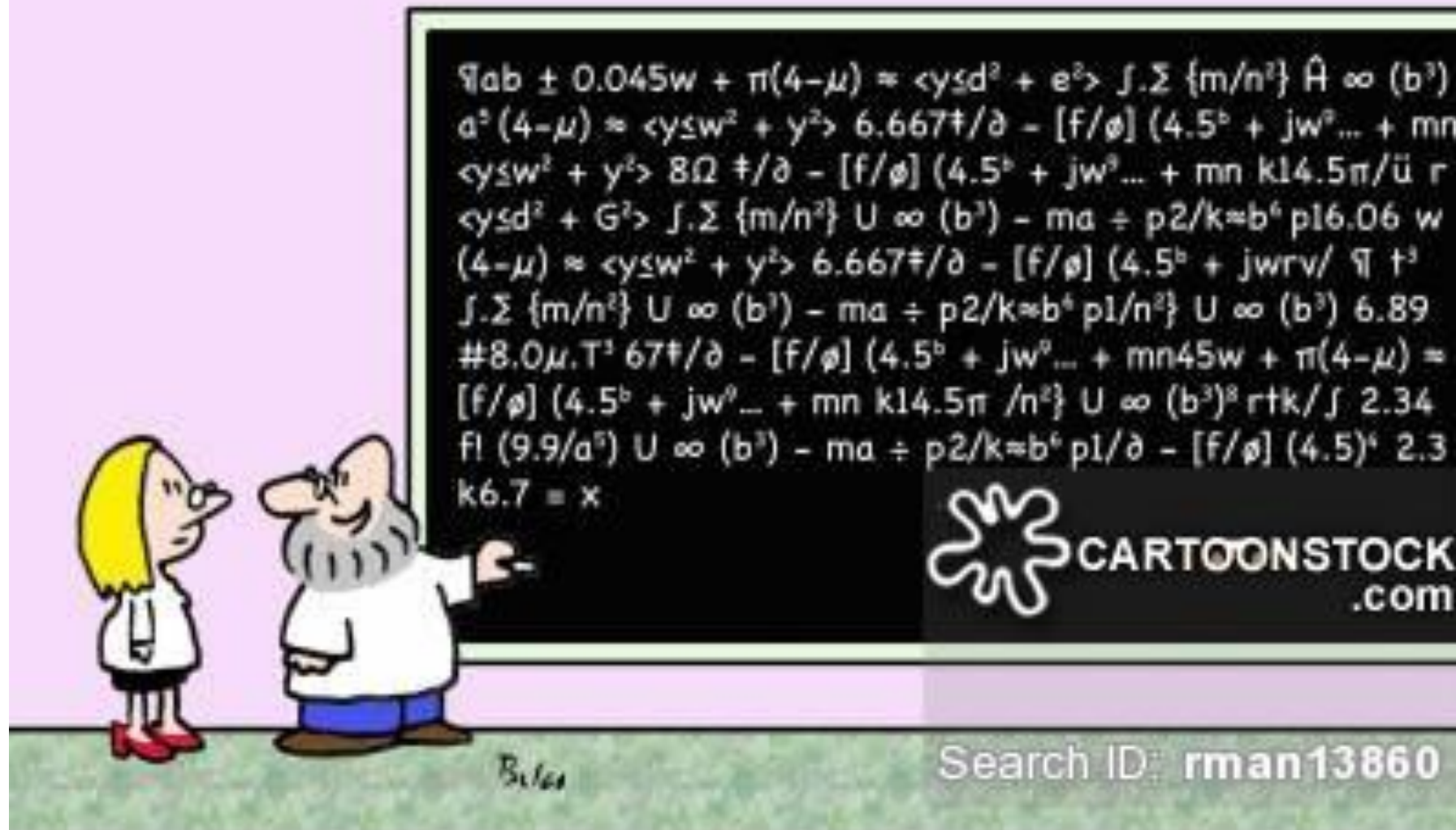




RORBwin

An enabling tool for ARR2016

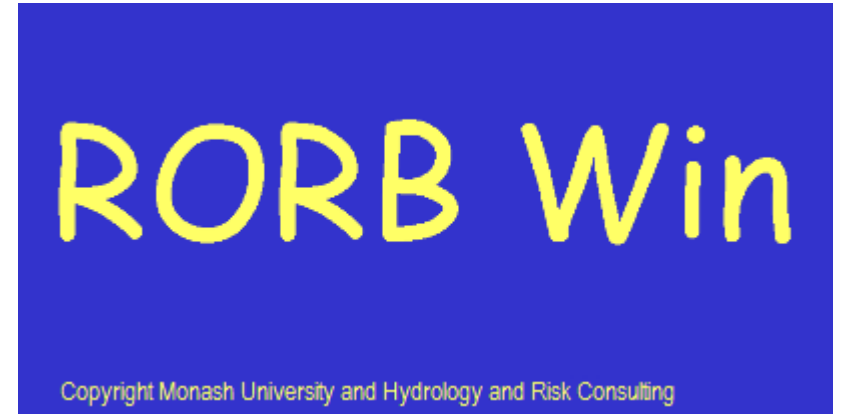
David Stephens
Hydrology and Risk Consulting



"...Therefore, we're in complete compliance with all federal guidelines."

Some background...

- RORBwin – rainfall runoff model
- Widely used in Victoria since late 1970s
- Originally developed by Laurenson and Mein (Monash Uni)
- Conceptual forebearer to numerous other modelling packages



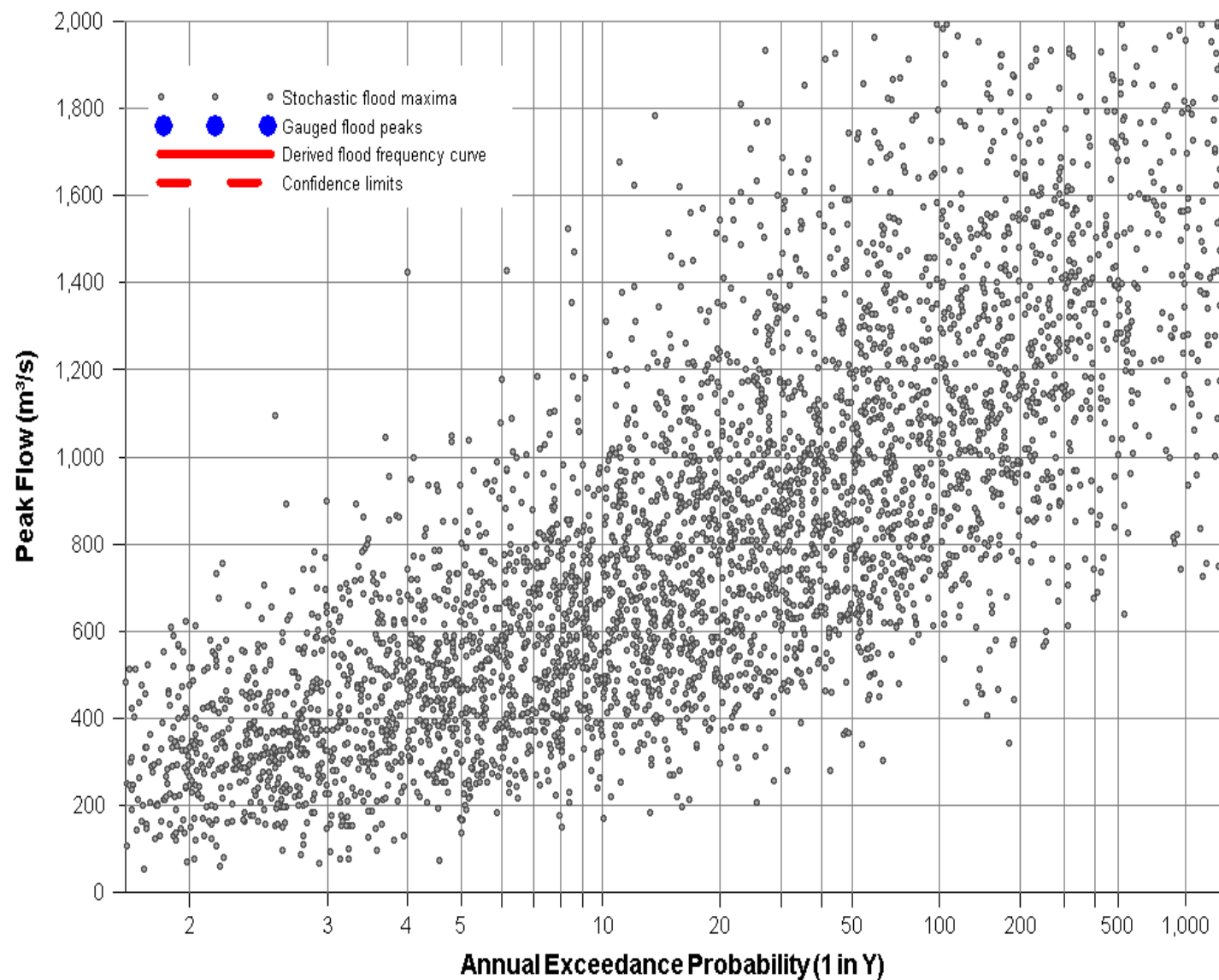
Why RORB?

- Simplicity!
- Pedigree and history of application
- Continual development process
- Preferred hydrologic model for a number of authorities
- GIS plug-ins
- Provided free of charge to industry

RORB – recent enhancements

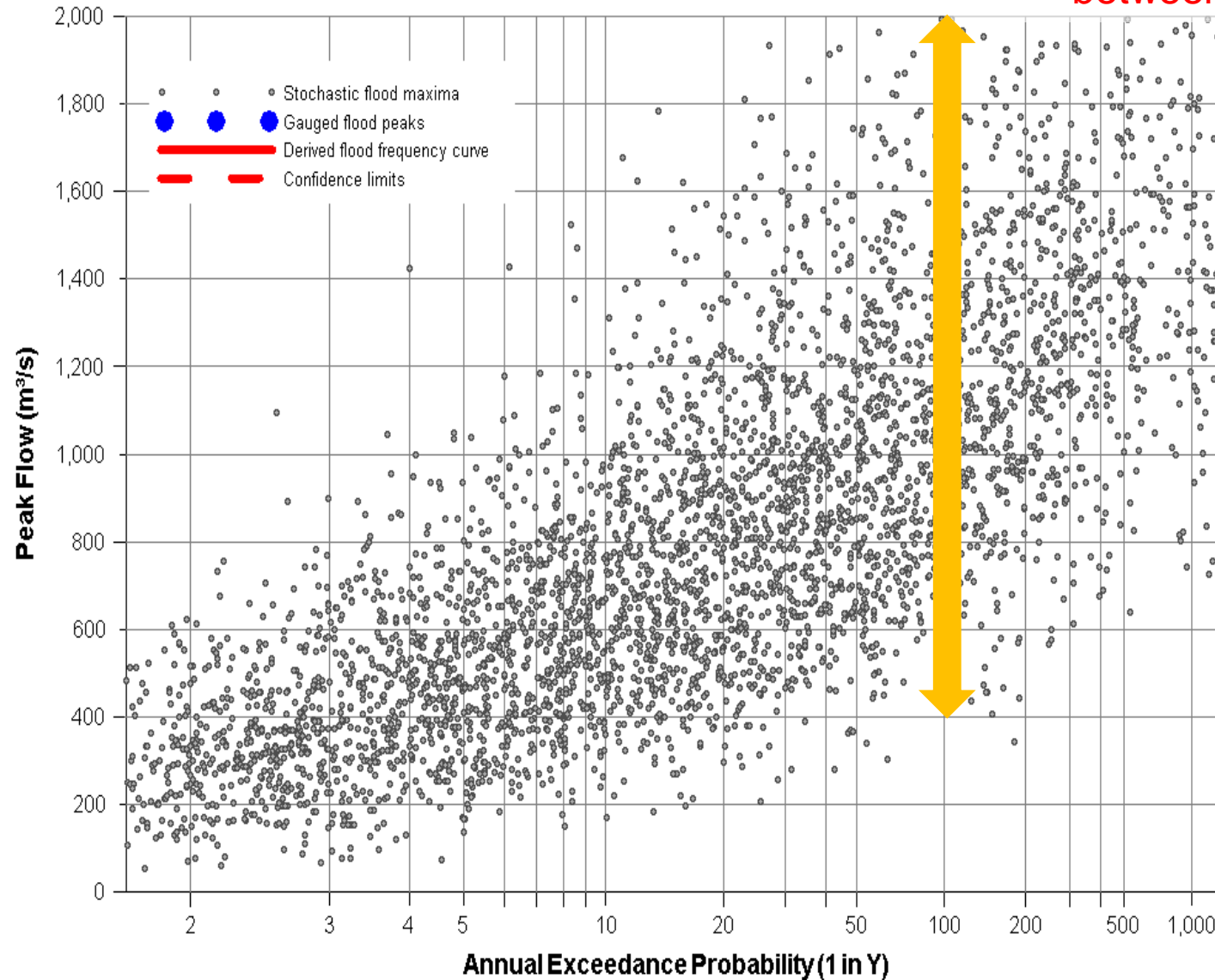
- Directly / indirectly connected impervious fractions
- Pre-burst rainfall
- Embedded burst filtering
- Automated extraction of median hydrographs

The nature of the problem

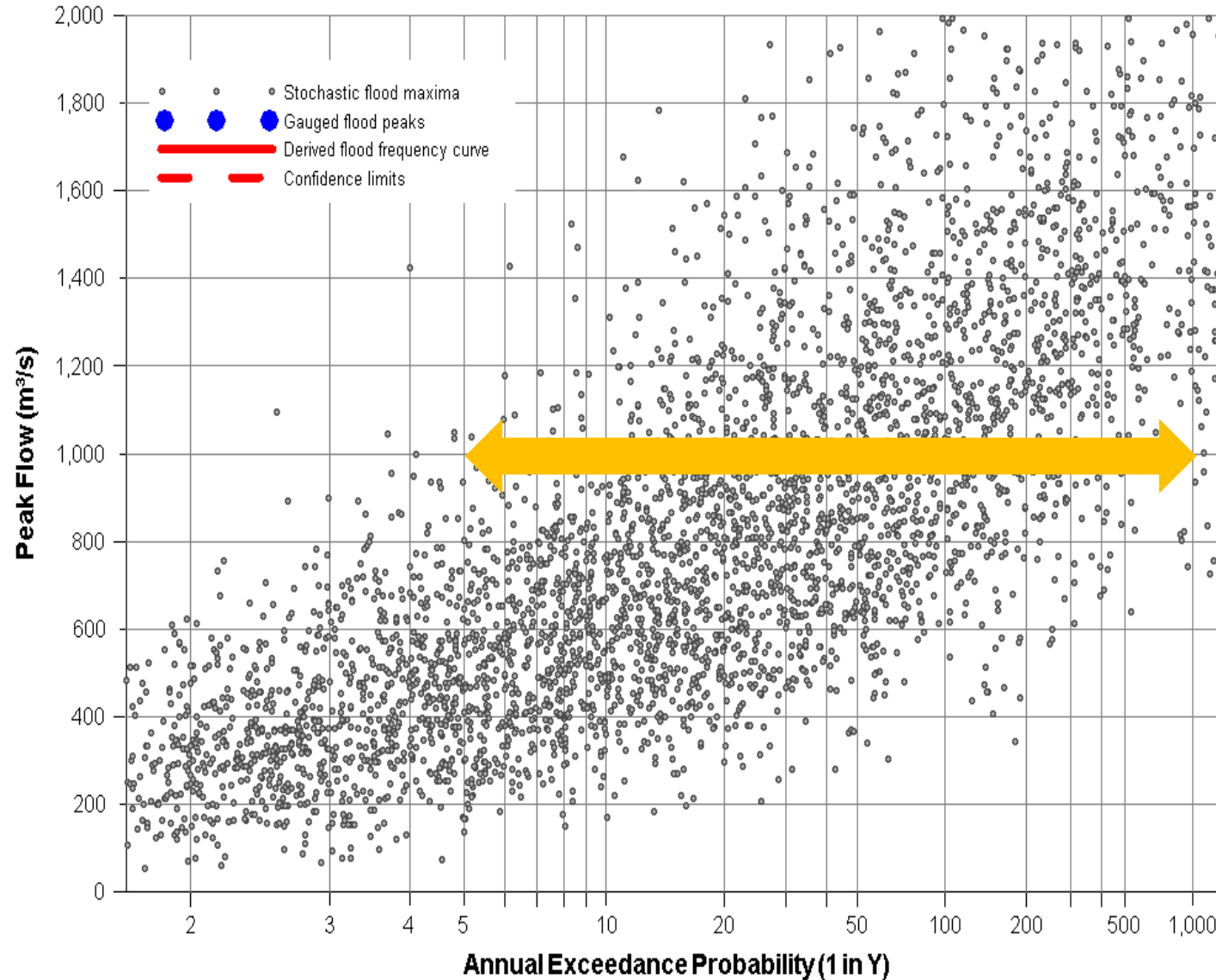


The nature of the problem

1% AEP rainfall could yield a flood
between 400 and 2,000 m³/s



The nature of the problem



1,000 m^3/s flood could result from a rainfall AEP that ranges between 20% and 0.1% AEP

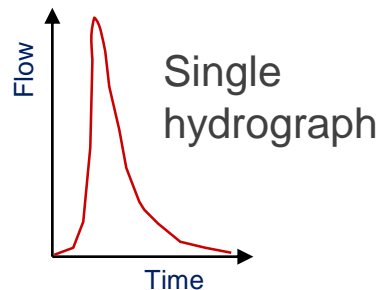
Modelling frameworks

Simple

Fixed loss, temporal & spatial patterns



Loss & routing models



Ensemble

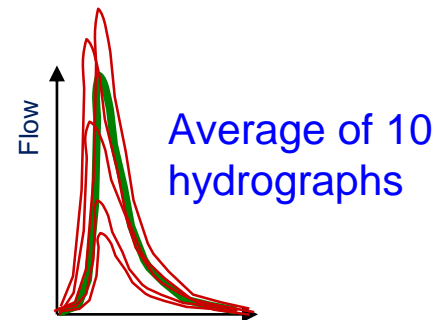
Vary temporal pattern



All other inputs fixed



Loss & routing models



Monte Carlo

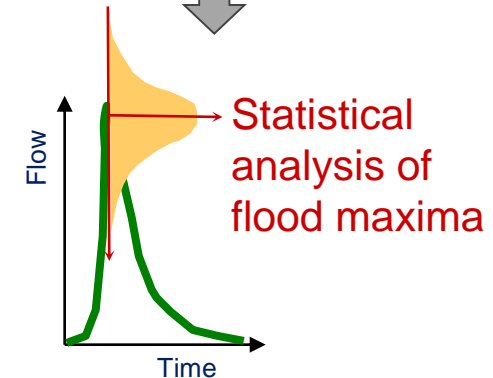
Vary all major factors



All other inputs fixed



Loss & routing models

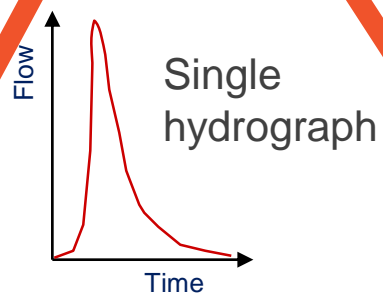
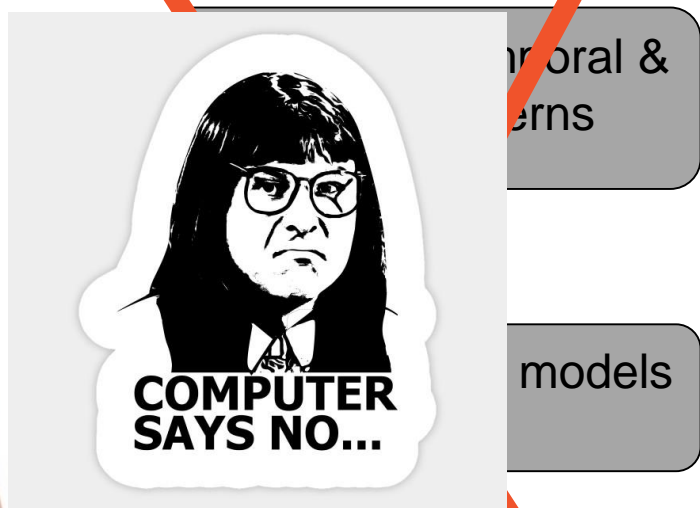


Modelling frameworks

Simple

Ensemble

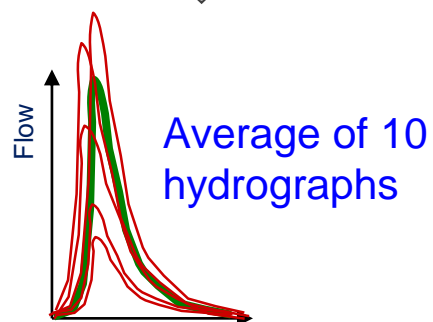
Monte Carlo



Vary temporal pattern

All other inputs fixed

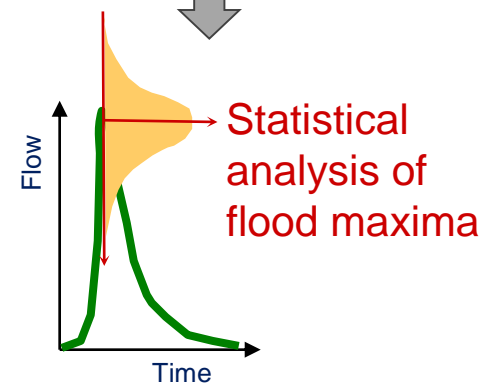
Loss & routing models



Vary all major factors

All other inputs fixed

Loss & routing models



Where to from here?

- RORB has been carefully developed to make implementation of ensemble and MC easy
- Reads IFD and Data Hub text files
- Ensembles don't need to be 10x the work!

I THOUGHT I WAS
INTERESTED IN UNCERTAINTY
BUT NOW I'M NOT SO SURE



Data sources

- IFD data – still available from BoM website
- Download as csv file and read into RORB
- Editable in Excel
- Some manual manipulation required if using AEPs rarer than 1%
- <http://www.bom.gov.au/water/designRainfalls/revised-ifd/?year=2016>



2016 Rainfall IFD Data System

[Help](#) | [New IFD feedback](#)

You have accepted the [Conditions of Use](#) and the [Coordinates Caveat](#).

[New Search >](#)

[Analysis](#)

Design Rainfalls

- ☐ Very Frequent
☒ IFDs (Frequent and Infrequent)
☐ Rare

Standard Durations

- ☒ 1 - 30 minutes
☒ 1 - 12 hours
☒ 24 - 168 hours

Non-Standard Durations

Duration: [minutes](#) [+](#)

Update

Reset

Location

Label: Not provided

Latitude: -37.94 [Nearest grid cell: 37.9375 (S)]

Longitude: 145.22 [Nearest grid cell: 145.2125 (E)]



IFD Design Rainfall Depth (mm)

Issued: 15 May 2018

Rainfall depth for Durations, Exceedance per Year (EY), and Annual Exceedance Probabilities (AEP).
[FAQ for New ARR probability terminology](#)

Table

Chart

Unit: [mm](#)

Duration	Annual Exceedance Probability (AEP)						
	63.2%	50%#	20%*	10%	5%	2%	1%
1 min	1.56	1.76	2.43	2.91	3.42	4.12	4.70
2 min	2.70	3.02	4.08	4.85	5.59	6.48	7.18
3 min	3.62	4.06	5.50	6.54	7.57	8.85	9.86
4 min	4.39	4.93	6.73	8.01	9.31	11.0	12.4
5 min	5.06	5.69	7.79	9.31	10.9	12.9	14.6
10 min	7.46	8.43	11.7	14.0	16.5	20.1	23.0
15 min	8.88	10.2	14.2	17.2	20.2	24.7	28.2



2016 Rainfall IFD Data System

[Help](#) | [New IFD feedback](#)

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[Update](#)

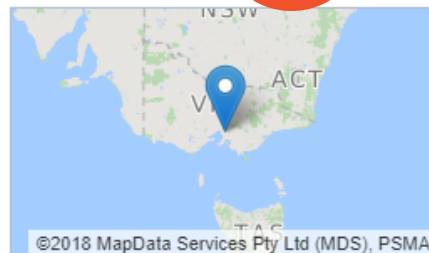
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[Table](#)

[Chart](#)

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3 min	3.62	4.06	5.50	6.54	7.57	8.85	9.86
4 min	4.39	4.93	6.73	8.01	9.31	11.0	12.4
5 min	5.06	5.69	7.79	9.31	10.9	12.9	14.6
10 min	7.46	8.43	11.7	14.0	16.5	20.1	23.0
15 min	8.88	10.2	14.2	17.2	20.2	24.7	28.2

Download to text file



2016 Rainfall IFD Data System

[Help](#) | [New IFD feedback](#)

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[New Search >](#)

[Analysis](#)

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- ☒ IFDs (Frequent and Infrequent)
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Standard Durations

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- ☒ 1 - 12 hours
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Non-Standard Durations

Duration: minutes +

Update

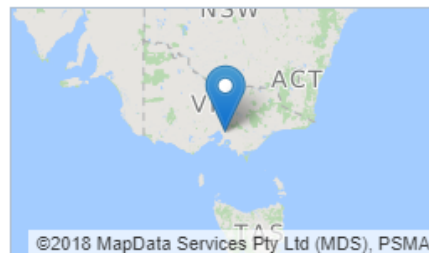
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10 min	7.46	8.43	11.7	14.0	16.5	20.1	23.0
15 min	8.88	10.2	14.2	17.2	20.2	24.7	28.2

Rare AEPs

Data sources

- ARR Data Hub
 - Areal reduction factors
 - Temporal patterns
 - Pervious area losses
 - Pre-burst depths
- Download as text file and CSV file and read into RORB
- No editing required
- <http://data.arr-software.org/>

Australian Rainfall & Runoff Data Hub - Results

Input Data

Longitude	145.22
Latitude	-37.94
Selected Regions (clear)	
Temporal Patterns	show
Areal Temporal Patterns	show



Region Information

Data Category	Region
River Region	Bunyip River
ARF Parameters	Southern Temperate
Temporal Patterns	Southern Slopes (Vic/NSW)

Data

Storm Losses

Note: Burst Loss = Storm Loss - Preburst

Note: These losses are only for rural use and are NOT FOR USE in urban areas

Storm Initial Losses (mm)	23.0
Storm Continuing Losses (mm/h)	3.8

Layer Info

Time Accessed	15 May 2018 09:18AM
Version	2016_v1

Temporal Patterns | [Download \(.zip\)](#)

code	SSmainland
Label	Southern Slopes (Vic/NSW)

Layer Info

Time Accessed	15 May 2018 09:18AM
Version	2016_v2

Areal Temporal Patterns | [Download \(.zip\)](#)

code	SSmainland
arealabel	Southern Slopes (Vic/NSW)

Layer Info

Time Accessed	15 May 2018 09:18AM
Version	2016_v2

[Download TXT](#)[Download PDF](#)

Australian Rainfall & Runoff Data Hub - Results

Input Data

Longitude	145.22
Latitude	-37.94
Selected Regions (clear)	
Temporal Patterns	show
Areal Temporal Patterns	show



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Data Category	Region
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Label	Southern Slopes (Vic/NSW)

Layer Info

Time Accessed	15 May 2018 09:18AM
Version	2016_v2

Areal Temporal Patterns | [Download \(.zip\)](#)

code	SSmainland
arealabel	Southern Slopes (Vic/NSW)

Layer Info

Time Accessed	15 May 2018 09:18AM
Version	2016_v2



Download losses, pre-burst and ARFs to text file



Australian Rainfall & Runoff Data Hub - Results

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Latitude	-37.94
Selected Regions (clear)	
Temporal Patterns	show
Areal Temporal Patterns	show



Region Information

Data Category	Region
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Storm Continuing Losses (mm/h)	3.8	Version	2016_v1

Layer Info

Temporal Patterns | [Download \(.zip\)](#)

code	SSmainland	Version	2016_v2
Label	Southern Slopes (Vic/NSW)		

Download point temporal patterns to CSV file
Need the “_increments.csv” file

Areal Temporal Patterns | [Download \(.zip\)](#)

code	SSmainland	Time Accessed	15 May 2018 09:18AM
arealabel	Southern Slopes (Vic/NSW)	Version	2016_v2

[Download TXT](#) [Download PDF](#)

Australian Rainfall & Runoff Data Hub - Results

Input Data

Longitude	145.22
Latitude	-37.94
Selected Regions (clear)	
Temporal Patterns	show
Areal Temporal Patterns	show



Region Information

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Layer Info

Time Accessed	15 May 2018 09:18AM
Version	2016_v1

Temporal Patterns | [Download \(.zip\)](#)

code	SSmainland
Label	Southern Slopes (Vic/NSW)

Layer Info

Time Accessed	15 May 2018 09:18AM
Version	2016_v2

Areal Temporal Patterns | [Download \(.zip\)](#)

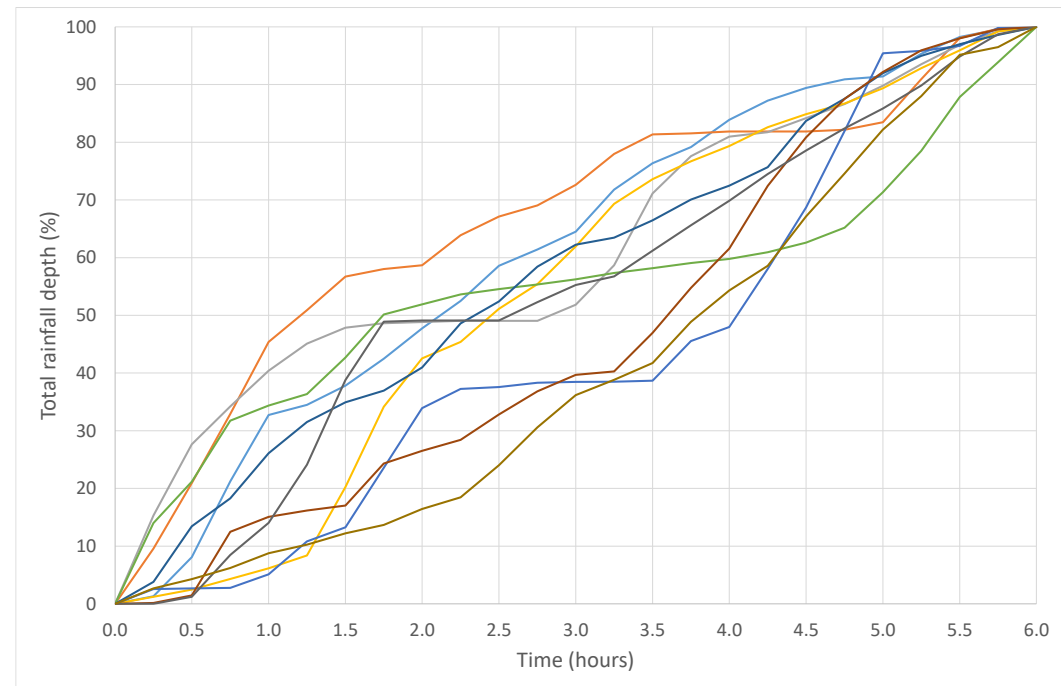
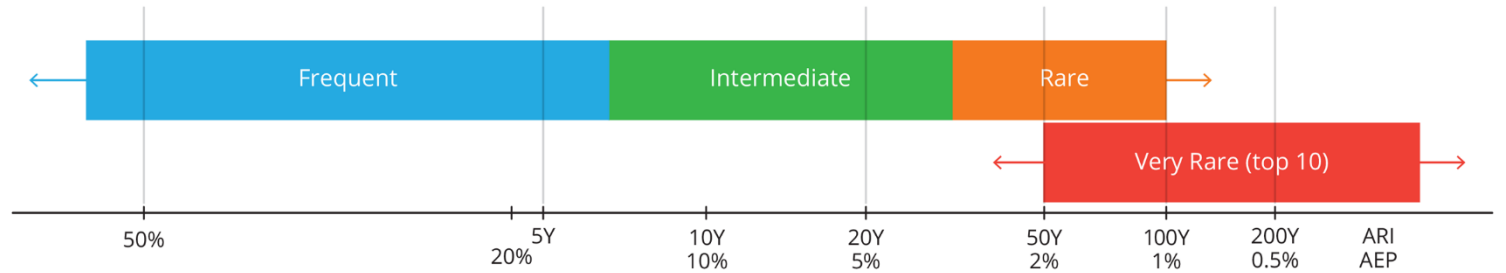
code	SSmainland
arealabel	Southern Slopes (Vic/NSW)
Version	2016_v2

[Download TXT](#) [Download PDF](#)

Download areal temporal patterns to CSV file
Need the “_increments.csv” file

Temporal patterns

- Point temporal patterns
- Areal temporal patterns (area > 75 km²)
- Different area 'bins'



RORB options

Design Rainfall Specification (ARR2016)

Data Hub files

Main Data Hub file (*.txt, contains ARFs and losses)
.\data_hub.txt

Temporal Patterns (*.increments.csv)
.\Areal_MB_Increments.csv

Standard area for areal temporal patterns (km²):

☒ Use regional losses
☒ Use ARFs from file

IFD data

.\AllIFD_-37.1_146.3_ifds.csv

Simulation details

Simulation type: ☐ Extract MC Hydrographs

Group batch results by: ☒ AEP or by ☐ Duration

Select AEP: to

Select duration: to No. time incs to be modelled:

Temporal pattern details

☐ Filter Embedded Burst? ☐ Filtered Temporal Patterns Output File (MC)

Spatial pattern details

☐ Non-uniform pat.?

Pre-Burst

☐ Apply Pre-burst

Loss Factor details

☒ Constant losses
☐ Variable losses

Areal Reduction Factor details

☐ Replace total catchment area with value of km²

Output directory

.\

RORB options

Design Rainfall Specification (ARR2016)

Data Hub files

Main Data Hub file (*.txt, contains ARFs and losses)
.\data_hub.txt Use regional losses
Use ARFs from file

Temporal Patterns (*.increments.csv)
.\Areal_MB_Increments.csv Browse...

Standard area for areal temporal patterns (km²): From .CAT

IFD data
.\AllIFD_-37.1_146.3_ifds.csv Browse... View/edit IFD data

Simulation details

Simulation type: Ensemble simulation Extract MC Hydrographs Group batch results by: AEP or by Duration

Select AEP: 10% to 1%

Select duration: 1 hour to 3 hour No. time incs to be modelled: 200

Temporal pattern details

Select patterns for deterministic runs Filter Embedded Burst? Filtered Temporal Patterns Output File (MC)

Spatial pattern details

Non-uniform pat.? Edit Pattern

Areal Reduction Factor details

Edit Coeff. Replace total catchment area with value of 0.00 km²

Output directory

.\ Browse ...

Pre-Burst

Apply Pre-burst Edit pre-burst

Loss Factor details

Constant losses
Variable losses
AEP factors
Duration factors

Cancel Help OK

RORB options

Design Rainfall Specification (ARR2016)

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.\data_hub.txt Browse...

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.\AllIFD_-37.1_146.3_ifds.csv Browse... View/edit IFD data

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Select patterns for deterministic runs ☐ Filter Embedded Burst? ☐ Filtered Temporal Patterns Output File (MC)

Spatial pattern details

☐ Non-uniform pat.? Edit Pattern

Pre-Burst

☐ Apply Pre-burst Edit pre-burst

Loss Factor details

☒ Constant losses ☐ Variable losses

AEP factors

Duration factors

Areal Reduction Factor details

Edit Coeff. ☐ Replace total catchment area with value of 0.00 km²

Output directory
.\ Browse ...

Cancel Help OK

Temporal patterns

RORB options

Design Rainfall Specification (ARR2016)

Data Hub files

Main Data Hub file (*.txt, contains ARFs and losses)
.\data_hub.txt Browse... ☒ Use regional losses
☒ Use ARFs from file

Temporal Patterns (*.increments.csv)
.\Areal_MB_Increments.csv Browse...

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IFD data

.\AllIFD_-37.1_146.3_ifds.csv IFD data file View/edit IFD data

Simulation details

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Temporal pattern details

Select patterns for deterministic runs ☐ Filter Embedded Burst? ☐ Filtered Temporal Patterns Output File (MC)

Spatial pattern details

☐ Non-uniform pat.? Edit Pattern

Pre-Burst

☐ Apply Pre-burst Edit pre-burst

Loss Factor details

☒ Constant losses
☐ Variable losses
AEP factors
Duration factors

Areal Reduction Factor details

Edit Coeff. ☐ Replace total catchment area with value of 0.00 km²

Output directory

.\ Browse ...

Cancel Help OK

RORB options

Design Rainfall Specification (ARR2016)

Data Hub files

Main Data Hub file (*.txt, contains ARFs and losses)
.\data_hub.txt Browse... ☒ Use regional losses
☒ Use ARFs from file

Temporal Patterns (*.increments.csv)
.\Areal_MB_Increments.csv Browse...

Standard area for areal temporal patterns (km²): From .CAT

IFD data
.\AllIFD_-37.1_146.3_ifds.csv Browse... View/edit IFD data

Simulation details

Simulation type: Ensemble simulation ☐ Extract MC Hydrographs

Select AEP: 10% to 1%

Select duration: 1 hour to 3 hour

Group batch results by: AEP or by Duration
No. time incs to be modelled: 200

Temporal pattern details

Select patterns for deterministic runs ☐ Filter Embedded Burst? ☐ Filtered Temporal Patterns Output File (MC)

Spatial pattern details

☐ Non-uniform pat.? Edit Pattern

Pre-Burst

☐ Apply Pre-burst Edit pre-burst

Loss Factor details

☒ Constant losses
☐ Variable losses
AEP factors
Duration factors

Areal Reduction Factor details

Edit Coeff. ☐ Replace total catchment area with value of 0.00 km²

Output directory

.\ Browse ...

Cancel Help OK

Select ensemble simulation and AEPs/durations of interest

Outputs

KORBWIn Batch Run Summary

Program version 6.32 (last updated 3rd September 2017)

Copyright Monash University and Hydrology and Risk Consulting

Date run: 11 May 2018 15:55

Catchment file : .\Delatite.catg

Rainfall location: User defined

Temporal pattern : ARR2016 areal temporal patterns, 500 km² standard area

Spatial pattern : Uniform

Areal Red. Fact. : Based on ARR 2016 (Book 2 Chapter 4)

Loss factors : Constant with ARI

Parameters: kc = 25.00 m = 0.80

Loss parameters	Initial loss (mm)	Cont. loss (mm/h)
	27.00	4.30

Peak Description

01 Calculated hydrograph, TongaBridge

Run	Duration	AEP	TPat	Rain(mm)	ARF	Peak0001
1	12 hour	10%	1	69.40	0.89	48.5609
1	12 hour	10%	2	69.40	0.89	62.7997
1	12 hour	10%	3	69.40	0.89	68.8250
1	12 hour	10%	4	69.40	0.89	57.7552
1	12 hour	10%	5	69.40	0.89	18.2086
1	12 hour	10%	6	69.40	0.89	34.7888
1	12 hour	10%	7	69.40	0.89	44.4580
1	12 hour	10%	8	69.40	0.89	44.8110
1	12 hour	10%	9	69.40	0.89	34.1419
1	12 hour	10%	10	69.40	0.89	70.4261
2	24 hour	10%	1	91.90	0.93	19.9730
2	24 hour	10%	2	91.90	0.93	38.7507
2	24 hour	10%	3	91.90	0.93	24.1128

Outputs

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1	12 hour	10%	8	69.40	0.89	44.8110
1	12 hour	10%	9	69.40	0.89	34.1419
1	12 hour	10%	10	69.40	0.89	70.4261
2	24 hour	10%	1	91.90	0.93	19.9730
2	24 hour	10%	2	91.90	0.93	38.7507
2	24 hour	10%	3	91.90	0.93	24.1128

12 hour, 10% AEP
ensemble results

Outputs

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1	12 hour	10%	7	69.40	0.89	44.4580
1	12 hour	10%	8	69.40	0.89	44.8110
1	12 hour	10%	9	69.40	0.89	34.1419
1	12 hour	10%	10	69.40	0.89	70.4261
2	24 hour	10%	1	91.90	0.93	19.9730
2	24 hour	10%	2	91.90	0.93	38.7507
2	24 hour	10%	3	91.90	0.93	24.1128

12 hour, 10% AEP
ensemble results

Median = 46.7 m³/s

Outputs

KORBWIn Batch Run Summary

Program version 6.32 (last updated 3rd September 2017)

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Date run: 11 May 2018 15:55

Catchment file : .\Delatite.catg

Rainfall location: User defined

Temporal pattern : ARR2016 areal temporal patterns, 500 km² standard area

Spatial pattern : Uniform

Areal Red. Fact. : Based on ARR 2016 (Book 2 Chapter 4)

Loss factors : Constant with ARI

Parameters: kc = 25.00 m = 0.80

Loss parameters	Initial loss (mm)	Cont. loss (mm/h)
	27.00	4.30

Peak Description

01 Calculated hydrograph, TongaBridge

Run	Duration	AEP	TPat	Rain(mm)	ARF	Peak0001
1	12 hour	10%	1	69.40	0.89	48.5609
1	12 hour	10%	2	69.40	0.89	62.7997
1	12 hour	10%	3	69.40	0.89	68.8250
1	12 hour	10%	4	69.40	0.89	57.7552
1	12 hour	10%	5	69.40	0.89	18.2086
1	12 hour	10%	6	69.40	0.89	34.7888
1	12 hour	10%	7	69.40	0.89	44.4580
1	12 hour	10%	8	69.40	0.89	44.8110
1	12 hour	10%	9	69.40	0.89	34.1419
1	12 hour	10%	10	69.40	0.89	70.4261
2	24 hour	10%	1	91.90	0.93	19.9730
2	24 hour	10%	2	91.90	0.93	38.7507
2	24 hour	10%	3	91.90	0.93	24.1128

12 hour, 10% AEP
ensemble results

Median = 46.7 m³/s

Use run 1 for design

Outputs

- Results provided as details of individual runs and batch summary
- Box plots can be constructed to determine medians and critical durations
- Individual runs for hydraulics/design easily identified and extracted from summary results

RORB - future directions

- Melbourne training course to be run May
- Major modernization project underway
- Regular minor enhancements and bug fixes