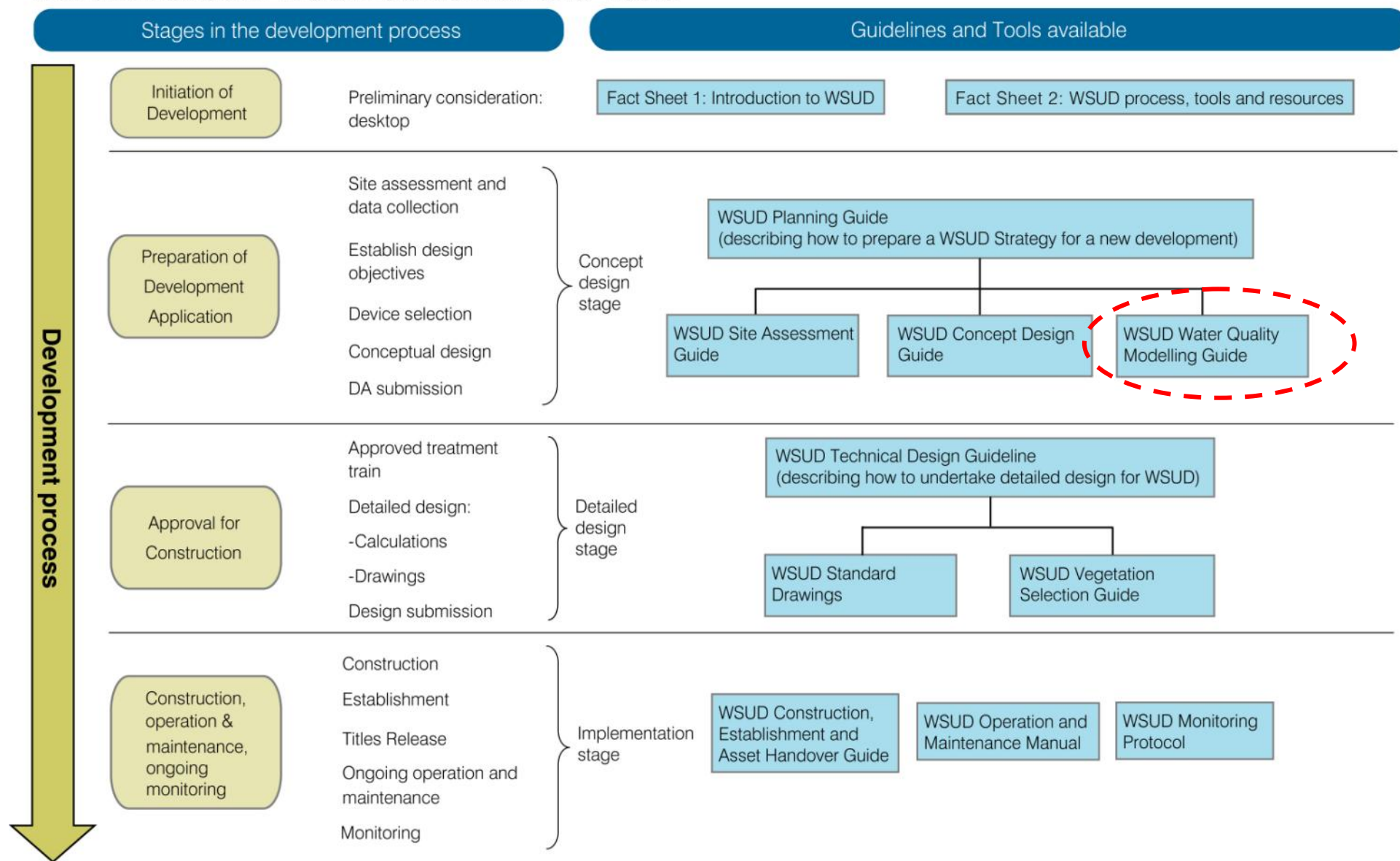




# MUSIC Modelling for Darwin



# Darwin Harbour WSUD Guidelines and Tools



# Need for Stormwater Quality Modelling

1. To predict or determine water quality from a specific catchment (land use)
2. Predict the relative performance of treatment systems
3. Evaluate the performance of treatment systems against specified standards

# Benefits of Stormwater Quality Modelling

- Urban catchments include multiple land uses and an extensive drainage network
- Every rainfall event is different
- Stormwater pollutant loads in stormwater are highly non-linear; pollutant loads depend partly on antecedent conditions but are also stochastic in nature
- There are typically a wide range of alternative management options
- Stormwater treatment performance depends on a large number of variables including antecedent rainfall and individual storm patterns

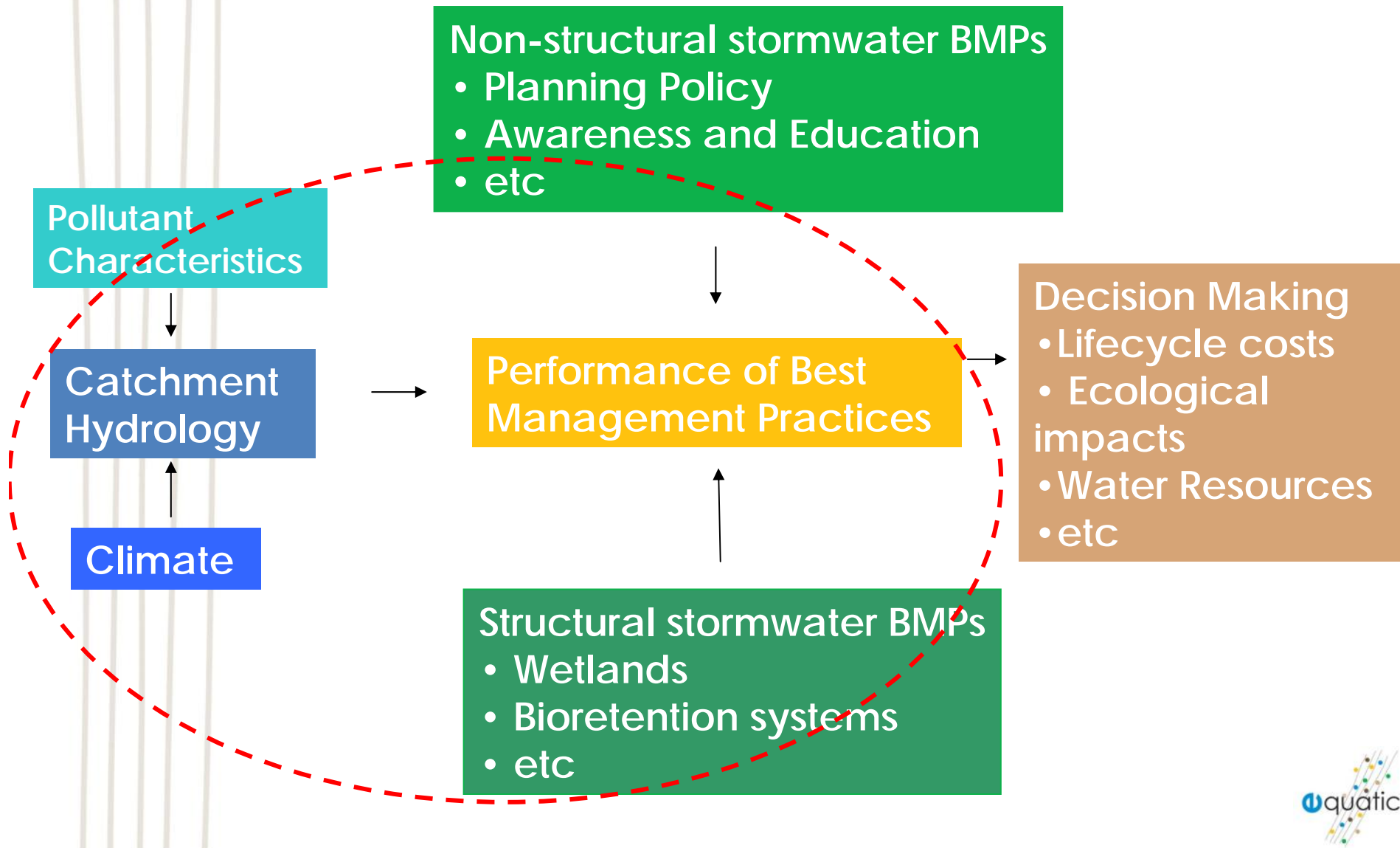
# Role of MUSIC

1. MUSIC is a concept design tool that is used for decision support primarily for stormwater management
2. MUSIC assists in the evaluation of concept designs of possible treatment systems
3. MUSIC assists in indicative size and layout of treatment systems
4. MUSIC is NOT a detailed design tool
5. MUSIC does not assist in design of stormwater drainage and has limited application for wastewater systems

# Need for Stormwater Quality Modelling

1. To predict or determine water quality from a specific catchment (land use)
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# Where does MUSIC Fit?



# Modelling Considerations

- **Runoff quality and quantity**
- **Spatial scale**
- **Temporal scale**
- **Data requirements**





## What is MUSIC?



MUSIC is a user friendly computer based system that enables users to evaluate the performance and cost of stormwater management options

- flow
- water quality
- lifecycle cost

Can model treatment measures including

- wetlands
- bioretention systems/rain gardens
- infiltration systems
- swales and buffers
- ponds & basins
- stormwater harvesting and reuse (including tanks & to some extent ASR)



## What is MUSIC?

- Models urban stormwater flow and quality
- Continuous simulation
- Range of spatial and temporal scales

Music functions through:

- Pollutant Generation Module
- Runoff Generation Module
- Pollutant Removal Module
- Lifecycle costing Module





## What is MUSIC Used For ?

- Stormwater Treatment
- Rainwater Harvesting and Reuse
- Stormwater Harvesting and Reuse
- Catchment Hydrology and Waterway Processes
- Lifecycle Costing
- Catchment Management/Planning





# Where to get MUSIC?



The screenshot shows the eWater Toolkit website. The header includes the 'Catchment Modelling TOOLKIT' logo and navigation links for Themes, Tools, Support, Search, and Login. A breadcrumb trail indicates the current location: Home > Tools > MUSIC. A 'Become a member' button is visible in the top right. The main content area is divided into a left sidebar and a main right section. The sidebar contains links for MUSIC Software (Download software, Access & licence fee, System requirements, Features and Limitations, History & credits), Support (Mailing list, Bugs, News and events, Documentation, Publications), and Contact information for eWater CRC (eWater Ltd.), including address, phone, fax, email, and website. The main section provides an Overview, Purpose, Target user group, Complexity, Example applications, and Overview of features, advantage and benefits for the MUSIC software.

**Catchment Modelling TOOLKIT**

Themes Tools Support Search Login

Home > Tools > MUSIC [Become a member](#)

**MUSIC**

**Software**

- [Download software](#)
- [Access & licence fee](#)
- [System requirements](#)
- [Features and Limitations](#)
- [History & credits](#)

**Support**

- [Mailing list](#)
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- [News and events](#)
- [Documentation](#)
- [Publications](#)

[MUSIC Home](#)

**Contact**

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**Overview**

[email to a friend](#) | [share](#)

**Purpose**

MUSIC is designed to simulate urban stormwater systems operating at a range of temporal and spatial scales; catchments from 0.01 km<sup>2</sup> to 100km<sup>2</sup> and modelling time steps ranging from 6 minutes to 24 hours to match the catchment scale.

**Target user group**

MUSIC is designed for urban stormwater engineers, planners, policy staff and managers in consultancies and state, regional and local government agencies.

**Complexity**

MUSIC is designed for use by a range of urban stormwater professionals. It requires a sound knowledge of urban stormwater management principles and practices. The MUSIC software, with its user-friendly interface and supporting documentation, enable users to quickly commence applying MUSIC to their own real applications.

**Example applications**

MUSIC has had widespread application around Australia, including:

- Melbourne Water is using MUSIC to plan future and assess land development proposals, and to design stormwater treatment strategies for new and existing drainage schemes. Application of MUSIC has resulted in significant savings on capital works, whilst still satisfying water quality criteria.
- Brisbane City Council uses MUSIC for urban catchment planning, and to design new stormwater treatment measures in Brisbane.
- Engineering consultants around Australia have used MUSIC to design urban development proposal, which meet Water Sensitive Urban Design standards.

**Overview of features, advantage and benefits**

MUSIC provides a user-friendly interface, to allow complex stormwater management scenarios to be quickly and efficiently created, and the results to be viewed using a range of graphical and tabular formats. This reduces the uncertainty surrounding the planning of stormwater management strategies, and may generate substantial cost-savings.

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**eWater CRC**

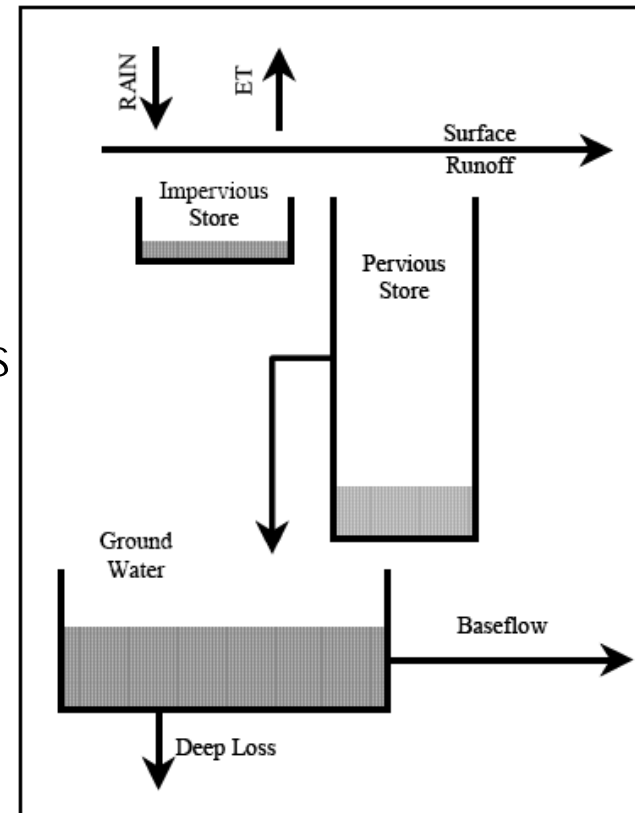
**quatica**

## Rainfall Runoff Process



# MUSIC rainfall runoff model and key parameters

- Rainfall Threshold (mm)
- Soil Capacity (mm)
- Initial Storage (%)
- Field Capacity
- Infiltration Capacity Coefficients
- Initial Depth (mm)
- Daily Recharge Rate (%)
- Daily Baseflow Rate (%)
- Deep Seepage (%)



# Runoff Parameters

Parameter	Recommended value
Rainfall Threshold (mm)	1
Soil Capacity (mm)	300
Initial Storage (%)	30
Field Capacity	250
Infiltration Capacity Coefficient a	200
Infiltration Capacity Coefficient b	1
Initial Depth (mm)	10
Daily Recharge Rate (%)	25
Daily Baseflow Rate (%)	5
Deep Seepage (%)	0

# Rainfall Runoff Model Notes

- Daily model with disaggregation
- In urban areas runoff dominated by impervious areas
  - Good estimate of catchment impervious important
- Relatively insensitive to pervious areas parameters
- Local Calibration??
- Routing?

Pollutant Generation Process

# Stormwater Quality Basics

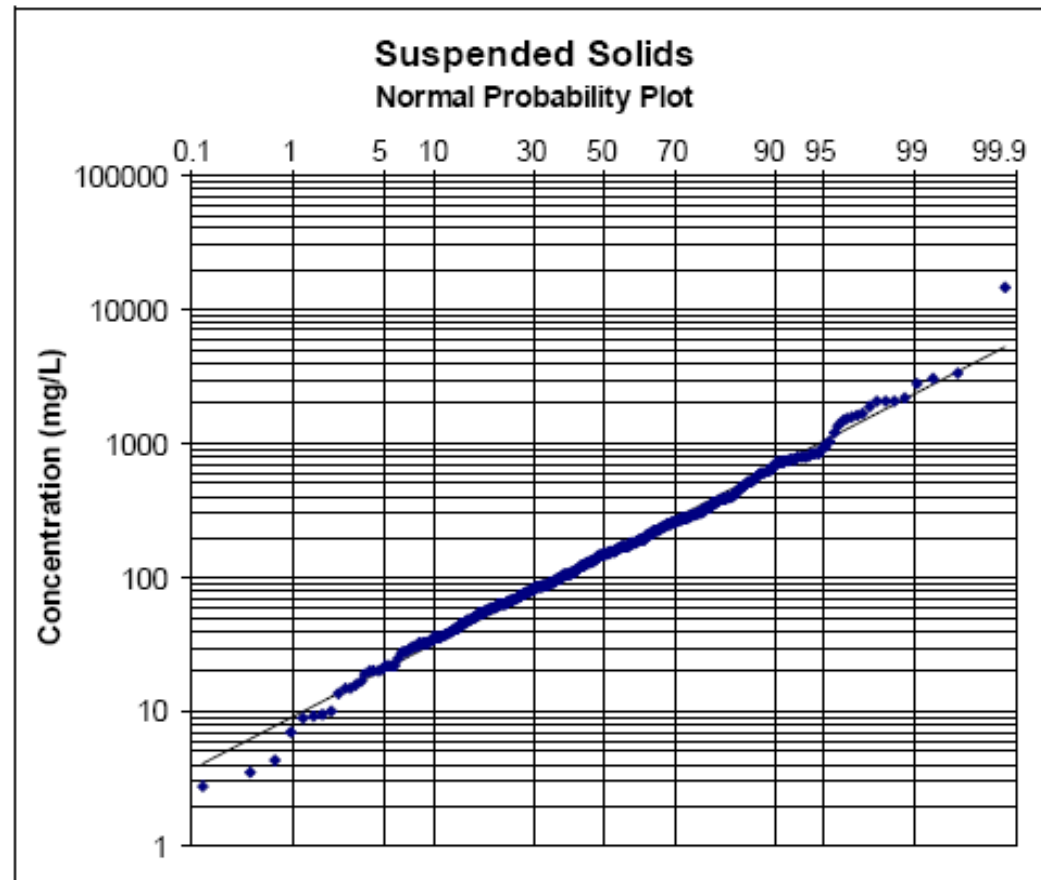


Figure 3.1 Suspended Solids Normal Probability Plot



# Stormwater Quality Basics

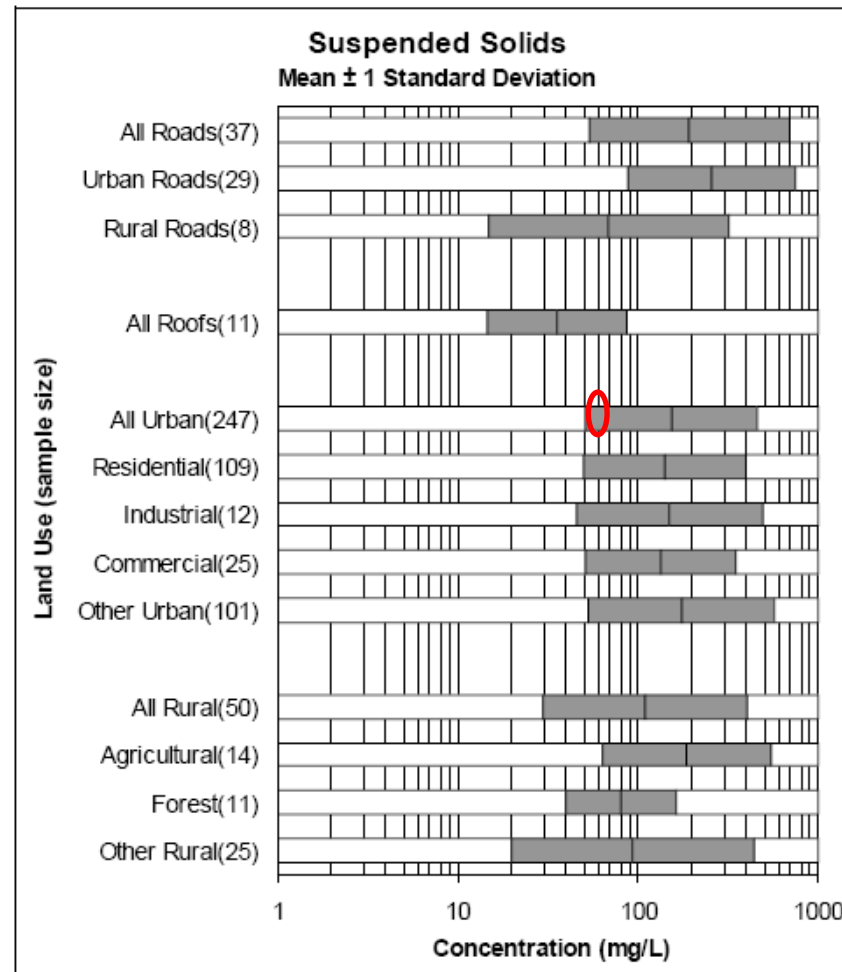


Figure 3.2 Suspended Solids Concentration vs Land Use

# Stormwater Quality

- Stormwater quality is stochastic
- Log-normal distribution
- MUSIC creates distributions using means and standard deviation inputs
- Default values have been determined for different land uses

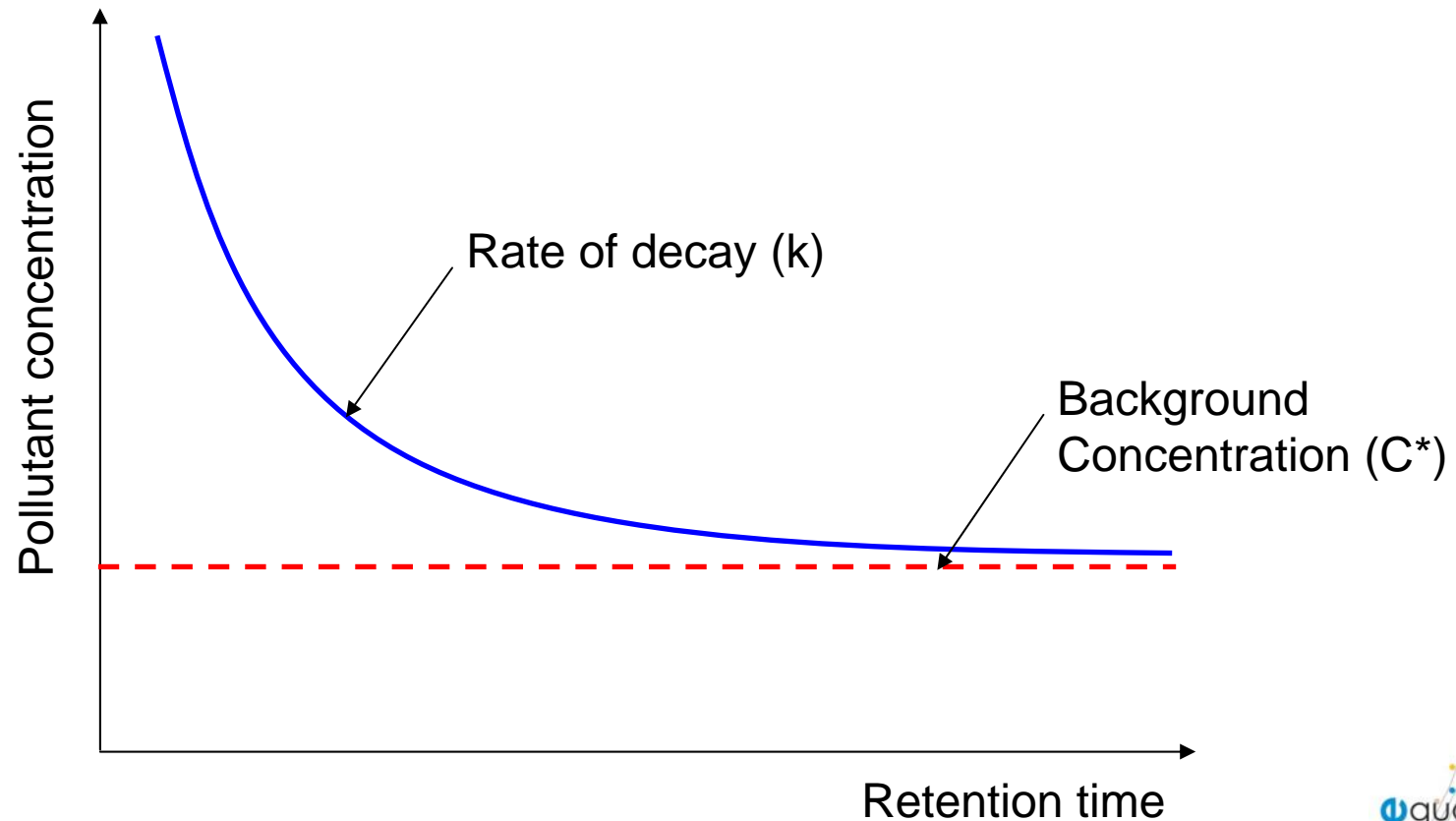
# Pollution Generation

Land-use category		Log10 TSS (mg/L)		Log10 TP (mg/L)		Log10 TN(mg/L)	
		Storm Flow	Base Flow	Storm Flow	Base Flow	Storm Flow	Base Flow
Forest	Mean Std Dev	1.90 0.20	0.9 0.13	-1.10 0.22	-1.5 0.13	-0.075 0.24	-0.14 0.13
Agriculture	Mean Std Dev	2.30 0.31	1.40 0.13	-0.27 0.30	-0.88 0.13	0.59 0.26	0.074 0.13
Roof Areas	Mean Std Dev	1.55 0.39	1.1 0.17	-0.92 0.29	-0.82 0.19	0.42 0.19	0.32 0.12
Road Reserves	Mean Std Dev	2.38 0.4	1.1 0.17	-0.6 0.5	-0.82 0.19	0.42 0.19	0.32 0.12
General Urban	Mean Std Dev	2.2 0.32	1.1 0.17	-0.45 0.25	-0.82 0.19	0.42 0.19	0.32 0.12

## Pollutant Removal Process

# Pollutant Removal Model

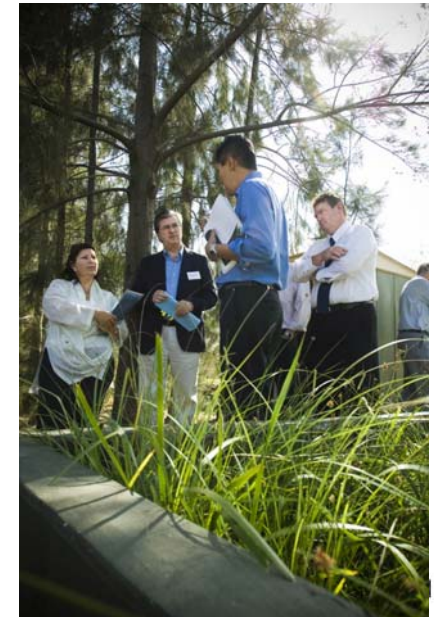
- First order kinetic Model ( $k$ - $C^*$  Model)
- $(C_{\text{out}} - C^*) / (C_{\text{in}} - C^*) = e^{-k/q}$





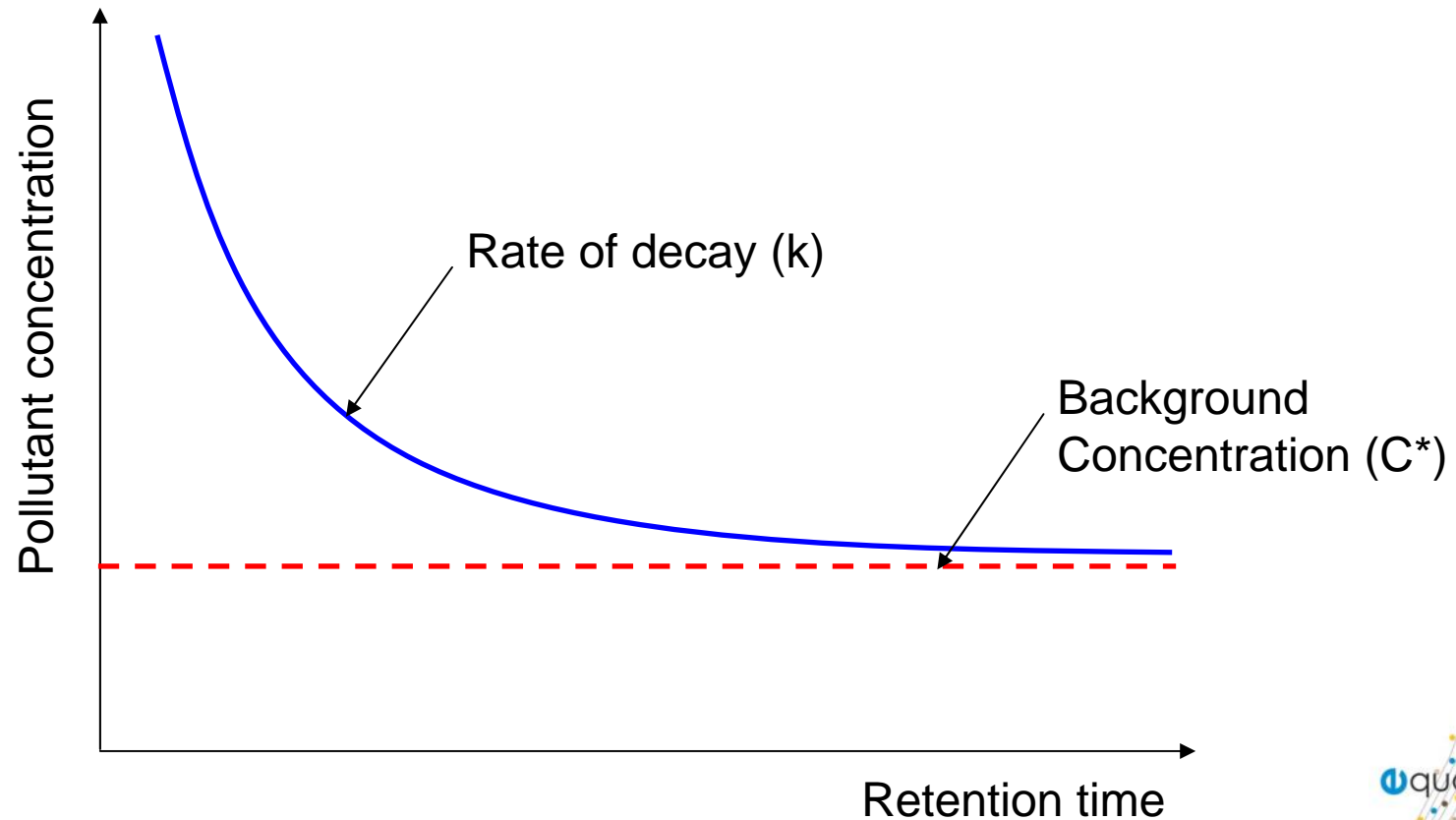






# Pollutant Removal Model

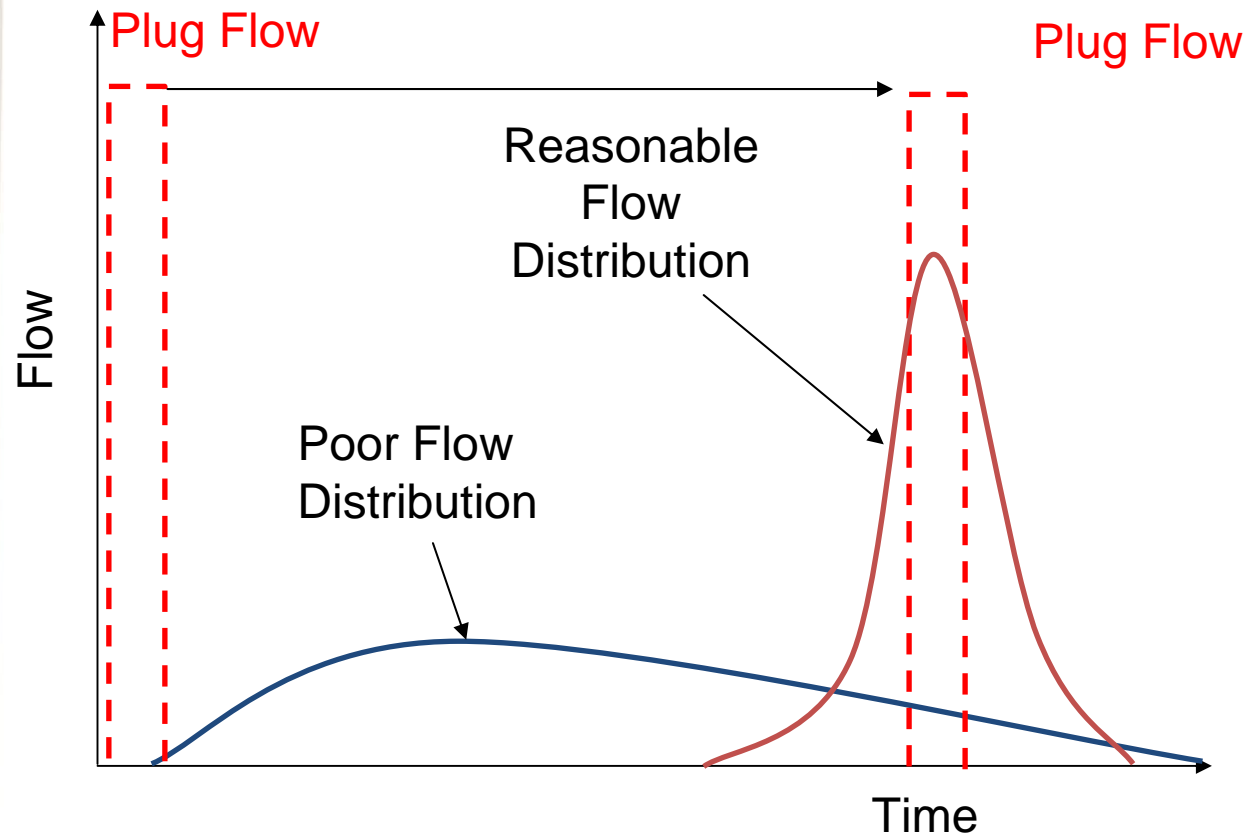
- Dependent on two factors: Areal loading rate and inflow concentration
- $(C_{\text{out}} - C^*) / (C_{\text{in}} - C^*) = e^{-k/q}$



# Continuously Stirred Tank Reactors

- Commonly used in chemical engineering processes
- Assumes that inflow is immediately and completely well mixed with the existing contents

# Continuously Stirred Tank Reactors





# Continuously Stirred Tank Reactors

- The hydraulic efficiency can be related to the number of CSTRs through this equation
  - Hydraulic Efficiency =  $1 - 1/(1 - N_{\text{CSTR}})$

Life Cycle Costing Module

# Lifecycle Costing

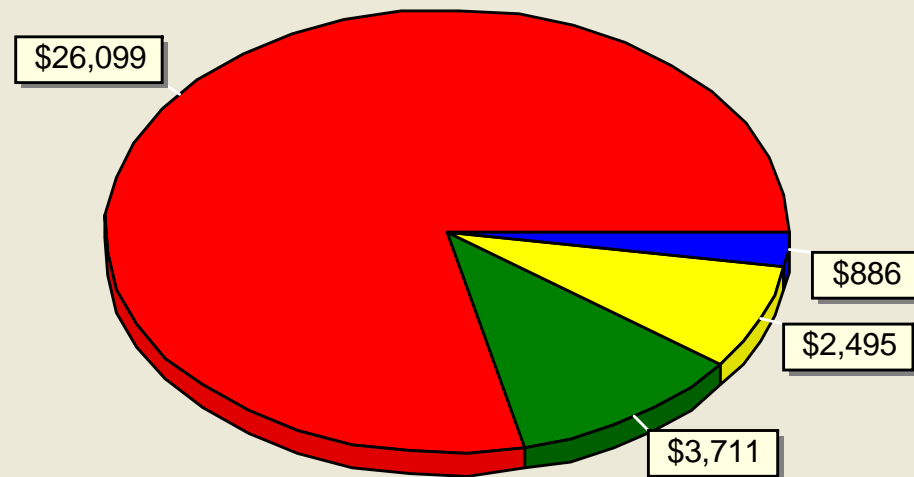
- A process to determine the sum of all expenses associated with a product or project including construction, installation, operation, maintenance, discarding and disposal costs
- Identifies all costs over life of system
- Accounts for time value of money
- Discounts costs back to given date (typically today)

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### Discounted Real Costs (\$2009)

Total Acquisition Cost	79 %
Sum of Annual Maintenance Costs	11 %
Sum of Renewal Costs	8 %
Decommissioning Cost	3 %



# Data for LCC Module

- Regression analysis of data collected around Australia
  - 6 states
  - 46 stormwater managers

