The Future of Wetlands for Waterway Protection

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Background

- Melbourne's **population set to double** over the next 30 years

- More people means **excess stormwater and recycled water** from new developments under BAU practice.

- Compound this with a **changing climate**

Background

A **90% flow reduction** in annual stormwater runoff is desirable to ensure waterway values are protected in ephemeral streams such as Emu Creek (Duncan, Fletcher, Vietz, Urrutiaguer, 2014)

Healthy Waterways Strategy (2018)

Progressively implement stormwater harvesting in priority areas. Once the catchment has reached its full development, this will require 80 GL/y of harvesting and 20 GL/y of infiltration.

Ensure DCI levels do not increase beyond current levels

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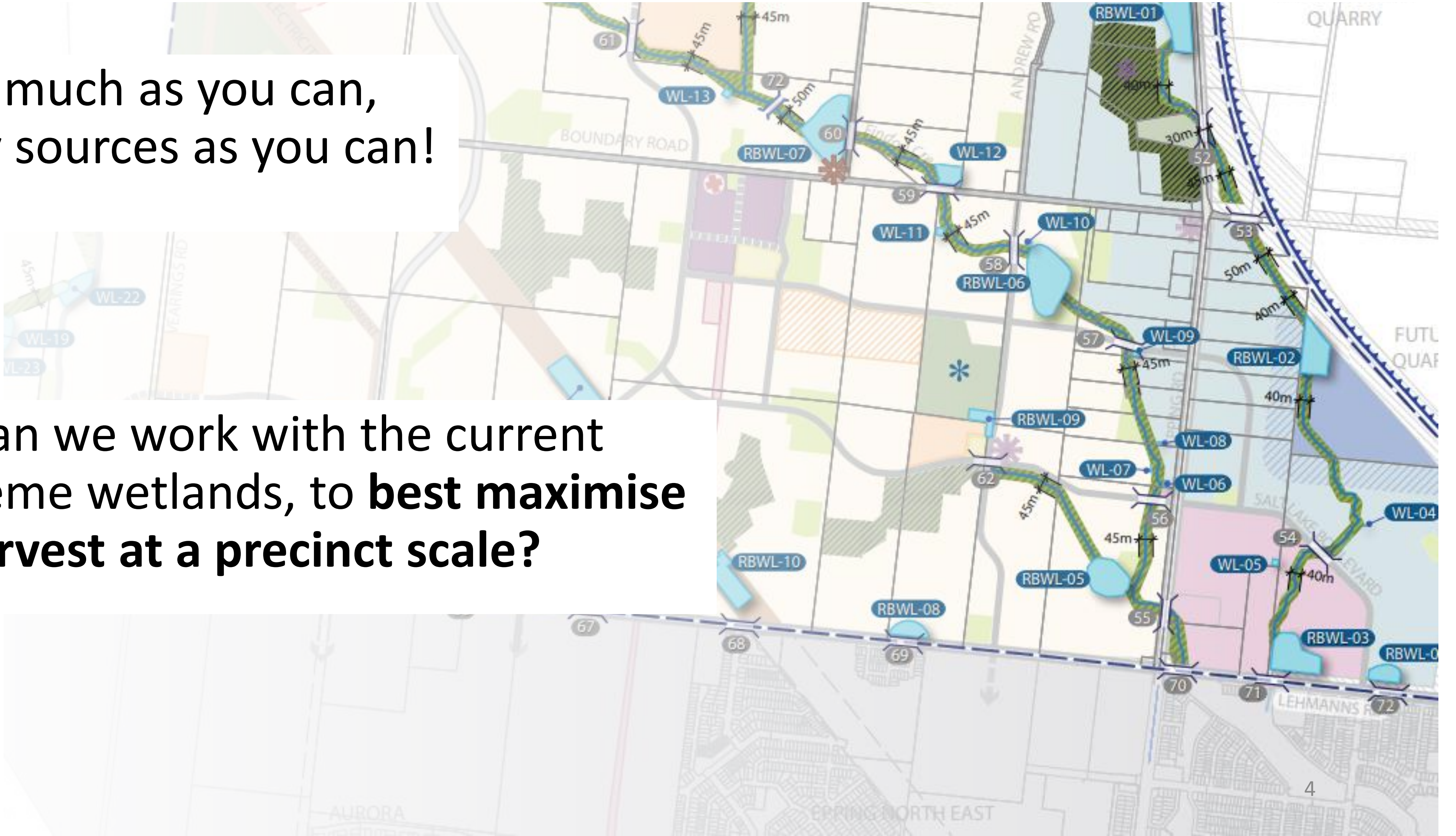
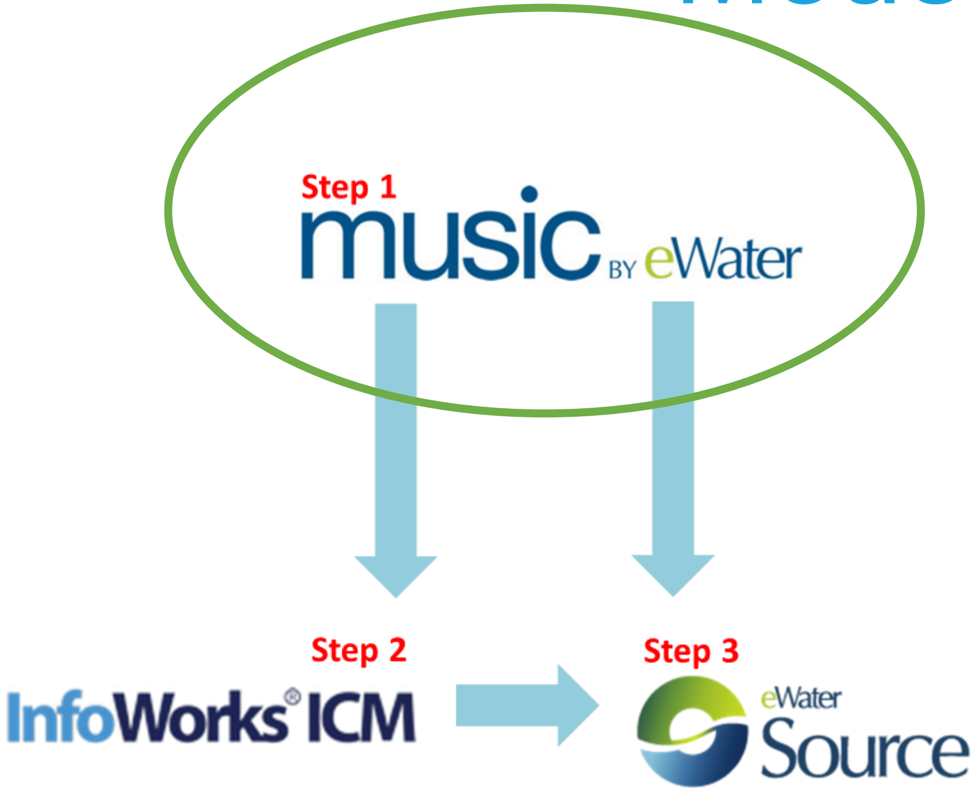
How do we achieve a 90% flow reduction target?

A: Harvest as much as you can, from as many sources as you can!

Q: How can we work with the current drainage scheme wetlands, to **best maximise our harvest at a precinct scale?**



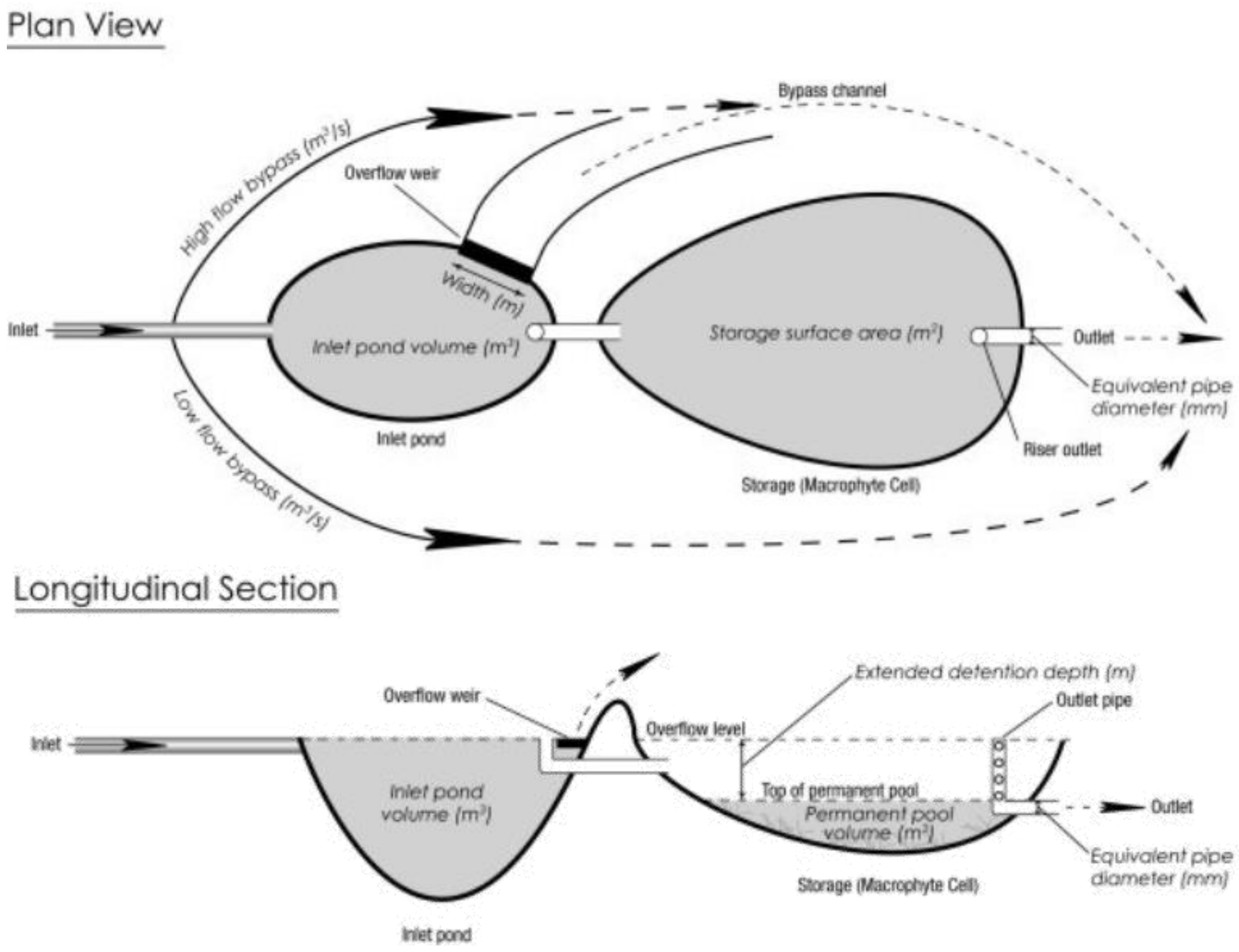
Modelling approach

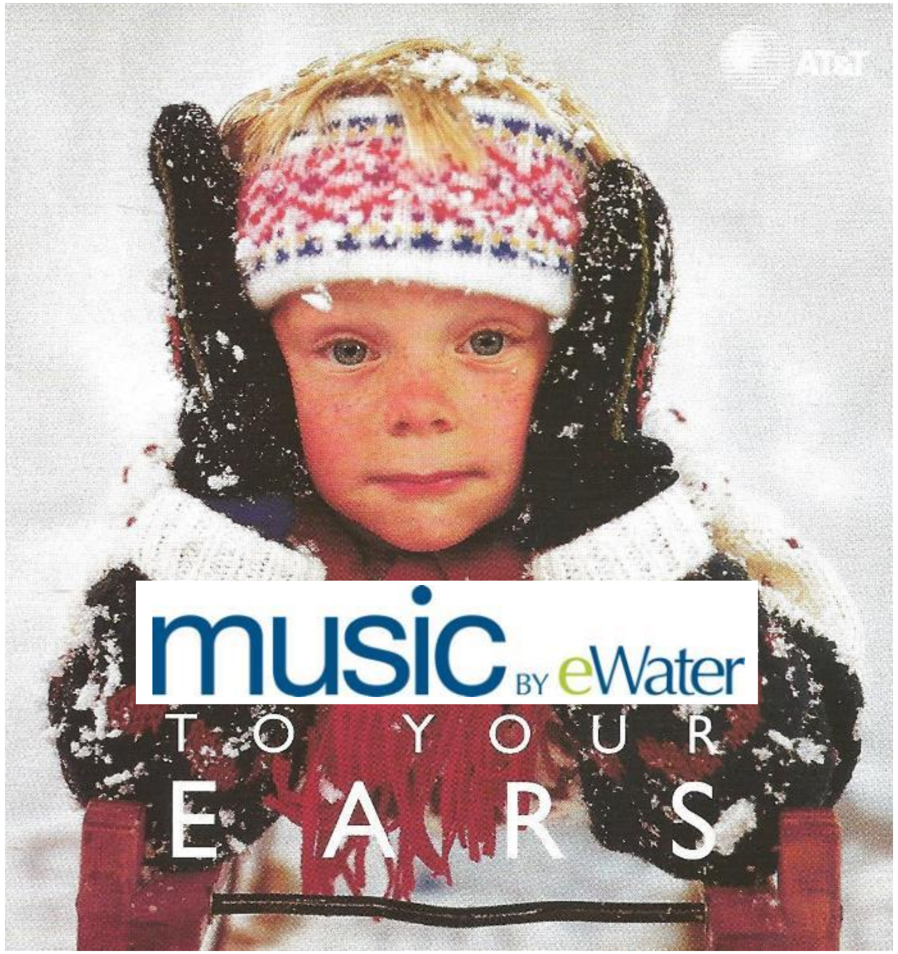


- Early modelling at a network level indicates **~55% are achievable**.
- Larger reductions (80 – 90%) cannot be achieved with the **current wetland configurations** (sized to fit within the existing retarding basin footprint)
- Restrictions due to **bypass** incl. high flow bypass and sediment pond overflow (30% HFB, 70% SP split of total bypass volume)

Terminology

Wetland





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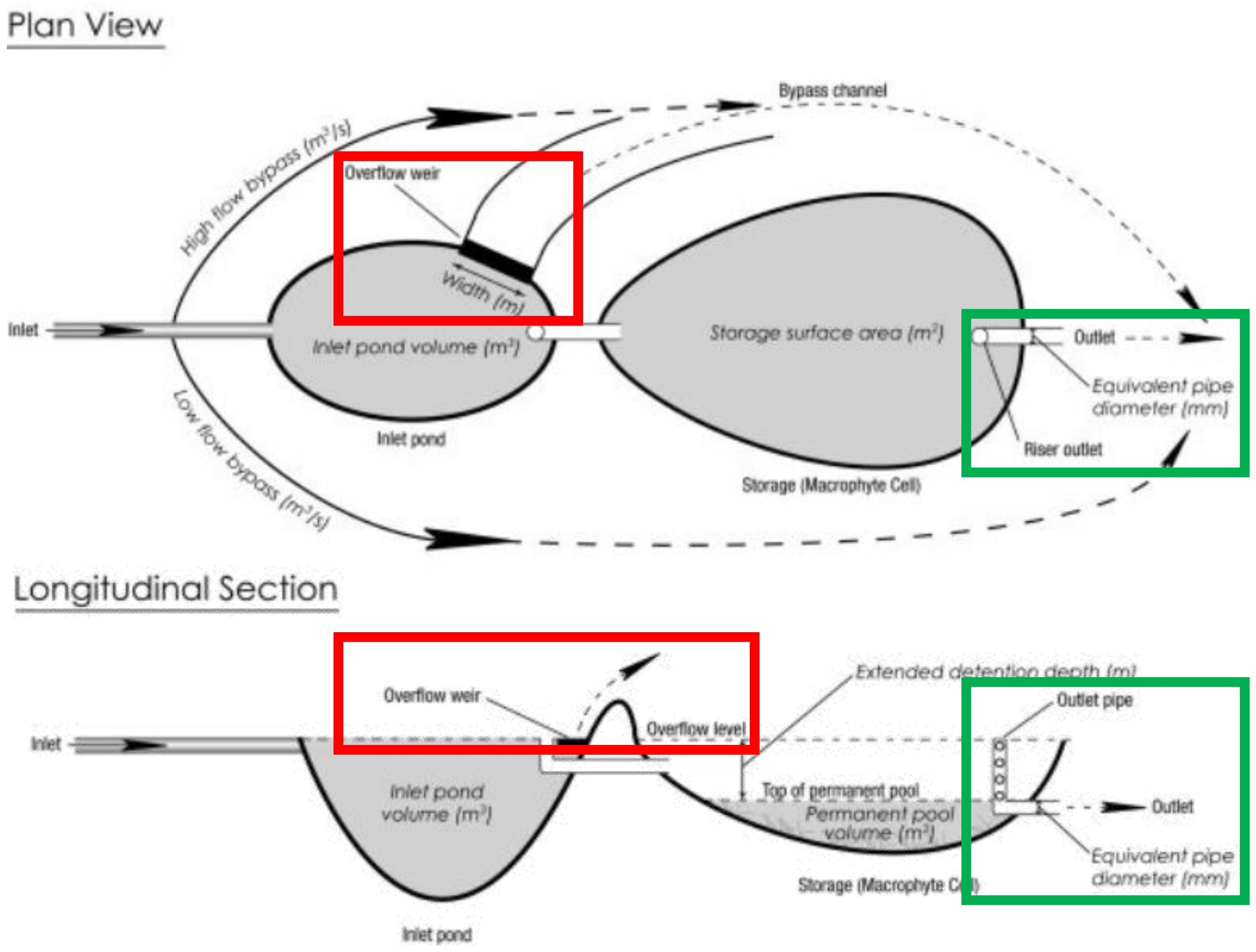
Wetland



Terminology:

- **Weir flow:** Exists via the sediment pond or wetland and has only minor treatment.
- **Pipe flow:** Exits via the wetland outlet riser (or choke plate) and receives full treatment.

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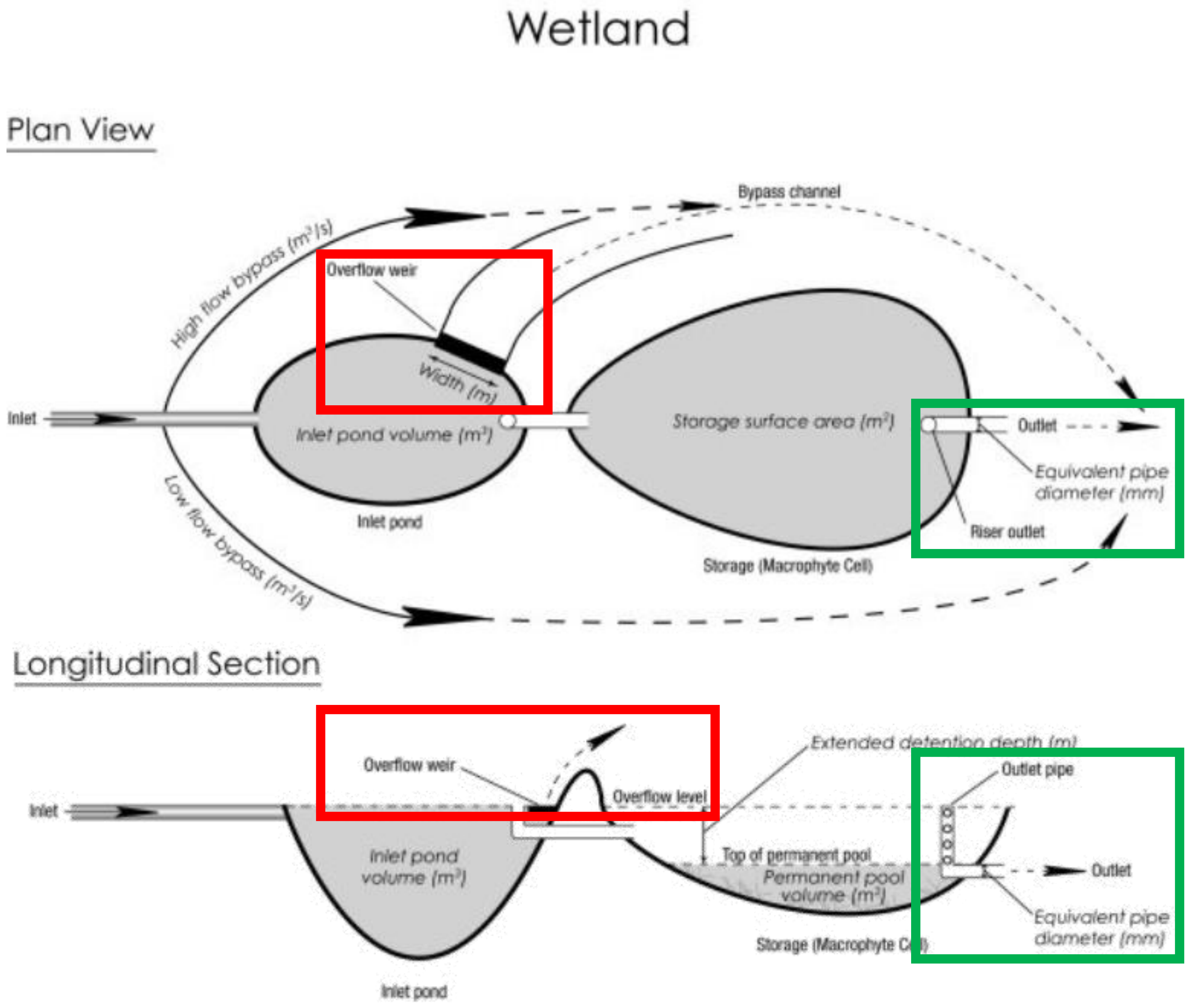

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Relevance:

- Harvesting **pipe flow** typically cannot achieve a 80%+ runoff reduction
- Harvesting **weir flow** presents two challenges:
  - Transferring and storing high flows
  - Managing water quality

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Part 1: Options assessment

Wetland 5 (WL5)

Catchment = 55.8 ha

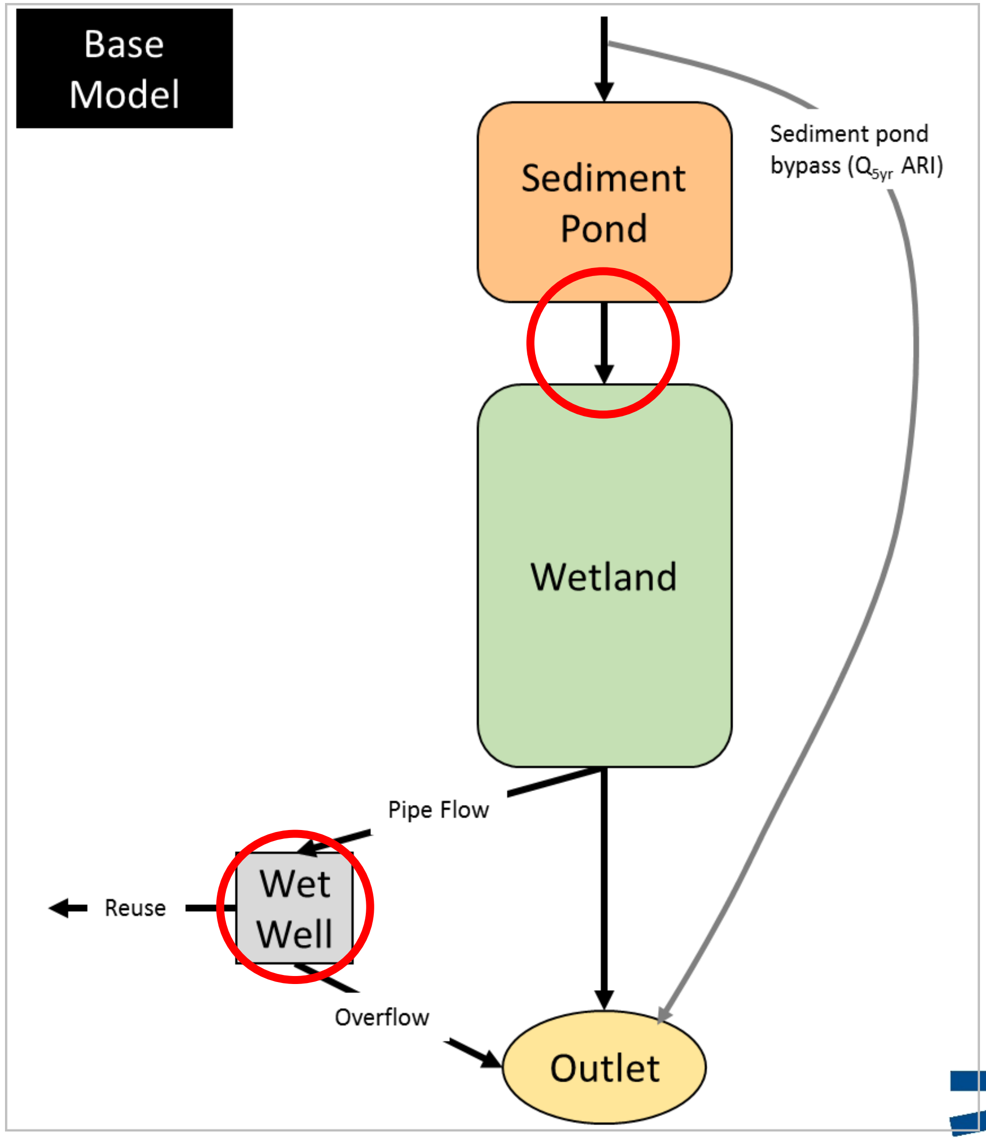
- Open space: 9.6 ha (10 % impervious)
- Residential: 46ha (75% impervious)

Treatment Area = 13,100 m^2

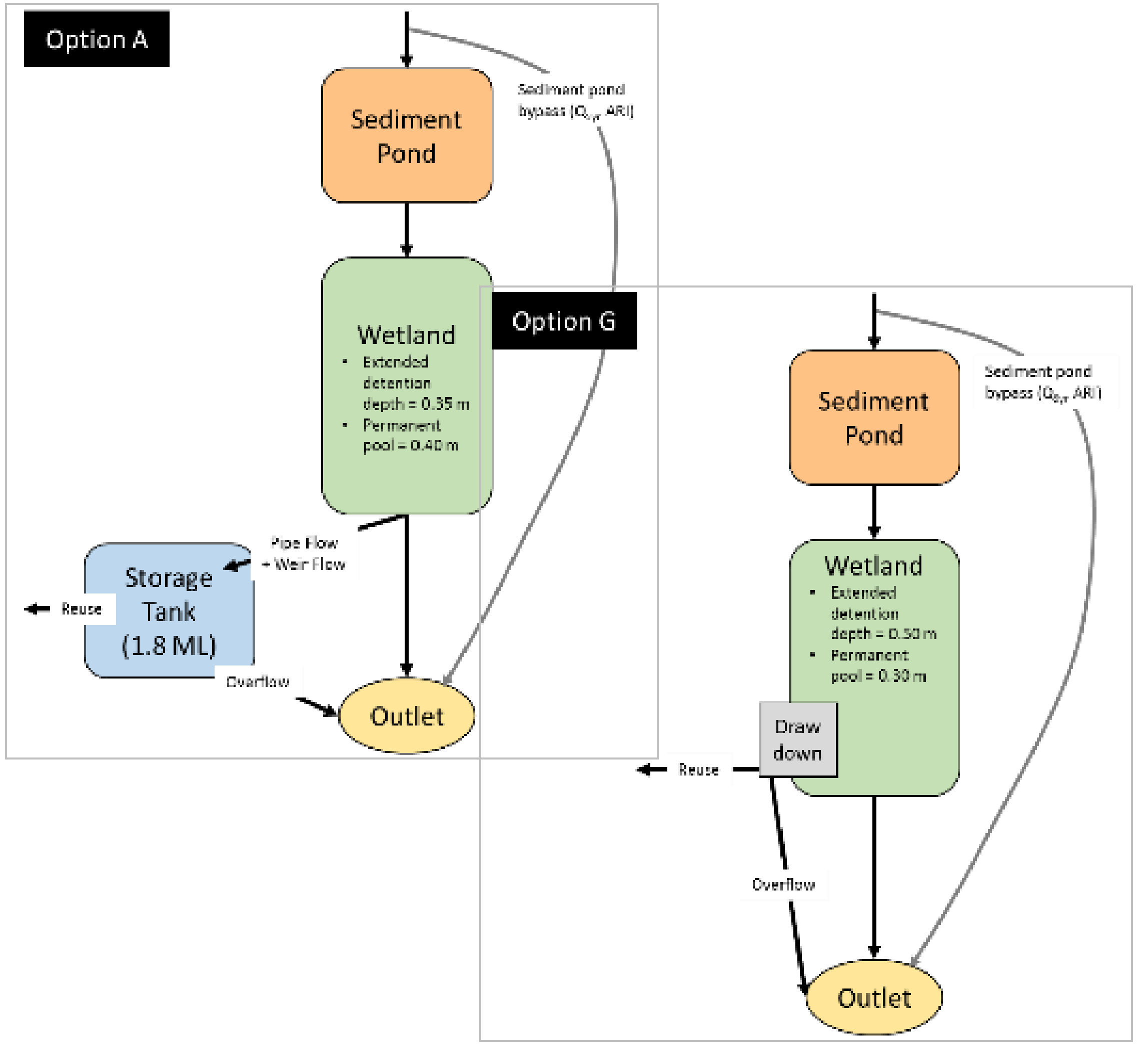
- Sediment pond = 2,100 m2
- Wetland = 11,000 m2

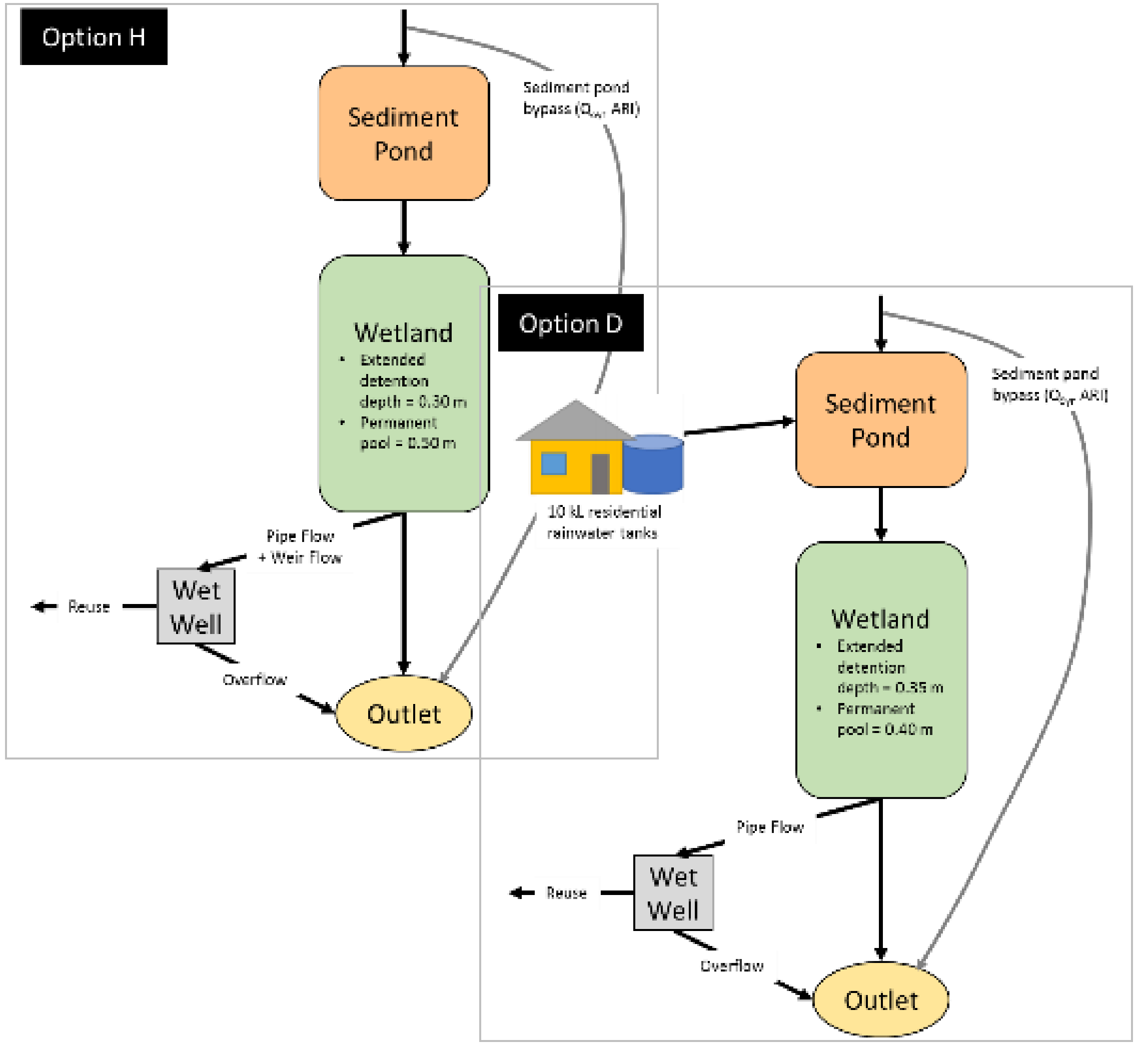
Base Model

- High flow bypass = Q5yr ARI
- Sediment pond to wetland connection throttled to Q3month ARI
- 400mm permanent pool (PP)
- 350 mm extended detention depth (EDD)
- 72hr notional detention time
- Pipe flow harvested from 20 kL wet well (20 L/s pump rate)
- Sized to meet best practice (80/45/45)
- No limit on storage or pump rate



Options 1 to 8





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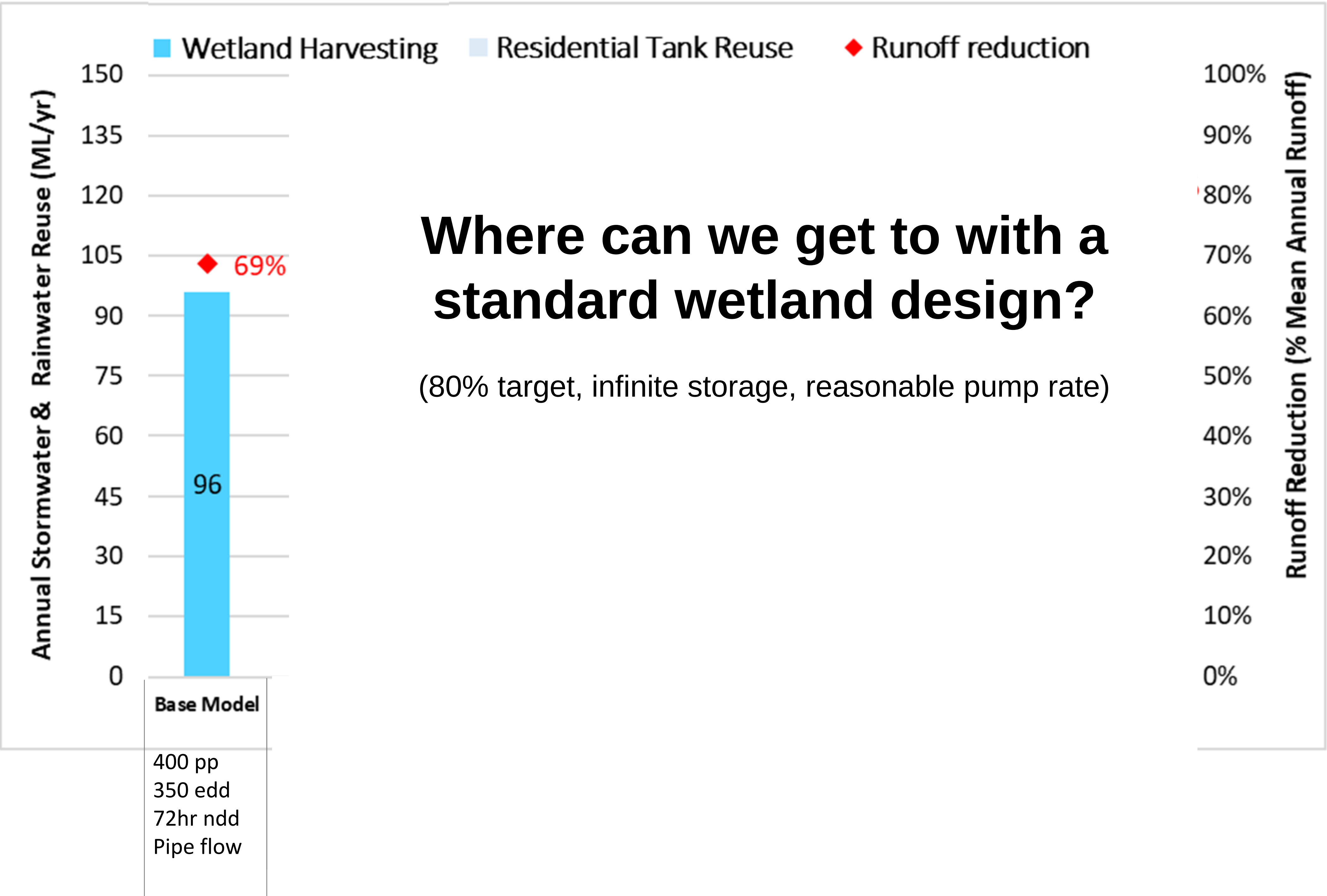

Where can we get to with a standard wetland design?

(80% target, infinite storage, reasonable pump rate)

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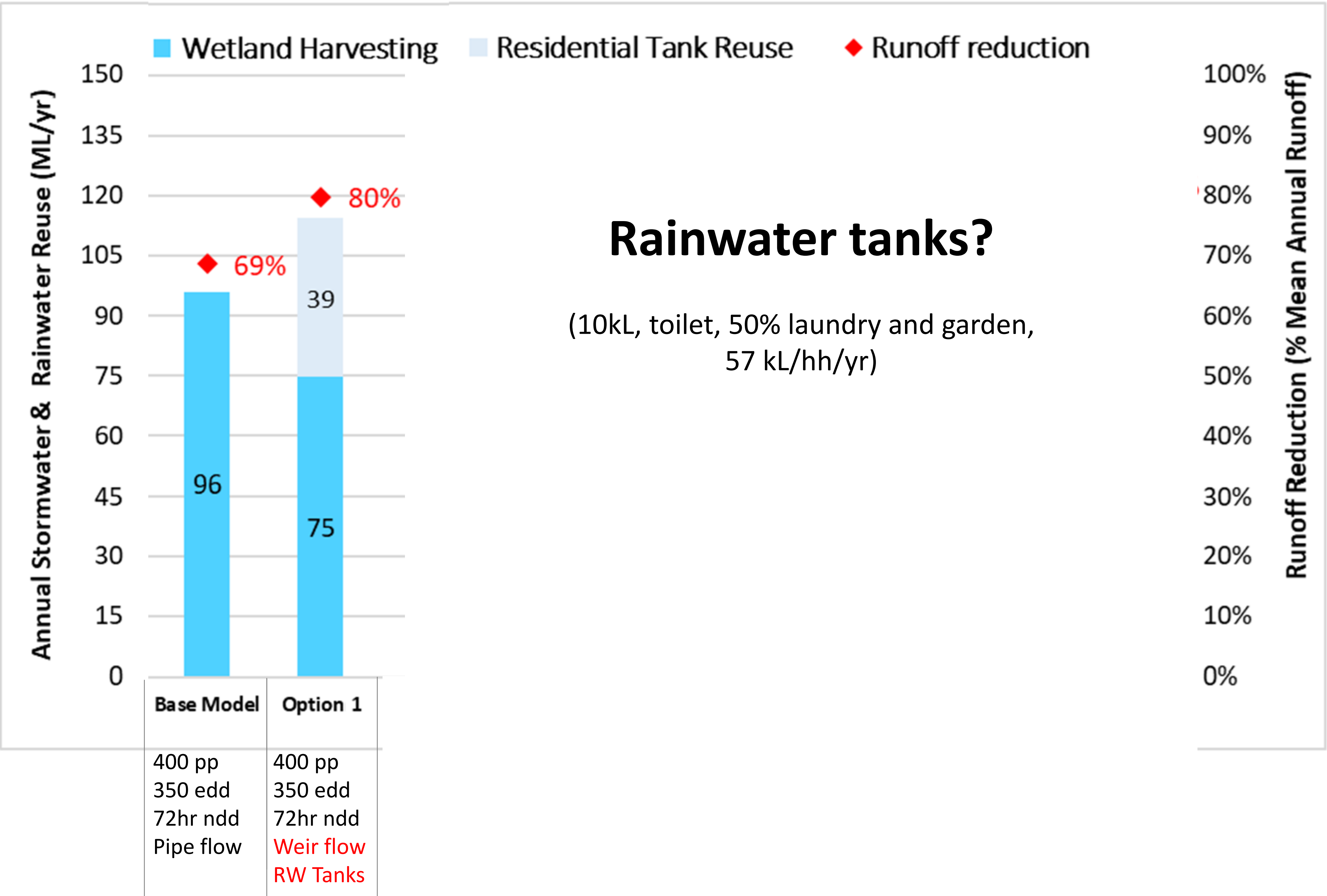
Rainwater tanks?

(10kL, toilet, 50% laundry and garden,
57 kL/hh/yr)



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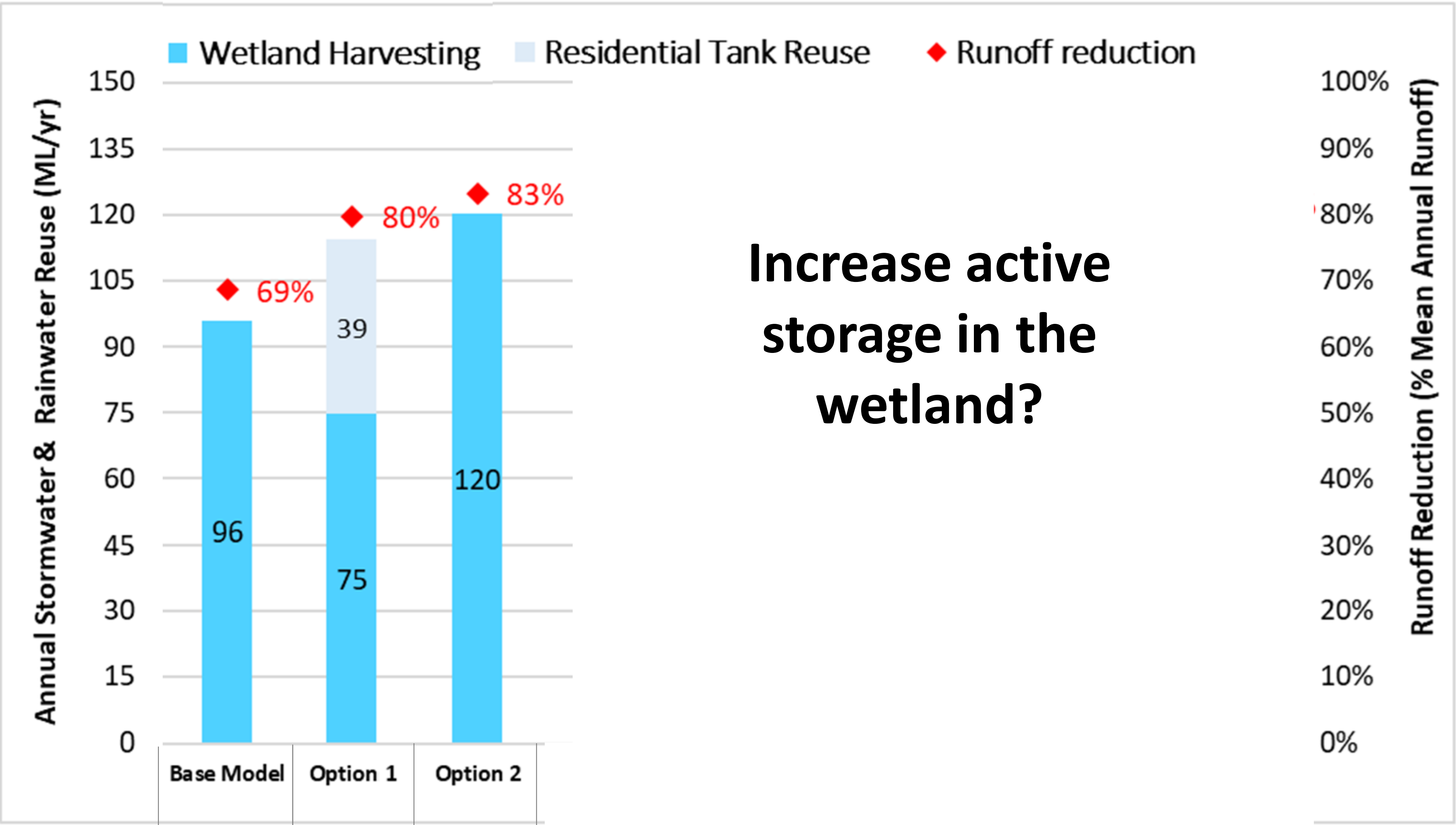
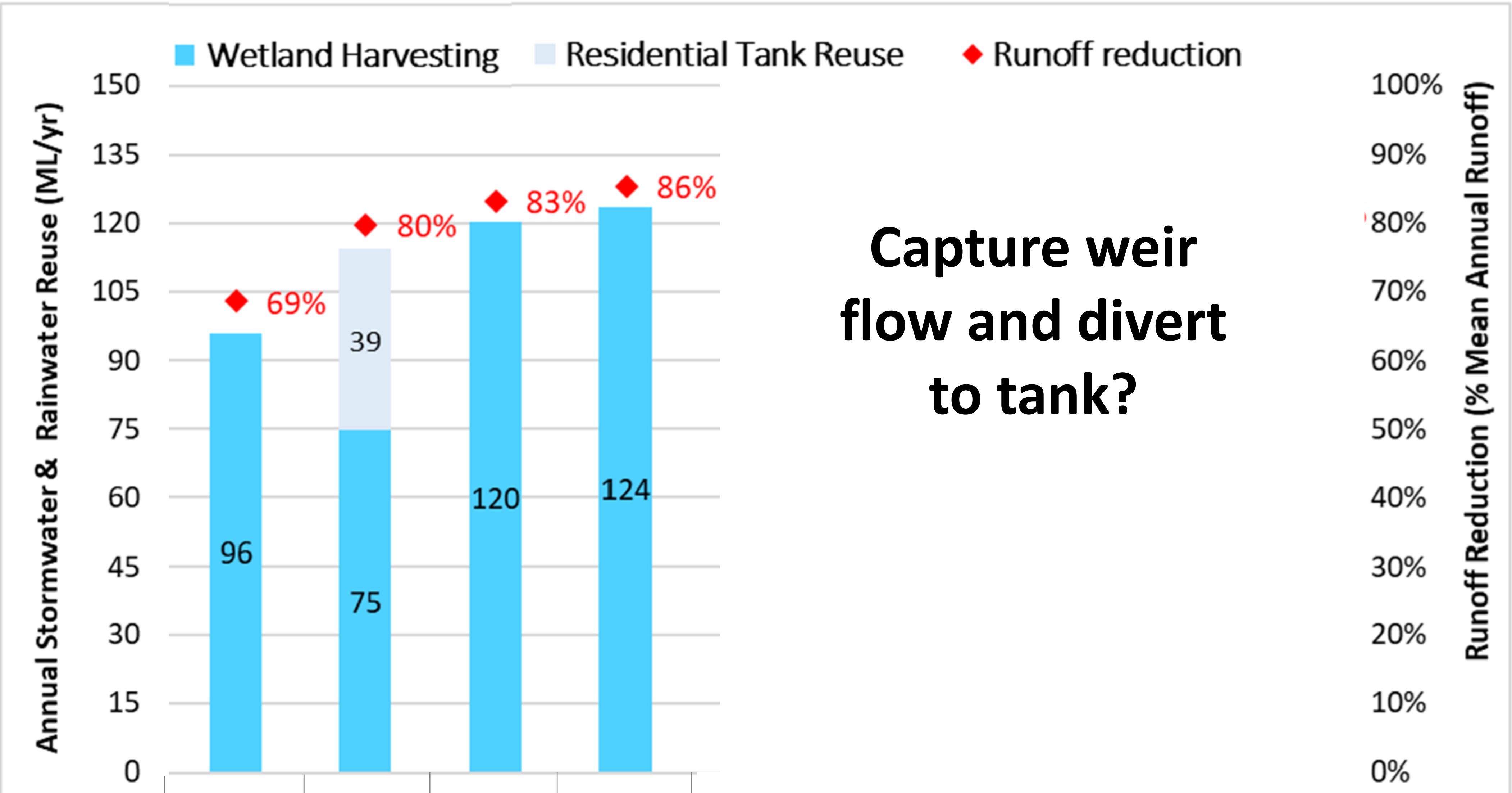
Increase active storage in the wetland?

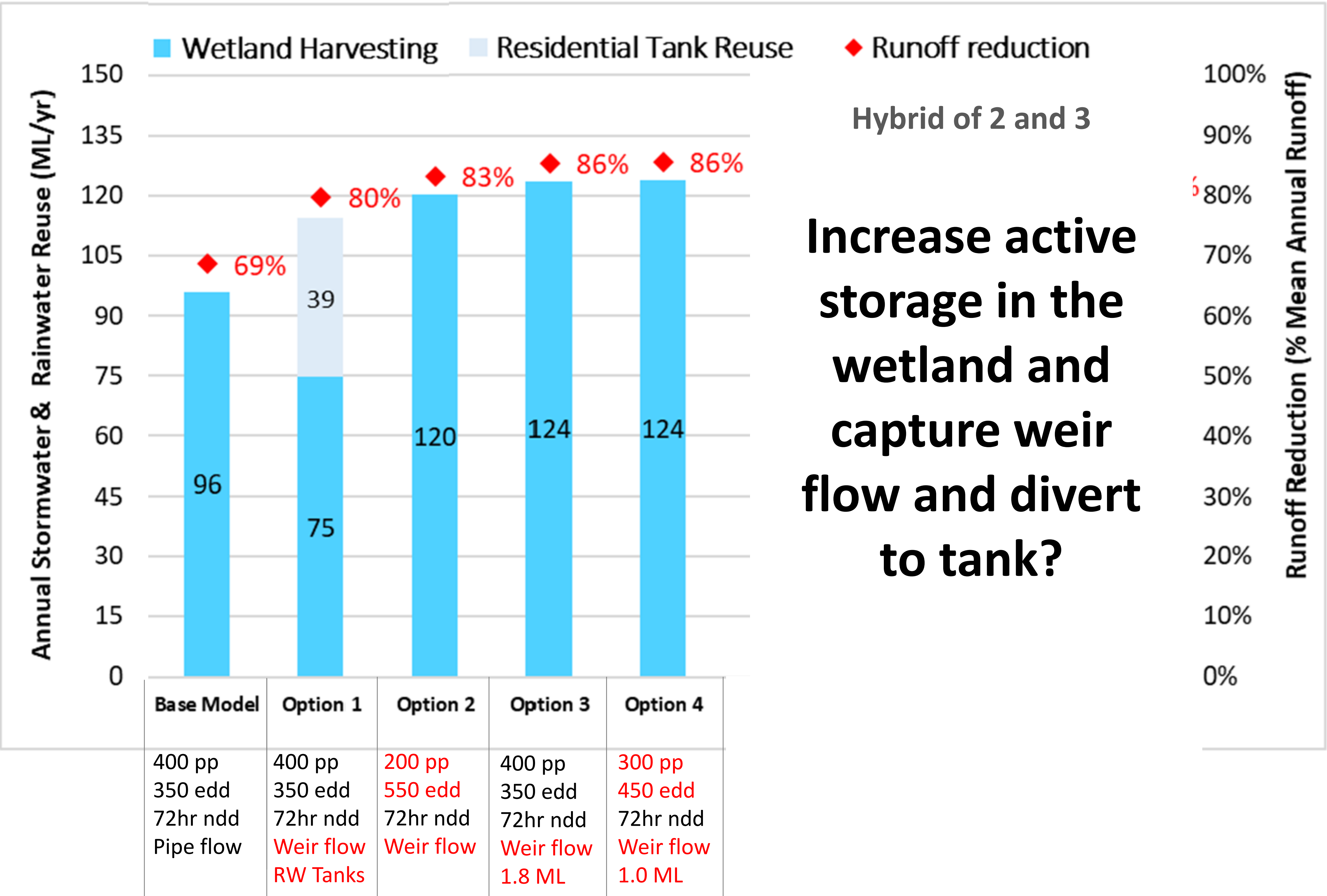


Base Model	Option 1	Option 2
400 pp 350 edd 72hr ndd Pipe flow	400 pp 350 edd 72hr ndd Weir flow RW Tanks	200 pp 550 edd 72hr ndd Weir flow



Capture weir flow and divert to tank?

Base Model	Option 1	Option 2	Option 3
400 pp 350 edd 72hr ndd Pipe flow	400 pp 350 edd 72hr ndd Weir flow RW Tanks	200 pp 550 edd 72hr ndd Weir flow	400 pp 350 edd 72hr ndd Weir flow 1.8 ML



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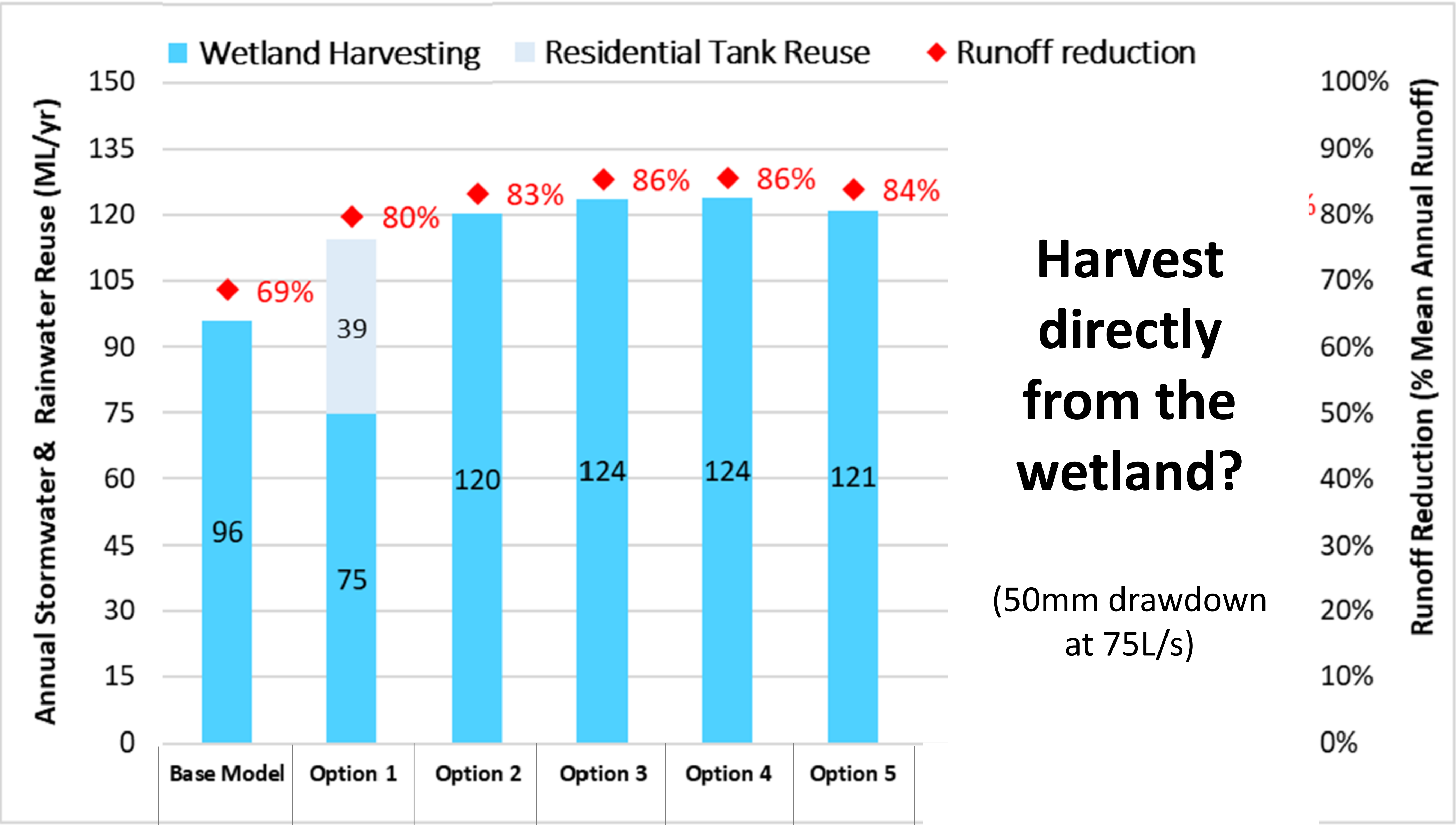
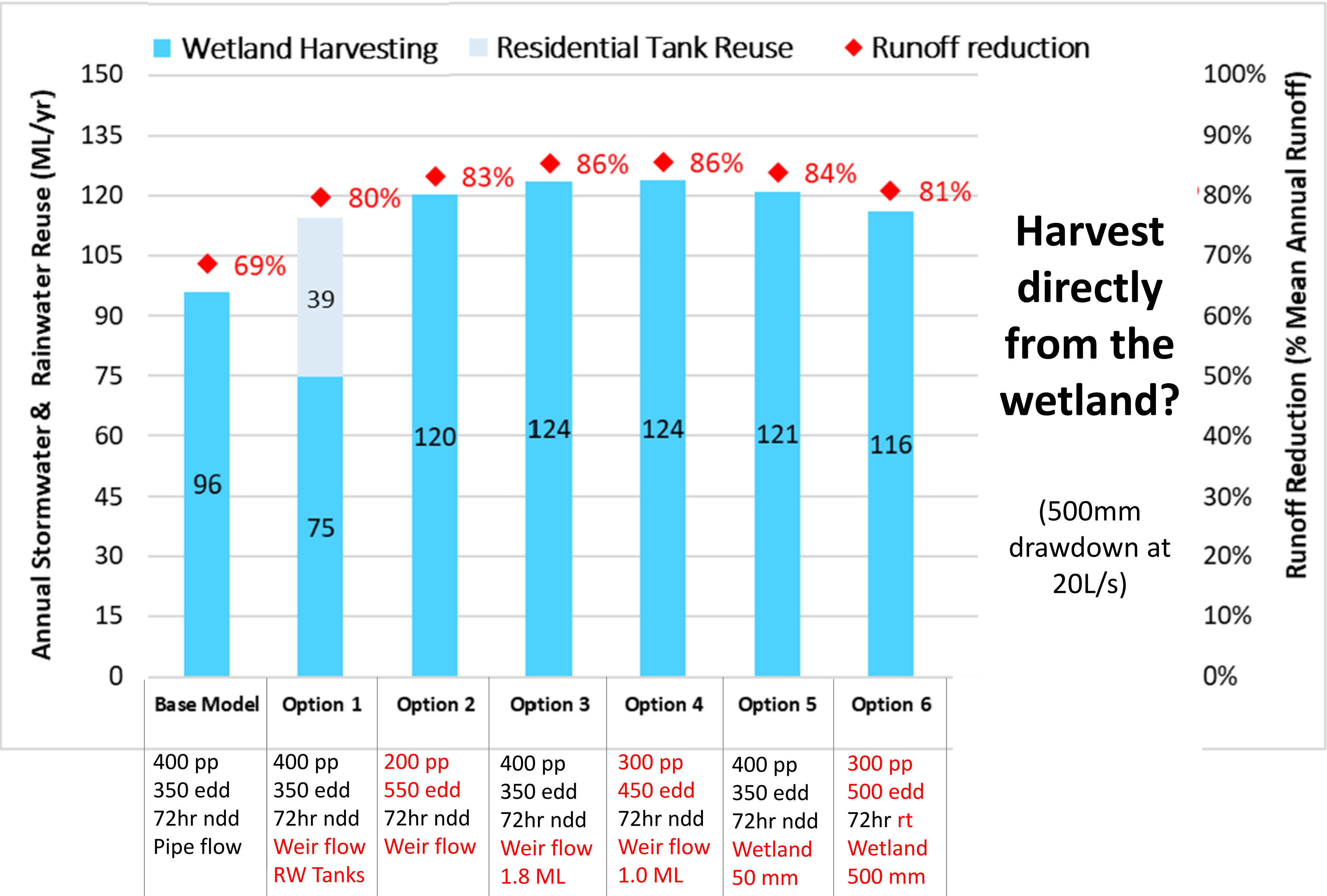


Base Model	Option 1	Option 2	Option 3	Option 4	Option 5
400 pp 350 edd 72hr ndd Pipe flow	400 pp 350 edd 72hr ndd Pipe flow RW Tanks	200 pp 550 edd 72hr ndd Weir flow	400 pp 350 edd 72hr ndd Weir flow 1.8 ML	300 pp 450 edd 72hr ndd Weir flow 1.0 ML	400 pp 350 edd 72hr ndd Wetland 50 mm



Harvest directly from the wetland?

(500mm drawdown at 20L/s)

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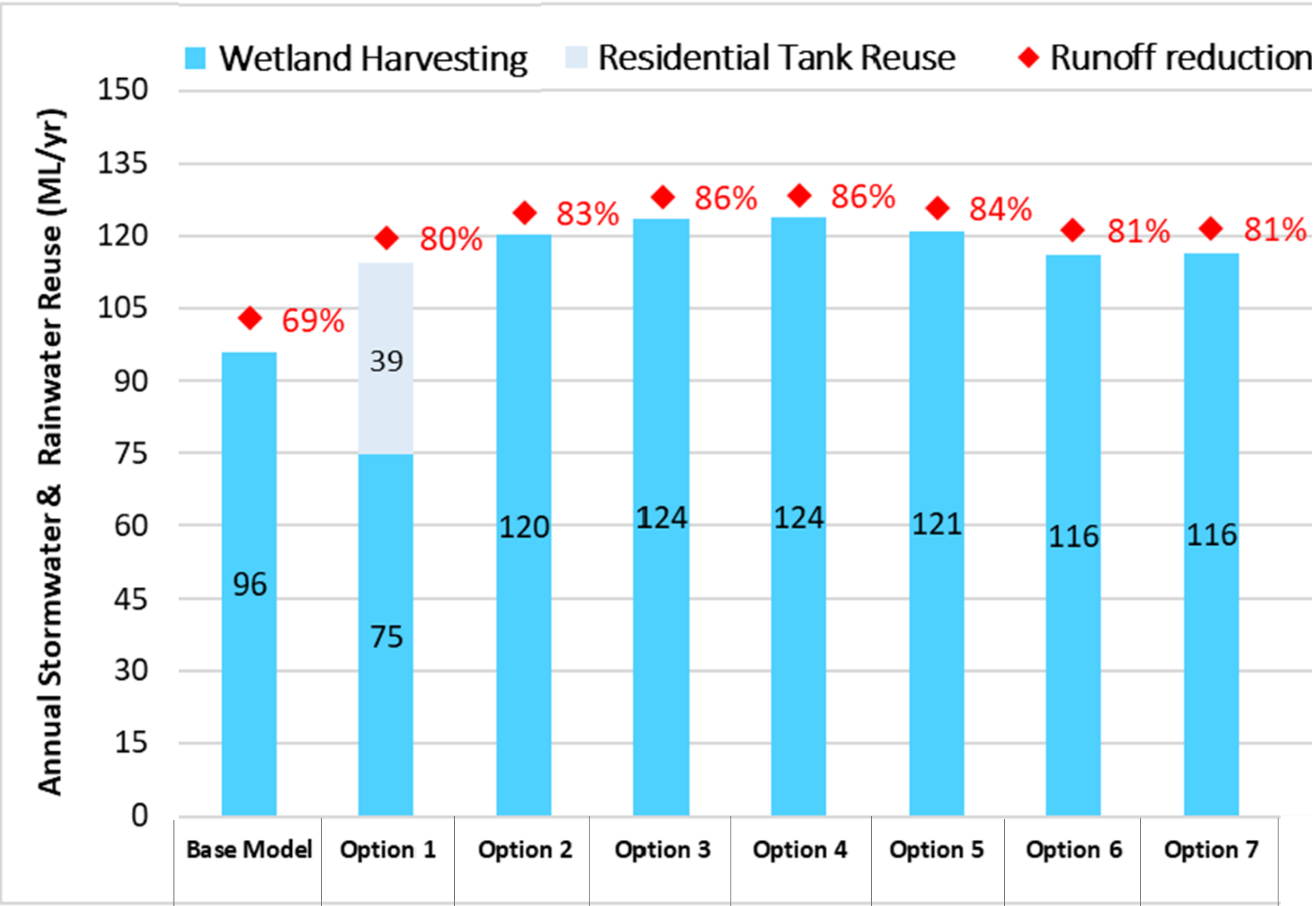

Base Model	Option 1	Option 2	Option 3	Option 4	Option 5	Option 6	Option 7
400 pp	400 pp	200 pp	400 pp	300 pp	400 pp	300 pp	300 pp
350 edd	350 edd	550 edd	350 edd	450 edd	350 edd	500 edd	500 edd
72hr ndd	72hr ndd	72hr ndd	72hr ndd	72hr ndd	72hr ndd	72hr rt	48hr ndd
Pipe flow	Weir flow	Weir flow	Weir flow	Weir flow	Wetland	Wetland	Weir flow
	RW Tanks		1.8 ML	1.0 ML	50 mm	500 mm	

Increase active storage in the wetland and decrease detention time?

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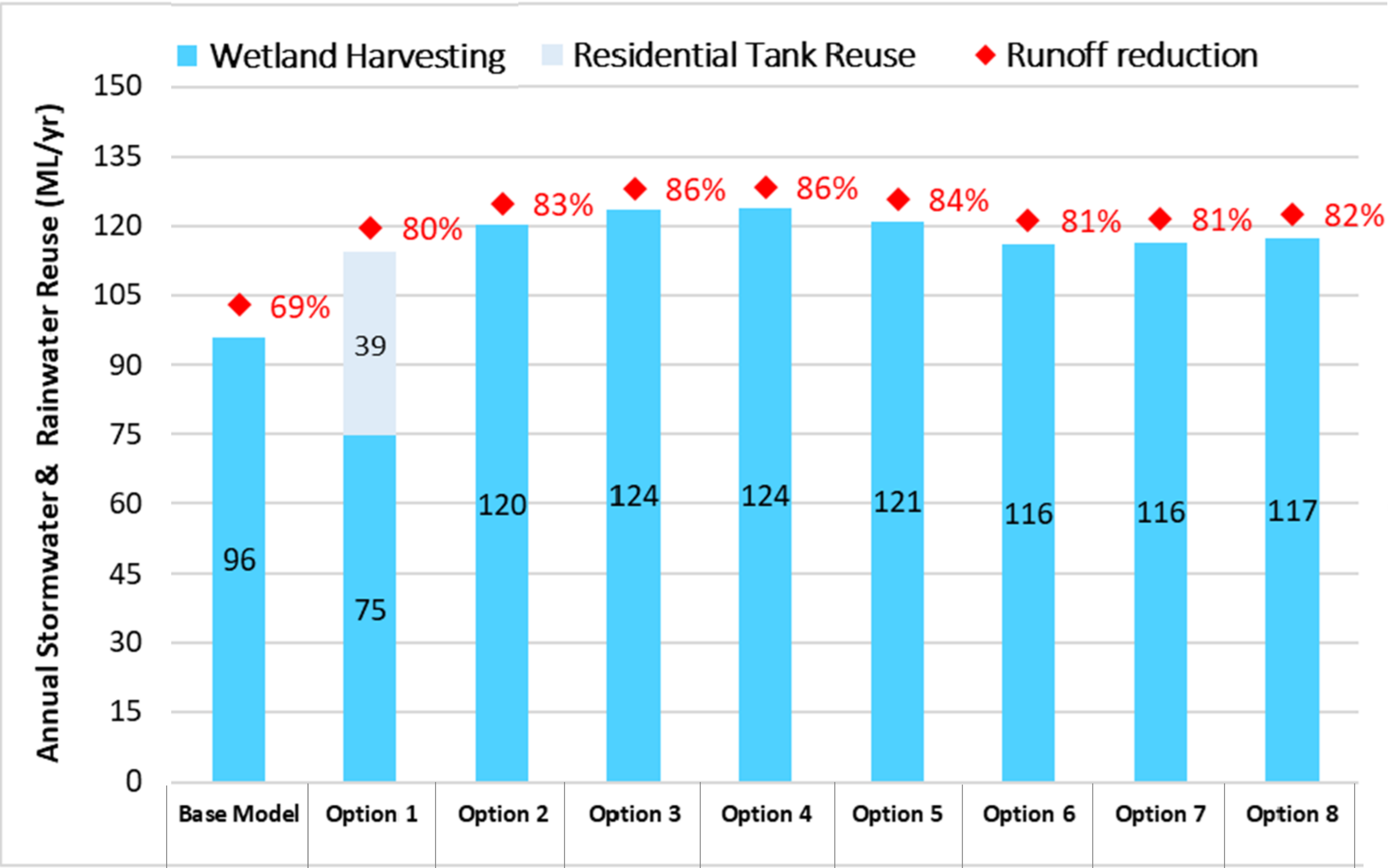

Base Model	Option 1	Option 2	Option 3	Option 4	Option 5	Option 6	Option 7	Option 8
400 pp 350 edd 72hr ndd Pipe flow	400 pp 350 edd 72hr ndd Weir flow RW Tanks	200 pp 550 edd 72hr ndd Weir flow	400 pp 350 edd 72hr ndd Weir flow 1.8 ML	300 pp 450 edd 72hr ndd Weir flow 1.0 ML	400 pp 350 edd 72hr ndd Wetland 50 mm	300 pp 500 edd 72hr rt Wetland 500 mm	300 pp 500 edd 48hr ndd Pipe flow	300 pp 500 edd 72hr ndd Weir flow

Increase active storage in the wetland and harvest weir flow?

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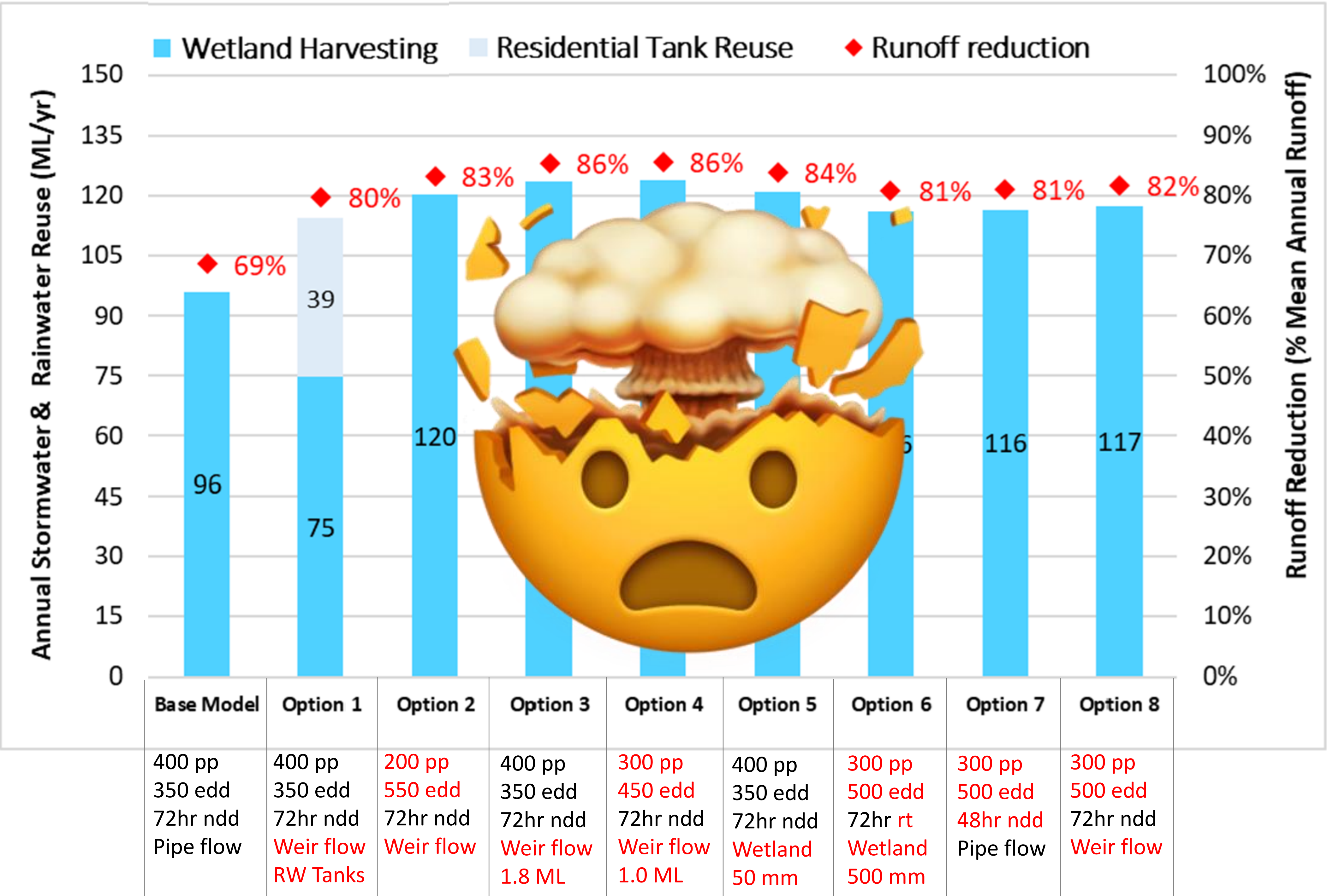

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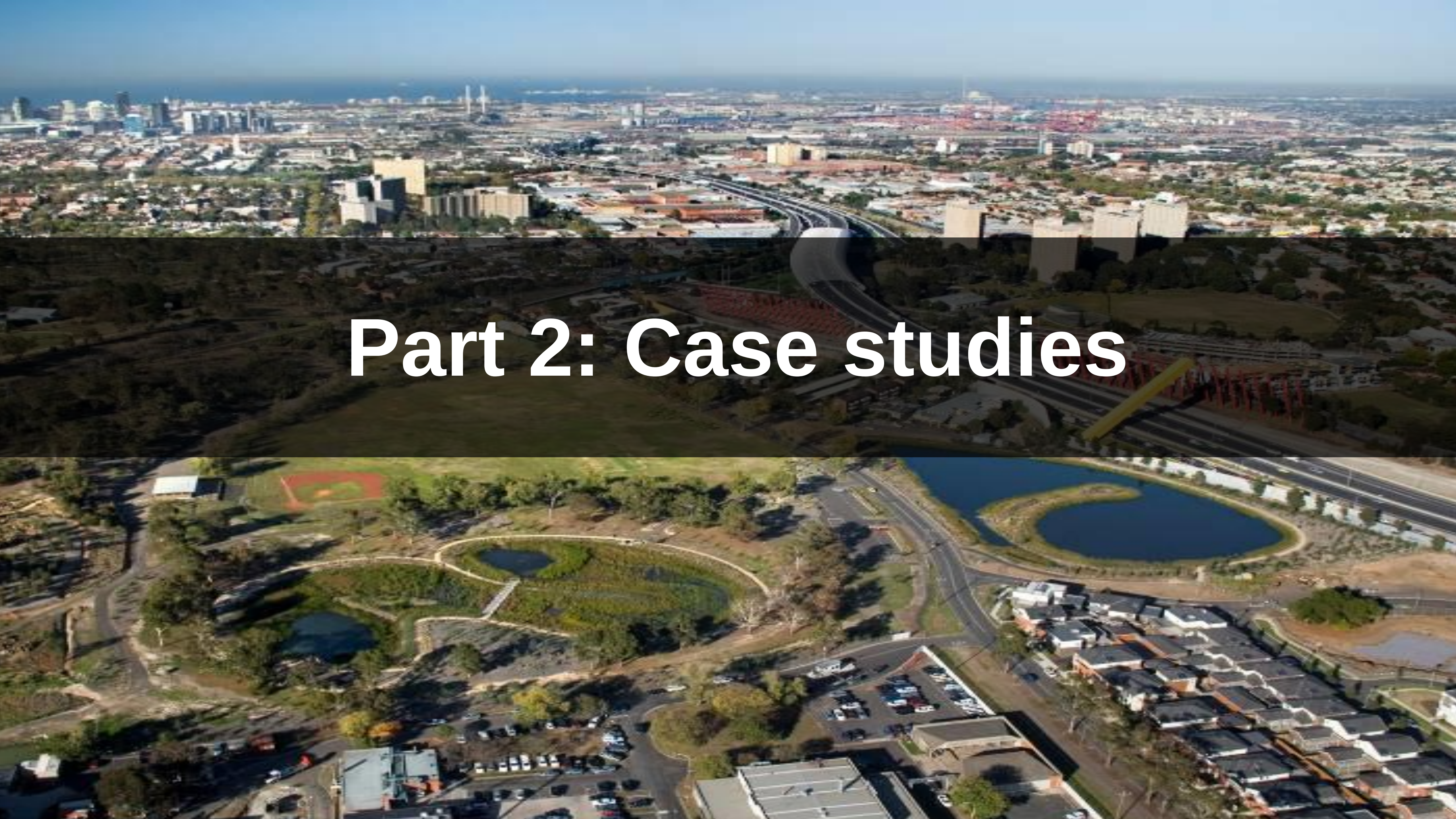
Part 2: Case studies



Case Study

1. Select **promising options** for further examination (iterative)

2. Apply the design changes to **six functional wetland designs** prepared from a drainage services scheme (DSS)

3. Assess **performance, costs and risks**

Options Selected

Option 3 – Tanks and weir flow

- 90% runoff reduction: **Tank 2.5 ML** and 135 L/s pump rate.
- 80% runoff reduction: **Tank 0.85 ML** and 75 L/s pump rate.

Option 6 – Wetland drawdown

Increase EDD, decrease PP, 72hr residence time, **drawdown wetland**, 80% runoff reduction

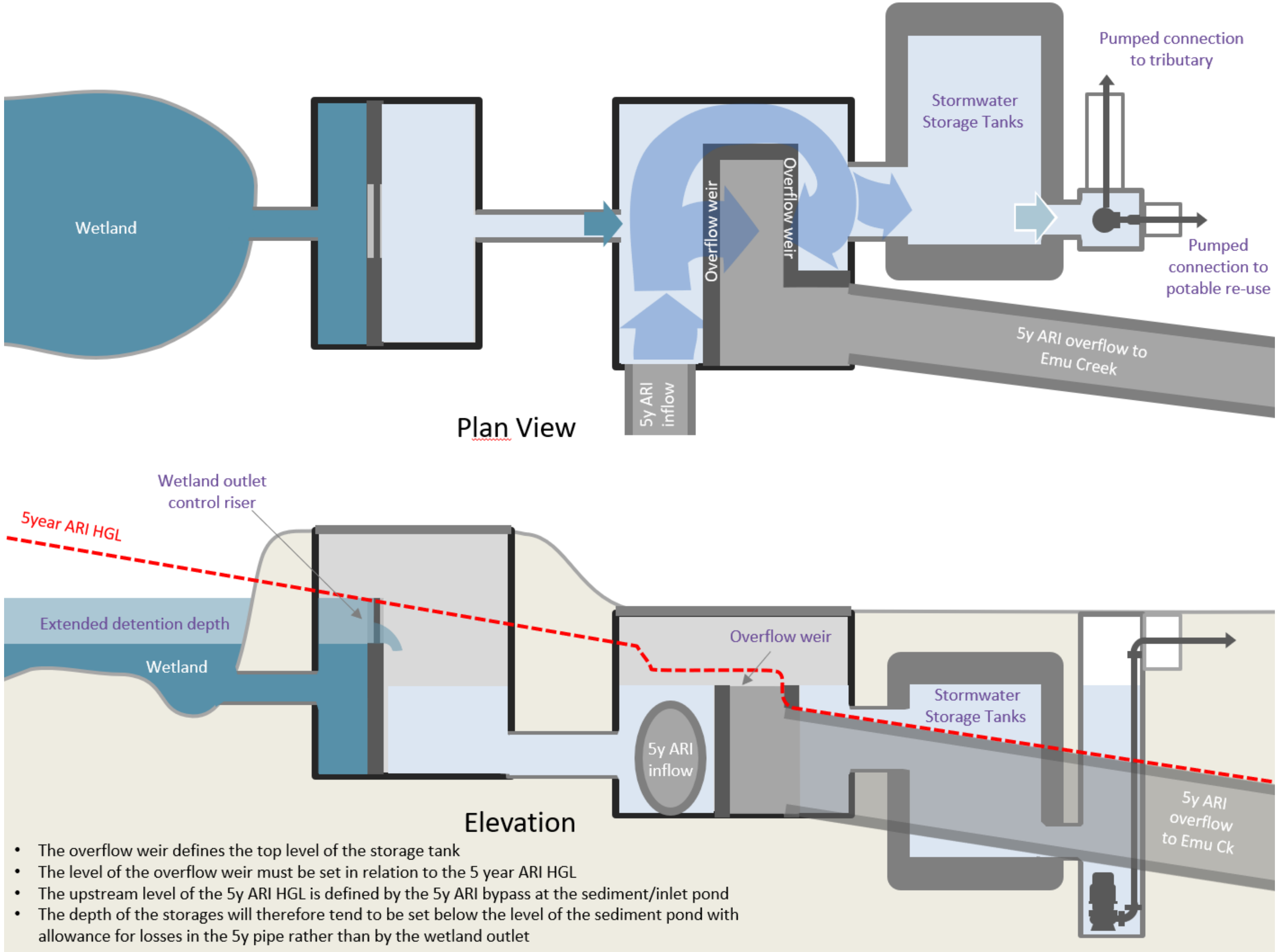
Option 7 – Reduced detention time

Increase EDD, decrease PP, **48hr NDD**, harvest pipe flow from 20 kL wet well, 80% runoff reduction

Option 8 – Increase storage and weir flow

Increase EDD, decrease PP, 72hr NDD, harvest pipe flow and **weir flow** from 20 kL wet well, 80% runoff reduction

Harvesting Weir Flow



- The overflow weir defines the top level of the storage tank
- The level of the overflow weir must be set in relation to the 5 year ARI HGL
- The upstream level of the 5y ARI HGL is defined by the 5y ARI bypass at the sediment/inlet pond
- The depth of the storages will therefore tend to be set below the level of the sediment pond with allowance for losses in the 5y pipe rather than by the wetland outlet

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BENG (CIVIL) HONS
Director, Civil Engineering

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Treatment

	Notional Detention Time (days)	90th % Residence Time (days)
Option 3	3	4
Option 6	n/a	3
Option 7	2	2
Option 8	3	2

Notional detention time (ndd) uses the designed wetland properties (volume and equivalent pipe diameter) to approximate the detention time. It doesn't account for the permanent pool volume.

Residence time (rt) is the time a particle of water spends in the wetland assuming plug flow and a wetland volume including:

- 100% of the extended detention volume, and
- up to 50% of the permanent pool volume is assumed to be involved in plug flow.

A wetland must achieve a 72 hour residence time 90% o more of the time. (Constructed Wetlands Design Manual, Melbourne Water, 2017)

Research based on 72 hour residence time.

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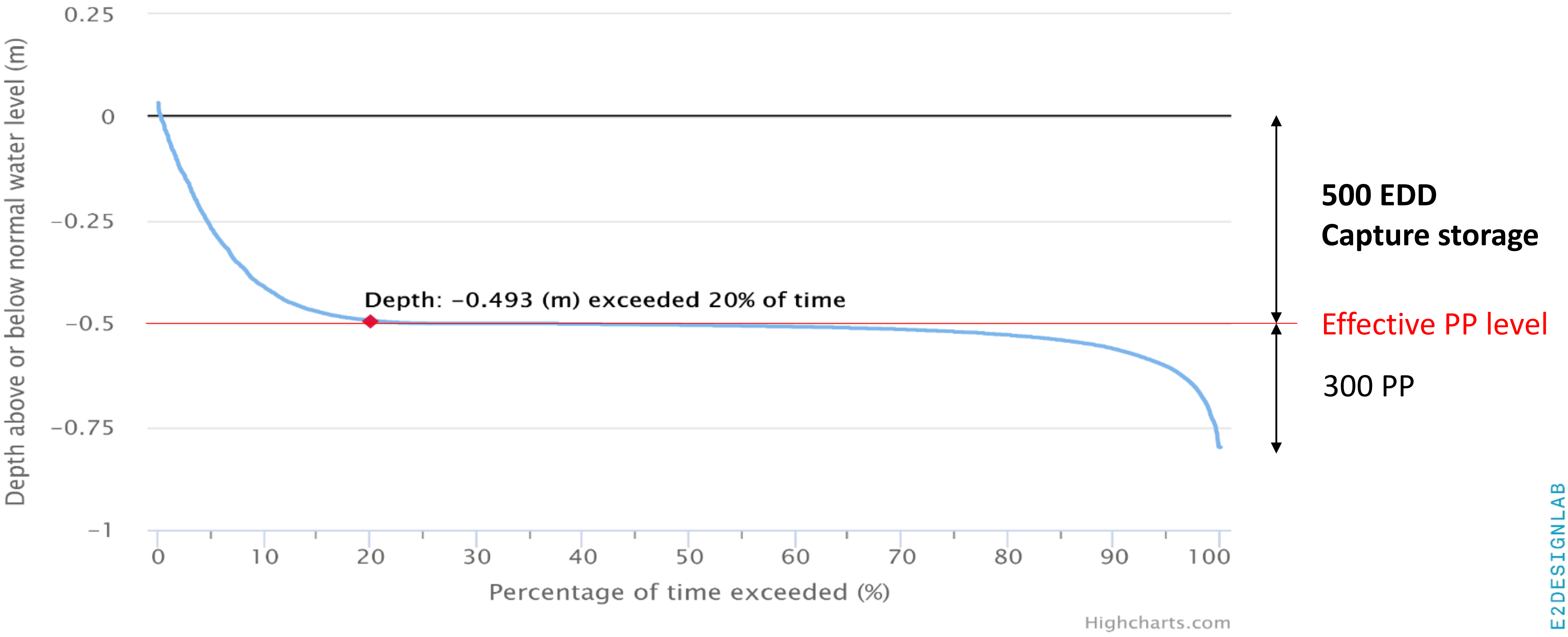
Treatment

	Notional Detention Time (days)	90th % Residence Time (days)
Option 3	3	4
Option 6	n/a	3
Option 7	2	2
Option 8	3	2

Inundation Frequency



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Weir flow, treatment, inundation

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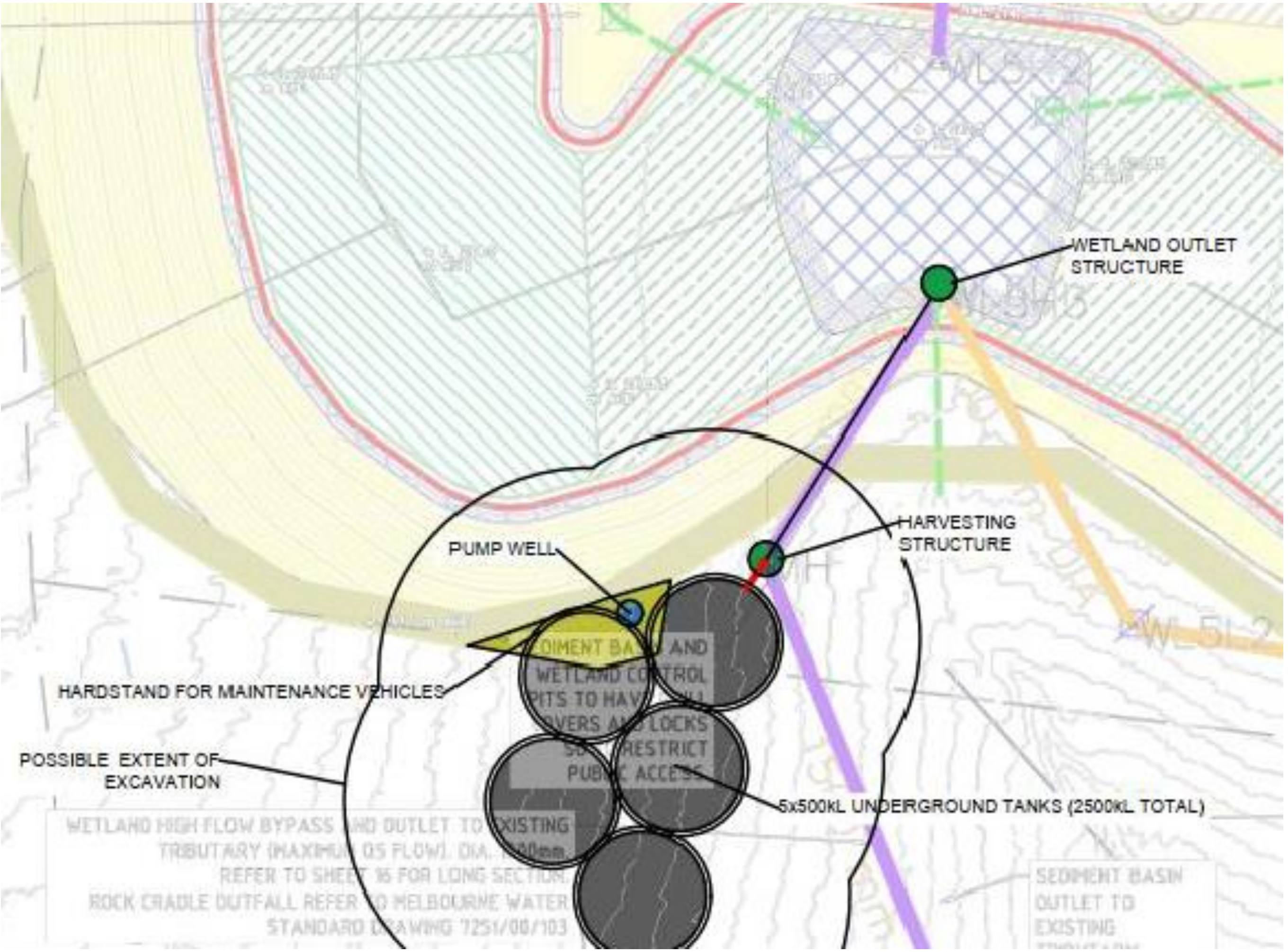
Cost items

Infrastructure

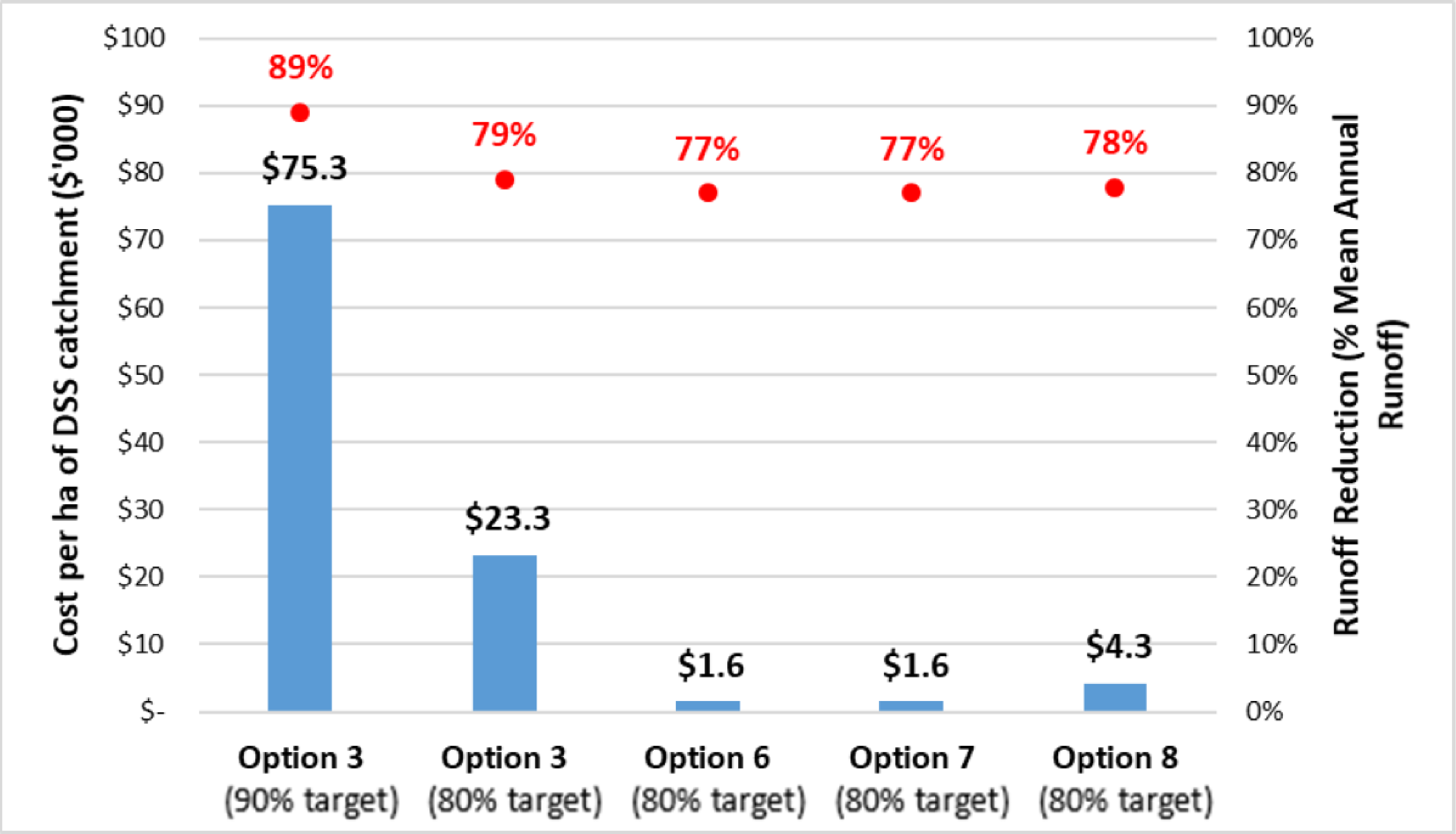
Tank
Earthworks
Access track and hardstand
Pipework
Power supply
Overflow structure
Telemetry

Contingencies etc.

Land Aquitision



Costs and Performance



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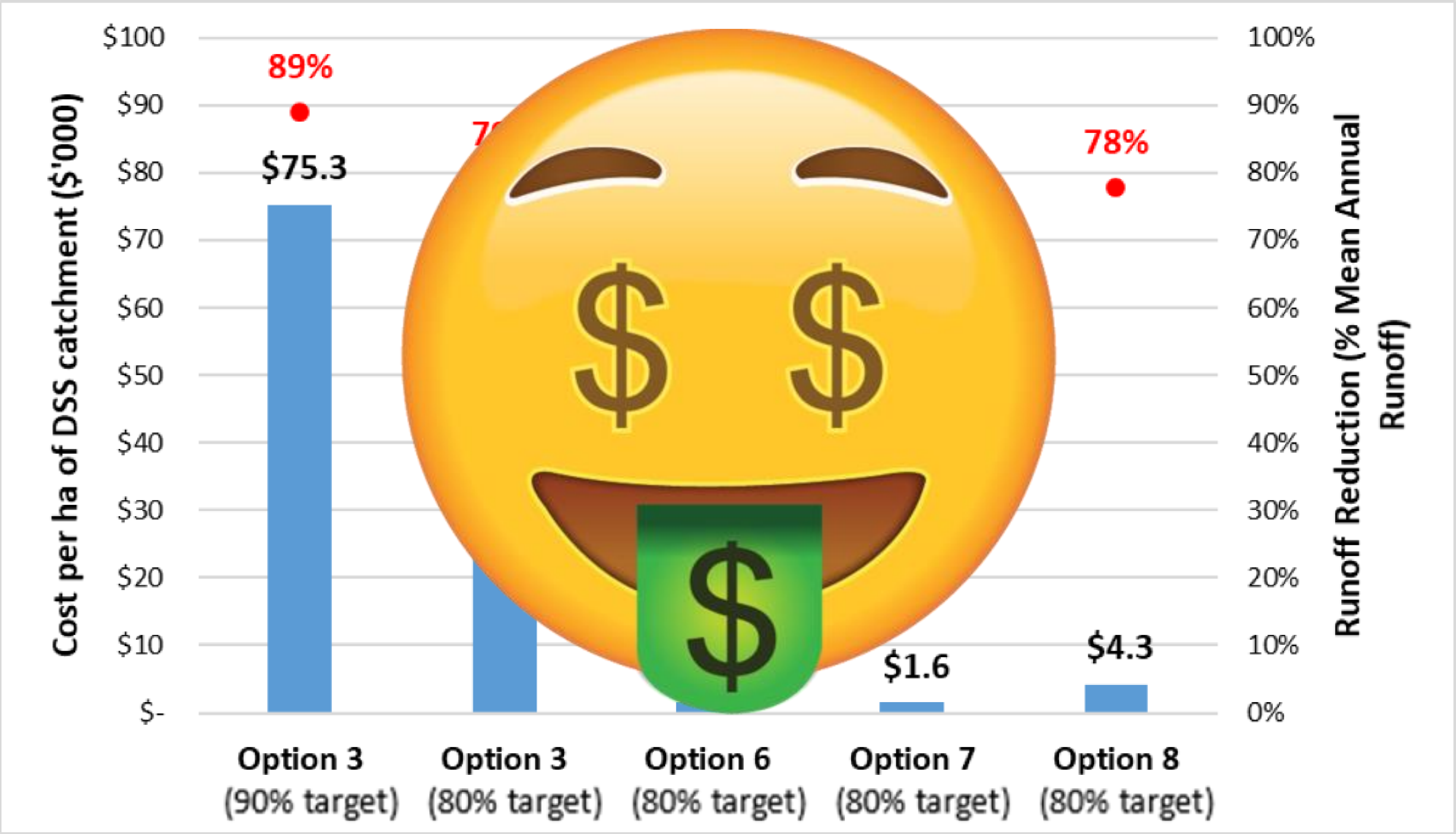
Costs and Performance



Discussion

Option 3 – Tanks and weir flow

- High cost, maintenance risk

Option 6 – Wetland drawdown

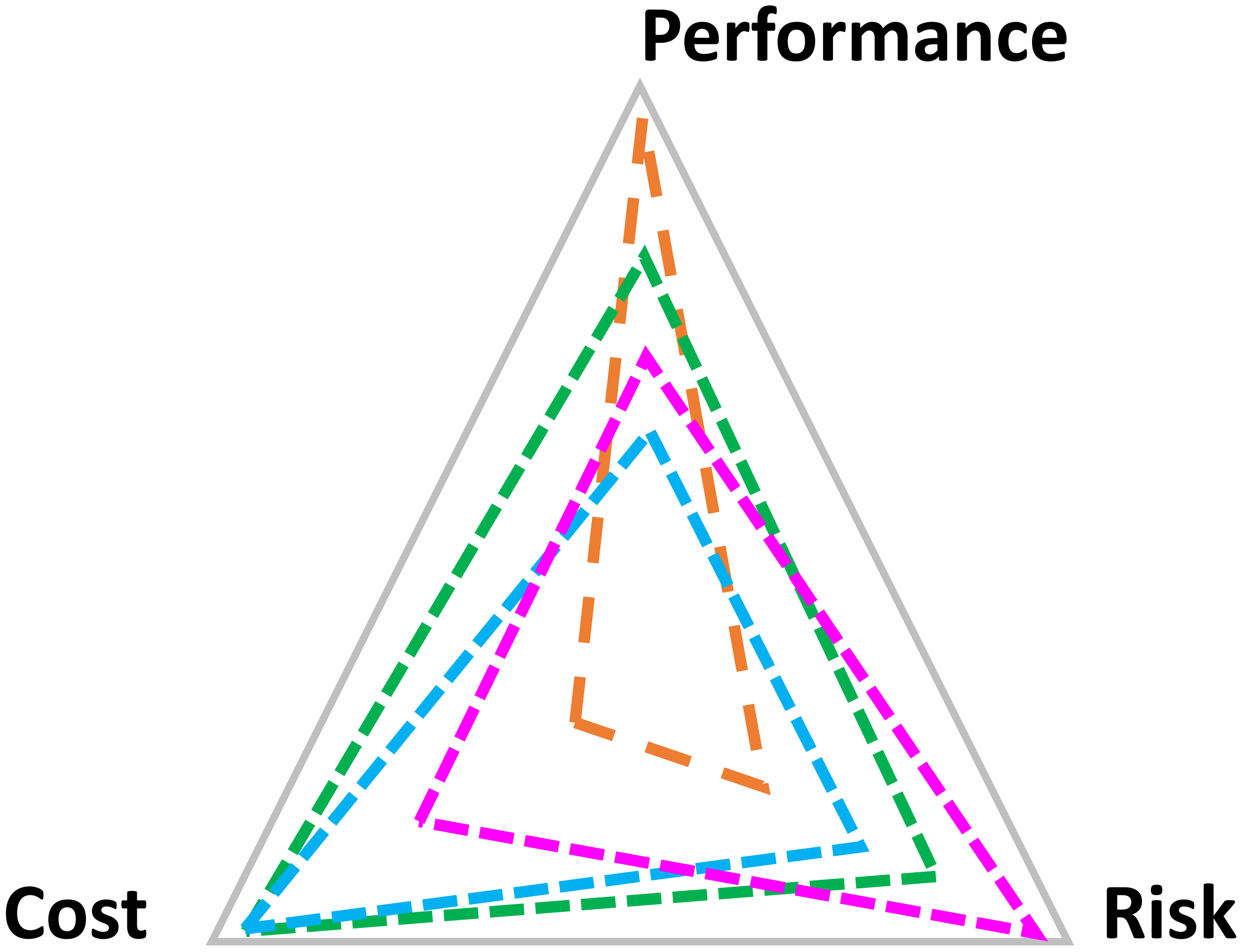
- Moderate cost
- Lower WQ risk
  - Longer RT
  - Improved through operation
- More control for pumped flow to waterway
- Lower cost of future adjustments

Option 7 - Reduced detention time

- Low cost
- WQ risk
- Low flexibility

Option 8 - Increase storage and weir flow

- Moderate cost
- Lower WQ risk



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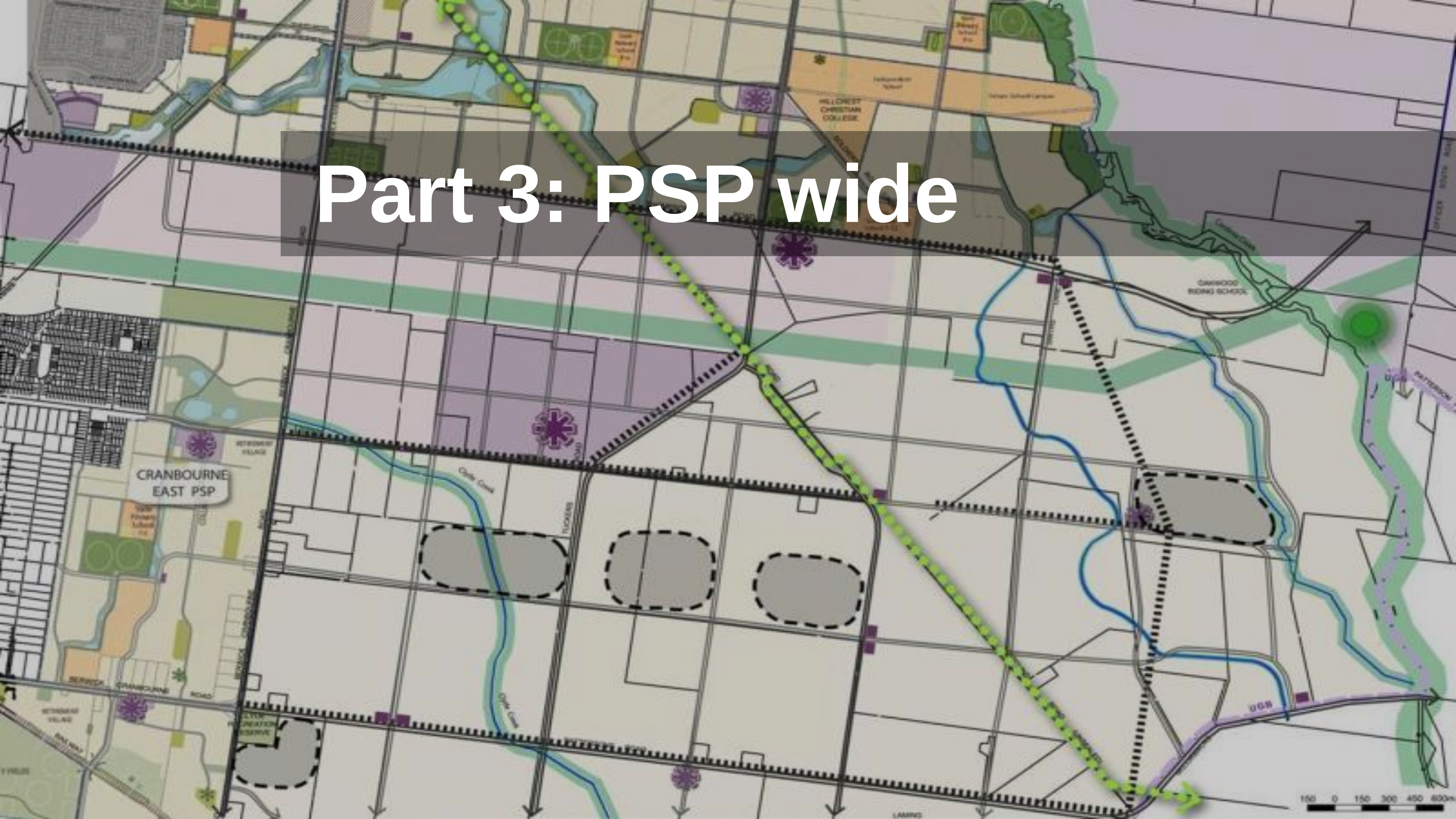
Part 3: PSP wide



PSP Wide

Adopted option 6 – Wetland drawdown

Initial performance = 74% runoff reduction

- Removal of existing development (180ha)
- Adjustments to catchment/treatment ratio, high flow bypass etc.

Refined performance = 80% runoff reduction

- Performance varied across wetlands

Conclusions

There are many ways* to achieve high runoff reductions, it boils down to a choice between cost, performance and risk.

**This assessment assumed no limits on storage or transfer infrastructure.*

In ‘harvesting mode’ increasing extended detention depth (500mm +) is a cost effective method to achieve high yields.*

**Relies on pump operation and backup ‘treatment mode’ in the event of failure.*

Smart technology has the potential to further increase yields and treatment performance.

This applies equally to wetlands designed for treatment only.

Thankyou

Melbourne Water

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WATERWAY ECOSYSTEM RESEARCH GROUP