Urban hydrology

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Aim of the session

- Identify the Committee's preferences for managing urban development for its impact on stream flows

Some info to help

- Why manage the effects of runoff?
- What does different infill and greenfield development practice get you?
  - How and why does hydrology differ
  - How do the effects on stream health differ
  - How and why do costs differ

Why manage the runoff effects?

- One of many factors that affect stream ecology
  - Water quality (eg, toxicants, temperature)
  - Flow (eg, low flows, total runoff, disturbances)
  - Habitat (eg, bank stability, stream bed, shade, passage)

Why manage the runoff effects?

- People need places to live
- More hard surfaces
  - more runoff
  - faster runoff
- Cost to develop and live there
- Resilience
- Climate change
- Amenity of the built environment

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Your scenarios

- Package of interventions covering many factors that affect stream health
- Today’s focus is on urban runoff
- Improved
  - Slow the water down
  - Limited removal of runoff reaching the stream
- Water sensitive
  - Reduce the area of hard surfaces
  - Slow the water down
  - Store and remove runoff from reaching the stream

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Case studies

- Relatively small catchments with lots of urban development in the scenarios
- Magnify the effects of urban development and changes in practice within each development type
- Results likely to be less dramatic in mixed land use catchments

Results to look for

- Annual average runoff
  - changes indicate a likely shift in the stream ecology towards less diverse macroinvertebrate communities with fewer sensitive species
- Frequency of bed disturbing flows
  - too much disturbance can mean only the tolerant species (typically the small and rapidly species colonising species) survive while sensitive species are lost
- Life cycle costs per household
  - Difference in costs to install and maintain the scenario bundles of stormwater mitigation measures
  - Split of private and public borne costs

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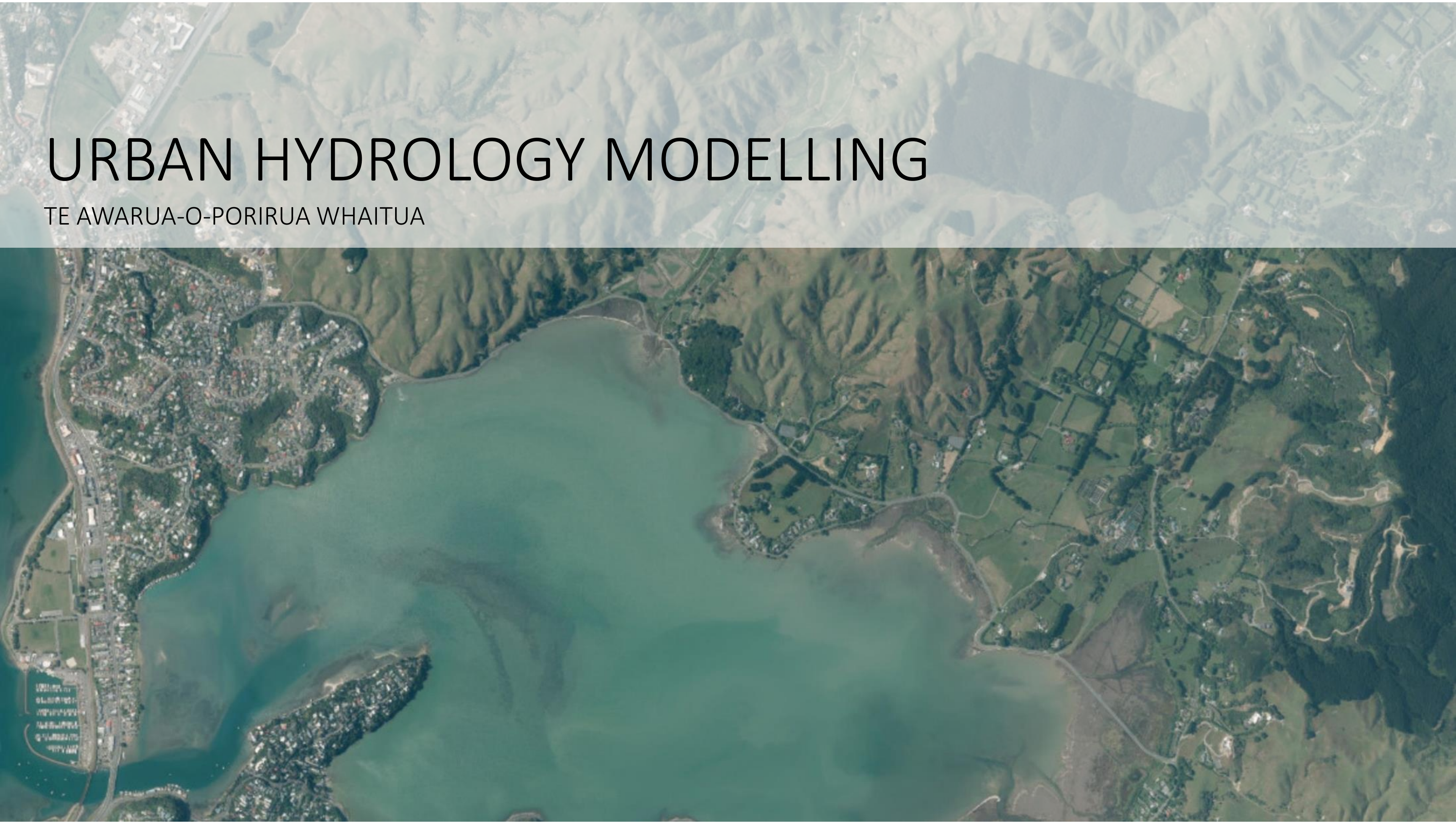
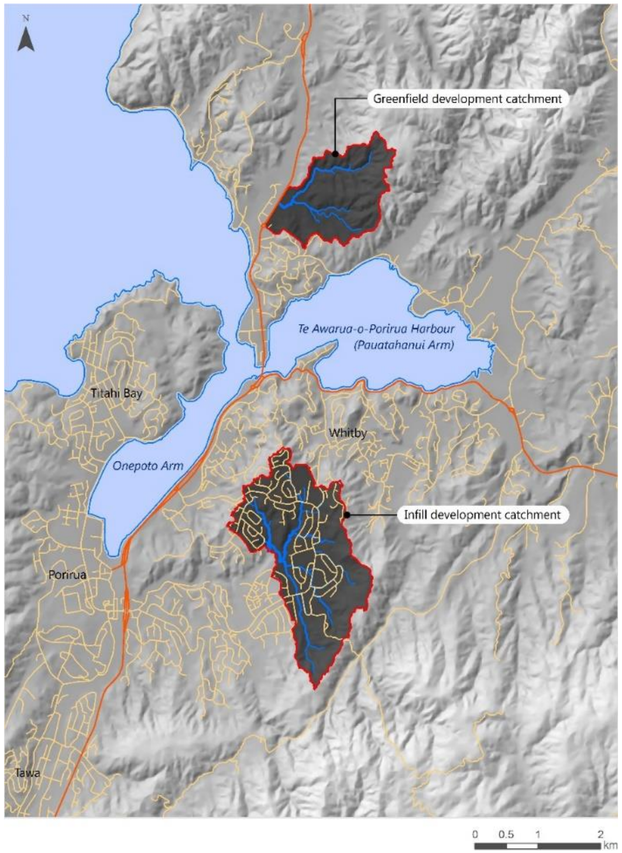
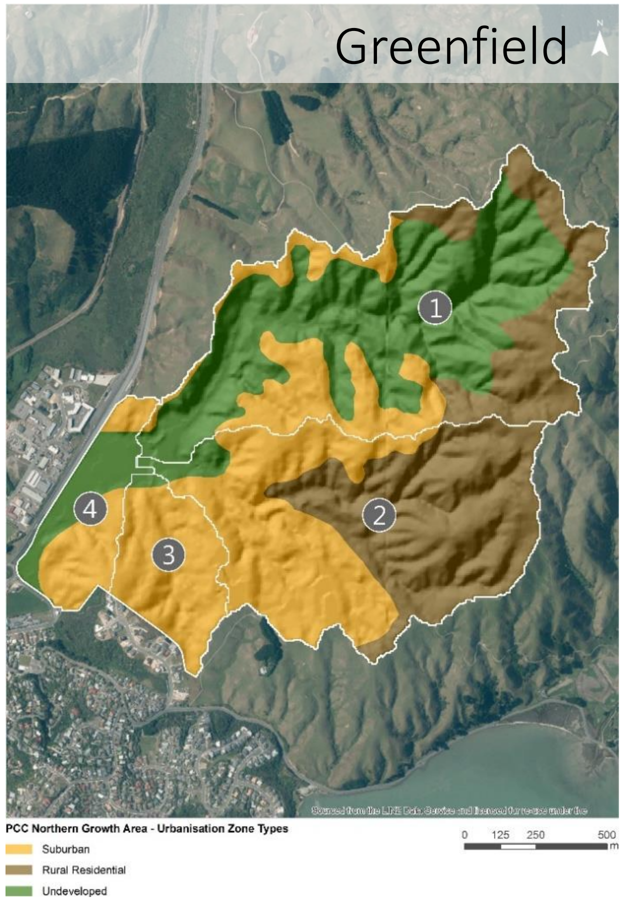
URBAN HYDROLOGY MODELLING

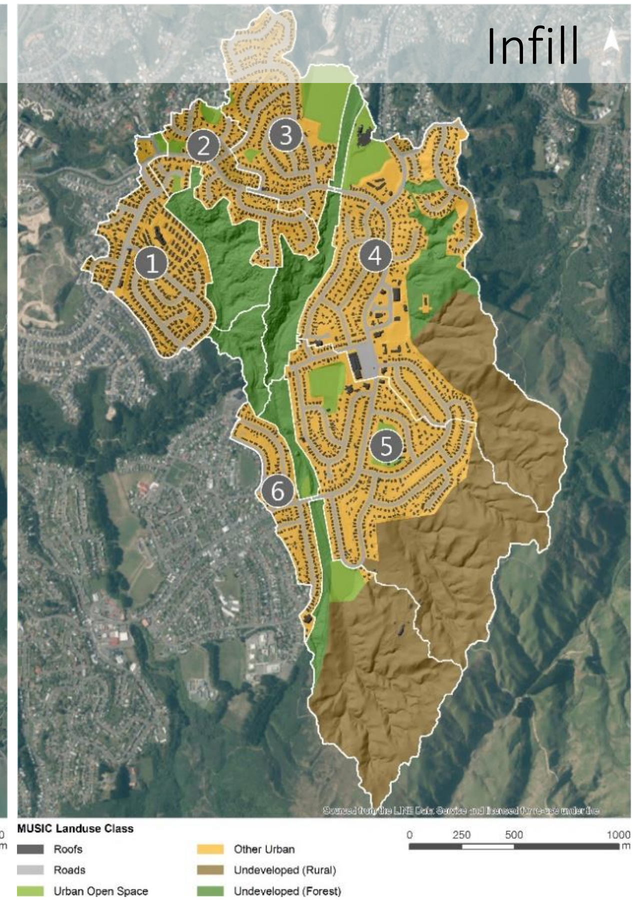
TE AWARUA-O-PORIRUA WHAITUA



Case study catchments







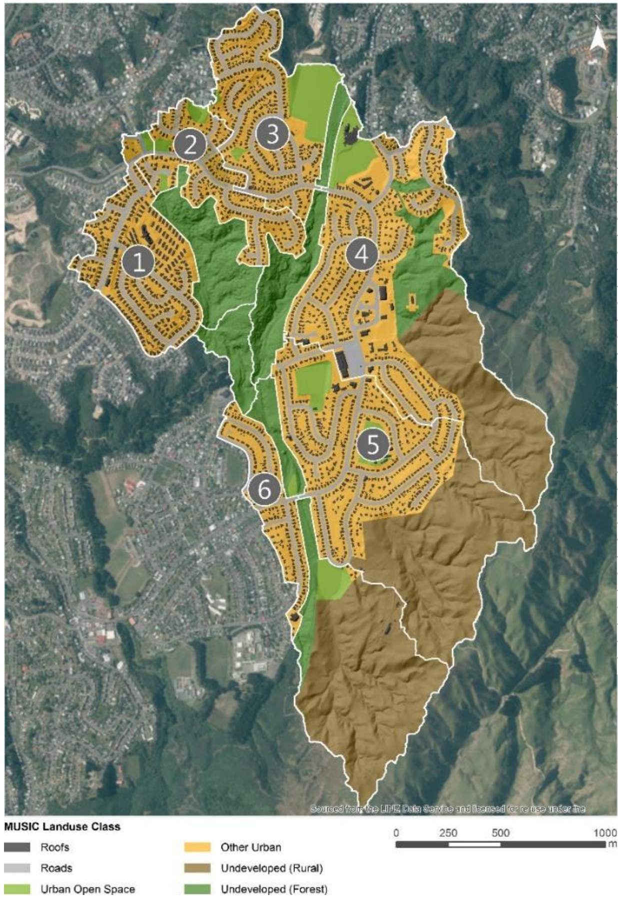
Hydrology model

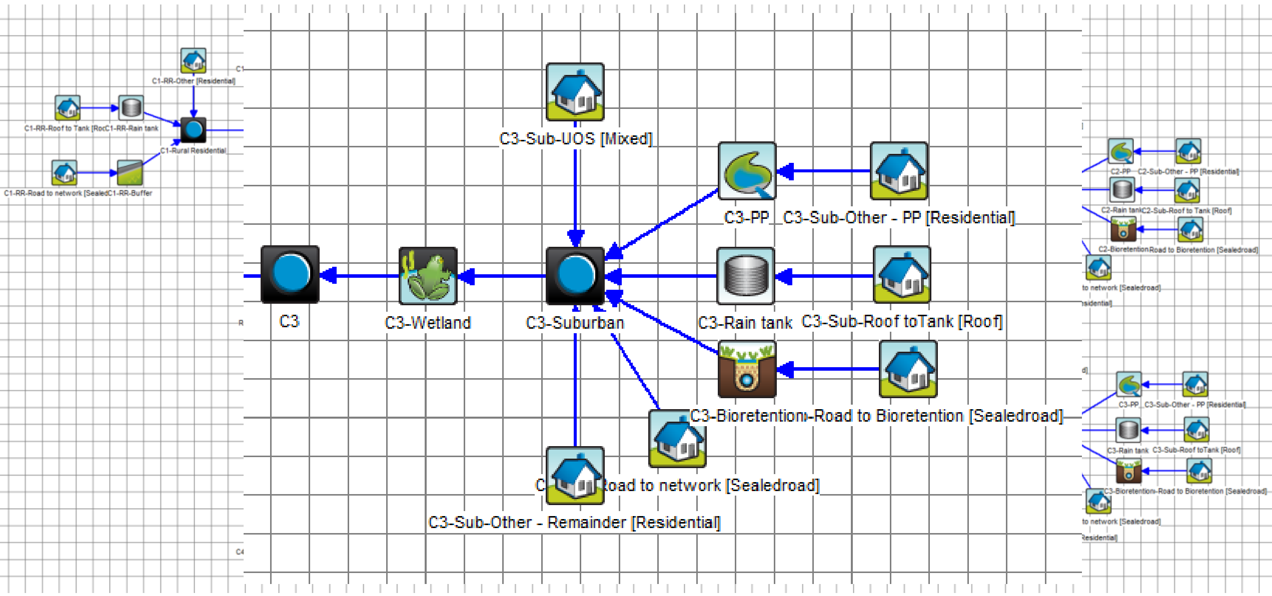
- Converts rainfall into stormwater runoff
- Compare changes in runoff across development scenarios
    - Effect of landuse changes
    - Effect of stormwater management devices
        - – Rainwater tanks (reuse of captured water)
        - – Raingardens in streets
        - – Wetlands (reuse of treated water)
        - – Permeable paving
- Report results
    - Annual volume of runoff
    - Number of bed-disturbing flows per year

Model scenarios

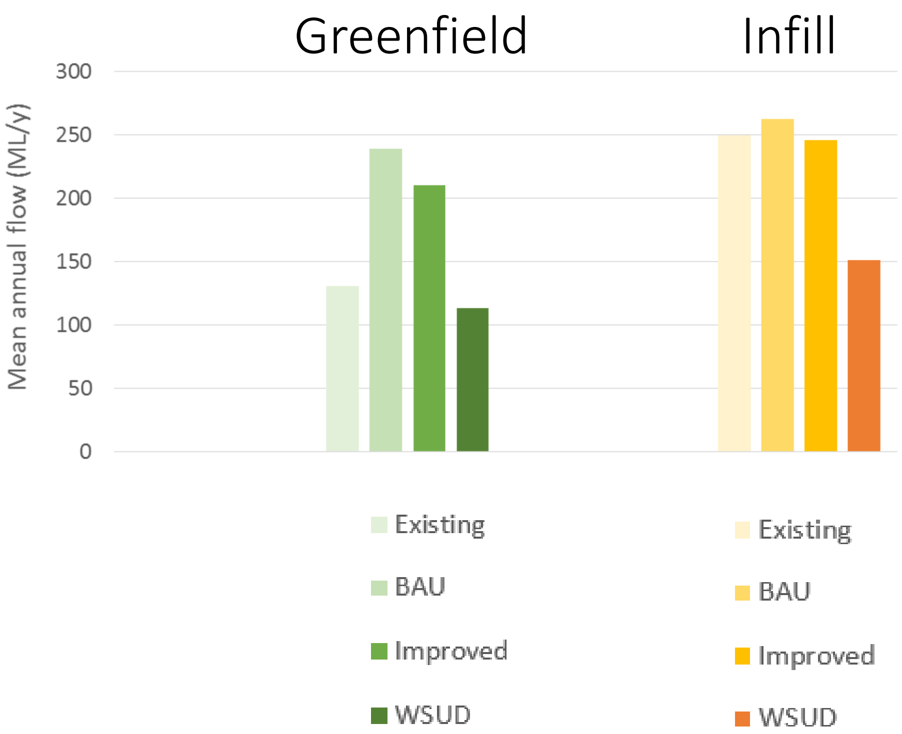
- Existing
- BAU
  - Higher dwelling density, greater imperviousness
  - No mitigation of runoff
- Improved
  - Same density and imperviousness as BAU
  - Some mitigation of runoff using devices = stormwater **detention**
- WSUD
  - Same density but reduced imperviousness
  - Extensive use of runoff mitigation devices = stormwater **retention**

Model structure (Infill catchment)





Results – Runoff volume



% volume reduction

Greenfield

BAU to WSUD: 53%

Improved: 10%

WSUD: 43%

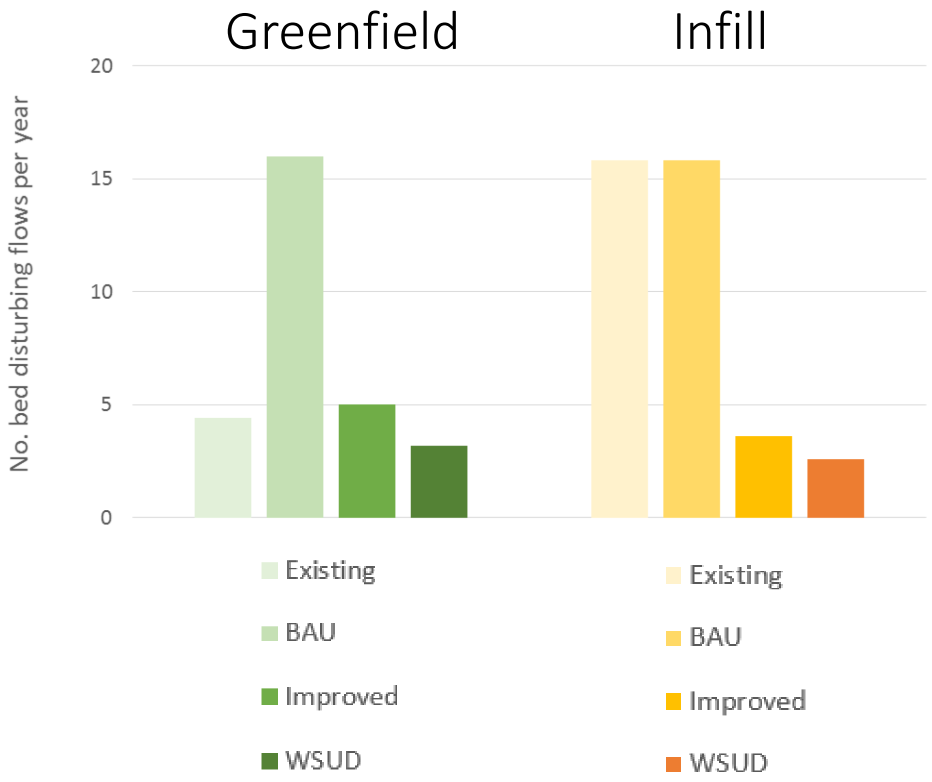
Infill

BAU to WSUD: 42%

Improved: 6%

WSUD: 37%

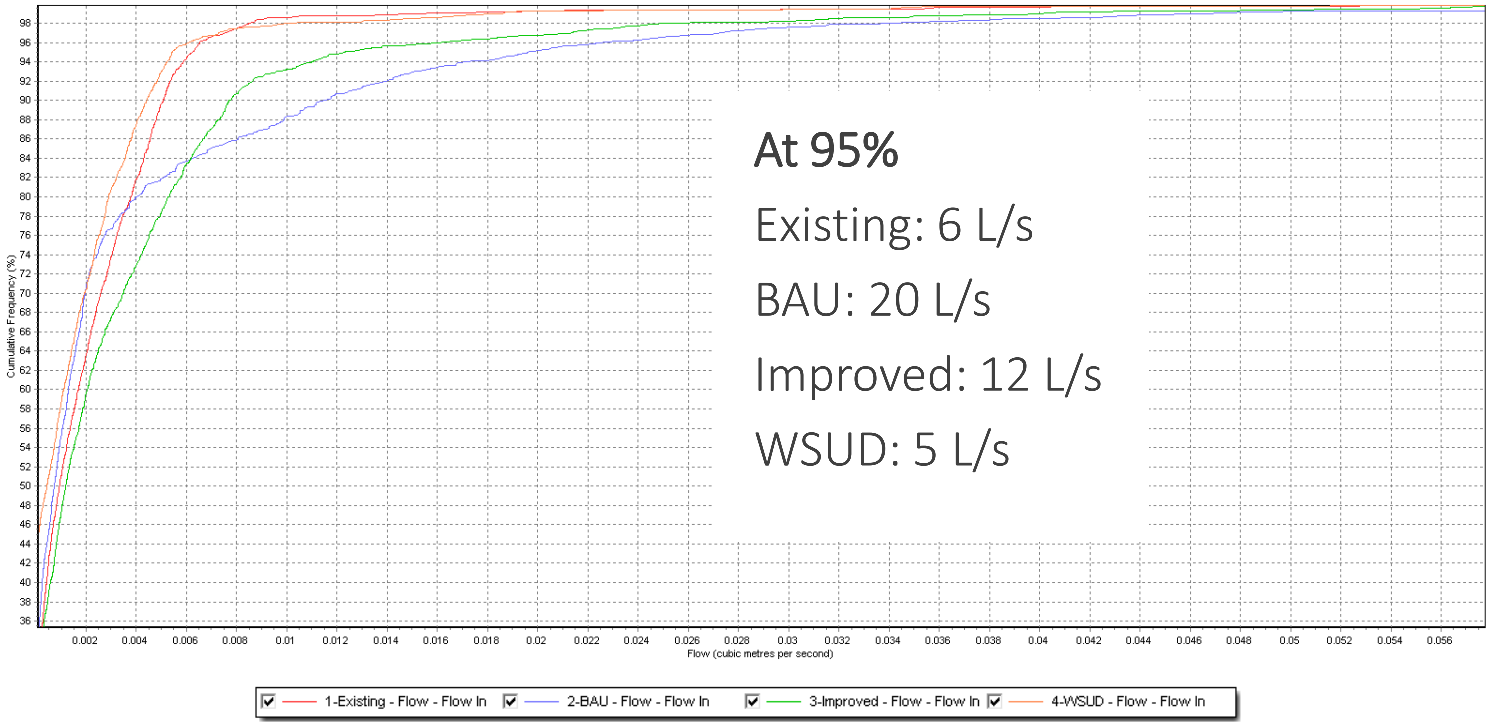
Results – Bed disturbing flows



Key messages

- Improved scenario
    - Reduces frequency of bed-disturbing flows
    - Has small effect on total runoff volume
- WSUD scenario
    - Reduces bed-disturbing flows **and** total runoff volume
- Greatest benefit through stormwater **retention**
    - Re-use collected rainwater within houses (constant daily use)
    - Infiltration of stormwater (less viable)
- WSUD approach has wider benefits than just hydrology
    - Water quality improvement
    - Amenity enhancement
    - Reduced demand on mains water supply (rain tanks)
    - Resilience, e.g. household water supply following earthquake

Results – Cumulative frequency distribution



At 95%

Existing: 6 L/s

BAU: 20 L/s

Improved: 12 L/s

WSUD: 5 L/s

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THE COST AGGREGATION MODEL

PORIRUA WHAITUA

Synopsis....

- What is life cycle costing and how can we use it?
- Information on the Porirua Whaitua LCC models (assumptions)
- LCC results for our two case study catchments

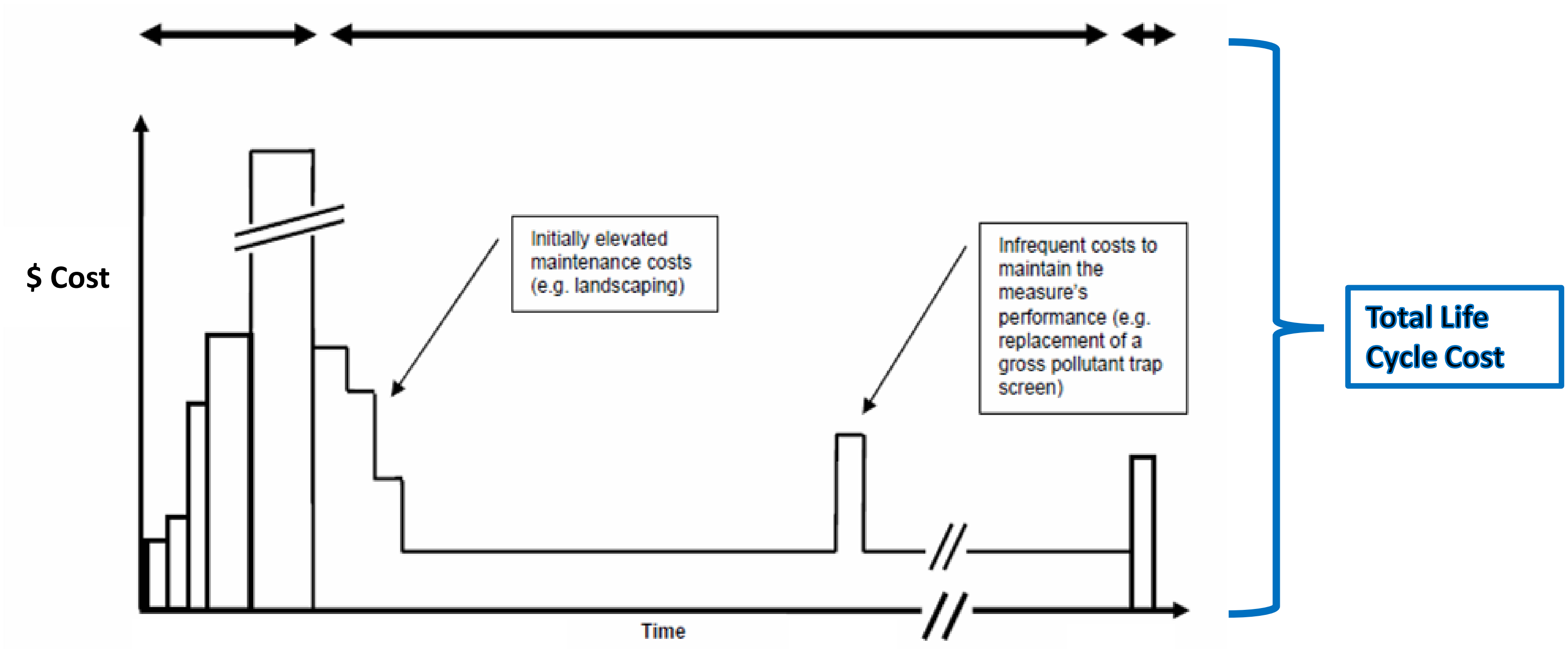
What is life cycle costing (LCC)?

Definition:

“…..the process of assessing the cost of a product over its life cycle or a portion thereof…..”

Ref: Australian/New Zealand Standard 4536:1999

Treasury New Zealand



Phases in the life cycle of a stormwater practice and potentially associated costs (Taylor, 2003)

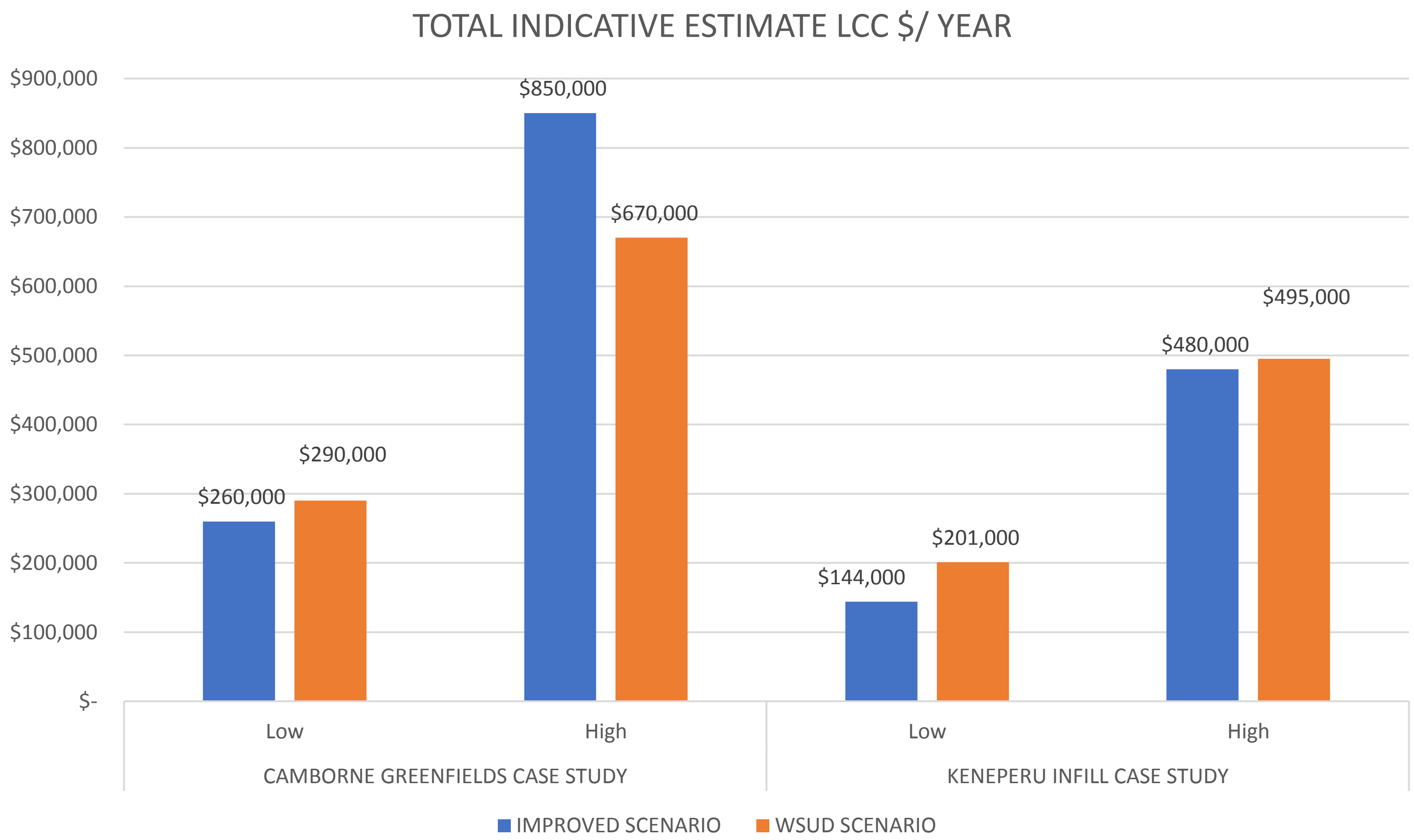
How the stormwater LCC model works

- Builds on existing LCC Work
- Based on generating a total LCC which includes analysis of TAC and maintenance costs over a 50 year analysis period (base date of 2017)
- Relates to:
  - best practice design of the mitigations
  - impervious area treated
  - treatment performance

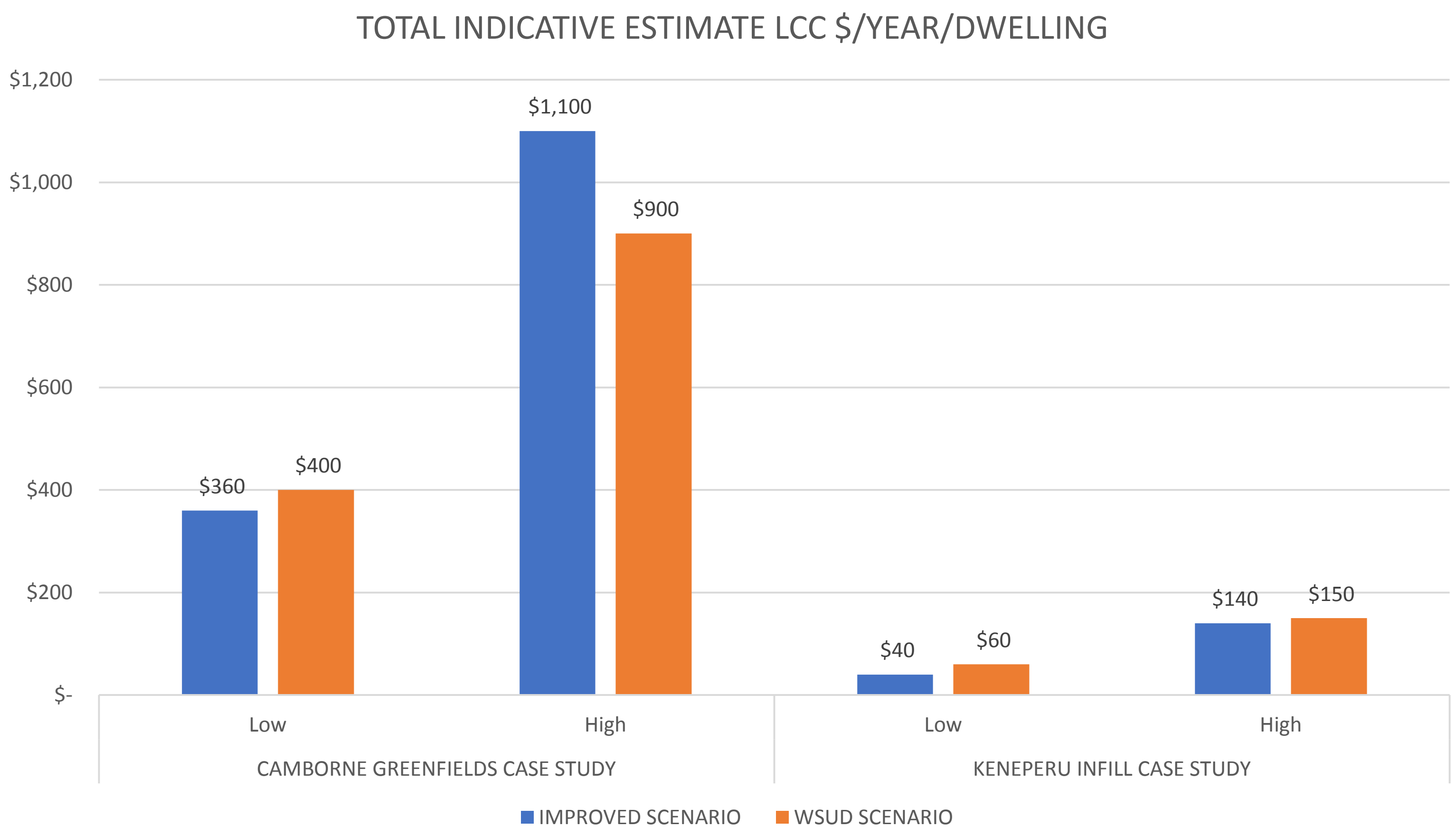
Understanding how to use LCCs

- Allows comparison of costs of one or more devices against another
- Balances performance (benefits) against cost
- Use ranges to express uncertainty due to data gaps or large variation in costs (focus on ranges rather than absolutes)
- Look for patterns and relative differences between scenario results
- Today’s results are indicative based on the interventions and dwellings in our two case studies only.

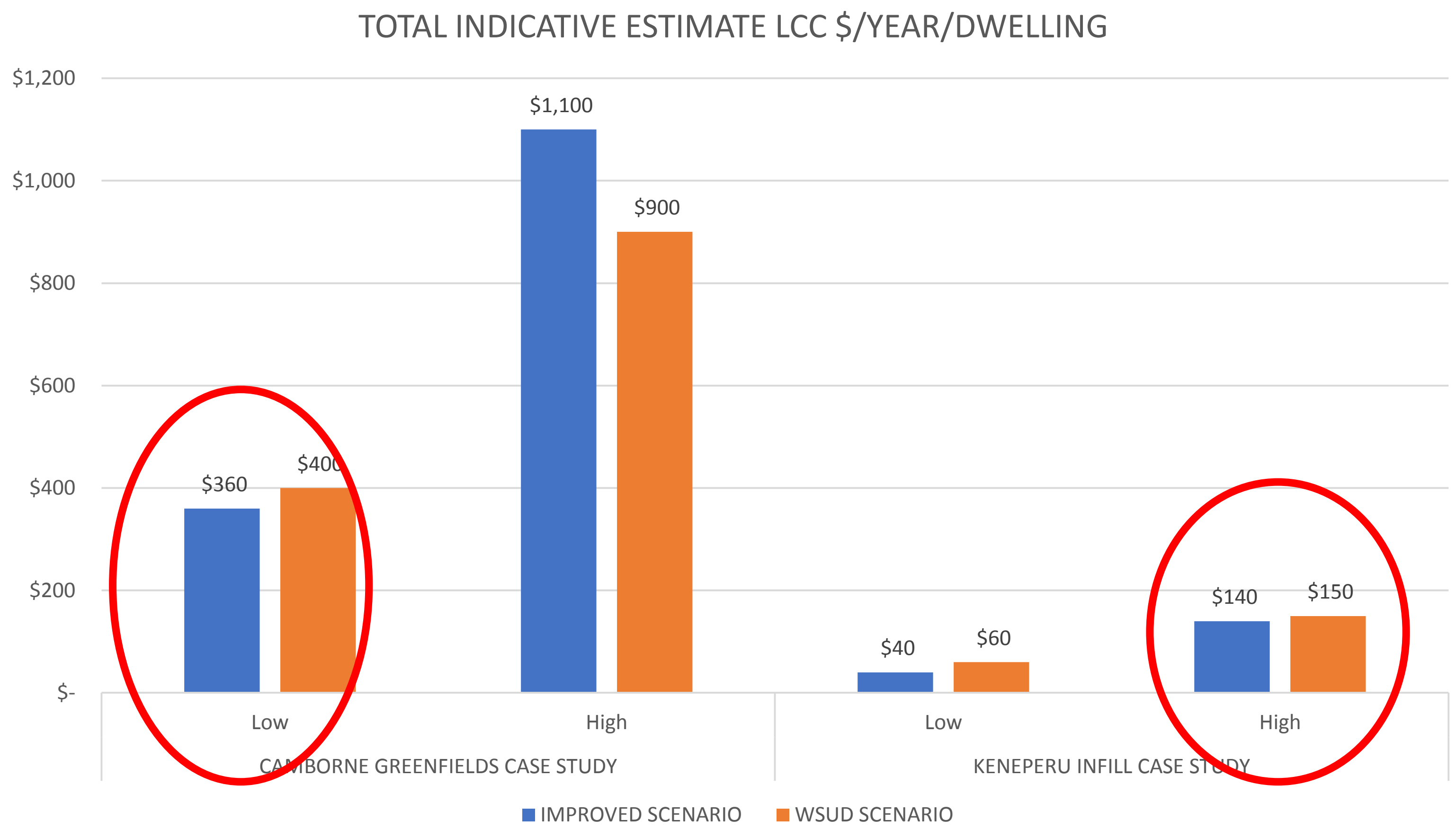
Cost Results – urban costs



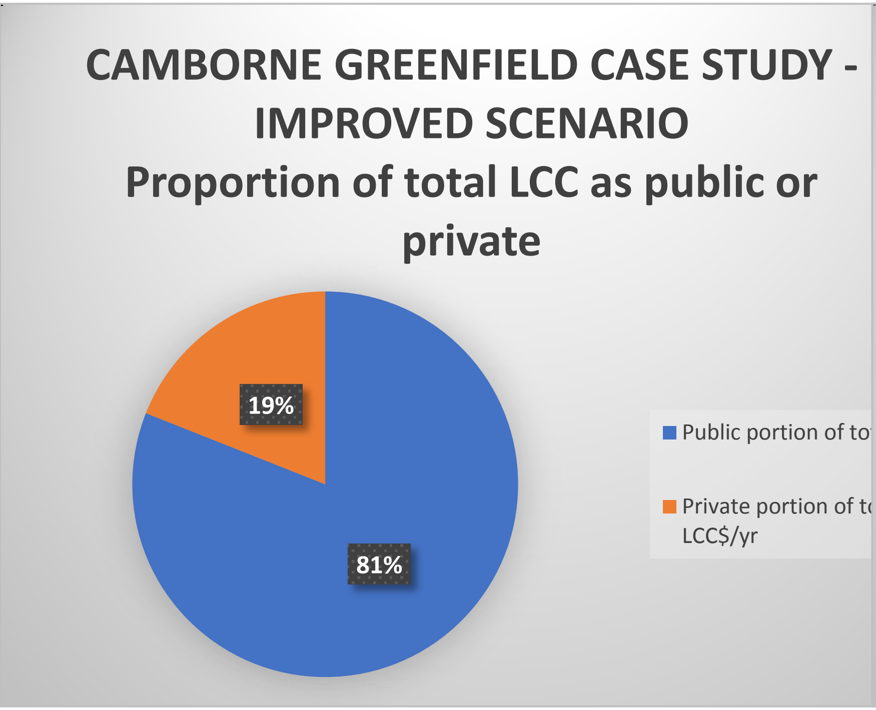
Cost Results – urban costs

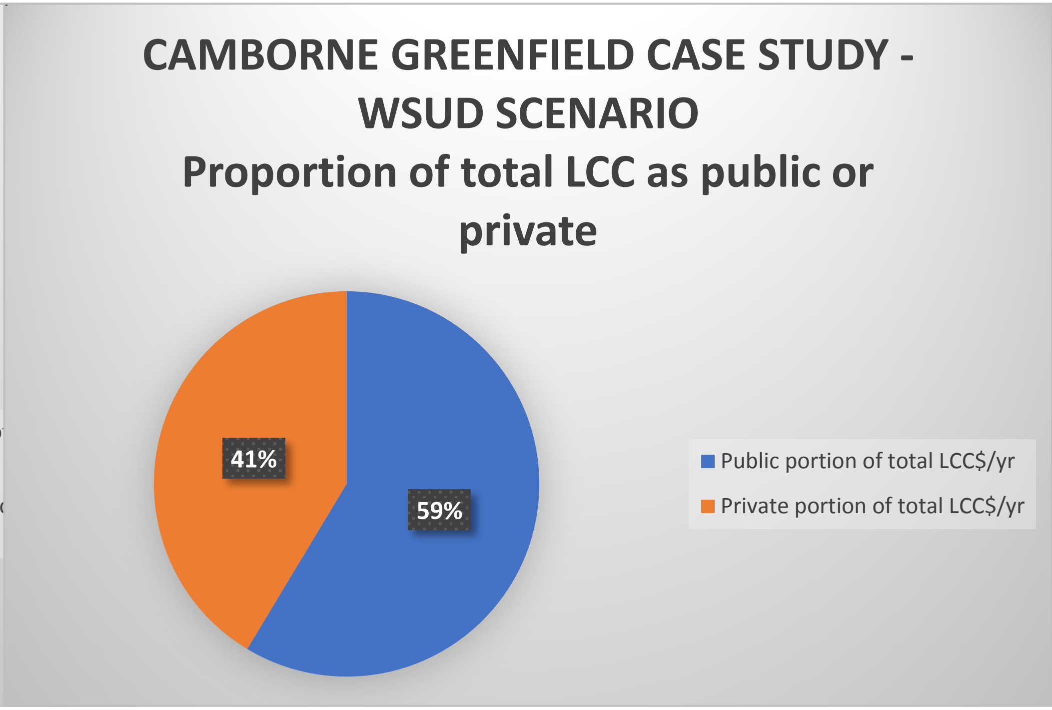


Cost Results – which costs to use?



Cost Results – public / private split (urban)





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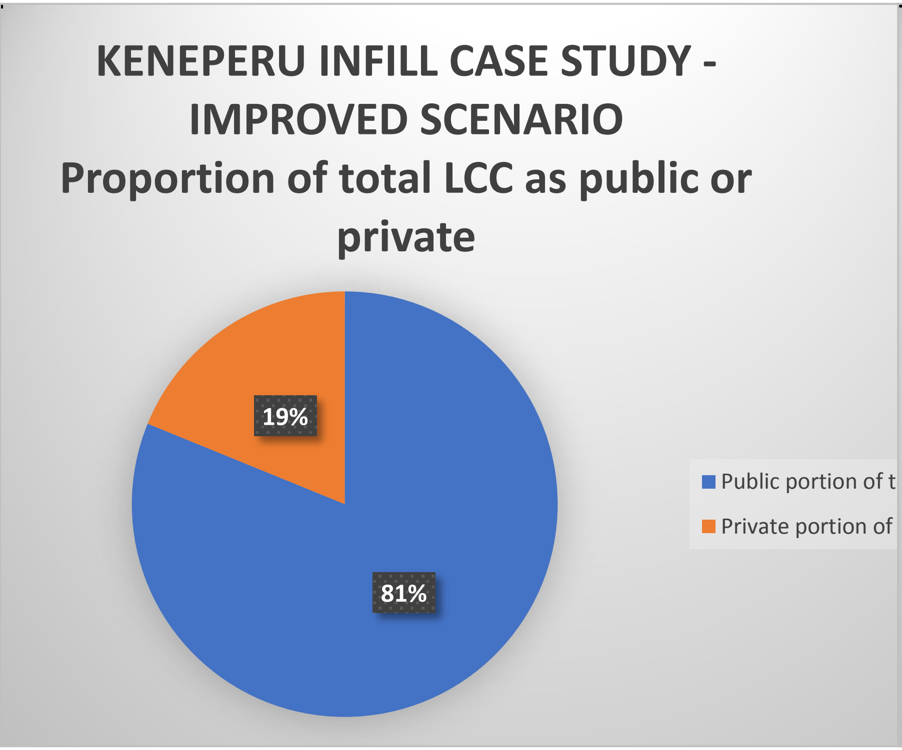

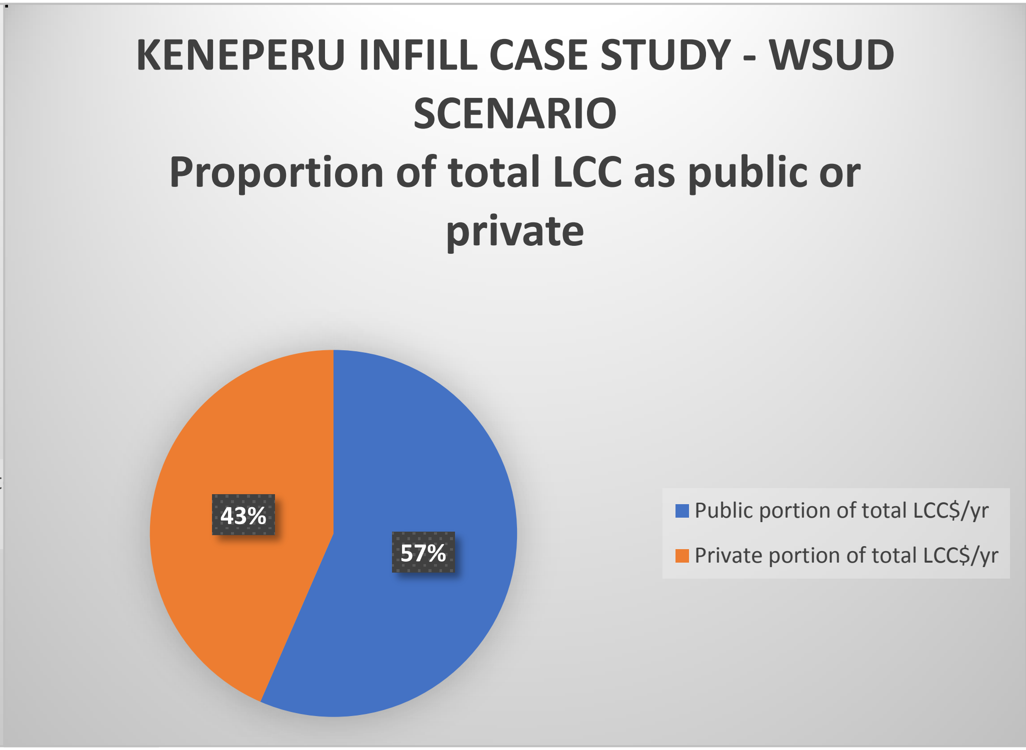

Take home messages……

- Costs are indicative estimates of LCCs – relative difference between scenarios

- The difference in costs between the ‘improved’ and ‘water sensitive’ scenarios are relatively small

- Wetlands are a major driver of the large ranges in cost estimates, particularly for the ‘improved scenario’

Take home messages……

- Keneperu – use high-end of cost range of estimate (infill)
- Taupo at Camborne – use low-end of cost range estimate (greenfield)
- “Improved’ scenario models a high share of public costs from catchment scale methods to slow water down
- “Water sensitive” scenario models higher shares of privately borne costs from the higher use of lot scale retention and in home reuse