ARR Revision Project 23: Urban Chapter

Transitioning drainage into urban water cycle management

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Australian Rainfall & Runoff

ENGINEERS AUSTRALIA

Supported By

Australian Government

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Overview

Overview of insights from investigations into integrating urban drainage into urban water cycle management

ARR Revision project 23

This presentation is my own views

Contributions from a review panel convened by Stormwater Australia

Incorporating over a decade of experience from alternative projects, policies and research

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What is Australian Rainfall and Runoff?

Three full editions of ARR published by Engineers Australia:

- 1958 – First Report of the Stormwater Standards
- 1977 – Flood Analysis and Design
- 1987 – A Guide to Flood Estimation

A national guideline for policy decisions, estimation of flooding and design of stormwater infrastructure

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Motivations for Revision

- Many practices and methods recommended in ARR 1987 are "outdated"
- More rainfall and streamflow data
  - Improved understanding of climate processes
- Changes in professional and community aspirations

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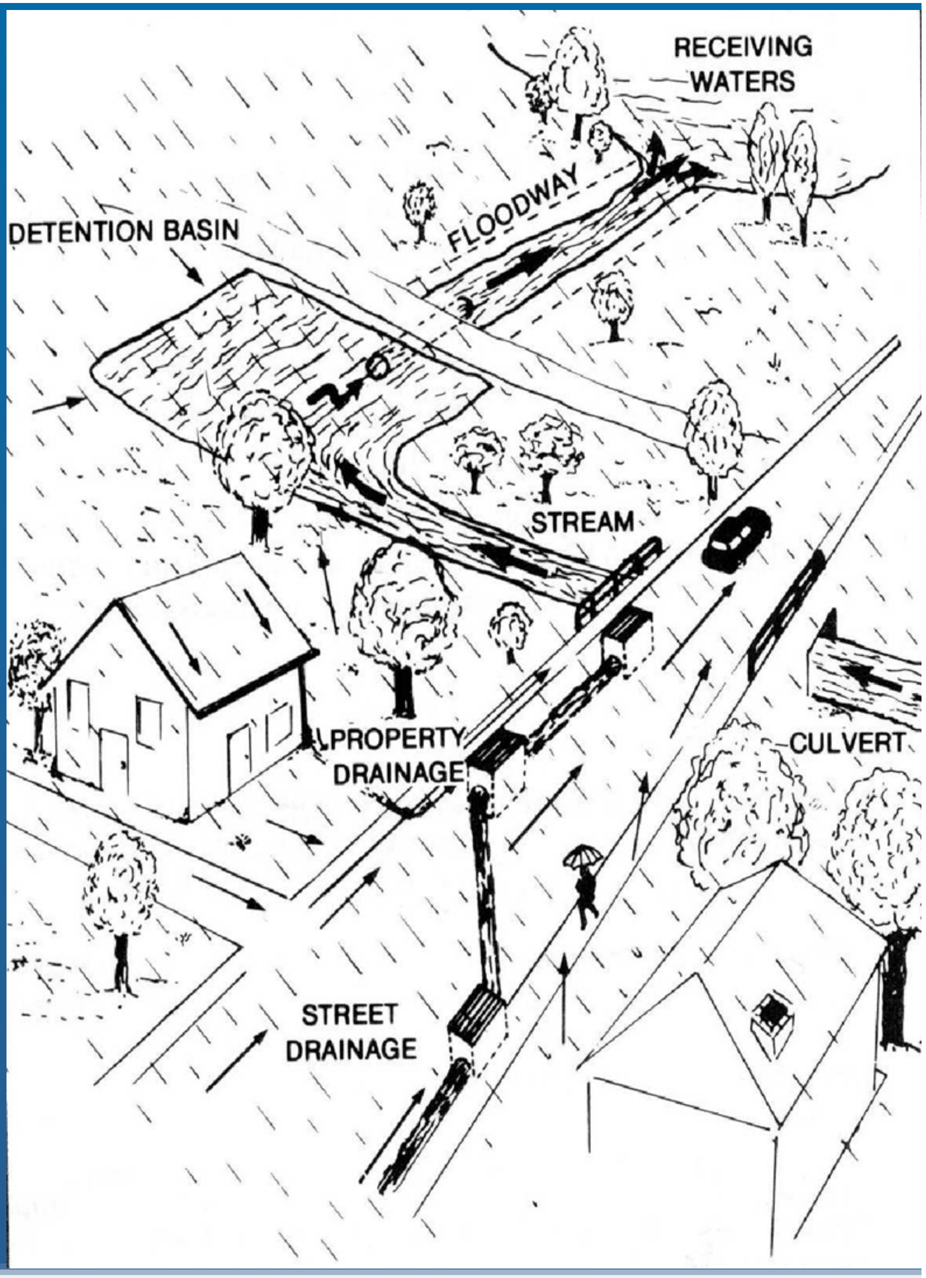
Knowledge Gaps Addressed by Revision

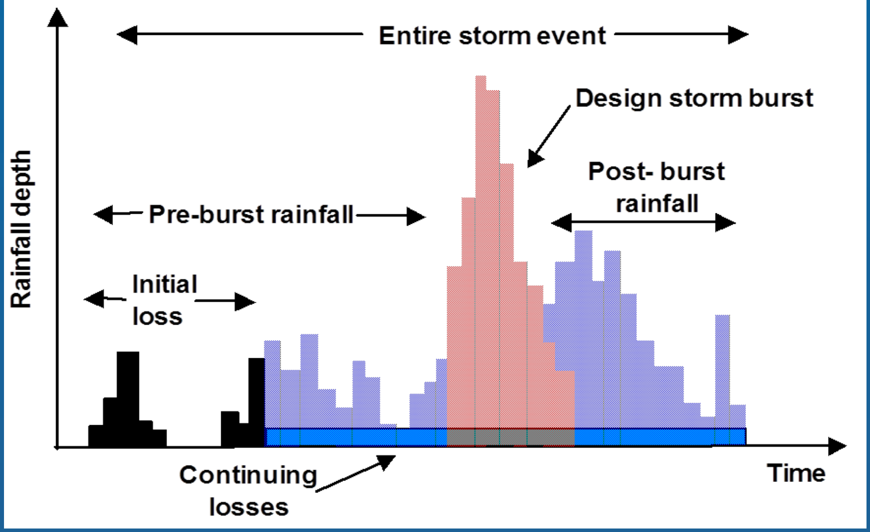
- Insufficient and incomplete rainfall and streamflow data
- Inadequate advice on modelling and simulation techniques for catchment systems
- Narrow focus on major and extreme floods
  - Need guidance on a complete spectrum of flood flows

Stormwater Drainage

- Minor/major system
- Minor system designed to minimise nuisance
  - Pipes and pits provided to discharge stormwater runoff from smaller rain events
- Major system designed to prevent property damage and loss of life
  - Roads and overland flow paths convey stormwater runoff from larger rain events
- Infrastructure designed using event based “storm burst” methods

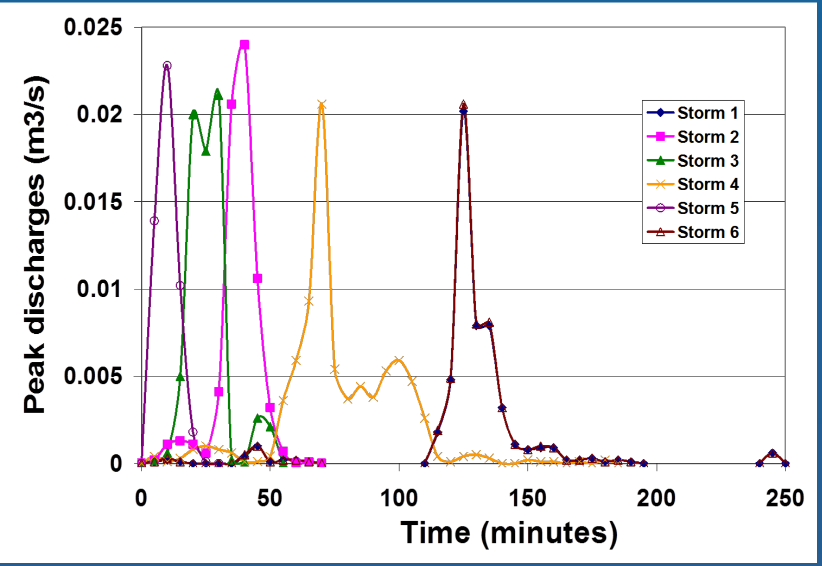


Design Storms (1987) to "Real" Rainfall (2015 +)



Analysis using real rainfall accounts for flow volumes and variability

Computer age allows use of **real rainfall sequences**



Statistical **design storm bursts**

Rational Method was "best known"

Hand calculations, programmable calculators

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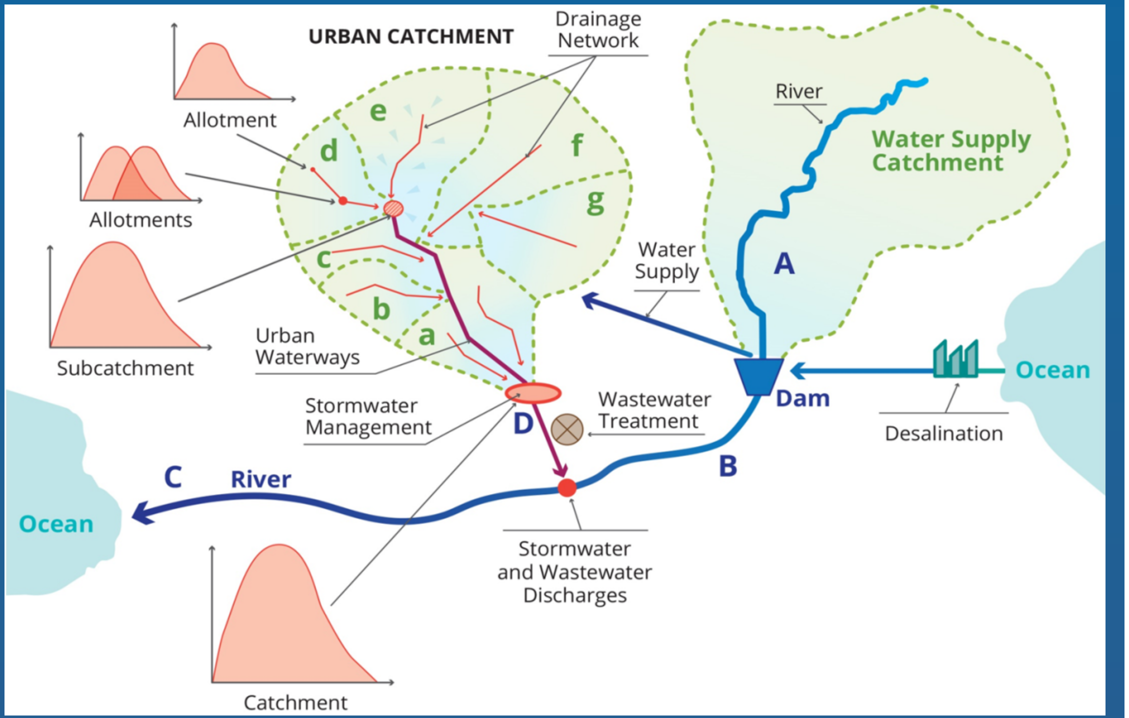
Traditional Scale Issues

- Water demanded, stormwater and wastewater generated, hydrology altered at decentralised scale
- Urban areas alter hydrology and water quality:
  - Water demands (B)
  - Within urban areas (a-h)
  - Downstream of urban areas (C)
- Flow management at bottom of urban catchment (D)
  - Does not account for changes within catchments (increased density, aging infrastructure, climate



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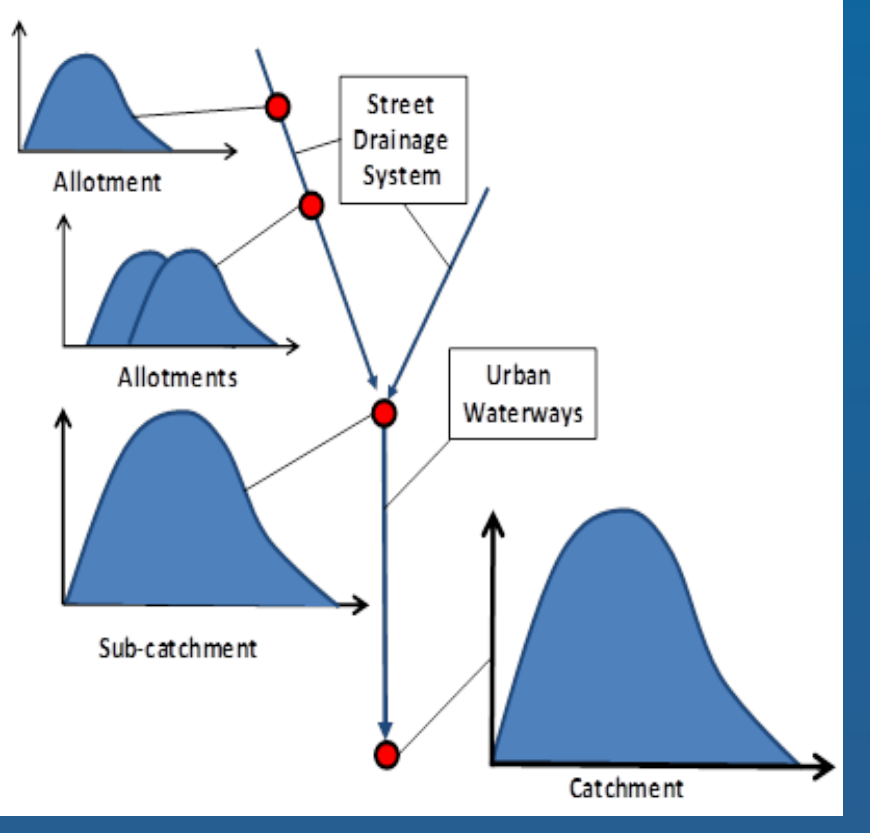
Cumulative Challenges

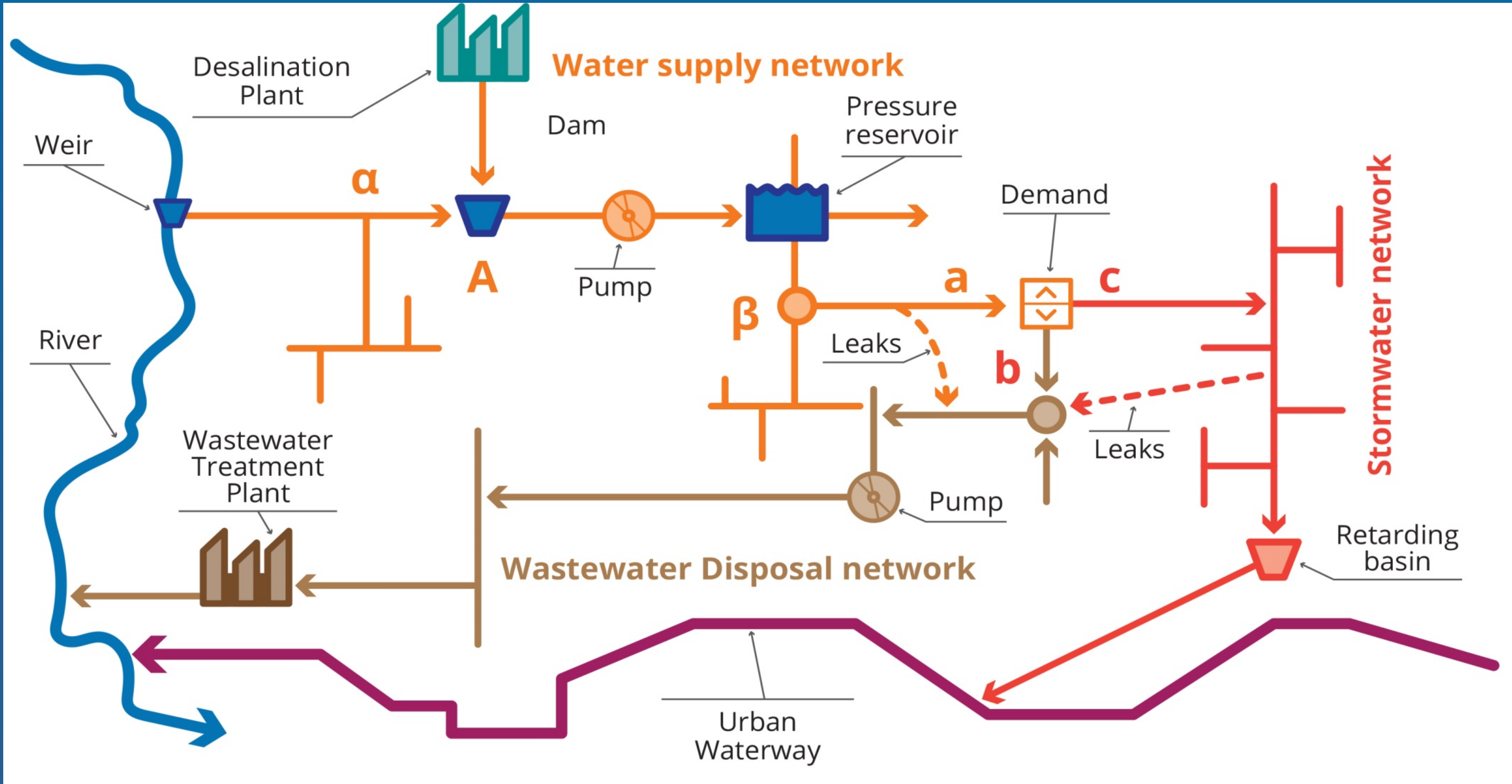
The responses of urban catchments are cumulative

- Not static or average or linear
- Dependent on spatial and temporal characteristics throughout catchments

Traditional analysis relies on "engineering judgement" to assess benefits or impacts of



Stormwater Management is Part of Linked Water Cycle Processes



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Deconstructing Peak Flows into Volume and Time

Losses = changes in volume and timing of flows

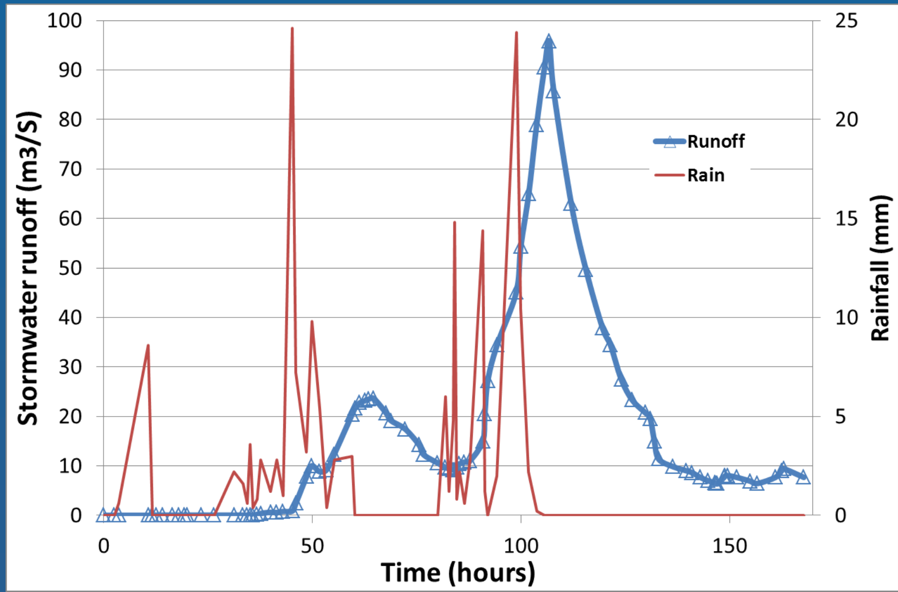
Example from 2011 flood at Ararat

Vegetation, natural storages, barriers and disconnection

- Reduce volumes and slow flows (timing)

Avoiding greater flows (bigger volumes at faster time)

$Q = m^3/S$



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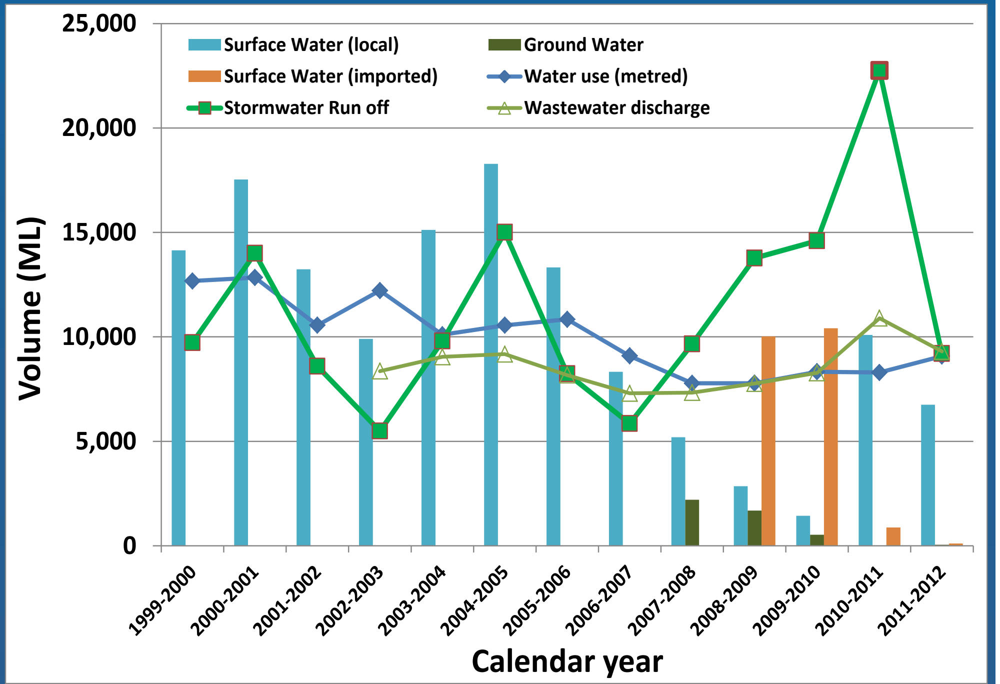
Stormwater is Part of the Urban Water Cycle (Ballarat Example)

- Dependent on water collected from local rivers (Moorabool and Yarrowee Rivers)
- Reduced flows in local rivers supplemented by groundwater and importing water from dryer regions
- Halved water demand using water efficiency and rainwater harvesting
- Cumulative impacts on surrounding communities



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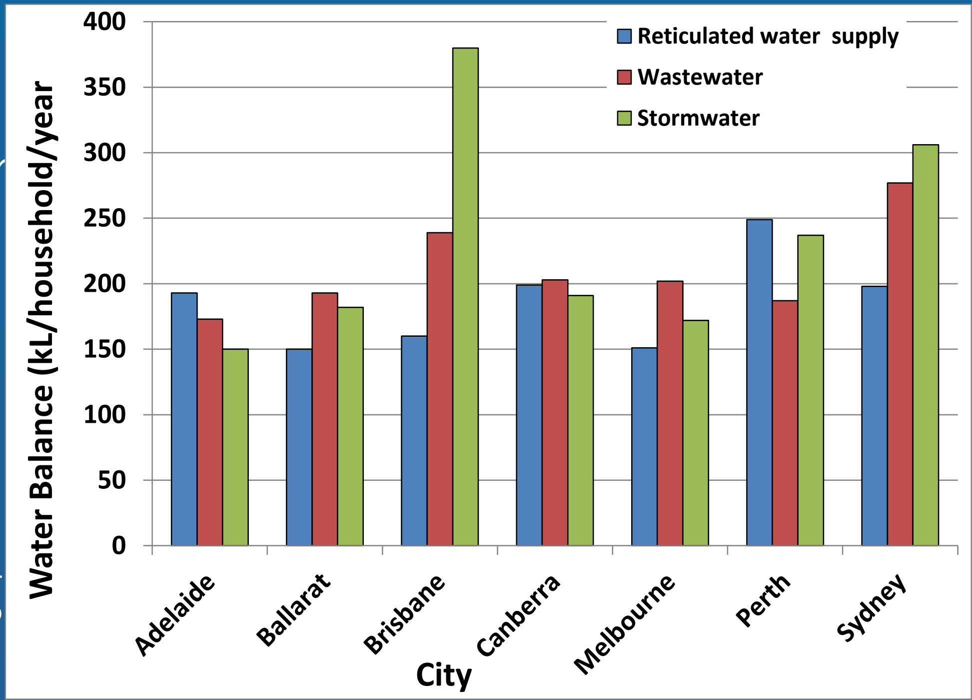
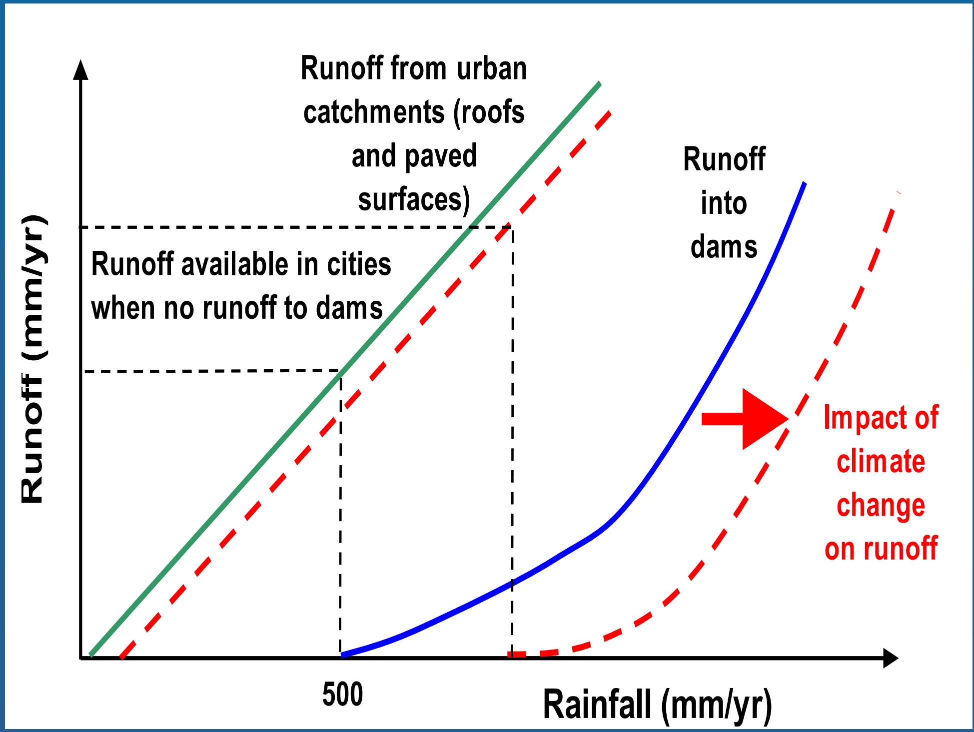
Quantum of the Resource

- Average annual volumes of stormwater runoff from properties similar or greater than water use
- Similar for wastewater
- The local water resources are greater than water extracted from surrounding catchments



Relative Efficiency of Urban Catchments Challenge is Opportunity

- Urban catchments more efficient at generating stormwater runoff than natural catchments
- Ability to supplement regional water supplies
  - Allows banking water in regional storages and increased environmental flows in regional rivers
- Increased runoff volumes are challenges for flooding,



The Opportunity of Integrated Systems

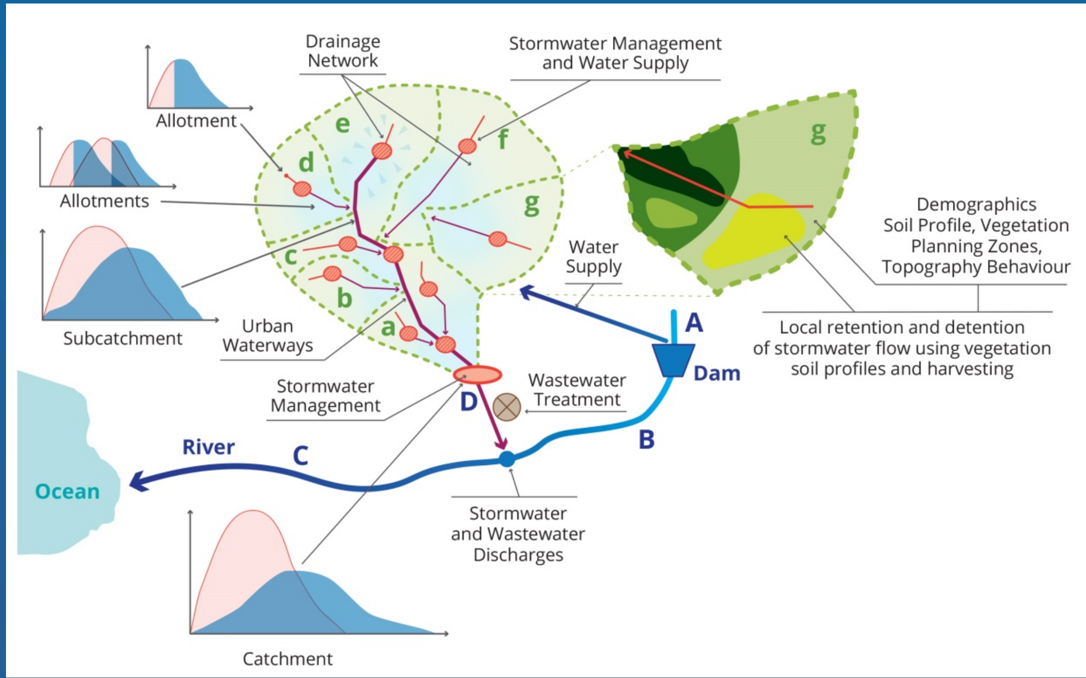
Multiple physical and ecosystem responses in catchments

Solutions at multiple scales

- WSUD and IWCM

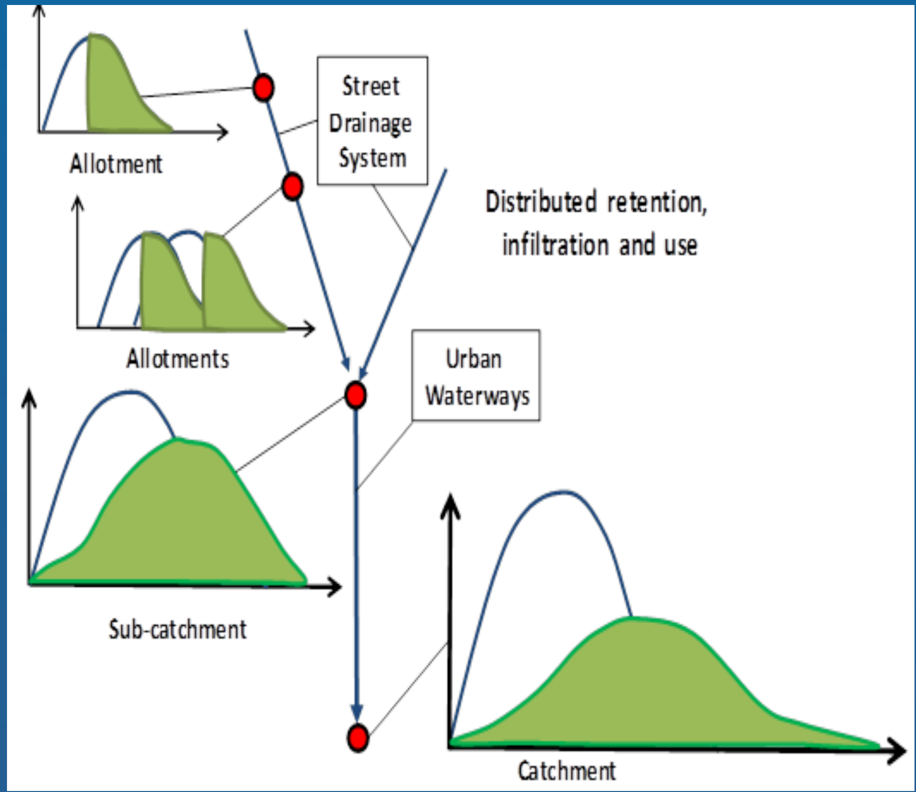
Distributed "within catchment" solutions provide whole of system benefits

- Cannot be realised by analysis at bottom of catchment (D) and engineering judgement about runoff coefficients

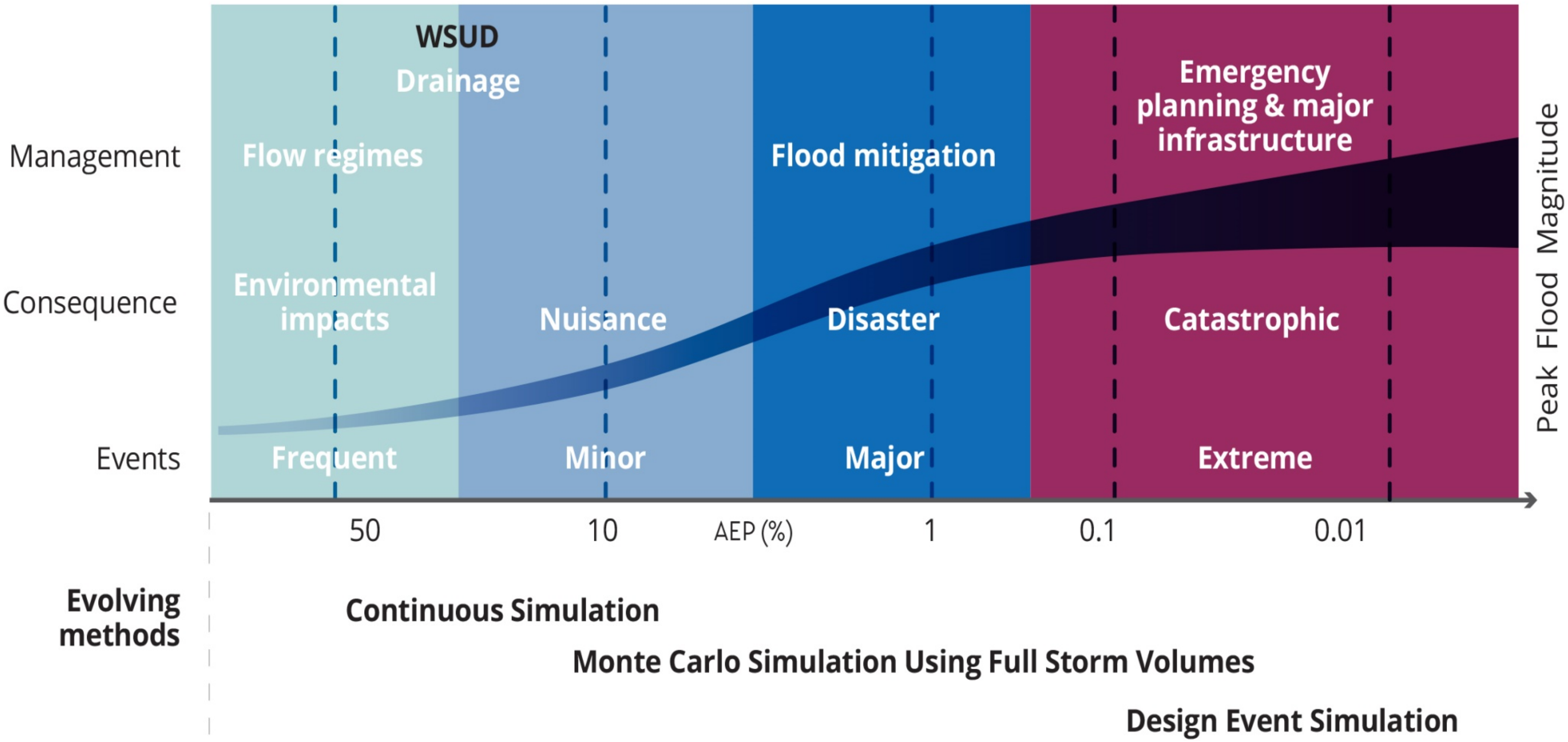


Cumulative Issues: the future is restoring past natural regimes

- Urban catchments display volume sensitive and cumulative responses
- Distributed solutions can cascade across scales to mitigate cumulative impacts
- A treatment train restores natural flow regimes of volumes
- Measures that change volumes at source (not peak flows) can provide natural



Managing the Full Spectrum of Runoff Events



Value or Cost of Stormwater Resource

it is worth doing something!

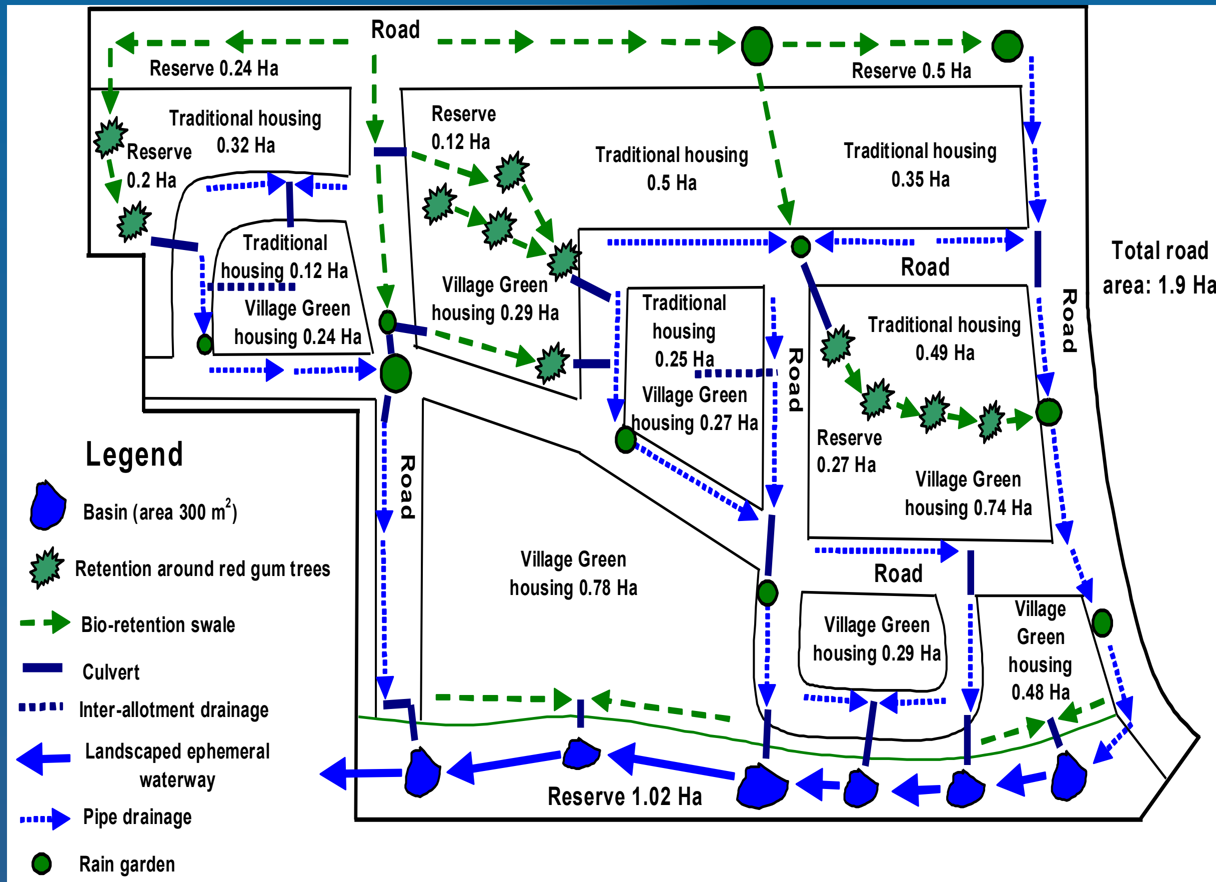
- Water cycle costs to 2050 for Greater Melbourne (NPV at 5%)
  - Water $36 b, Sewage $24 b, stormwater $12 b
  - But SW drives $9 b of sewage costs
  - And Nutrient costs up to $50 b
- Source control can provide up to $6 b benefits
- IWCM/WSUD can provide up to $10 b benefits
- Additional benefits for reduced nutrient loads, healthy waterways and increased liveability.
- However, these benefits can only be realised by acceptance of new

A Case Study: Renaissance Rise

Mernda
Circa 2005
WSUD project
Treatment train:

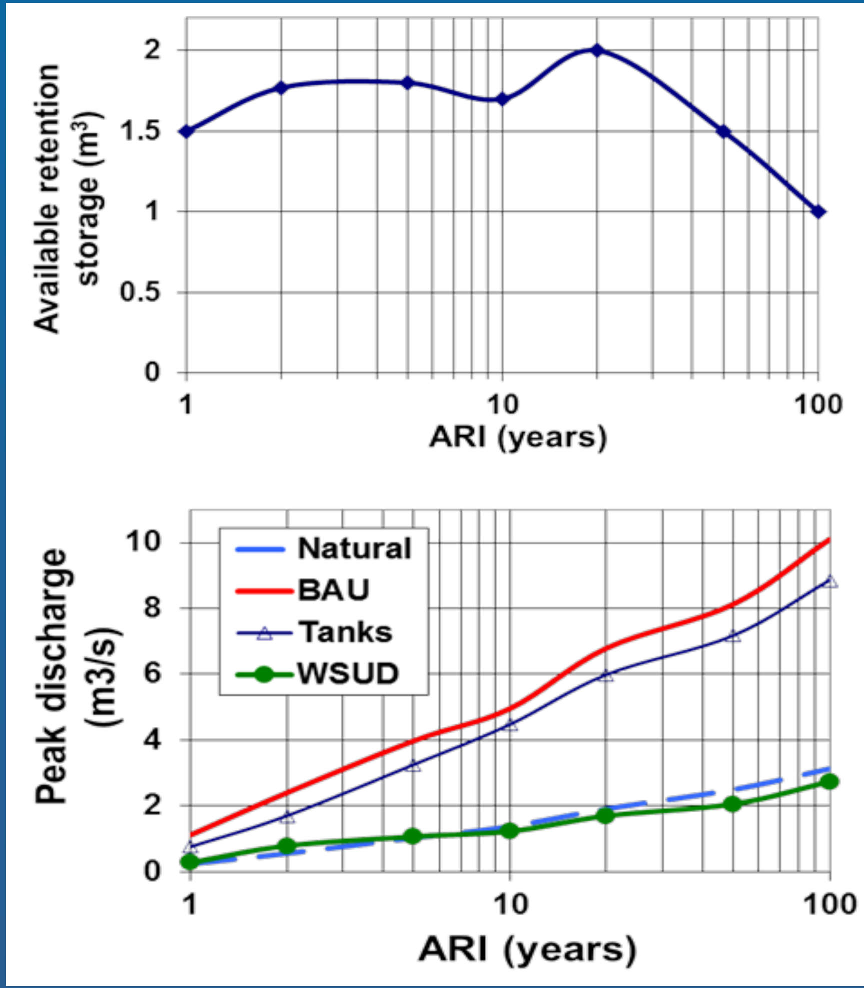
- Rainwater harvesting
- Swales
- Rain gardens
- Buffer strips
- Bio-retention
- Detention

Multi-use infrastructure
Cascading retention solutions



Case Study: Integrated Design Challenges

- Could not be designed using event based assumptions
  - Engineering judgement about runoff coefficient C was inadequate
  - Multi-disciplinary process
- Used continuous simulation, real rainfall sequences and Monte Carlo to determine available storage prior to storm events
- Then employed hydraulic model with design storms extended to include full volumes
- Dependent on the leadership of Paul Mitchell and John



Key Insights

- Future of stormwater management includes integrated planning and design
- A multi-disciplinary and multiple scale approach
- New guidelines must encourage advanced analysis and innovation
- Must account for advances in science and practice over the next 30 years
- New design methods include continuous simulation, Monte Carlo, complete real storms, and

Contour Bank and Buffer Strip

Flood Mitigation and Bio-retention

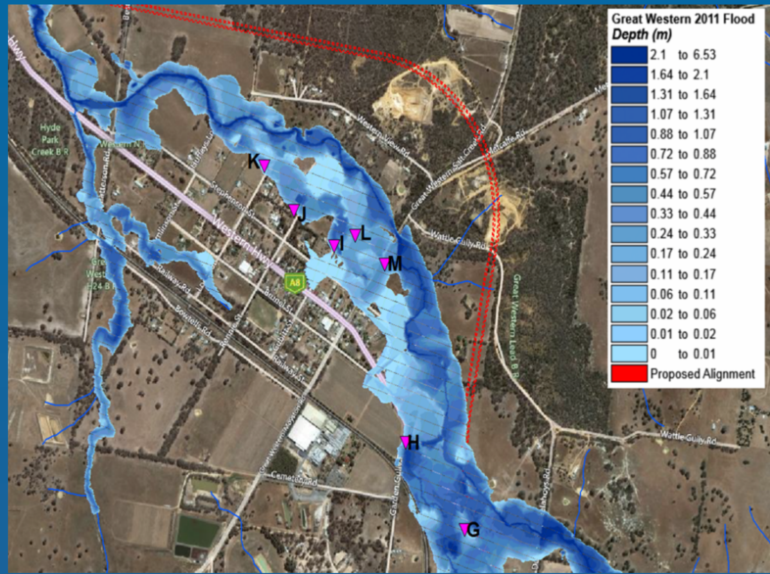
Key Insights

Must link infrastructure design with quality guidelines (ARQ) and water cycle infrastructure

- urban drainage is an integrated part of the urban water cycle
- avoid duplication of infrastructure

Behavior of water cycle systems is cumulative rather than static.

This insight indicates need for ongoing diligence and innovation to avoid transferring problems to future generations.



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Project 23:
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