A KALEIDOSCOPE OF STORMWATER OPTIONS

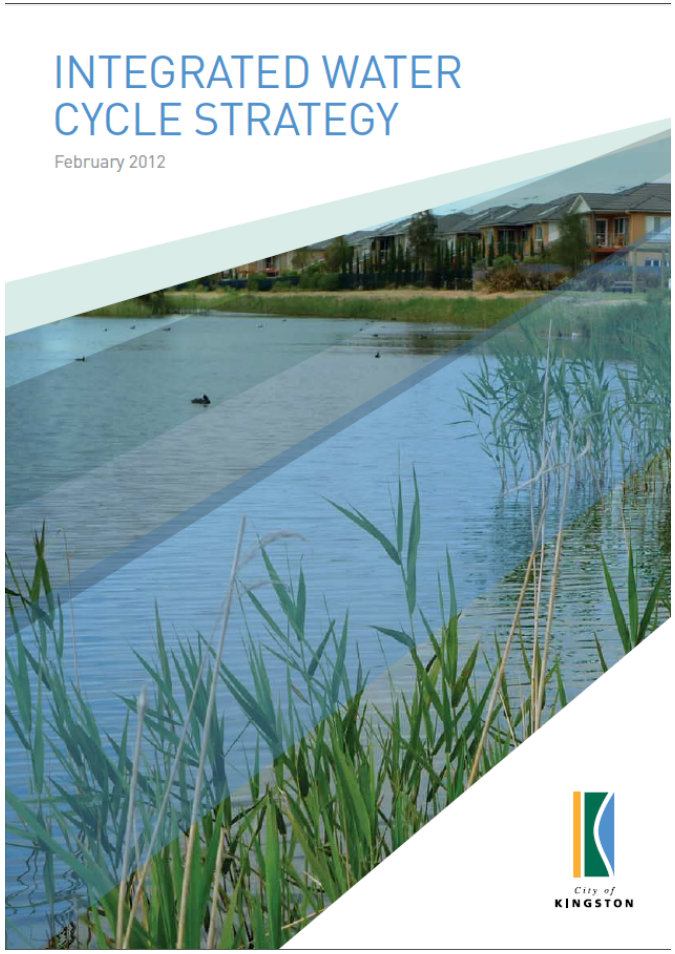
- THE NEXT GENERATION FOR KINGSTON

Georgie Wettenhall and Alan West

DesignFlow

Background

- Integrated Water Cycle Strategy adopted in 2012
- Vision and guiding principles
- Sets targets:
  - Stormwater treatment
  - Potable water reduction



DesignFlow

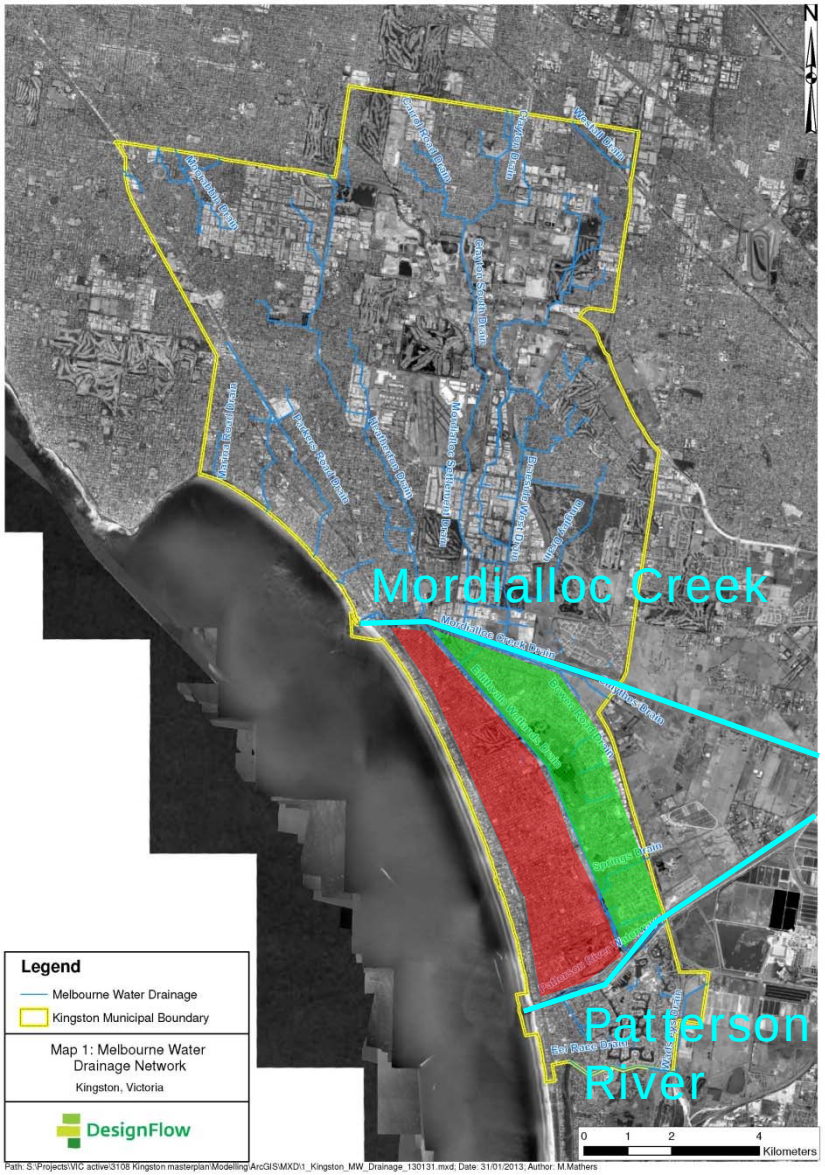
Stormwater treatment and reuse prioritisation project

- What is the optimal combination of works to meet targets?
- How much will it cost?
- How should works be prioritised?
- What are the benefits of works?

DesignFlow

City of Kingston context

- Minimal greenfield development
- Catchment boundaries do not align with municipal boundary
- Committed to WSUD including many streetscape raingardens
- Pumps used as part of minor/major drainage systems for significant proportion of municipality



Project outputs

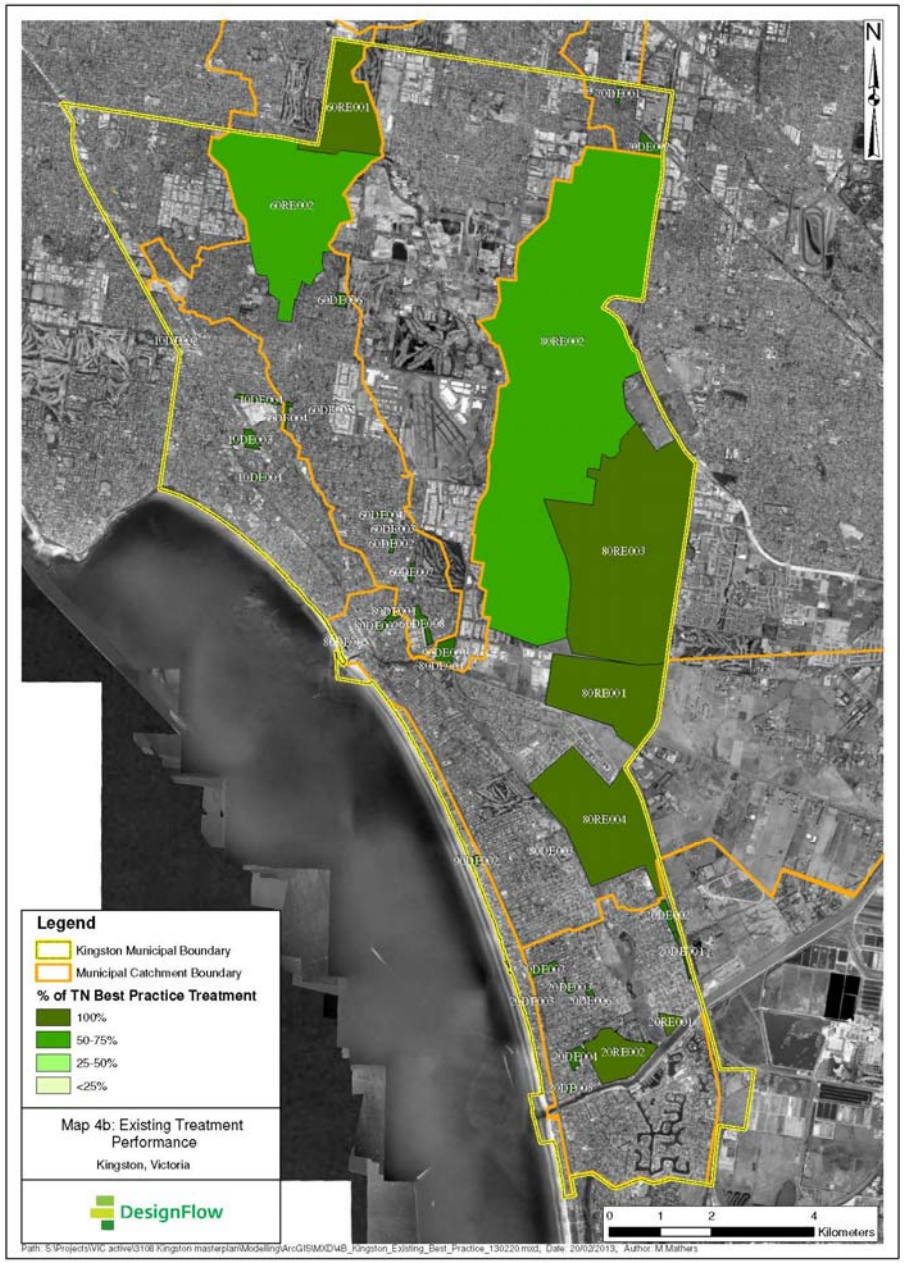
1. **Maps:** Location & performance of existing & proposed assets

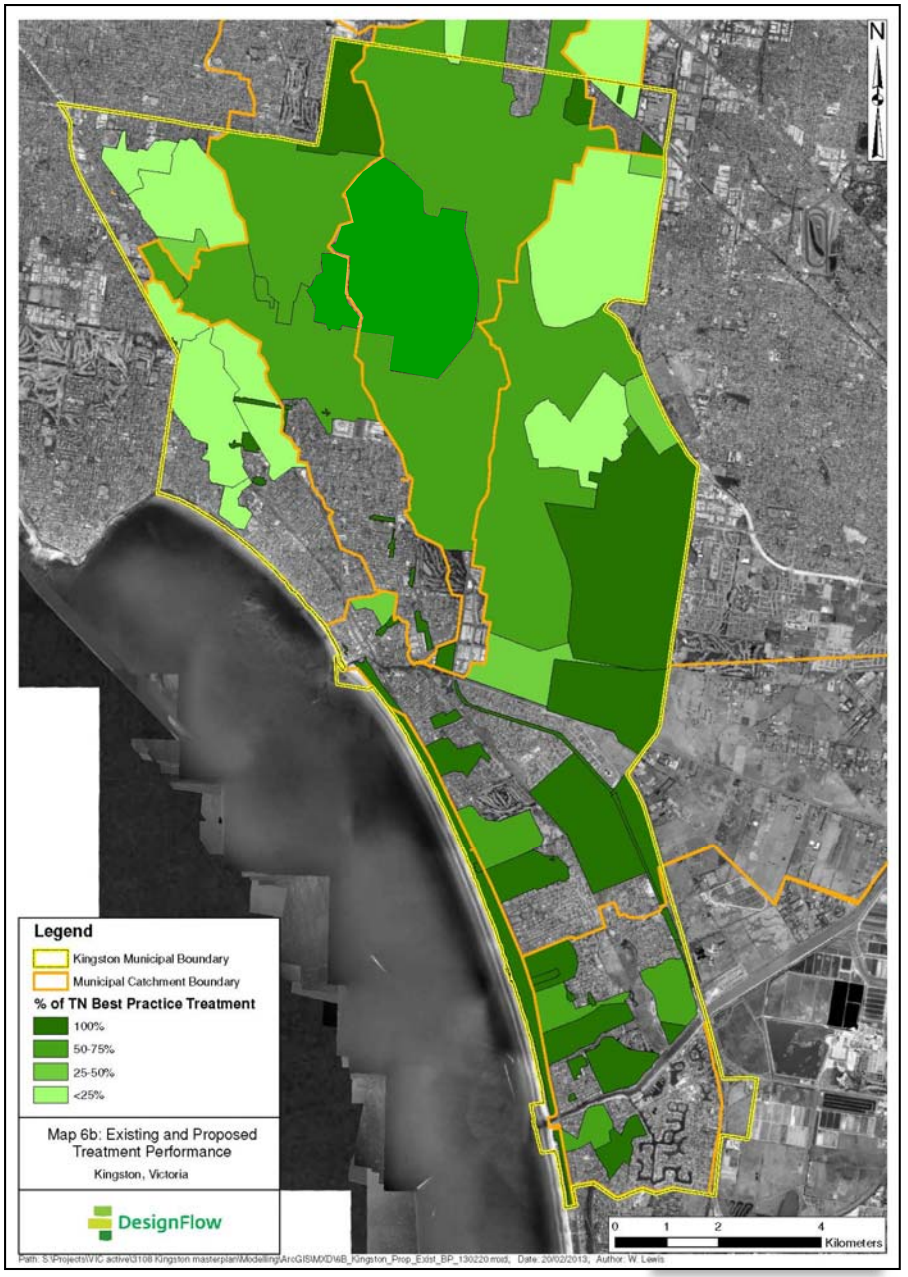
2. **Opportunity prioritisation:** System for ranking opportunities based on multiple costs and benefits across project lifecycle

3. **Refined targets:** Refinement of Kingston's stormwater treatment targets

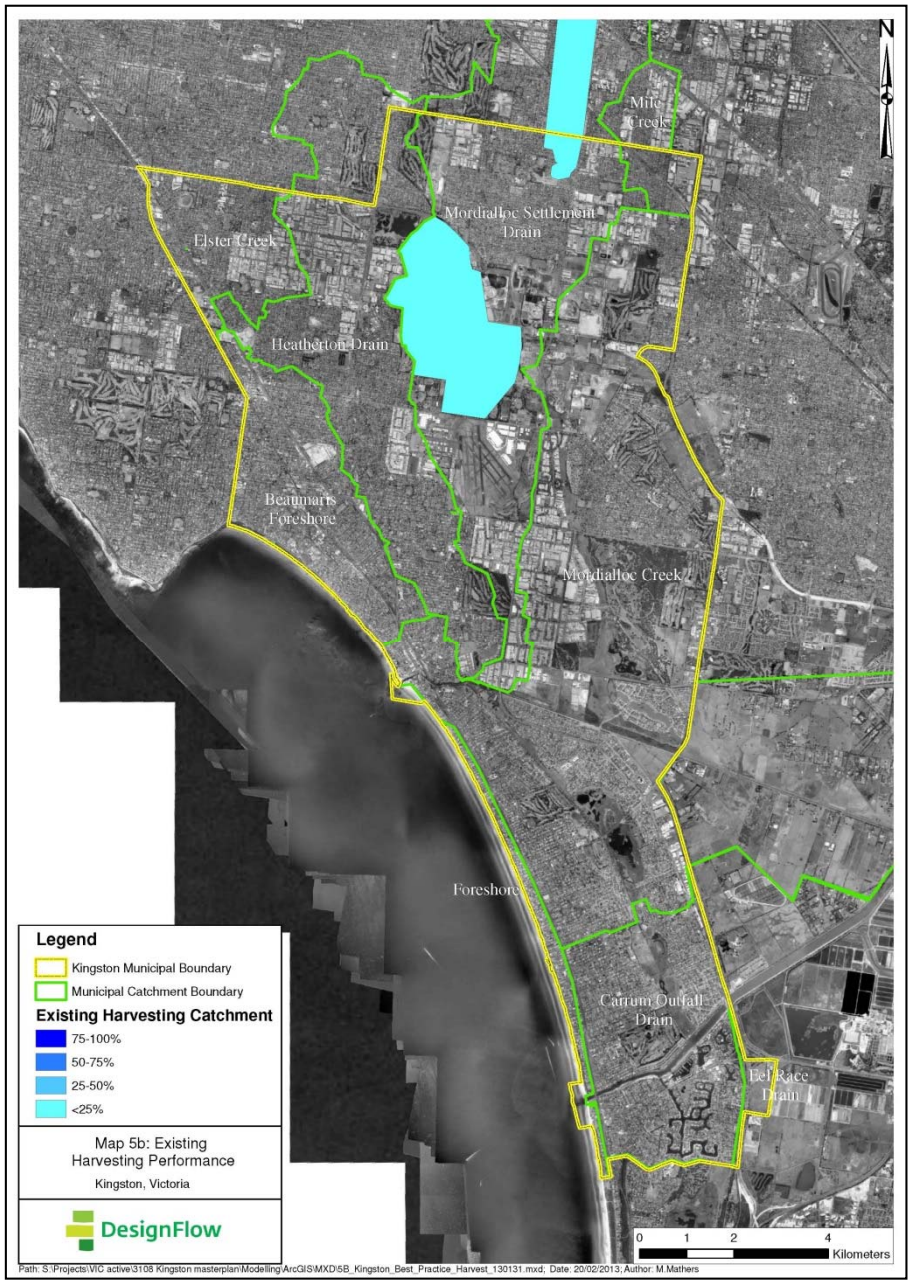
4. **Asset Descriptions:** Operation, performance & cost of existing & proposed assets

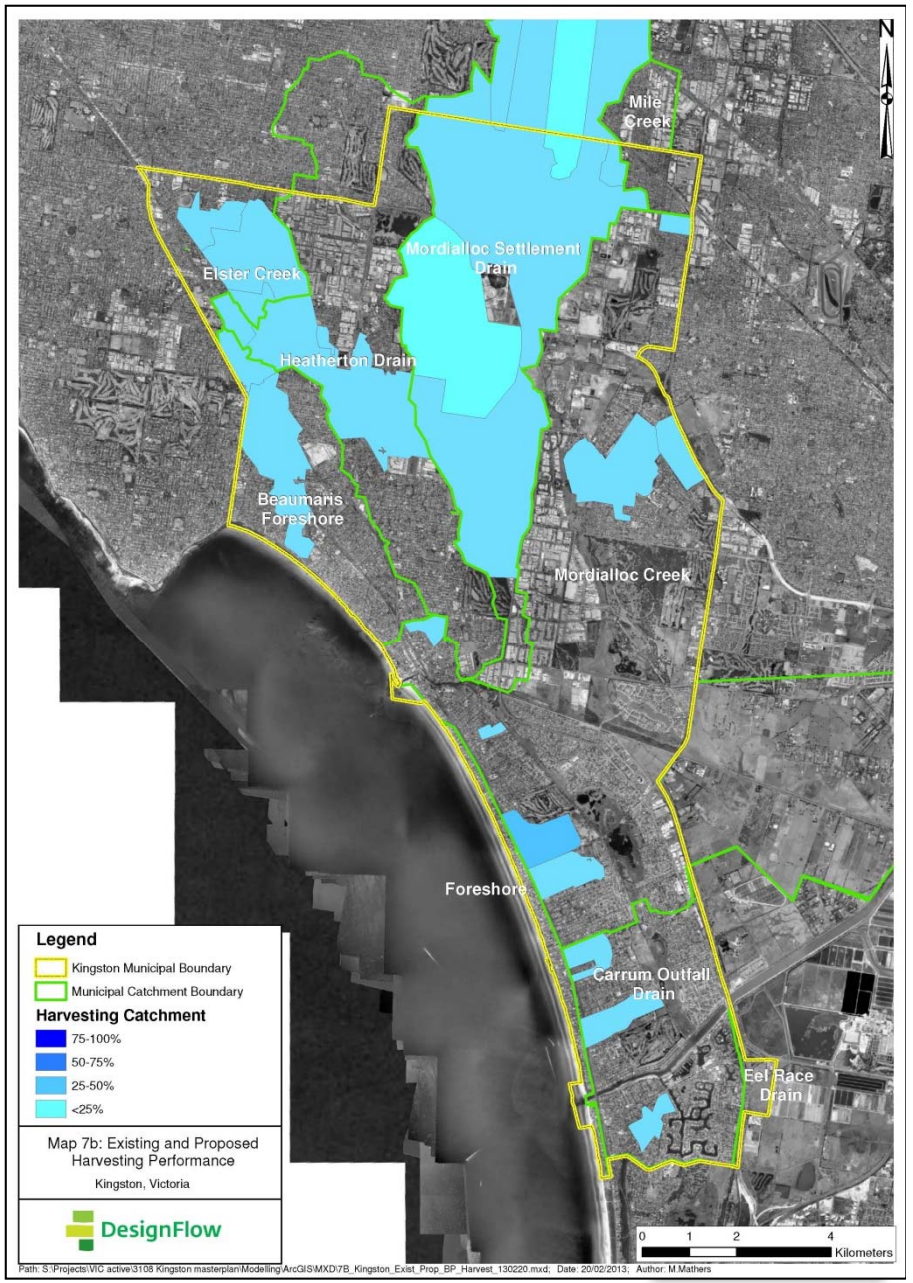
Maps – treatment performance



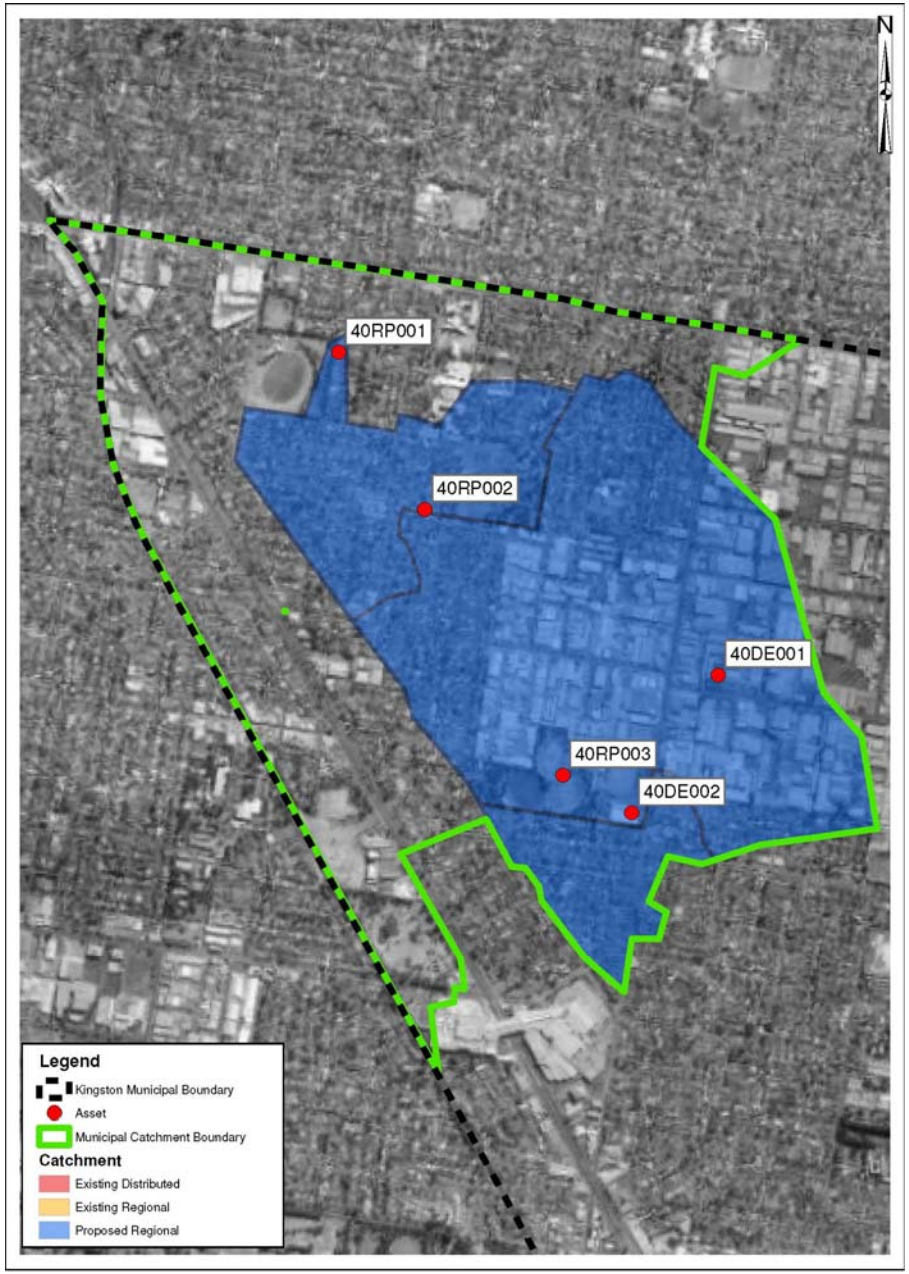


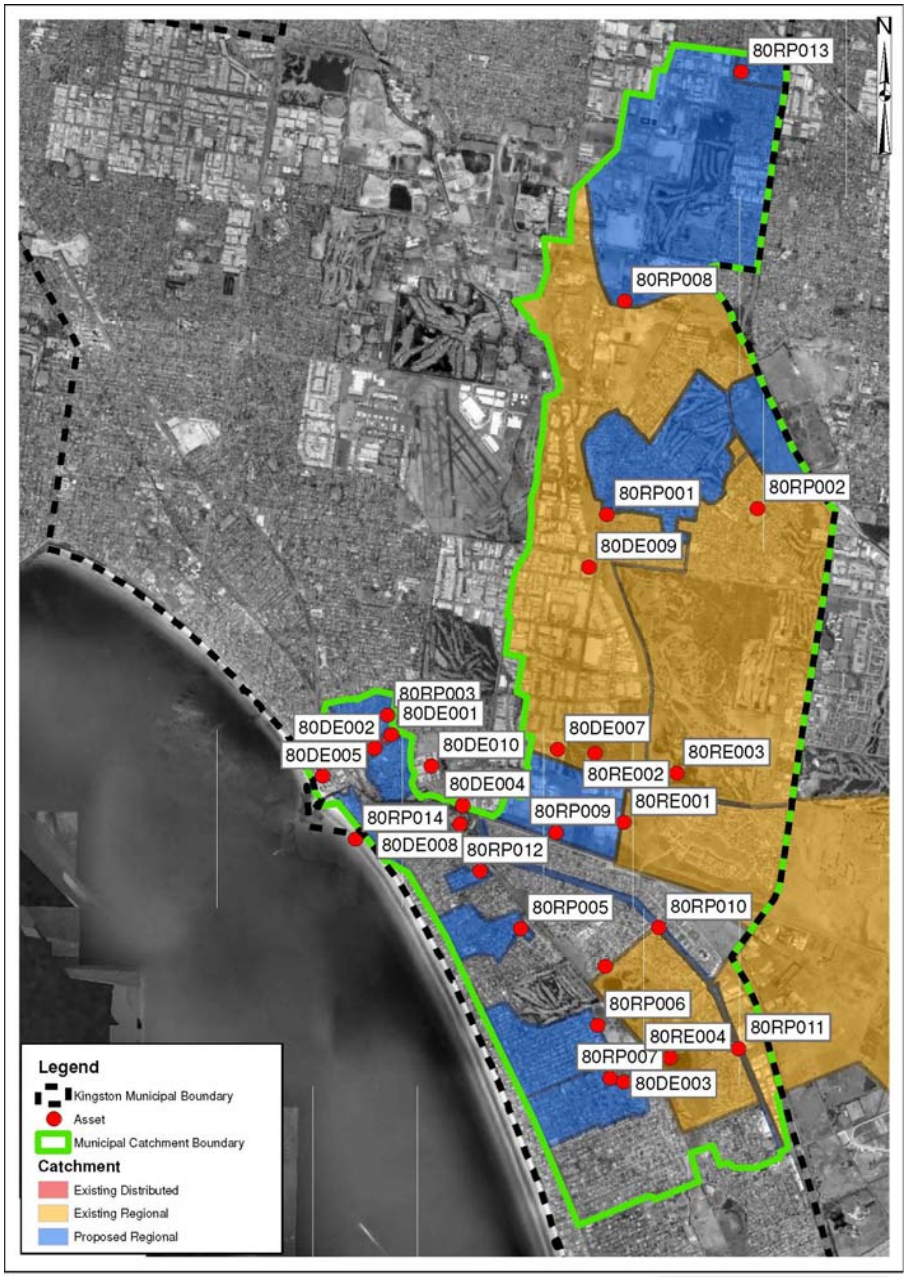
Maps – harvesting performance





Maps – location of proposed assets





Opportunities

- **Regional:** > 20 ha catchment
  - E.g. divert flows from pipe to a bioretention in a park. Filtered flows stored in tank and used to irrigate sport field
- **Distributed:**
  - E.g. Rainwater tanks and streetscape raingardens

DesignFlow

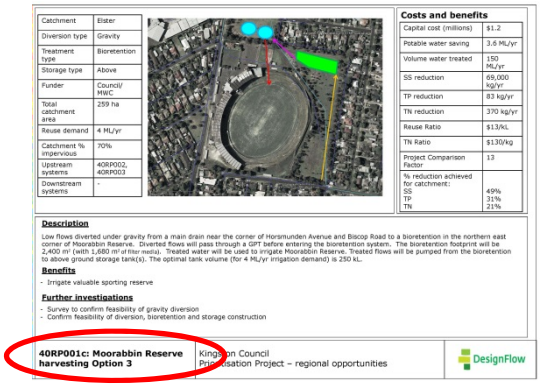
Regional opportunities

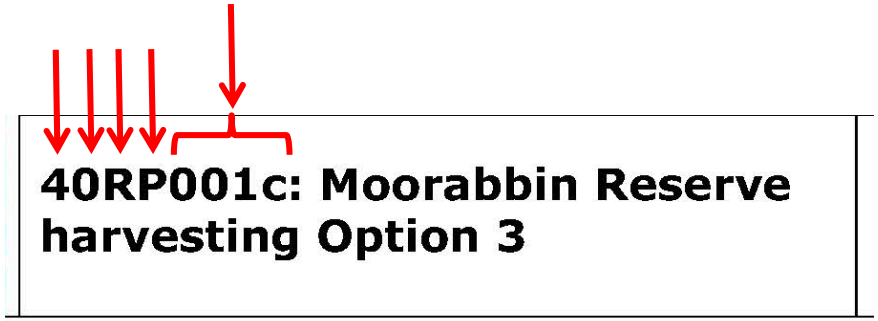
- **Long list:** based on GIS catchment info & aerial photos showing potentially available land
- **Short list:** based on site visits and comparison

- Ideal site:
  - Big catchment
  - Lots of unencumbered space
  - Levels allow for gravity diversion
  - Non potable water demand

DesignFlow

Asset / opportunity coding





Code component	Description
First digit	Regional catchment asset is within
Second digit	Spare parameter - can be used in future to indicate asset properties
First letter	"R" = regional opportunity "D" = group of distributed assets
Second letter	"E" = existing asset "P" = proposed asset
Last 3 - 4 digits	Unique number for the particular asset

Project comparison factor

- Ranks projects based on performance
- Function of:
  - Relative cost per kg of TN removal
  - Relative cost per kL of stormwater used (e.g. irrigation)

- For those that don't like equations
  - **High** project comparison factor = **Good**
  - **Low** project comparison factor = **Bad**

DesignFlow

Project comparison factor

- **Annual cost**

$$\frac{\text{Capital cost}}{30} + \text{Annual maintenance cost}$$

- **Reuse Ratio**

$$\frac{\text{Annual cost}}{\text{Annual reuse volume (kL)}}$$

- **TN Ratio**

$$\frac{\text{Annual cost}}{\text{Annual total nitrogen reduction (kg)}}$$

- **Project Comparison Factor**

$$\frac{\text{Max Reuse Ratio}}{\text{Reuse ratio for project}} + \frac{\text{Max TN Ratio}}{\text{TN ratio for project}}$$

DesignFlow

Project comparison factor example: Edithvale Rec Res

DesignFlow

Project comparison factor example: Edithvale Rec Res

- **Annual cost**

$$\frac{\$428{,}904}{30} + \$11{,}000 = \$25{,}297$$

- **Reuse Ratio**

$$\frac{\$25{,}297}{8{,}120} = 3.1$$

- **TN Ratio**

$$\frac{\$25{,}297}{95.4} = 265$$

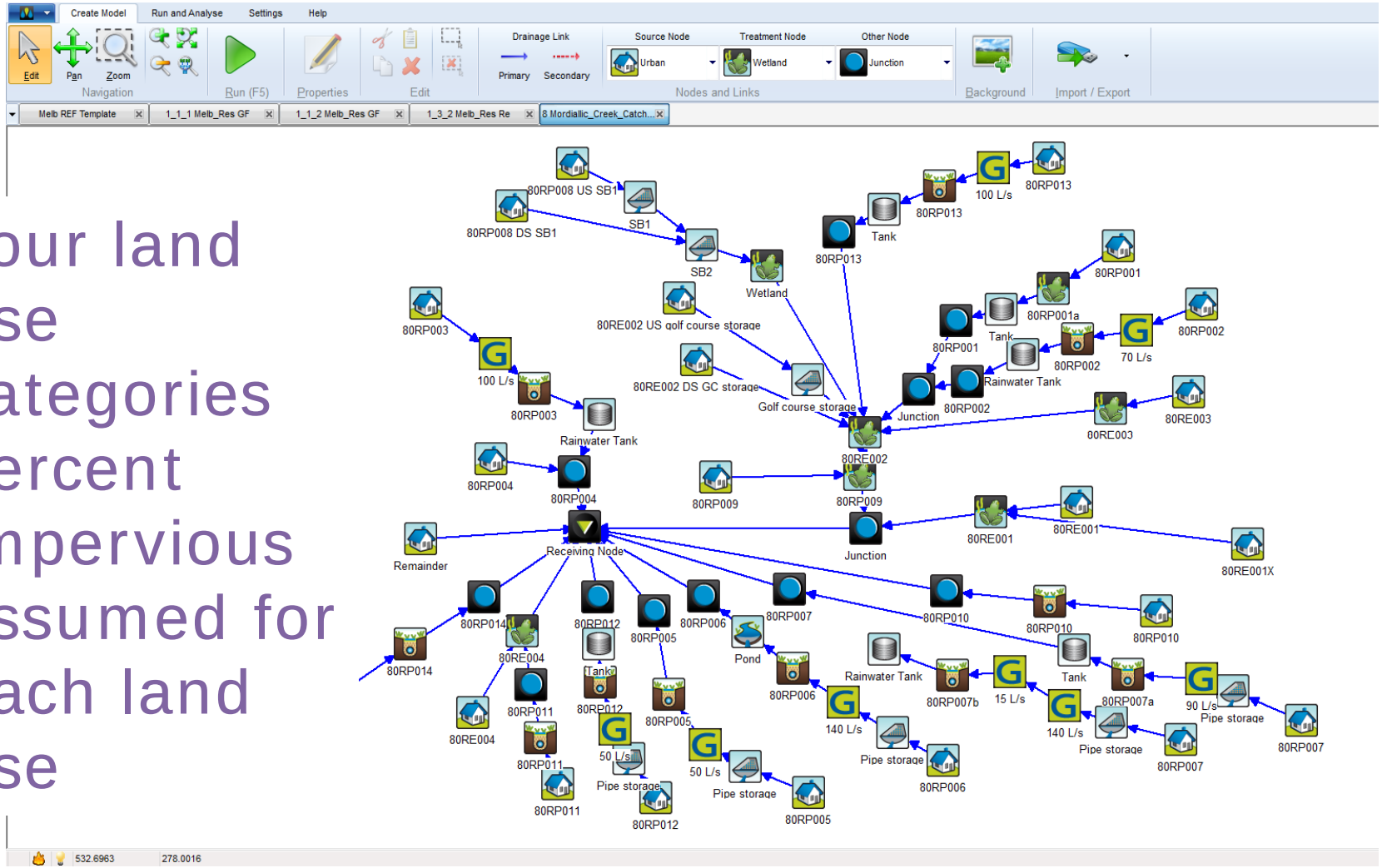
- **Project Comparison Factor**

$$\frac{15.8}{3.1} + \frac{1606}{265} = 11.1$$

DesignFlow

Modelling performance

- Four land use categories
- Percent impervious assumed for each land use



Cost estimates

- Capital
  - Site establishment
  - Diversion from existing drain including pump
  - Pipe from diversion to treatment
  - Electricity and control
  - GPT
  - Treatment (bioretention/wetland)
  - Pump from treatment to storage
  - Pipe from treatment to storage
  - Storage
  - Reinstatement
  - Project management
- Maintenance
  - GPT, Pump, treatment, general pits and tanks

DesignFlow

Cost estimates

- Items & rates from past experience
- 20% contingency
- Pump cost excluded if needed for flow conveyance
- Site specific costs (e.g. traffic management where works beneath road)
- Differentiated between gravity and pumped diversions
- Assumed treated flows not pumped if underground storage

DesignFlow

Prioritisation of large systems

- Cost of treating/harvesting using regional assets ~four times less than distributed

Opportunity type	Project comparison factor range
Regional	1.6 to 54
Distributed	0.2 to 2.1

DesignFlow

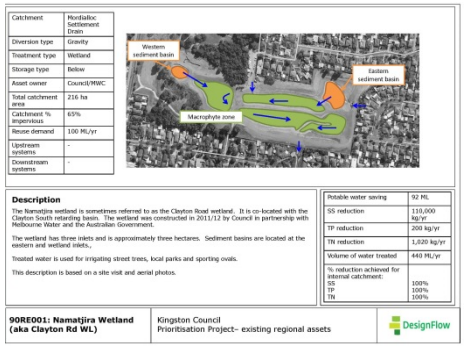
Cost effectiveness extremes

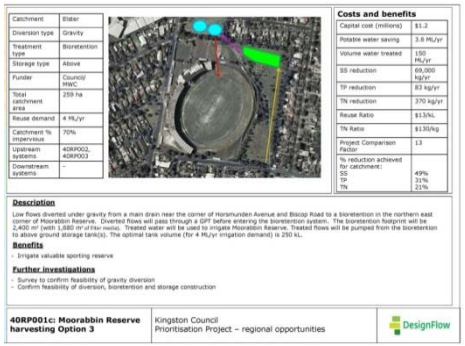
- **BEST:** ”Green wedge harvesting” (uses open storage)
  - $1.98/kL of reuse
  - $129/kg of TN
- **WORST:** Distributed porous paving
  - no reuse
  - $1,100/kg of TN

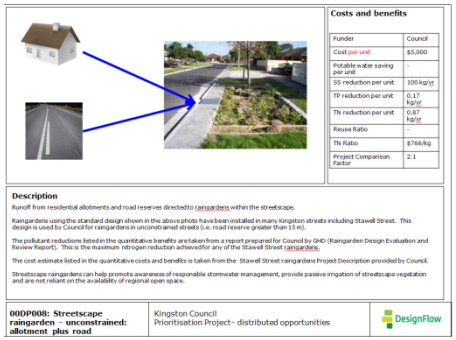
DesignFlow

Asset descriptions

- Three groups
  - Existing regional (11)
  - Proposed regional (44)
  - Proposed distributed (12)
- Stand alone descriptions in standard format for easy reference
- Could be used as attachments to design briefs, funding applications etc
- More opportunities can be added in future



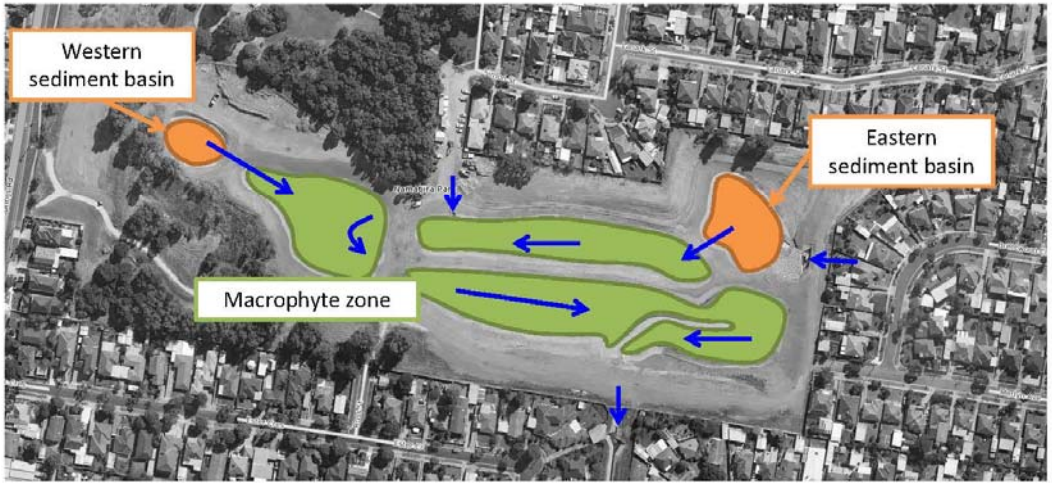




DesignFlow

Project summaries – existing * 11

Catchment	Mordialloc Settlement Drain
Diversion type	Gravity
Treatment type	Wetland
Storage type	Below
Asset owner	Council/MWC
Total catchment area	216 ha
Catchment % impervious	65%
Reuse demand	100 ML/yr
Upstream systems	-
Downstream systems	-



Description

The Namatjira wetland is sometimes referred to as the Clayton Road wetland. It is co-located with the Clayton South retarding basin. The wetland was constructed in 2011/12 by Council in partnership with Melbourne Water and the Australian Government.

The wetland has three inlets and is approximately three hectares. Sediment basins are located at the eastern and wetland inlets.,

Treated water is used for irrigating street trees, local parks and sporting ovals.

This description is based on a site visit and aerial photos.

Potable water saving	92 ML
SS reduction	110,000 kg/yr
TP reduction	200 kg/yr
TN reduction	1,020 kg/yr
Volume of water treated	440 ML/yr
% reduction achieved for internal catchment: SS TP TN	 100% 100% 100%

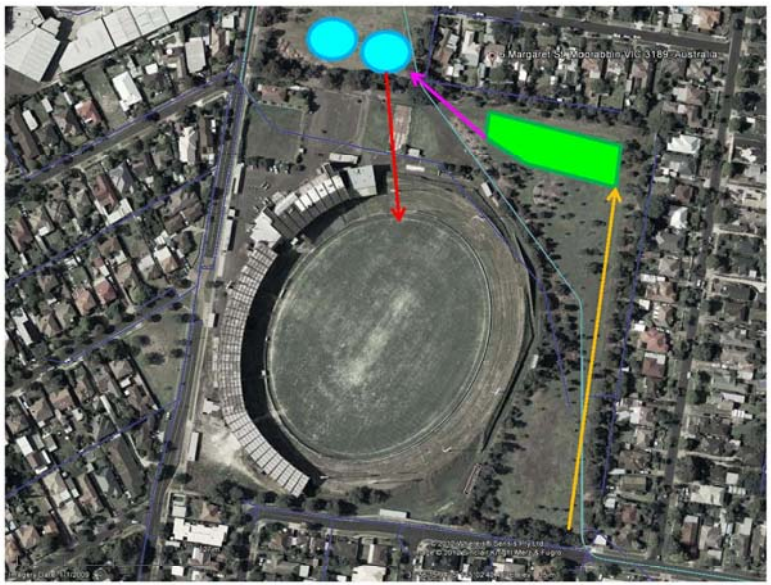
90RE001: Namatjira Wetland (aka Clayton Rd WL)

Kingston Council
Prioritisation Project– existing regional assets

DesignFlow

Project summaries – proposed * 44

Catchment	Elster
Diversion type	Gravity
Treatment type	Bioretention
Storage type	Above
Funder	Council/ MWC
Total catchment area	259 ha
Reuse demand	4 ML/yr
Catchment % impervious	70%
Upstream systems	40RP002, 40RP003
Downstream systems	-



Costs and benefits

Capital cost (millions)	$1.2
Potable water saving	3.6 ML/yr
Volume water treated	150 ML/yr
SS reduction	69,000 kg/yr
TP reduction	83 kg/yr
TN reduction	370 kg/yr
Reuse Ratio	$13/kL
TN Ratio	$130/kg
Project Comparison Factor	13
% reduction achieved for catchment: SS TP TN	 49% 31% 21%

Description

Low flows diverted under gravity from a main drain near the corner of Horsmunden Avenue and Biscop Road to a bioretention in the northern east corner of Moorabbin Reserve. Diverted flows will pass through a GPT before entering the bioretention system. The bioretention footprint will be 2,400 m² (with 1,680 m² of filter media). Treated water will be used to irrigate Moorabbin Reserve. Treated flows will be pumped from the bioretention to above ground storage tank(s). The optimal tank volume (for 4 ML/yr irrigation demand) is 250 kL.

Benefits

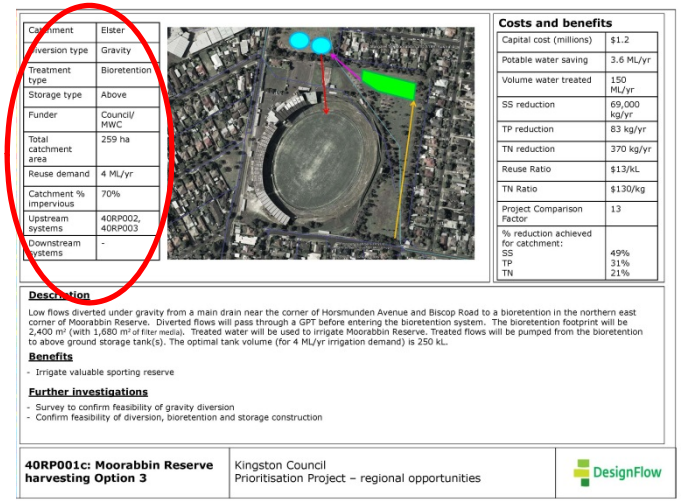
- Irrigate valuable sporting reserve

Further investigations

- Survey to confirm feasibility of gravity diversion
- Confirm feasibility of diversion, bioretention and storage construction

40RP001c: Moorabbin Reserve harvesting Option 3	Kingston Council Prioritisation Project – regional opportunities	DesignFlow

Project summaries - proposed



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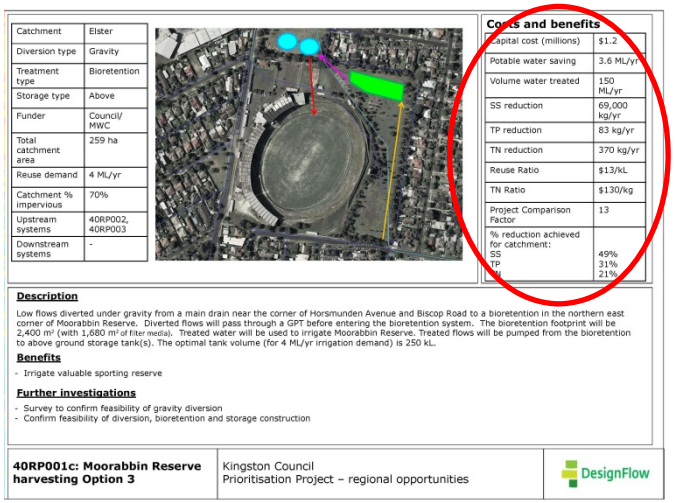
Kingston Council
Prioritisation Project – regional opportunities

DesignFlow

Project summaries - proposed



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Kingston Council
Prioritisation Project – regional opportunities

DesignFlow

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DesignFlow

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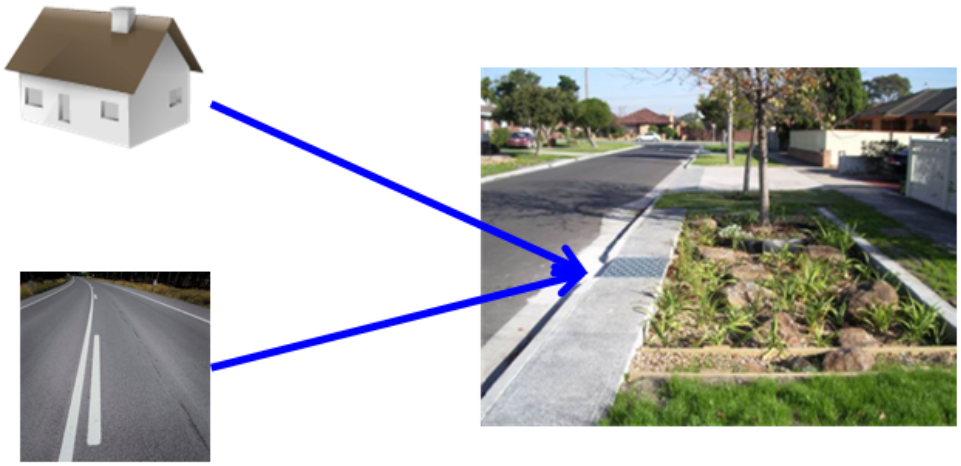

Costs and benefits

Funder	Council
Cost per unit	$5,000
Potable water saving per unit	-
SS reduction per unit	100 kg/yr
TP reduction per unit	0.17 kg/yr
TN reduction per unit	0.87 kg/yr
Reuse Ratio	-
TN Ratio	$766/kg
Project Comparison Factor	2.1

Description

Runoff from residential allotments and road reserves directed to raingardens within the streetscape.

Raingardens using the standard design shown in the above photo have been installed in many Kingston streets including Stawell Street. This design is used by Council for raingardens in unconstrained streets (i.e. road reserve greater than 15 m).

The pollutant reductions listed in the quantitative benefits are taken from a report prepared for Council by GHD (Raingarden Design Evaluation and Review Report). This is the maximum nitrogen reduction achieved for any of the Stawell Street raingardens.

The cost estimate listed in the quantitative costs and benefits is taken from the Stawell Street raingardens Project Description provided by Council.

Streetscape raingardens can help promote awareness of responsible stormwater management, provide passive irrigation of streetscape vegetation and are not reliant on the availability of regional open space.

00DP008: Streetscape raingarden – unconstrained: allotment plus road	Kingston Council Prioritisation Project– distributed opportunities	DesignFlow

Learnings

- Many regional opportunities available
- Insufficient space to direct runoff from all areas to large systems
- Prioritise large systems and invest in distributed systems for catchments where large systems not possible
- Refine IWMS targets and confirm future budgets

DesignFlow

IWMP targets

Type of target	Target set in Kingston IWCS
Stormwater Treatment	
(i) Short Term	Treat 75 ha every 5 years (or 15 ha/year)
(ii) Long Term	Achieve 100% best practice by 2040 by reducing nitrogen loads discharging into Port Philip Bay by 8,000 kg (at the rate of approx. 300 kg/yr).
Stormwater Reuse	
(i) Storm Term	Reuse 30 ML/year by 2016
(ii) Long Term	Reduce total potable water consumption by 15% (1700 ML) by 2040 and 30% (3500 ML) by 2070.

DesignFlow

Revised targets

Type of Target	Revised Target
Stormwater Treatment	Achieve 85% of best practice for the whole of Kingston by 2050. This involves implementation of: • New regional projects at $1.3M/year (36%) • New distributed projects at $0.3M/year (2%) • Private rain water tanks at $3.0M/year (7%) (600 properties installing 4 kL tanks each year) • Existing Assets (40%) • Maintaining public assets at an ongoing cost of around $1M/year post 2050.
Stormwater Reuse	Harvest 3,480 ML/year of stormwater by 2050 for irrigation and non-potable uses such as toilet flushing.

DesignFlow

Key messages from Council

- Maps powerful for influencing planning permit assessment and works program
- Existing assets need to be accounted for when setting targets
- Council reserves can unlock cost effective opportunities to treat water from large drains
- Project comparison factor very useful to help justify funding and compare competing WSUD projects

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