Introduction to Australian Rainfall and Runoff (ARR) 2016

Presenters:

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Note: This presentation is SWS's general take on ARR 2016. This presentation, in no way, should this be taken as the complete interpretation of ARR2016. It is recommended that each individual familiarise themselves with ARR 2016 before application to individual projects.

References

- Ball J, Babister M, Weeks W, Weinmann E, Retallick M, Testoni I, (Editors), 2016, Australian Rainfall and Runoff: A Guide to Flood Estimation, Commonwealth of Australia.

http://arr.ga.gov.au/arr-guideline

Book 9 Chapter 6 - Modelling Approaches, was released in December 2019

Description of Australian Rainfall and Runoff (ARR) 2016

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Book 1 Scope and Philosophy

Background to document

Book 2 Rainfall Estimation

Describes
- changes in terminology,
- new IFD's
- bursts etc..

- Describes inputs required as per Book 5 and Book 7

Book 3 Peak Flow Estimation

Fitting to Gauged Data to obtain:

- Flood Frequency if you have gauged data,
- Regional Flood Models (rural catchments)- (Regional Flood Frequency Estimator - RFFE)

- RFFE to apply as Step 4 when calculating flood flows to "check" design flows obtained

Book 4 Catchment Simulation for Design Flood Estimation

Describes Event Models such as

- Simple event,
- Ensemble event,
- Monte Carlo event

- To apply as Step 3 when calculating flood flows to chose event type to apply to the model

Book 5 Flood Hydrograph Estimation

- Losses, flood routing, types of models

- To apply as Step 2 - when calculating flood flows (User/Catchment input)

Book 6 Flood Hydraulics

"Usual suspects" - Pits/pipes etc. + Blockage, Safety (OLFP's)

Book 7 Application of Catchment Modelling Systems

- ARR Data Hub - Input data for design flood estimation.

- To apply as Step 1 - when calculating flood flows

Book 8 Estimation of Very Rare to Extreme Floods

- Change in Method from ARR87

Book 9 Runoff in Urban Areas

- RB design, culverts HGL etc.
- Good handbook methods here

- Chapter 6 - Urban Catchment modelling
    - Modelling approaches
    - On the way!

Major Changes

1. Change in Terminology

Move from Average Recurrence Interval (ARI)
to Annual Exceedance Probability (AEP).

Move to describing event as “Frequent” to “Extreme”

Definitions (Section 2.2.3 ARR2016):

AEP: The probability of an event being equalled or exceeded within a year.

ARI: The average time period between occurrences equalling or exceeding a given value.

Frequency Descriptor	EY	AEP (%)	AEP (1 in x)	ARI
Very Frequent	12			
	6	99.75	1.002	0.17
	4	98.17	1.02	0.25
	3	95.02	1.05	0.33
	2	86.47	1.16	0.5
	1	63.21	1.58	1
Frequent	0.69	50	2	1.44
	0.5	39.35	2.54	2
	0.22	20	5	4.48
	0.2	18.13	5.52	5
	0.11	10	10	9.49
Rare	0.05	5	20	20
	0.02	2	50	50
	0.01	1	100	100
Very Rare	0.005	0.5	200	200
	0.002	0.2	500	500
	0.001	0.1	1000	1000
Extreme	0.0005	0.05	2000	2000
	0.0002	0.02	5000	5000
			↓	
			PMP/ PMPDF	

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<u>Relationship:</u>

$$AEP = 1 - e^{\left(\frac{-1}{ARI}\right)}$$

Recommended terminology as shown in Figure 1.2.1 ARR2016

(reproduced on the left)

Relating the new IFD's terminology to the Old IFD terminology

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<u>What AEP is the 5-year ARI?</u>

$$AEP = 1 - e^{\left(\frac{-1}{ARI}\right)} = 1 - e^{\left(\frac{-1}{5}\right)} = 0.1813 = 18.13\%\ AEP$$

It is <u>not</u> the 20% AEP (This is a 4.48-Year ARI)

- Practitioners need to be carful with terminology in reporting and when obtaining information from BOM.
- Planning requirements, Council, IDM, CMA Manuals etc must be clear on what is required.
- SWS design minor systems to 18.13% AEP (1 in 5.52 AEP = 1 in 5 ARI).
- Many manual imply 20% AEP (1 in 5 AEP = 1 in 4.48 ARI)

2. New IFD Data Available

A new range of IFD's available.

New mathematical model used to determine IFD's so factors are no longer relevant from 1987 IFD's.

IFD's Reported as a total depth rather than an intensity.

1987 Method:

100-Year ARI, 3 hr storm
Intensity = 19.9 mm/hr

2016 Method:

1% AEP, 3 hr storm
duration depth = 59.8 mm

IFD Design Rainfall Depth (mm)

Issued: 02 September 2016

Rainfall depth for Durations, Exceedance per Year (EY), and Annual Exceedance Probabilities (AEP).

	EY	Annual Exceedance Probability (AEP)					
Duration	1EY	50%	20%	10%	5%	2%	1%
1 min	1.6	1.8	2.4	2.9	3.3	4.0	4.5
2 min	2.7	3.0	4.0	4.8	5.5	6.4	7.2
3 min	3.7	4.1	5.5	6.4	7.4	8.7	9.8
4 min	4.5	5.0	6.7	7.9	9.1	10.8	12.1
5 min	5.1	5.7	7.7	9.2	10.6	12.6	14.3
10 min	7.6	8.5	11.6	13.8	16.2	19.4	22.0
15 min	9.3	10.4	14.2	16.9	19.8	23.8	27.1
30 min	12.4	13.9	18.9	22.5	26.2	31.4	35.7
1 hour	16.2	18.0	24.1	28.5	32.9	39.1	44.0
2 hour	20.7	22.9	30.2	35.3	40.5	47.6	53.2
3 hour	23.9	26.4	34.5	40.2	45.9	53.6	59.8
6 hour	30.5	33.6	43.8	50.8	57.9	67.5	75.1
12 hour	38.7	42.9	56.4	65.7	75.3	88.2	98.4
24 hour	48.5	54.2	72.7	85.9	99.3	117.7	132.4
48 hour	59.0	66.5	91.5	109.7	128.1	154.2	175.4
72 hour	65.2	73.6	101.9	122.8	144.2	175.0	200.2
96 hour	69.5	78.4	108.2	130.2	153.4	186.9	214.5
120 hour	73.0	81.9	111.9	134.1	158.3	193.1	222.1
144 hour	75.8	84.8	114.1	135.8	160.3	195.6	225.3
168 hour	78.4	87.2	115.2	135.9	160.5	195.7	225.6

http://www.bom.gov.au/water/designRainfalls/revised-ifd/

3. Reduced application of the Rational Method

The probabilistic Rational Method should not be used for design or calibration (except on small catchments)

It can however be used to provided 'ball park' verification of models and designs.

Melbourne Water is advocating/supporting for the continued use of the rational method for small catchment pit and pipe design.

?? BoM frequently asked questions

Can I use the Probabilistic Rational Method with the 2016 IFDs to estimate peak flow rates?

No, the Probabilistic Rational Method was calibrated using the ARR87 IFDs not the new IFDs. The Probabilistic Rational Method and other flood estimation techniques have also being revised as part of the current Australian Rainfall and Runoff Revision project. Please refer to the ARR website for updates on design guidelines.

SWS Answer:

We must use 2016 IFD's.

BOM is referring to the calibrated runoff coefficients presented within ARR 1987. Since ARR 1987, almost all organisations revised runoff coefficients to be higher than those presented in ARR 1987. Provided the currently recommended runoff coefficients are used <u>with the updated IFD's</u> the Rational Method is applicable in certain situations under ARR2016.

Discuss……

4. Switch from Simple Event simulations to Ensemble or Monte Carlo Simulations

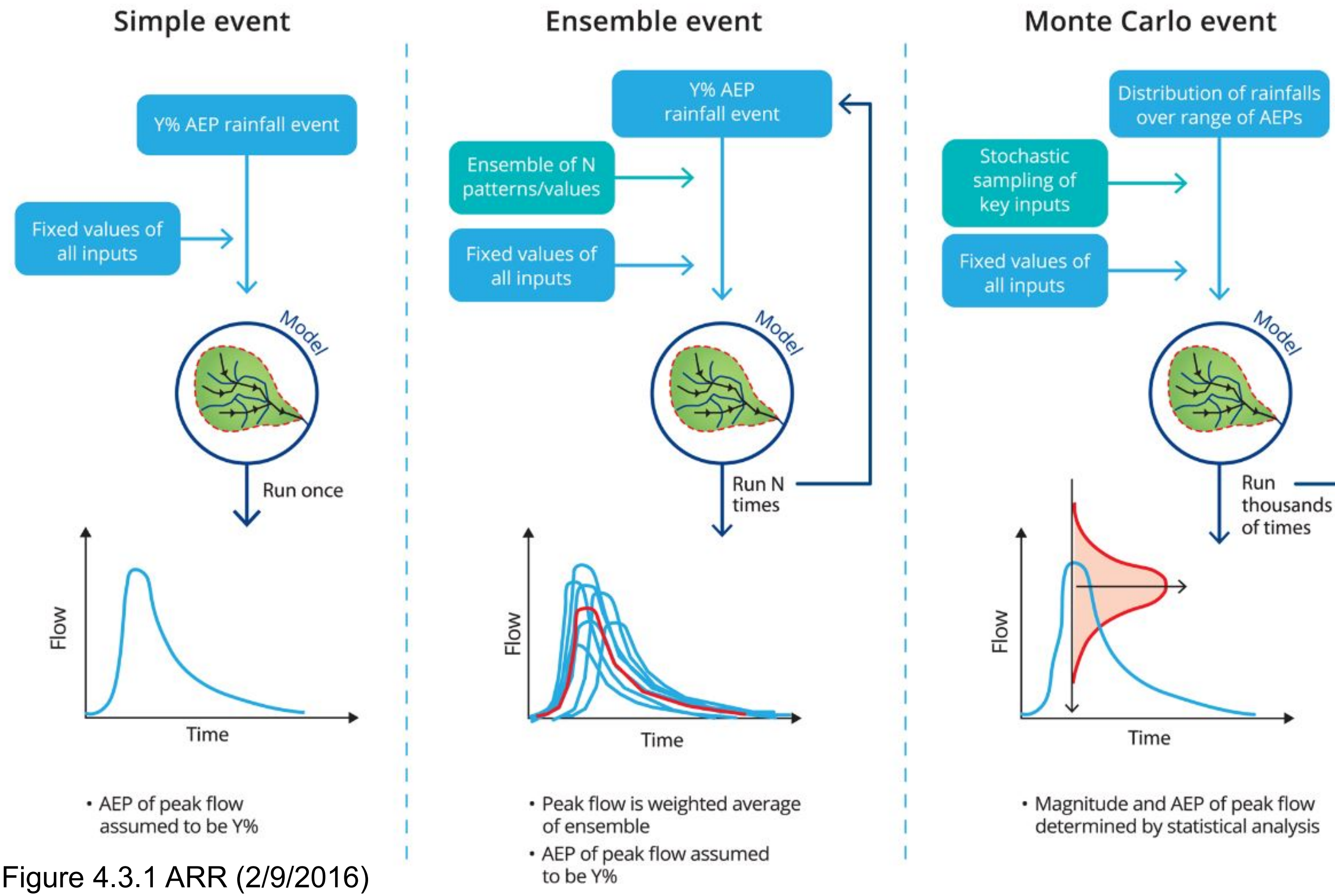


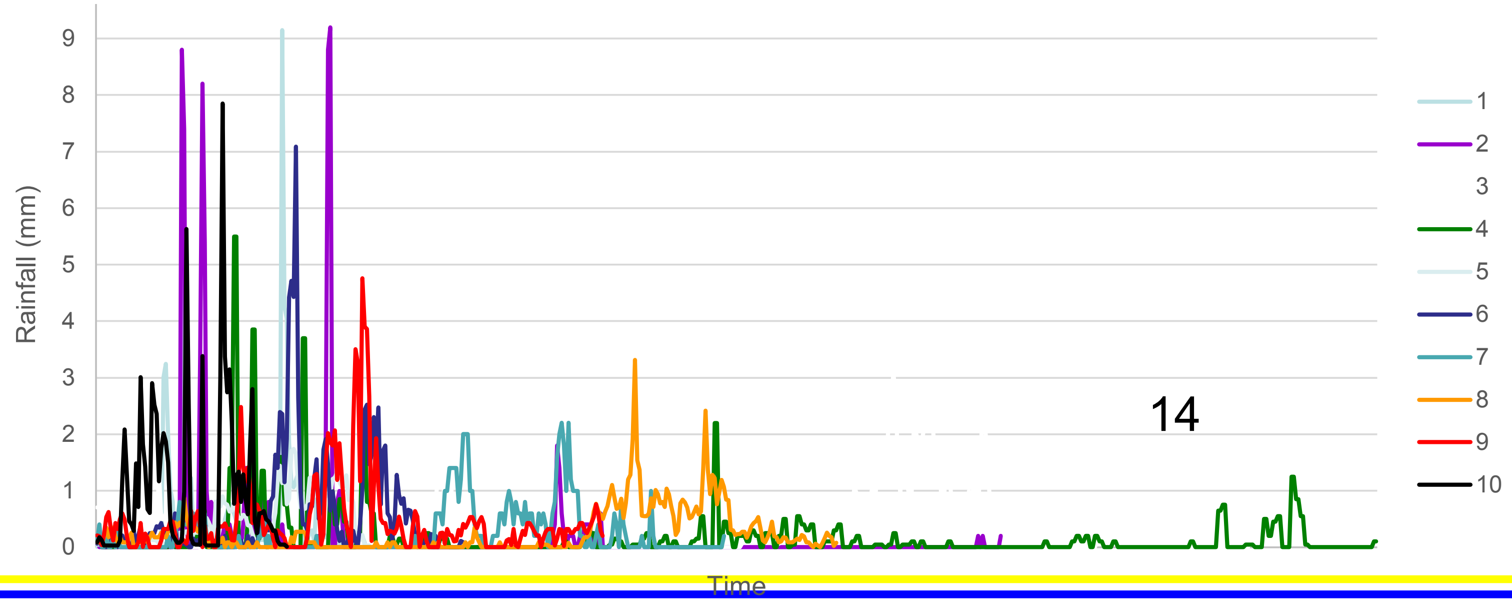
Figure 4.3.1 ARR (2/9/2016)

Ensemble Event Simulation

- 10 Temporal patterns for your location for the given AEP can be downloaded (24 durations - 10 minutes to 7 days).

- This eliminates the t_c as each of these 10 storms is just as likely to occur and your model (catchment) will determine which produces the peak hydrograph

- Computer Models (RORB, XP products etc). have been updated to ARR 2016 compliant.



How do you apply Changes 1 – 4 in calculating flood flows?

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1. Model Selection

Many models can be used to implement ARR2016 Hydrological changes.

ARR2016 Book 5, Chapter 6 - Explains background theory to Flood Hydrograph Modelling Approaches

- Time-Area approaches
- Unit Hydrograph Approaches
- Runoff Routing Approaches
- Rainfall on Grid Modelling Approaches

Note - Book 9 Chapter 6 – Urban Catchment Modelling (which is "on the way") will provide much more guidance to model selection when modelling urban catchments

ARR 2016 Compliance – what to apply??

Direction will be given in Book 9, chapter 6 (coming…)

Flow Estimation Models

i.e. Focus of the model is on hydrology

Model Type	Models which use this application	Description	Probable ARR 2016 Applicability in Urban Catchments
Rational method	Melbourne Water DSS spreadsheets	Peak flow estimation only – rough	Limited to very small catchments and pit and pipe design. • Need to use 2016 BoM Intensities
Time Area Method, Extended rational method, Unit Graph method	ILSAX, DRAINS, 12D	Peak flow and hydrograph estimation	Limited to small catchments and pit and pipe design. • Some programs do not yet have the capability for application of ARR 2016 temporal pattern considerations etc. ☑ **Drains/12D OK**
Runoff routing	RORB, RAFTS, WBNM, URBS	Peak flow and hydrograph estimation using non linear routing capabilities etc	Applicable to full compliance with ARR 2016 provided program has the capability for consideration of temporal pattern requirements etc. ☑ **ARR compliant for all catchment applications**
Continuous simulation	XP-RAFTS, MUSIC	Good simulation of frequent events, Limited capability to rare to very rare floods	• Applicable to full compliance with ARR 2016 provided data encompasses enough years to capture the full range of large floods. • Mainly applicable for stormwater pollutant modelling and water balance calculations etc

Flood Level and Drainage System Capacity Models

i.e. Focus of the model is on hydraulics. Hydrology done external to model

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Model Type	Models which use this application	Description	Probable ARR 2016 Applicability in Urban Catchments
Manning's formula, Culvert formula Hydraulic Grade Line Analysis	Melbourne Water DSS spreadsheets DRAINS, XP STORM, SWMM, PC DRAINS, 12D	Sizing of drainage systems -90% of urban drainage design covers this aspect of design	Limited to very small catchments and pit and pipe design etc. **☑ ARR compliant provided flow is OK – refer to relevant chapter**
Overland Flow - One dimensional hydraulic model	Hec Ras, MIKE 11	Peak flow input into channels or flow in one direction down overland flow paths or watercourses etc.	Simple flow in channels Flow in one direction down overland flow paths or watercourses etc. **☑ ARR compliant – refer to relevant chapter**
Overland Flow - Two dimensional hydraulic model	Hec Ras 2D, MIKE 21, TUFLOW etc	Hydrograph input into models which can model flow in two directions	Complex modelling of surface flow **☑ ARR compliant – refer to relevant chapter**

Combined Flow and Flood Level Models

i.e. Focus of the model is on hydrology and hydraulics

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Model Type	Models which use this application	Description	Probable ARR 2016 Applicability in Urban Catchments
Rain on Grid	TUFLOW, MIKE 21	Rain on grid converts to flow off grid and flood routing done as flow moves over defined topography.	Require good definition of surface. Sensitive to roughness calculations. Limited applicability to defining flood flows, especially in the upper portions of the catchment. ☑ **ARR compliant, but should not be used in all applications**
Runoff routing hydrological model as input to two dimensional hydraulic model	RORB/RAFTS/ WBNM with MIKE 21/ TUFLOW etc	Hydrograph input into models which can model flow in two directions	Complex modelling of surface flow. • Can be best in defining flood flows, extents and levels in complex flood plains. • Results can be compromised by catchment flow assumptions etc. • Limited capacity to "quiz" or change the model. ☑ **ARR compliant – but consider simpler model if possible to allow critique and changes in model over time if required (especially important in design applications)**

Model Application Ranges

Note: The table below has been formulated by Stormy Water Solutions. Individual or organisations may disagree with assumptions made. The table is intended as a guide only, but should give a reasonable guide to model selection in most urban modelling applications.

Model Type	Flood Type Applicability	Catchment Scale Applicability
Continuous simulation	Very frequent and frequent flow analysis (12 EY up to 10% AEP (at the moment))	Lot (<250 m^2) to Precinct scale (100's of km^2)
Rational Method	Frequent to Rare floods (1 EY to 5% AEP)	Lot scale (<250 m^2 to about 0.2 ha (say))
Time Area Method, Extended rational method, Unit Graph method	Frequent to Rare floods (1 EY to 2% AEP)	Lot scale to site (<250 m^2 to about 5 ha (say))
Runoff routing hydrological models	Frequent to Extreme Floods (1EY to 1,000,000 ARI (including 1% AEP))	Lot (<250 m^2) to Precinct scale (100's of km^2)

How do you apply Changes 1 – 4 in calculating flood flows?

2. Model Input (Rainfalls and Temporal Patterns) using the ARR2016 Datahub

http:/data.arr-software.org/

Used to obtain:

- IFD's
- Temporal Patterns
- Climate Change Factors
- Storm Losses (Rural)
- ARF Parameters
- Other factors

Need to have a location of the site:

ARR Data Hub

Enter coordinates or upload a shapefile

Australian Rainfall & Runoff

Longitude

145.137064

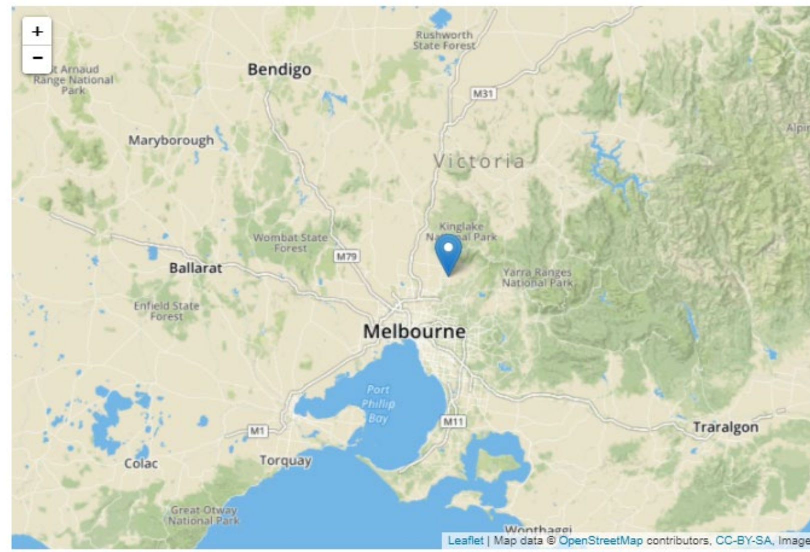
Latitude

-37.602202

Upload Shapefile (clear)

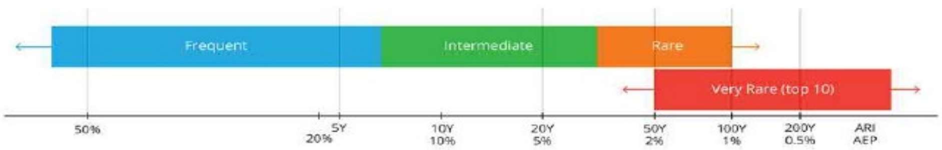
Choose Files No file chosen

- River Region ☑
- ARF Parameters ☑
- Storm Losses ☑
- Temporal Patterns ☑
- Areal Temporal Patterns ☑
- BOM IFD Depths ☑
- Median Preburst Depths and Ratios ☑
- Other Preburst Depths and Ratios ☑
- Interim Climate Change Factors ☑
- Select All ☑



3. Download temporal patterns using the ARR2016 Datahub

The Temporal Pattern File represents 10 Patterns for Each Duration for each AEP “Bin” = 10 x 24 x 3 = 720 Storms



Temporal Patterns | Download (.zip)

CODE	SSmainland
LABEL	Southern Slopes (Vic/NSW)

Areal Temporal Patterns | Download (.zip)

CODE	SSmainland
LABEL	Southern Slopes (Vic/NSW)

Only used for large catchment
s

BOM IFD Depths

Click here to obtain the IFD depths for catchment centroid from the BoM website

See next slide

Example Temporal Pattern File shown below:

EventID	Duration	TimeStep	Region	AEP	Increments											
5891	60	5	Southern	rare	3.45	5.86	3.02	2.5	9.31	11.72	5.17	10	16.55	18.97	10.69	2.76
5909	60	5	Southern	rare	11.95	15.65	15.1	11.99	8.38	6.83	7.79	6.04	4.43	4.43	4.97	2.44
5914	60	5	Southern	rare	8.5	9.5	7.5	5	9.5	8.5	12.5	13	14.5	4.5	2	5
5940	60	5	Southern	rare	12.21	11.14	16.13	8.18	2.31	1.46	7.56	13.53	7.58	8.44	6.96	4.5
5966	60	5	Southern	rare	22.4	15.23	6.83	2.51	4.04	3.46	2.33	3.17	7.49	16.96	7.06	8.52
5967	60	5	Southern	rare	13.95	22.09	12.21	2.91	3.49	2.91	3.49	0	3.49	5.81	16.28	13.37
5968	60	5	Southern	rare	4.65	11.2	5.7	11.52	13.11	10.78	6.41	13.98	10.61	4.54	3.86	3.64
5969	60	5	Southern	rare	2.51	10.07	12.15	8.89	1.97	11.07	13.33	8.18	6.64	13.04	10.37	1.78
5970	60	5	Southern	rare	7.72	6.37	7.06	7.91	8.06	9.03	7.95	12.24	7.47	6.22	10.46	9.51
5971	60	5	Southern	rare	1.11	3.33	3.9	1.49	3.01	13.25	15.06	10.24	16.27	18.67	9.04	4.63

4. Obtain Rainfall Depths for each duration

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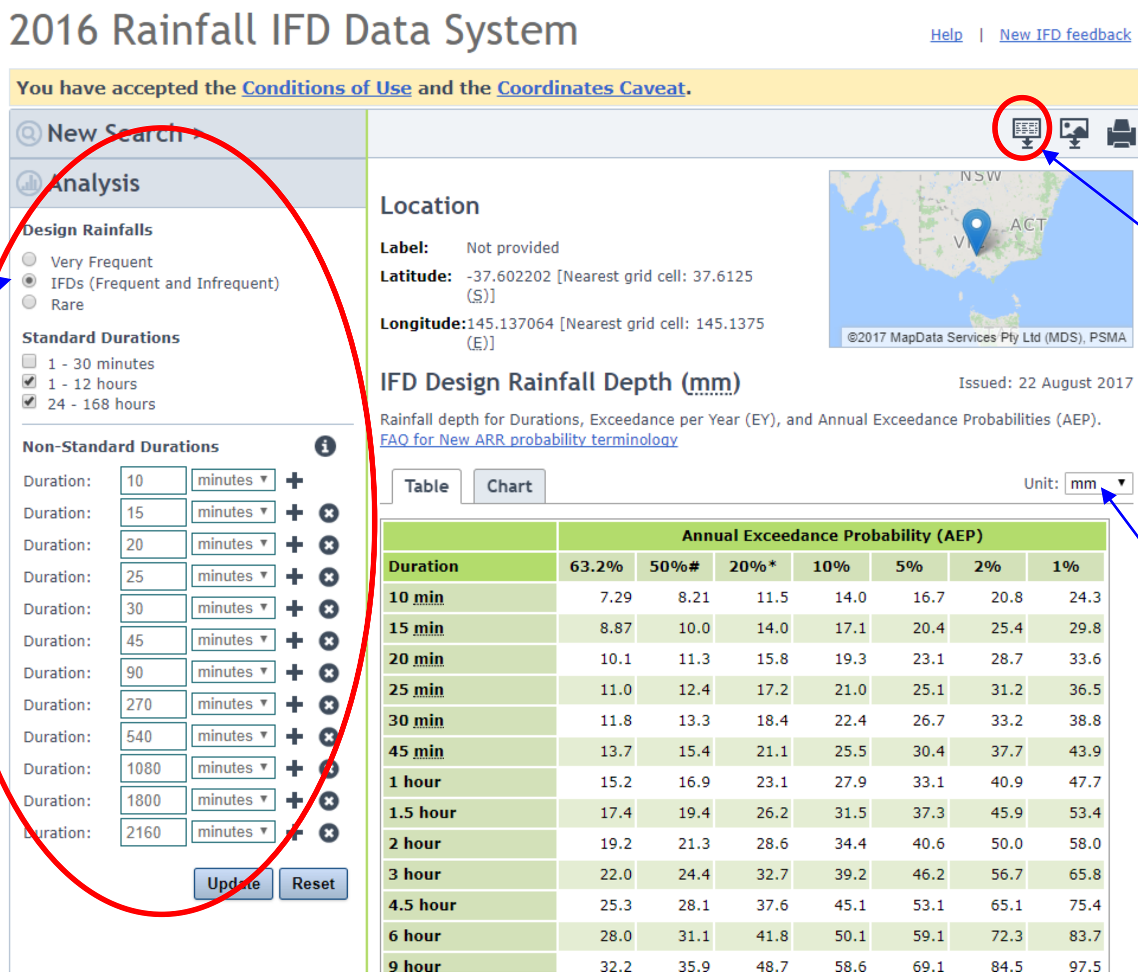
First download IFD File From BOM. Remember to update durations to match the Temporal Patterns

Add these durations to match the temporal pattern file

This button to Download CSV


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: 10 minutes
Duration: 15 minutes
Duration: 20 minutes
Duration: 25 minutes
Duration: 30 minutes
Duration: 45 minutes
Duration: 90 minutes
Duration: 270 minutes
Duration: 540 minutes
Duration: 1080 minutes
Duration: 1800 minutes
Duration: 2160 minutes

Update Reset

Location

Label: Not provided
Latitude: -37.602202 [Nearest grid cell: 37.6125 (S)]
Longitude: 145.137064 [Nearest grid cell: 145.1375 (E)]

IFD Design Rainfall Depth (mm)

Issued: 22 August 2017

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

Table Chart Unit: mm

	Annual Exceedance Probability (AEP)						
Duration	63.2%	50%#	20%*	10%	5%	2%	1%
10 min	7.29	8.21	11.5	14.0	16.7	20.8	24.3
15 min	8.87	10.0	14.0	17.1	20.4	25.4	29.8
20 min	10.1	11.3	15.8	19.3	23.1	28.7	33.6
25 min	11.0	12.4	17.2	21.0	25.1	31.2	36.5
30 min	11.8	13.3	18.4	22.4	26.7	33.2	38.8
45 min	13.7	15.4	21.1	25.5	30.4	37.7	43.9
1 hour	15.2	16.9	23.1	27.9	33.1	40.9	47.7
1.5 hour	17.4	19.4	26.2	31.5	37.3	45.9	53.4
2 hour	19.2	21.3	28.6	34.4	40.6	50.0	58.0
3 hour	22.0	24.4	32.7	39.2	46.2	56.7	65.8
4.5 hour	25.3	28.1	37.6	45.1	53.1	65.1	75.4
6 hour	28.0	31.1	41.8	50.1	59.1	72.3	83.7
9 hour	32.2	35.9	48.7	58.6	69.1	84.5	97.5

Note: Rainfall in mm, <u>NOT</u> in mm/hr.

Change to mm/hr in with "unit" tab if required for rational method

5. Download other results from the data hub

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Scroll to the bottom of the data hub and press the “Download TXT” tab.

This TXT file can be read by many programs and provides a record of the results.

Examples of common information in the file include:

- Initial losses,
- Areal reduction factors
- Continuing losses,
- Climate change parameters
- What basin you are in etc

Interim Climate Change Factors

Values are of the format temperature increase in degrees Celcius (% increase in rainfall)

	RCP 4.5	RCP6	RCP 8.5
2030	0.719 (3.6%)	0.739 (3.7%)	0.822 (4.1%)
2040	0.925 (4.6%)	0.915 (4.6%)	1.119 (5.6%)
2050	1.123 (5.6%)	1.085 (5.4%)	1.449 (7.2%)
2060	1.271 (6.4%)	1.294 (6.5%)	1.865 (9.3%)
2070	1.394 (7.0%)	1.526 (7.6%)	2.333 (11.7%)
2080	1.477 (7.4%)	1.778 (8.9%)	2.776 (13.9%)
2090	1.527 (7.6%)	2.009 (10.0%)	3.21 (16.1%)

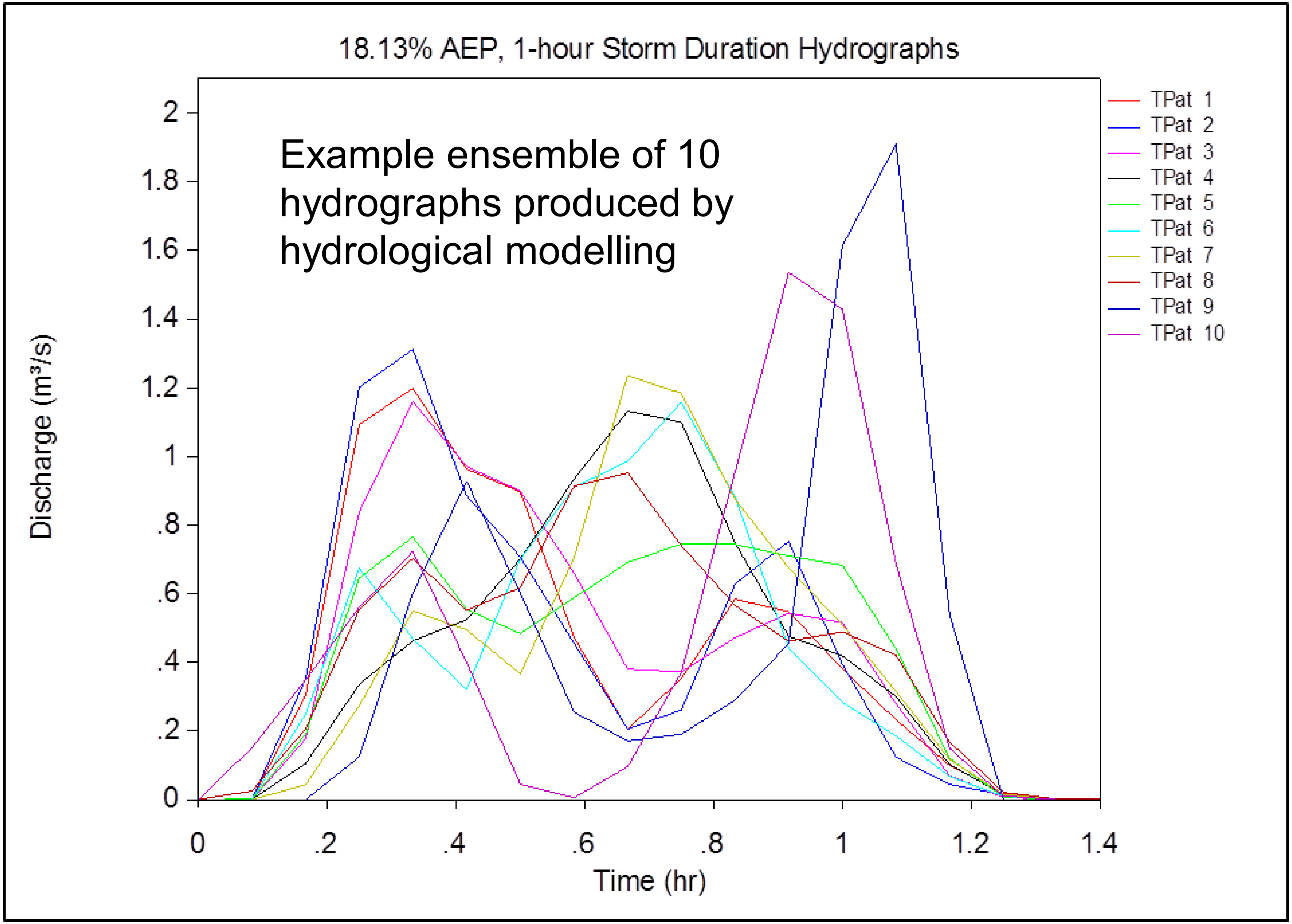
Download TXT | Generating PDF...

6. Reporting Model Results

Run data on program of choice to produce 240 hydrographs

For each 10 hydrographs in the 24 durations analysed a separate box and whisker plot is developed.

Box and whisker plots are a way of easily comparing large amounts of data.



18.13% AEP, 1-hour Storm Duration Hydrographs
Example ensemble of 10 hydrographs produced by hydrological modelling
Discharge (m³/s)
Time (hr)
0
.2
.4
.6
.8
1
1.2
1.4
1.6
1.8
2
TPat 1
TPat 2
TPat 3
TPat 4
TPat 5
TPat 6
TPat 7
TPat 8
TPat 9
TPat 10

Example ordered peaks

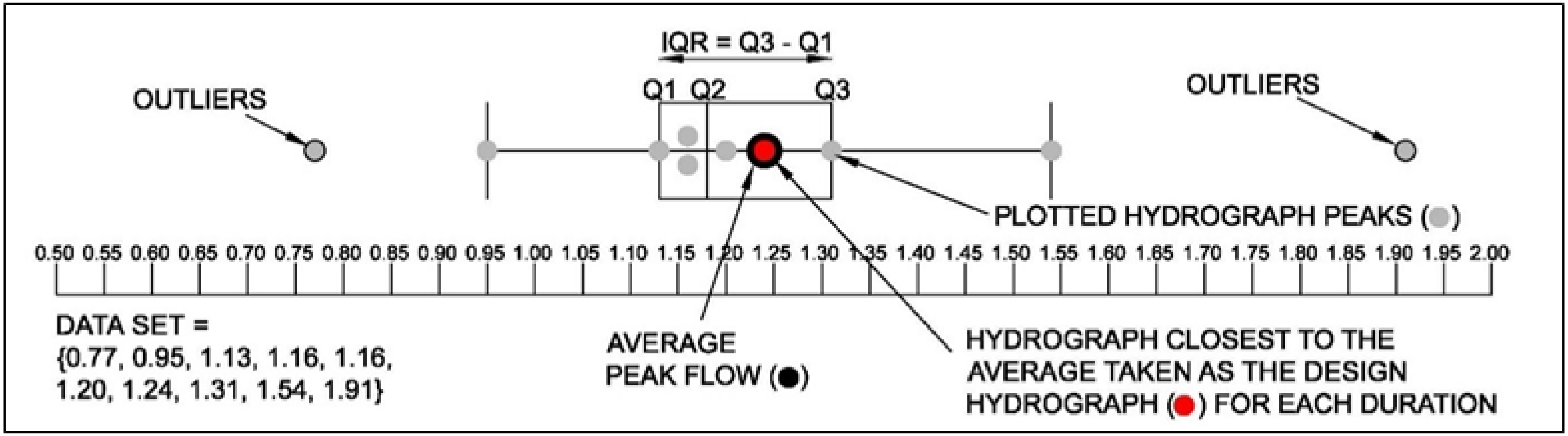
Local Order	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Temporal Pattern ID	5	8	4	6	3	1	7	2	10	9
Peak Flow (m^3/s)	0.77	0.95	1.13	1.16	1.16	1.20	1.24	1.31	1.54	1.91

From the data set shown, the following can be calculated:

- The median = Q_2 = the middle value of the data set = 1.18
- The lower quartile = Q_1 = the median of the lower half of the data set = 1.13
- The upper quartile = Q_3 = the median of the upper half of the data set = 1.31
- The interquartile range = IQR = $Q_3 - Q_1$ = 0.18
- The lower outlier value = $Q_1 - 1.5 \times IQR$ = 0.86

  If a hydrograph has a peak lower than this value it is considered and outlier. The hydrograph with a peak flow of 0.77 (TP 5) is an outlier in this example.
- The upper outlier value = $Q3 + 1.5 \times IQR$ = 1.58

  If a hydrograph has a peak higher than this value it is considered and outlier. The hydrograph with a peak flow of 1.91 (TP 9) is an outlier in this example.
- **The average flow = 1.24**

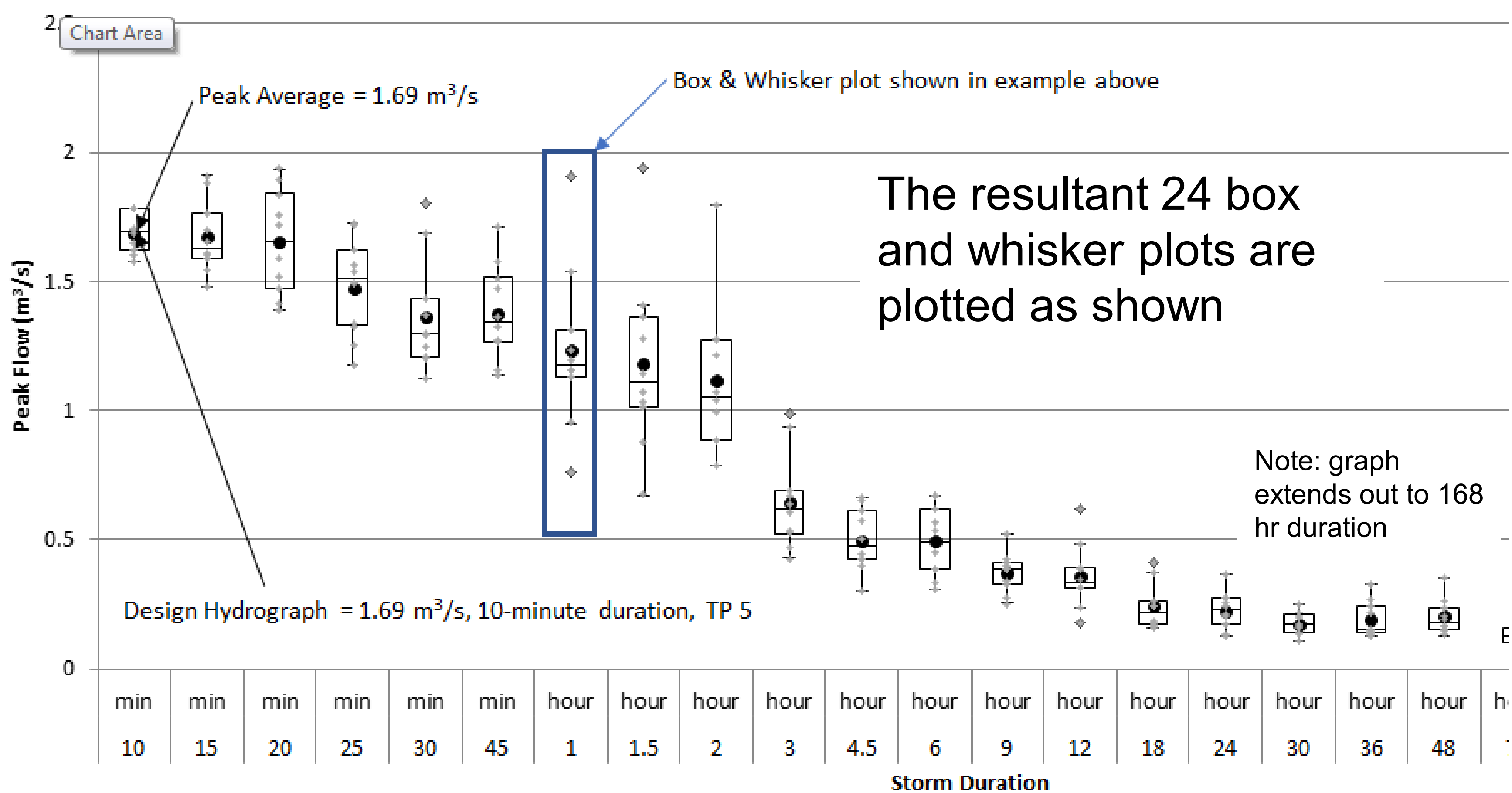


Box and whisker plot example for a 1-hour storm duration

The hydrograph that exhibits a peak flow closest to the average peak flow is then selected as the design hydrograph for this duration.

In this example, for this 1-hour duration, it is the hydrograph produced by temporal pattern 7 that produces a peak flow of 1.24 m^3/s.

Example 18.13%AEP Event, Box & Whisker Plot, All Durations



The final design hydrograph for (in this case), the 18.13% AEP storm, is then selected as the hydrograph that exhibits a peak flow closest to the peak average peak flow from each duration shown

7. Checking Model Results

Regional Flood Frequency Estimation Model (RFFE)

The Regional Flood Frequency Estimation (RFFE) is a method suggested within ARR 2016 to calculate peak flows in ungauged rural catchments, greater that 1 km^2 in area

The RFFE approach transfers flood frequency characteristics from a group of gauged catchments to the location of interest. The RFFE technique is a simplistic, “black box” flow estimation method, requiring only readily accessible catchment data to obtain design flood estimates relatively quickly.

ARR 2016 states that the RFFE technique is regarded as a state-of-the-art approach for estimation of design flood peak discharges at ungauged catchments

However the limitations of the method must be recognised.

- Only a small number of gauged catchments were available to represent the wide range of conditions experienced over an area of about 7.5 million km^2.

- Designers have a duty to use an alternative technique if that technique can be shown to be superior to RFFE Model and to utilise any available local data, both formal and informal to assist in understanding local conditions and improve upon RFFE Model 2015 estimates.

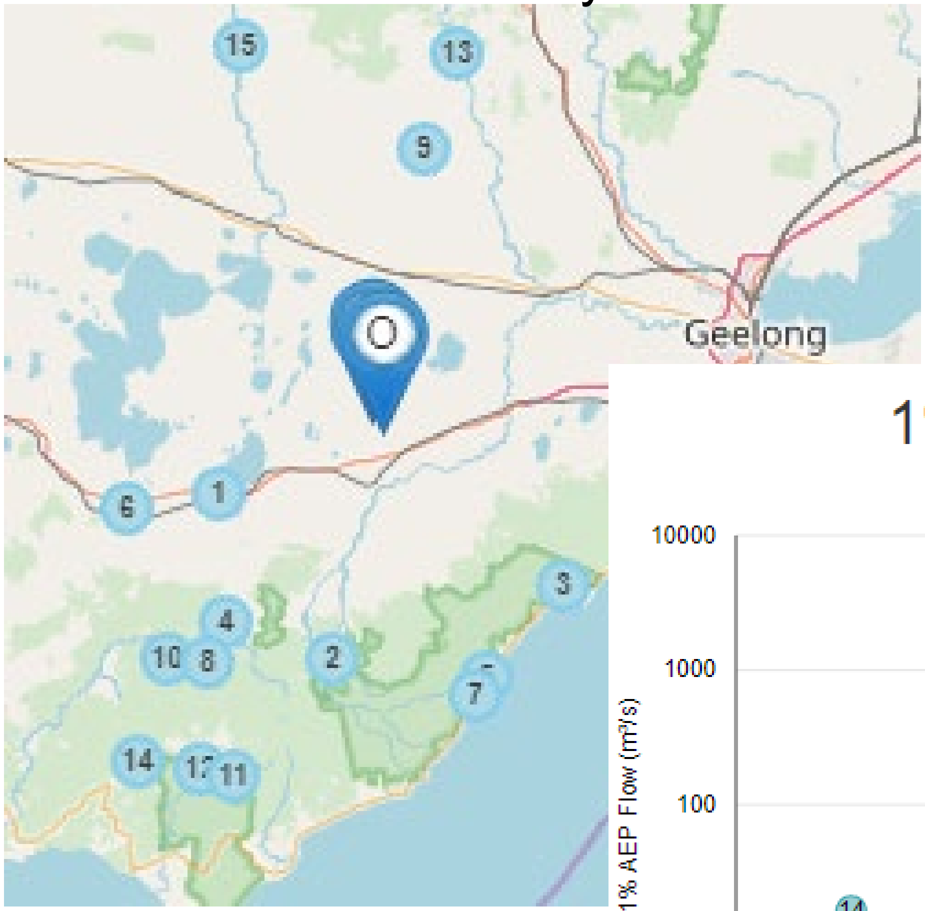
ARR 2016 recognises that the RFFE technique typically has limited predictive power.

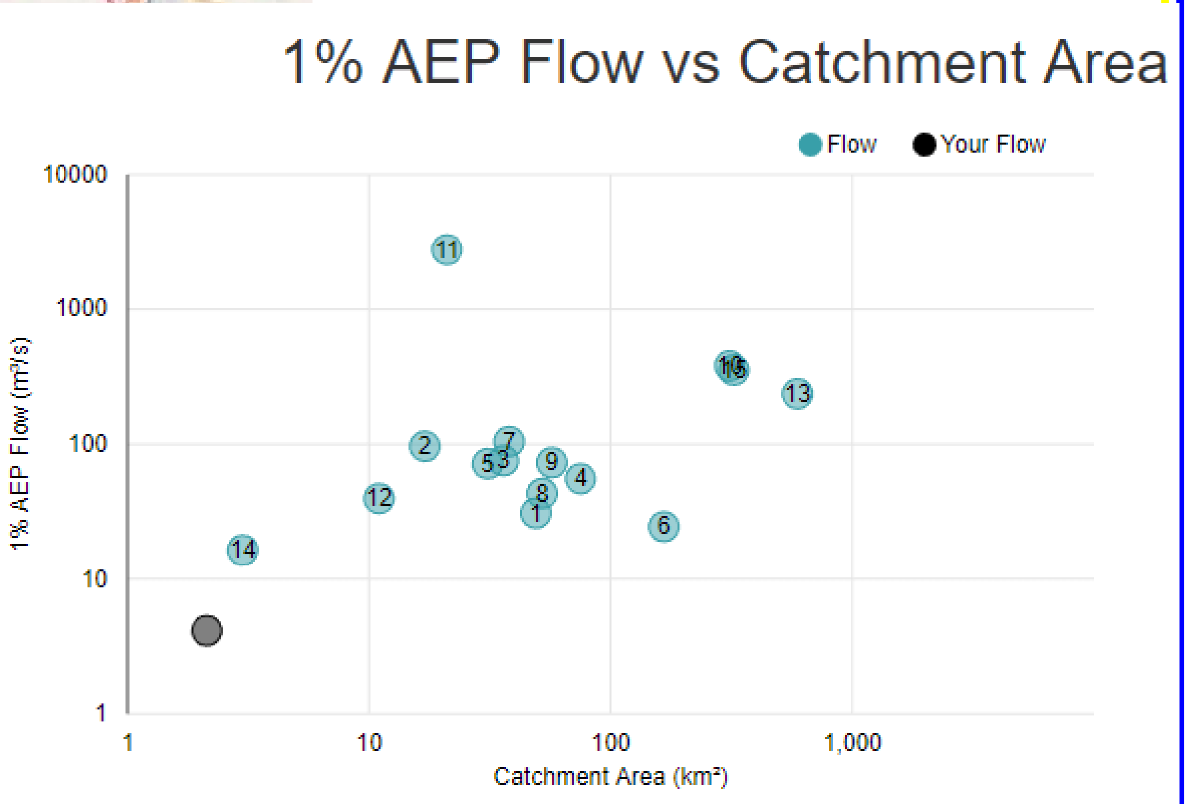
As such, design flood estimates produced by it are likely to have a lower degree of accuracy than those from a well calibrated catchment modelling system.

ARR 2016 states that the relative accuracy of the RFFE model is likely to be within ±50% of the true flow value ; however, in a limited number of cases the estimation error may exceed the estimation by a factor of two or more.

Given the above, SWS considers that the RFFE method can be used as a "rule of thumb" check on more robust models.

Example: RFFE model application to a small rural catchment in Colac Otway Shire





AEP (%)	Discharge (m^3/s)	Lower Confidence Limit (5%) (m^3/s)	Upper Confidence Limit (95%) (m^3/s)
50	0.690	0.250	1.94
20	1.30	0.490	3.45
10	1.81	0.680	4.88
5	2.41	0.880	6.63
2	3.32	1.16	9.53
1	4.13	1.40	12.3

- 1% AEP flood flow at the outlet is estimated at 4.13 m^3/s
- This could actually range between 1.4 m^3/s to 12.3 m^3/s (5% to 95% confidence limits.

Activities most organisations will need to undertake to become compliant with ARR2016

- Use software ARR 2016 compliant
- Adopt ARR2016 procedures for generation of design rainfall
- Use ARR2016 procedures for flood frequency analysis (if data available)
- Use ARR2016 terminology to describe flood magnitude and risk (AEP not ARI)
- Adopt ARR2016 procedures for development of climate change scenarios
- Use the ARR Data Hub to obtain hydrologic modelling parameters
- In rural areas, use the new regional flood frequency estimation tool as a “check” on design flows in place of the probabilistic rational method

- Use egress safety considerations for flow over and along roads
- Use blockage considerations in hydraulic analysis
- Uses of ARR procedures for interaction between riverine and coastal flooding
- Use ARR2016 methods for estimating frequent design flows
- Ensure guidance on hydraulic model use is consistent with ARR2016 approaches
- Stop using procedures that are no longer supported by ARR

Consultancies must be compliant with ARR 2016

What do we need from our referral Authorities and government agencies ?

Referral authorities are required to update project briefs and other internal manuals to be consistent with ARR2016

Referral authorities must require (or at least encourage) compliance by consultants

Clause 56.07 Victorian state Planning Provisions must give clear guidance on AEP's required for major/minor system design (there is an error in the definition at the moment)

Lead agencies must be clear on AEP required for major/minor system design in the interim – until 56.07 is updated

We require DELWP/MWC to lead on climate change. ARR16 gives tools for estimation but does not provide guidance on what to simulate (ie RCP 6.0 @ 2050??).

Why change?

Stormy Water Solutions

- As an industry we must use the best data and tools available to us
  - Our referral authorities must require this to occur
  - VCAT etc processed should ensure this occurs
- In Melbourne, design flows and flood storage requirements are typically slightly less than in the 1987 applications.
- The hydrological analysis changes are very interesting. As hydrologists, we have found applying ARR2016 to new jobs “fun”.
- Company reputation
- Staff engagement and training

JUST DO IT!