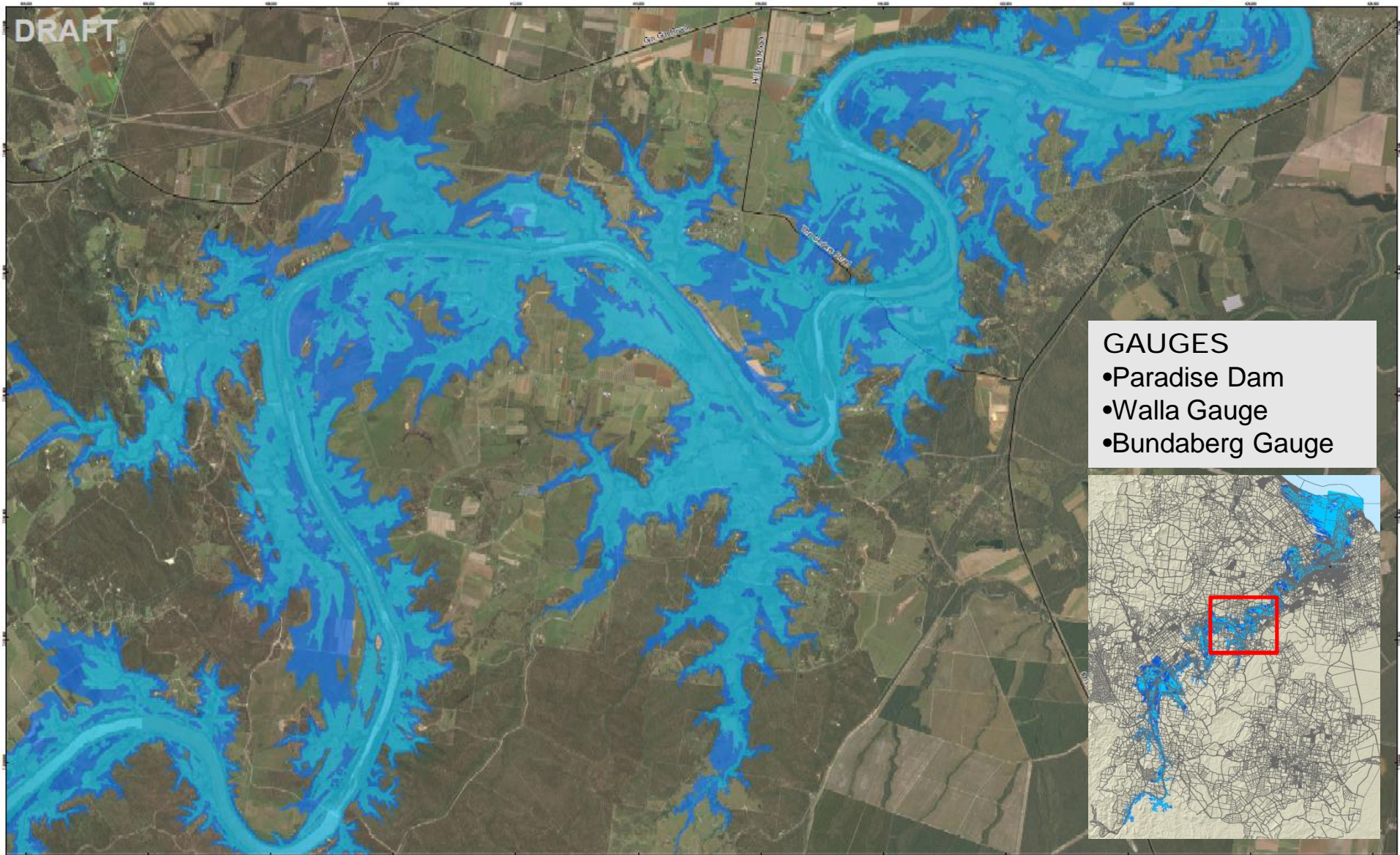


DRAFT

9.0m Gauge Height



In Progress - Incremental Maps Upstream



1:20,000 @ A0
 0 1 2
 Kilometres
 Map Projection: Universal Transverse Mercator
 Horizontal Datum: GDA 1994
 Grid: GDA 1994 MGA Zone 56



LEGEND

Road	0.5 Incremental Surfaces
Cadastral	9m
	11m

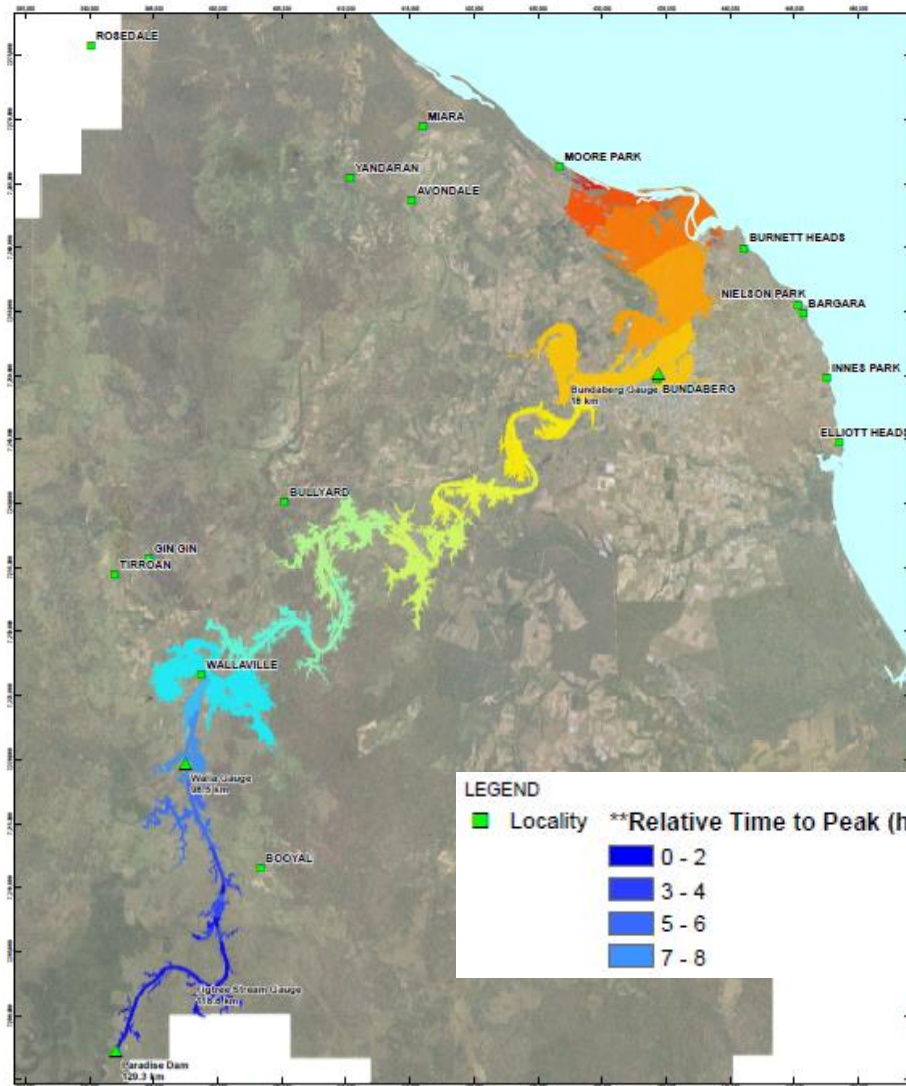
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 Burnett River Flood Study

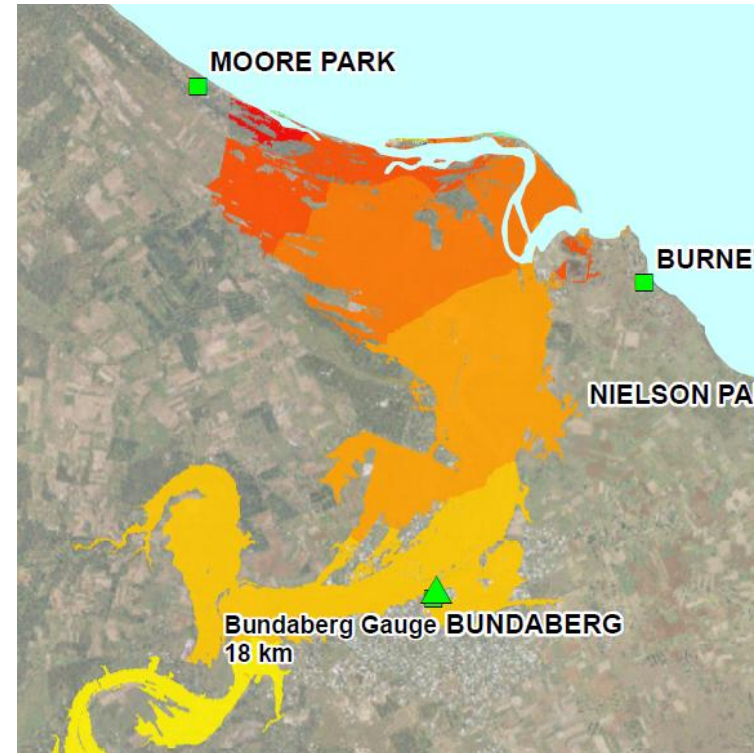
Job Number | 41-24728
 Revision | A
 Date | 26 Sep 2013

Flood Warning – Time to Peak Maps



LEGEND

■ Locality	**Relative Time to Peak (hrs)					
■ 0 - 2	■ 9 - 10	■ 19 - 20	■ 29 - 30	■ 31 - 32	■ 33 - 34	
■ 3 - 4	■ 11 - 12	■ 21 - 22	■ 31 - 32	■ 33 - 34		
■ 5 - 6	■ 13 - 14	■ 23 - 24	■ 25 - 26			
■ 7 - 8	■ 15 - 16	■ 25 - 26	■ 27 - 28			
	■ 17 - 18					



■ 9 - 10	■ 19 - 20	■ 29 - 30
■ 11 - 12	■ 21 - 22	■ 31 - 32
■ 13 - 14	■ 23 - 24	■ 33 - 34
■ 15 - 16	■ 25 - 26	
■ 17 - 18	■ 27 - 28	

**Displayed times are relative to peak at Paradise Dam, where time to peak at Paradise Dam = 48 hrs.

LEGEND

■ Locality	**Relative Time to Peak (hrs)					
■ 0 - 2	■ 9 - 10	■ 19 - 20	■ 29 - 30	■ 31 - 32	■ 33 - 34	
■ 3 - 4	■ 11 - 12	■ 21 - 22	■ 31 - 32	■ 33 - 34		
■ 5 - 6	■ 13 - 14	■ 23 - 24	■ 25 - 26			
■ 7 - 8	■ 15 - 16	■ 25 - 26	■ 27 - 28			
	■ 17 - 18					

**Displayed times are relative to peak at Paradise Dam, where time to peak at Paradise Dam = 48 hrs.

Scale: 1:50,000 (at A3)
 UTM Zone 55 S
 GDA 1984
 MGA 55 SA Zone 55

Map Projection: Universal Transverse Mercator
 Horizontal Datum: GDA 1984
 Vertical Datum: MGA 55 SA Zone 55

Scale: 1:50,000 (at A3)

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148 Ann Street Brisbane QLD 4000 Australia T 61 7 3218 3000 F 61 7 3218 3333 E brennald@ghd.com W www.ghd.com

Bundaberg Regional Council
 Burnett River Flood Study
 Relative Time to Peak
 100 y ARI Design Event

Job Number: 41-24728
 Revision: A
 Date: 08 Sep 2013

Figure 1



DRAFT Improving Dwelling Resilience to Flood Induced Scour - Guidelines for Footing Design
For
Dwellings Constructed within a Flood Hazard Area.

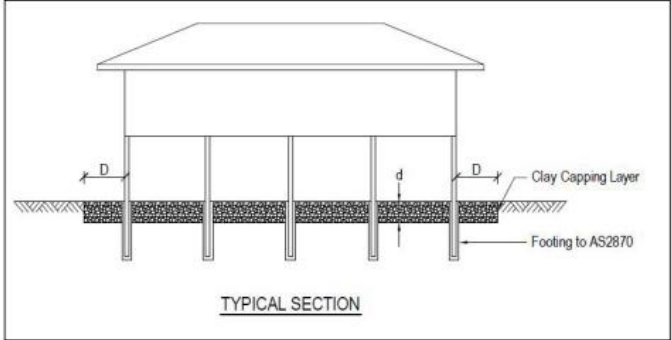


Figure 1.0 Typical Section

Based on the outcomes of the site scour risk assessment additional construction parameters can be selected from Table 1.0 below:

Table 1

Erosion Mat Details		
Scour Risk Factor	D (mm)	Cut Off Wall
NIL	N/A	N/A
LOW	1500	Yes
MED	2000	Yes
HIGH	Erosion Mat not suitable for scour risk factor HIGH or EXTREME	
EXTREME	Erosion Mat not suitable for scour risk factor HIGH or EXTREME	

Typical details pertaining to the cut off walls, edge beams and post / stump details are indicated in figures 3.0, 4.0 and 5.0 below:

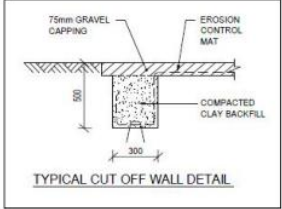


Figure 3.0 Typical Cut Off Wall Detail

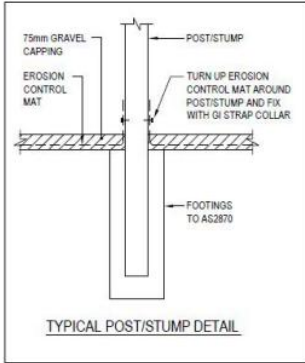


Figure 4.0 Typical Post / Stump Detail

4. Information Boards



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