Climate-Resilient Stormwater Management in Urban Areas

Stantec

Presenter:

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Impact of Climate Change and urbanization

Impact of Climate Change:

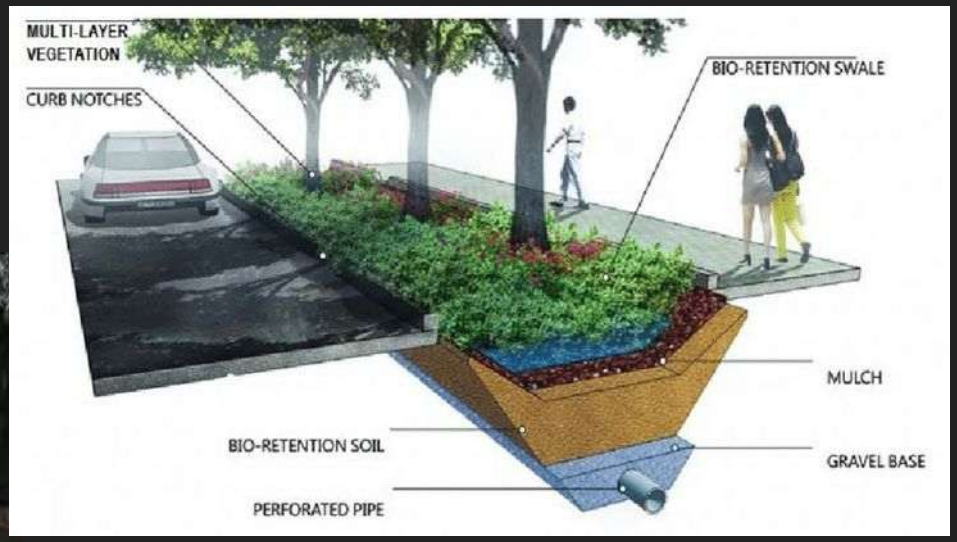
- Increased Rainfall Intensity
- Sea Level Rise
- Temperature Changes
- Extreme Weather Events
- Environmental Consequences

Impact of Urbanisation:

- Increased Impervious Surfaces
- Altered Natural Drainage
- Water Quality Degradation
- Loss of Habitat and Biodiversity
- Mitigation Measures

Possible solutions – WSUD and more

- Standards and Guidelines
- Water Quality Targets
- Climate Change Factor


MULTI-LAYER
VEGETATION
CURB NOTCHES
BIO-RETENTION SWALE
MULCH
BIO-RETENTION SOIL
GRAVEL BASE
PERFORATED PIPE

Water Sensitive Urban Design

QGIS + Python Plugin

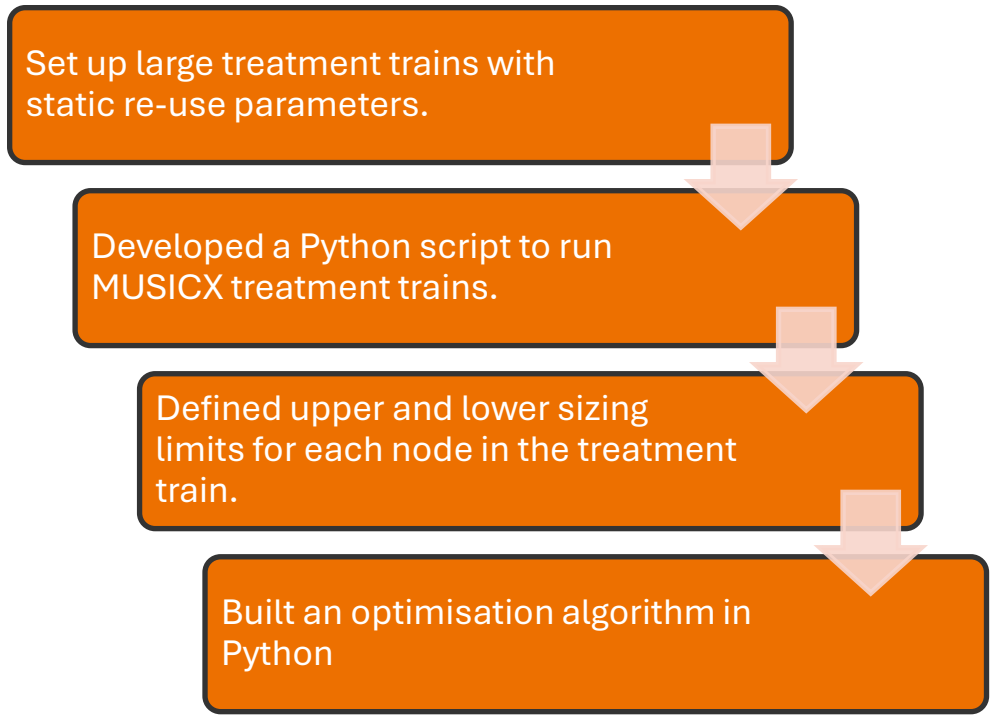
- Developed Python code as QGIS plugin
- Automated scenario creation
- Integrated spatial & hydrological datasets

MUSICX Optimisation

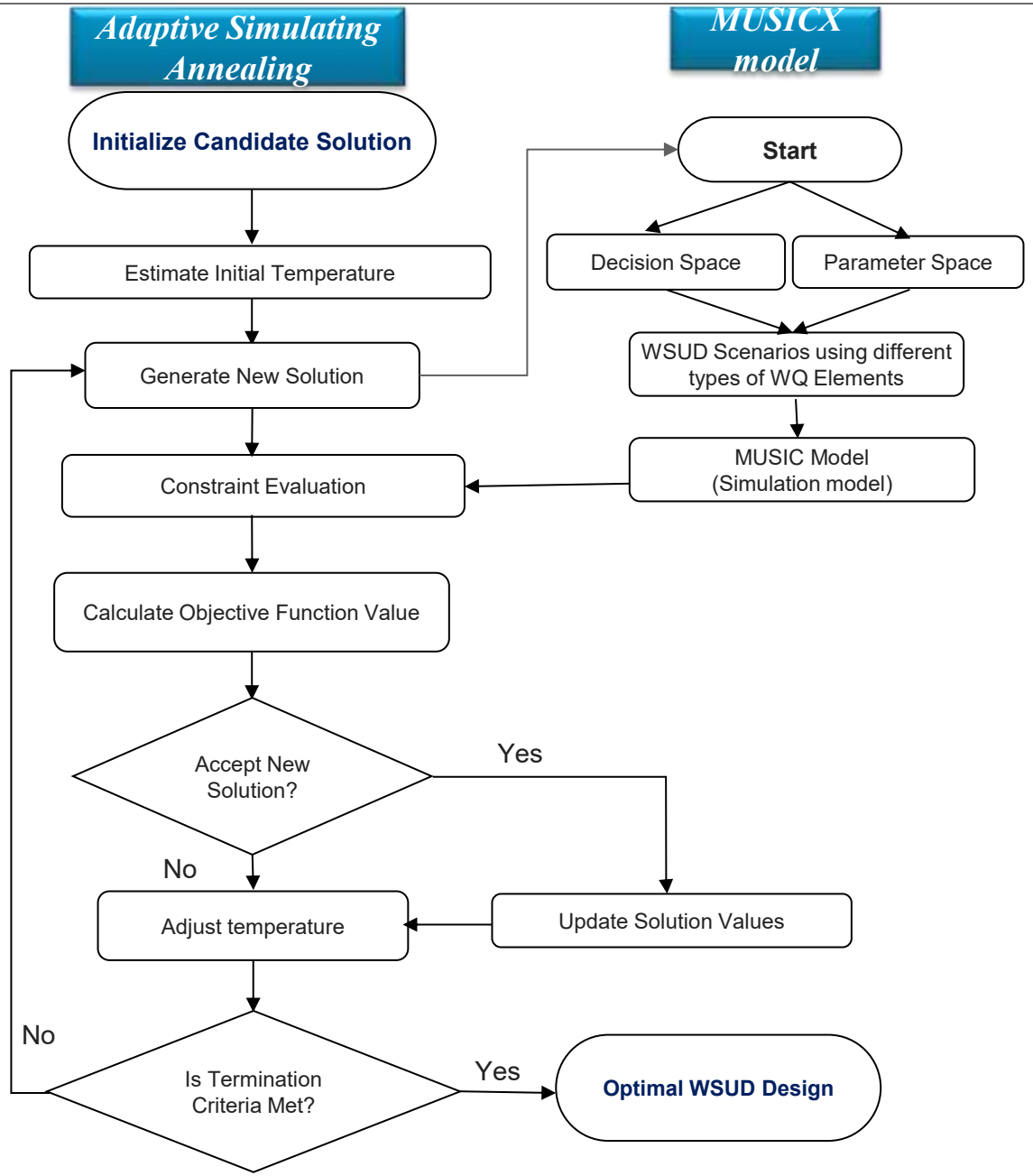
- Connected QGIS plugin with MUSICX
- Simulated stormwater flow + quality outcomes
- Incorporated climate resilience parameters

Scope of Scenarios

- Various number of development scenarios tested
- WSUD interventions: raingardens, wetlands, harvesting
- Limits considered: space, integration, synergies



Schematic linked simulation-optimization model



Modelling Process

- Unlimited MUSICX runs automated
- Machine learning optimisation
- Evaluated cost-effectiveness + meet the pollutant reduction targets

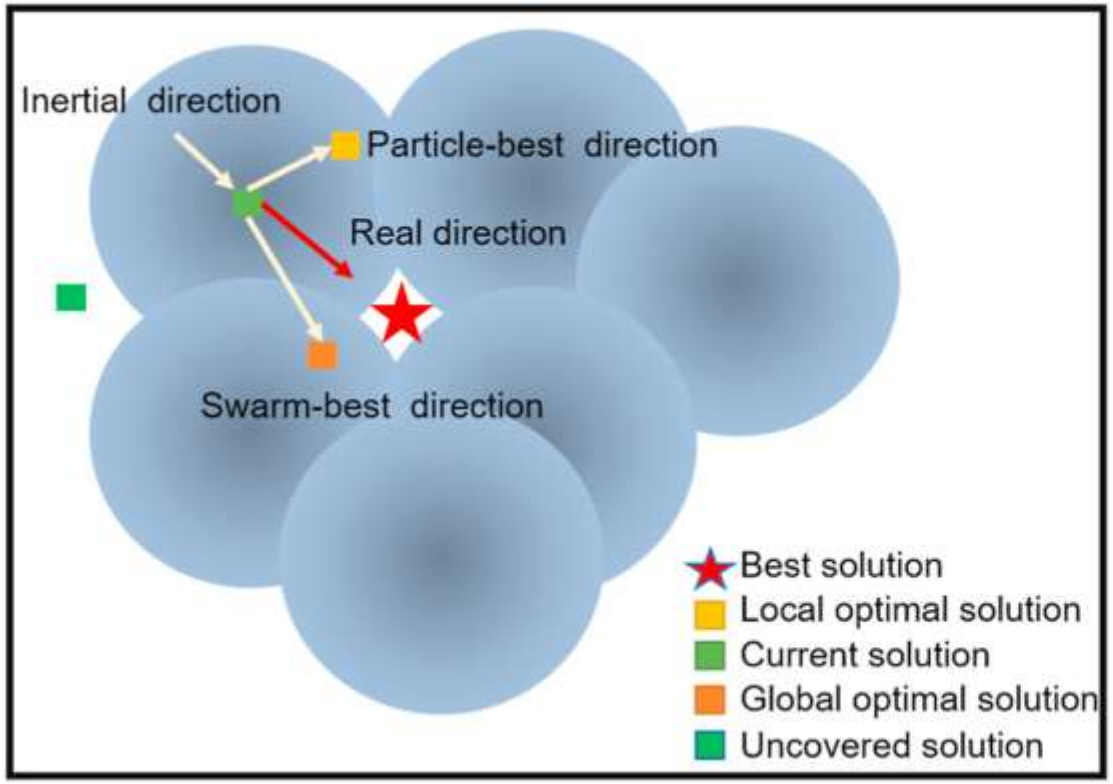
Dashboard & Visualisation

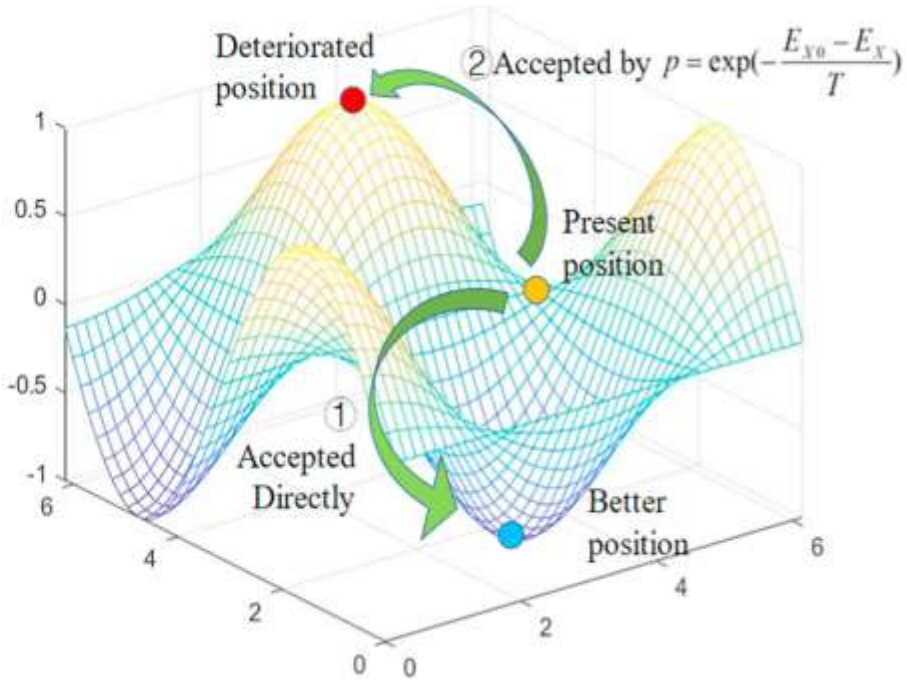
- Results in PowerBI dashboard
- User-friendly scenario comparison
- Clear communication for decision-makers

Benefits of Digital Approach

- Automated and faster modelling
- More accurate & transparent analysis
- Better trade-off decisions

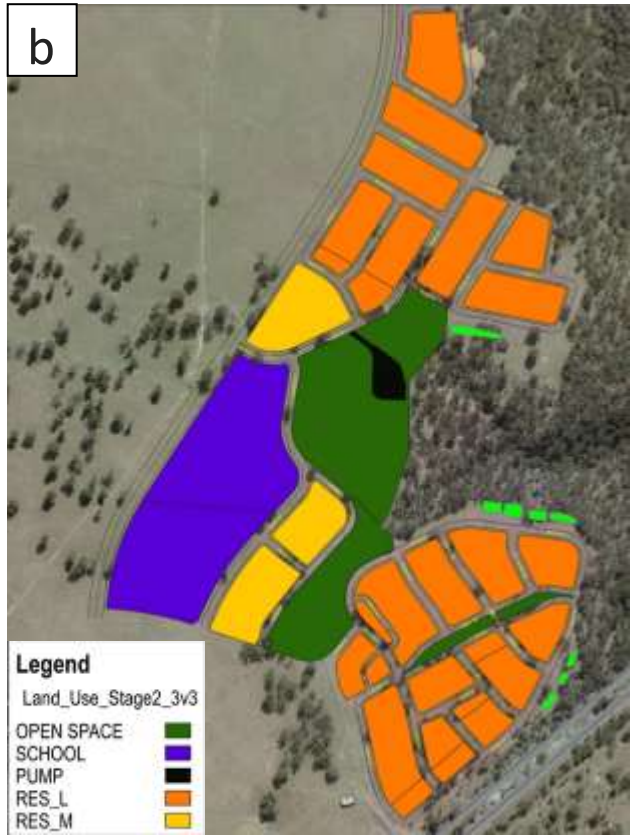
Adaptive Simulating Annealing (ASA) Optimisation Model





Source: Zhou, S., et al, 2021

Case Study



Site plan in a) existing condition, b) developed condition (Biffin and Hood, 2023). PUMP: The Pump station area; RES_L: Residential zone low density; RES_M: Residential zone medium density.

Integrated Water Management Strategy

Hybrid of these two is feasible

Table 4. Scenarios and key results

Scenario	BAU w BASIX	BASIX Plus	Almost Zero	Zero
Need for end of line WSUD	End of line WSUD	25% less space required for end of line WSUD	100% less space required for end of line WSUD	100% less space required for end of line WSUD
Rainwater tanks on each lot	2kl per lot	5 kL per lot	10 kL per lot	15 kL per lot
Use of rainwater tank water	Toilet and laundry	Toilet and laundry and outdoor and hot water	Toilet and laundry and outdoor and hot water	Everything but drinking, and leak to support baseflows
Streetscape design	Traditional	Traditional	Median swales	Median swales & fully disconnected
Runoff volume reduction	29%	36%	50%	79% (* this is near natural condition)
Potable demand reduction	40%	51%	63 %	72%
Other supply	Potable & third pipe	Potable & third pipe	Potable & third pipe	Potable
Precinct harvesting required	Yes	Yes	Yes	Only for large catchments
Zero impact	No	No	No	Yes

RWT not required

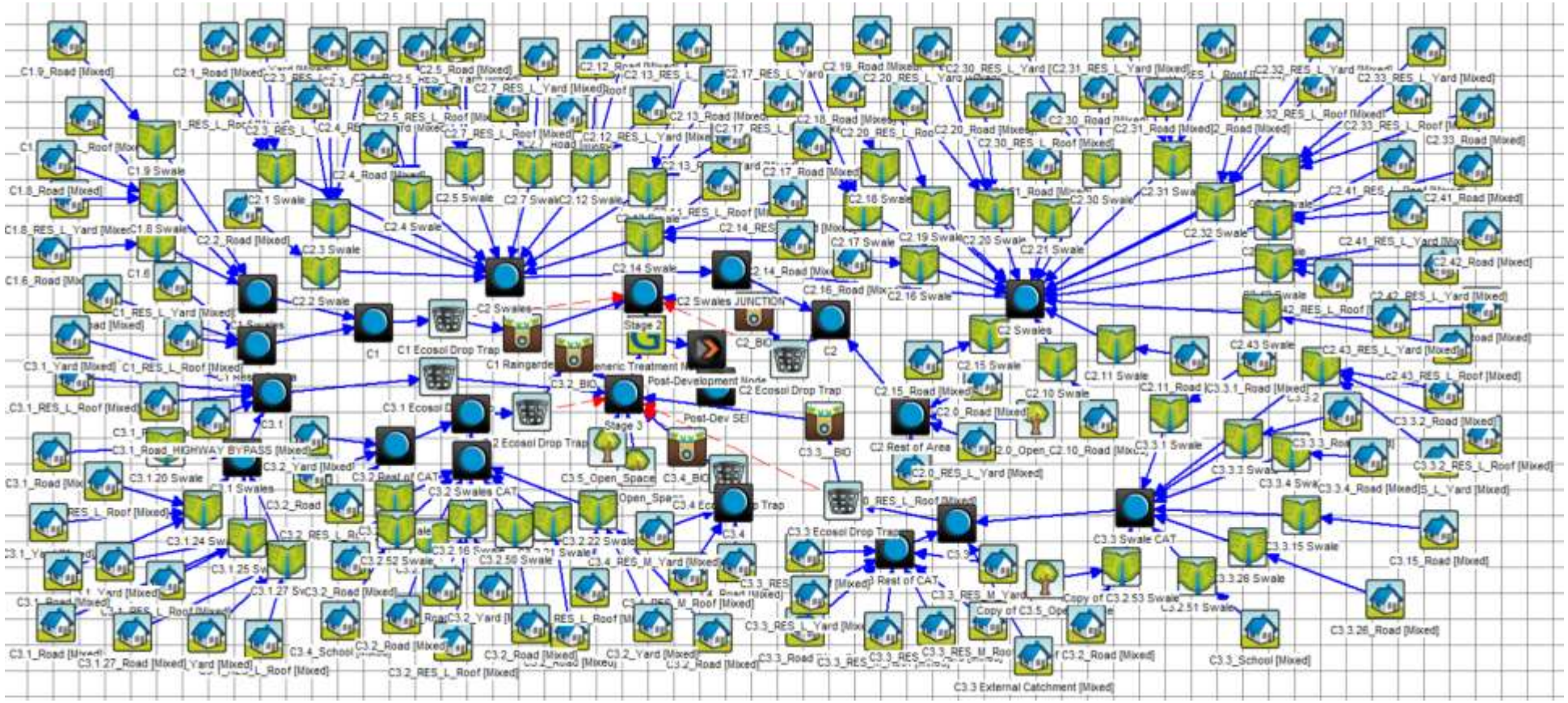
DCP requirement

IWMS Target Scenario

** Commercial / industrial developments that don't have ability to reuse water will require 5 to 7% of impervious area dedicated to linear vegetated infiltration systems (use of permeable pavements and nature strips will contribute to this)*

Concept Design Analysis

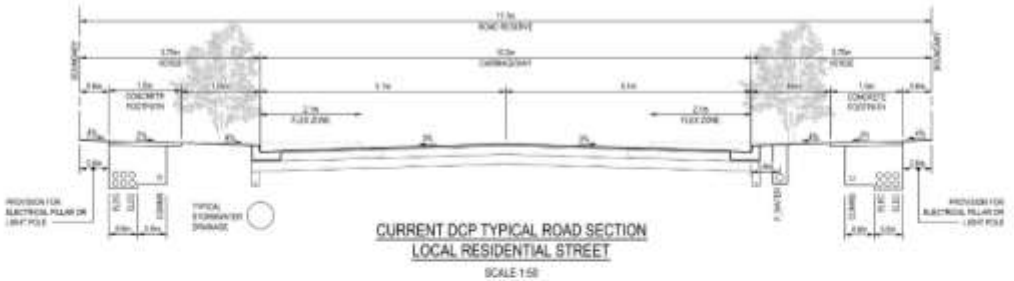
Concept Design Analysis

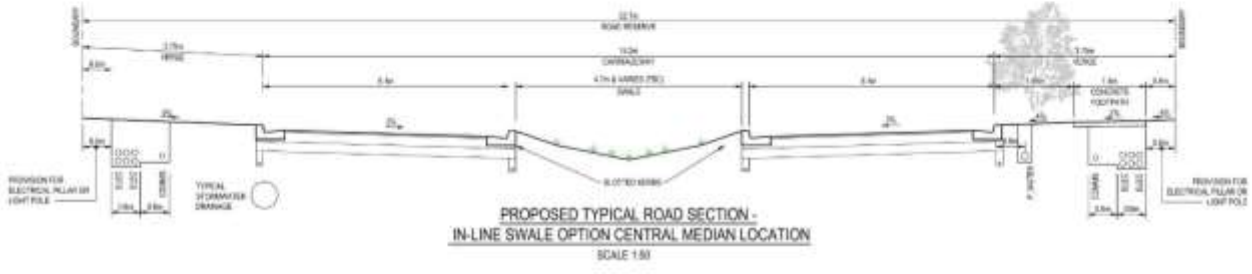


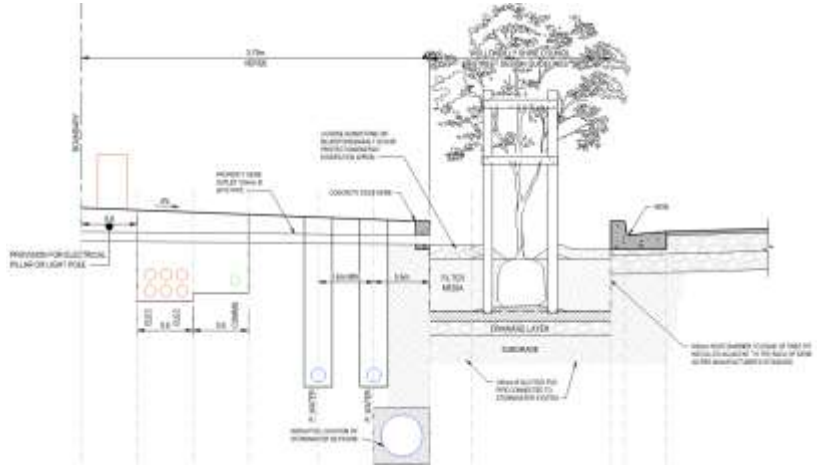
Pre-Development Stream Forming Flow (ML/yr)	Post-Development Stream Forming Flow (ML/yr)	Stream Erosion Index	DCP Target	IWMS Runoff Target (ML/ha/year)	IWMS Runoff Target for 50ha (ML/year)
47.9	38.4	< 1:1	1:1	2.5-3.5	125 – 150

Design & Construction Considerations

- Underground utilities (depth and standard arrangement)
- Utilities crossings to services lots on opposite side to main reticulation line
- Treated Water diversion (separate line to outlet?)
- Additional asset operations and maintenance
- Resident education (is the verge their asset to maintain?)

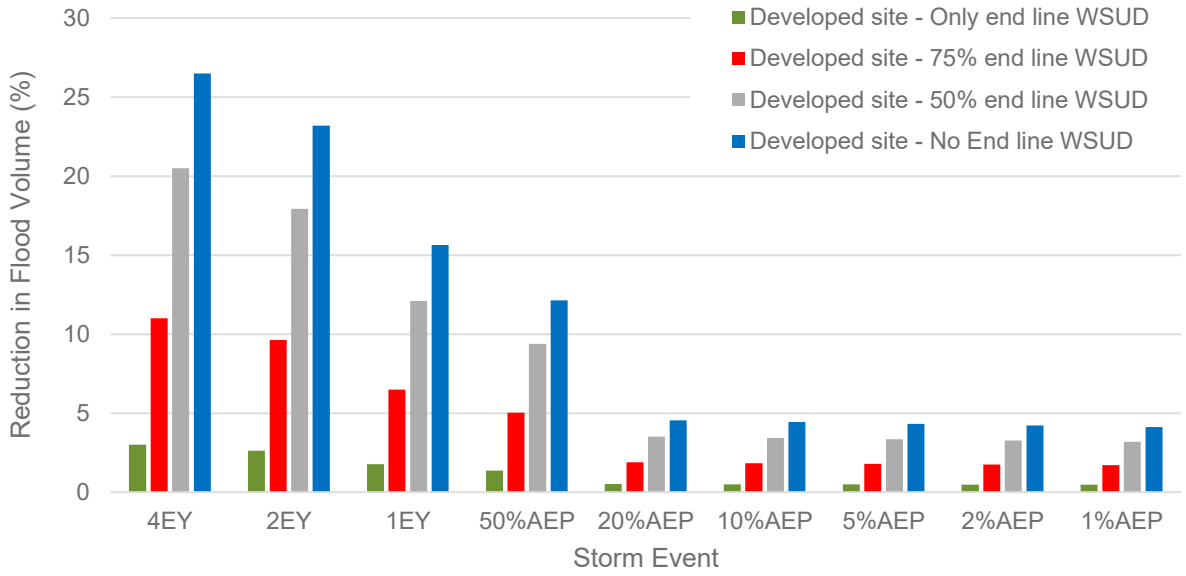




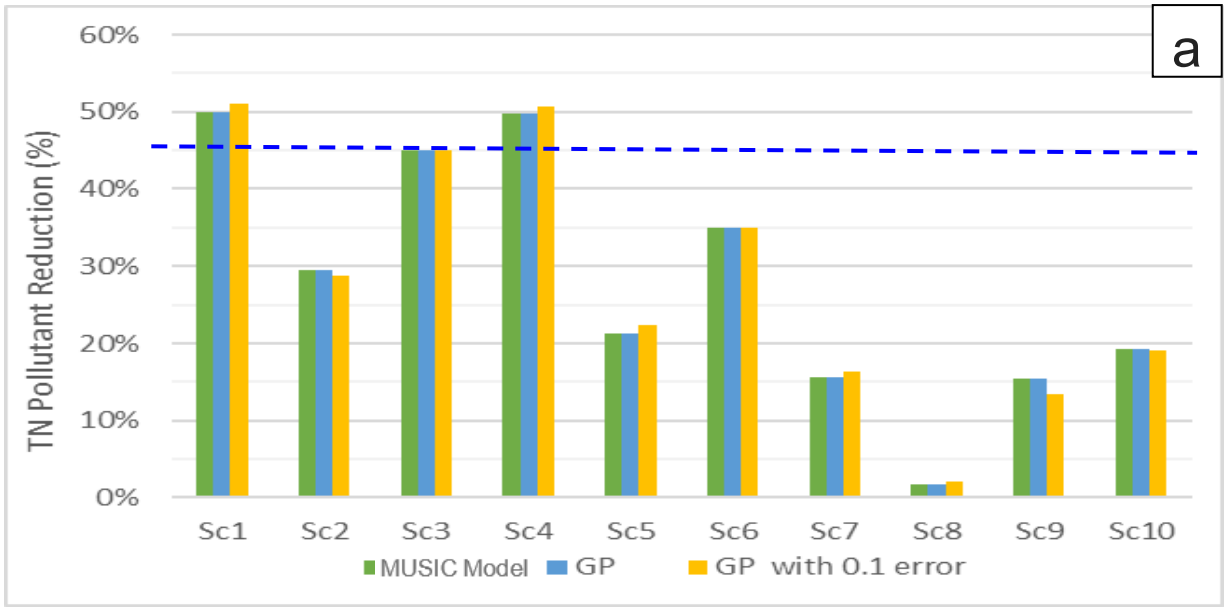


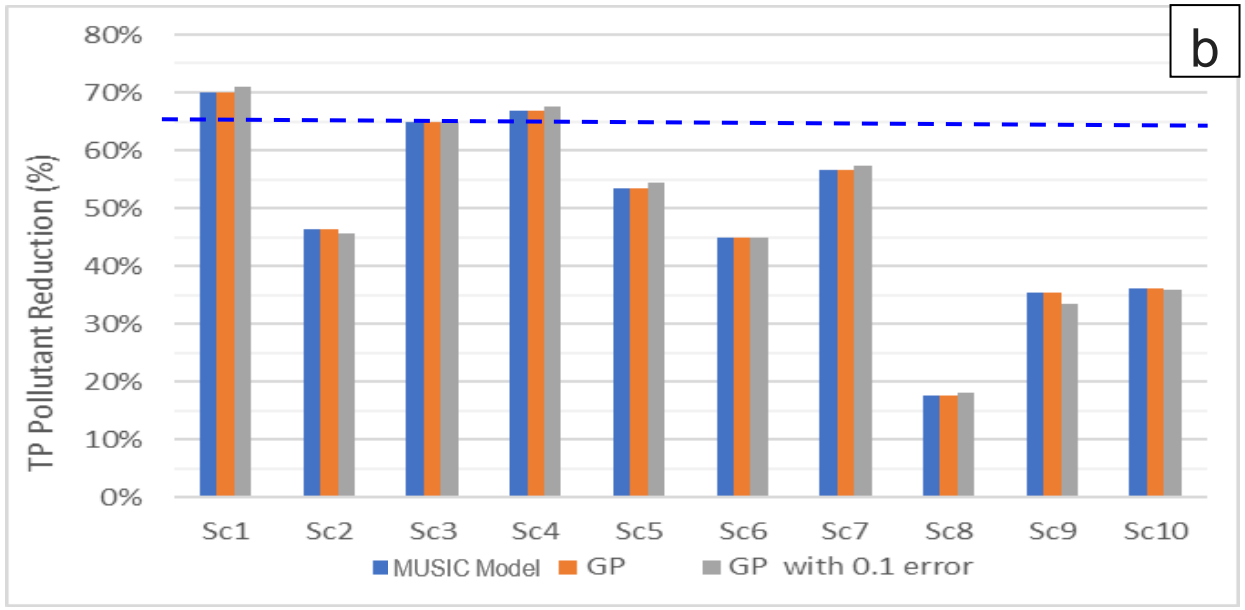
WSUD Options

- To reach the Water Quality targets need 5500 m^2 Bio-retention basins.
- Reduce End of Line Bio-retention Basins and add WSUD elements on urban areas.

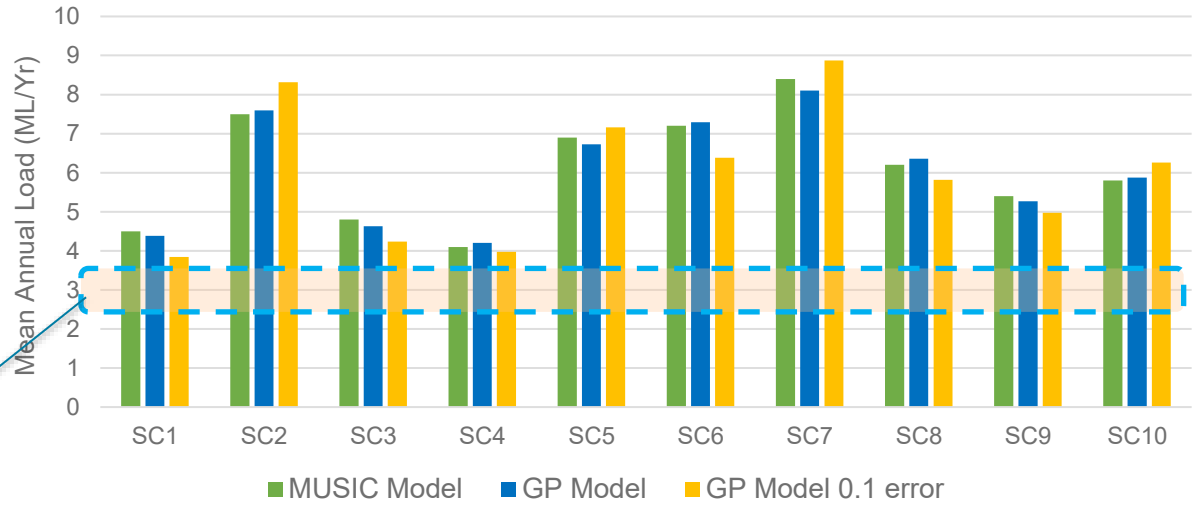


Results





Comparison TN (a), TP (b) reduction percentage and Mean Annual Load (ML/Yr) (c) of solution results between MUSIC model, GP surrogate models and uncertainty incorporated GP surrogate models with 10% error.



IWMS Runoff Target range (ML/ha/year)

Conclusion

- This study evaluated the performance of an Advanced approach of WSUD strategy in a real-life urban area to apply effective WSUD.
- The results effectively characterized WSUD in terms of type and location, highlighting the potential applicability WSUD in optimal locations.
- Effective performance of using plugin for complex hydraulic and hydrology processes in urban catchment areas, accommodating uncertainties in describing the system.
- Integrated approach: engineering + economics + digital tools
- Future-proofing cities against climate impacts

Thank you

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