



## Appendix F

# Memorandum



SUBJECT: North Byron FRMS&P – Initial and Continuing Loss Sensitivity Test  
PROJECT NUMBER: 117098

## 1. INTRODUCTION

As part of the peer review undertaken by WMA Water (March 2018) of the hydrologic model developed by BMT WBM for the North Byron Shire Flood Study (2016), it was identified that a review of the initial and continuing losses would be undertaken.

The Initial Loss (IL) parameter represents the loss of rainfall prior to the commencement of surface runoff. It is related to land type (e.g. urban, rural topography) and is used to represent antecedent conditions. The Continuing Loss (CL) represents the average loss rate during the remainder of the storm.

In the North Byron Shire Flood Study (NBFS), the Forested area IL values adopted for design events were significantly lower than those used in calibration events, and are also considered low compared to ARR2016 recommended median values. The CL adopted in the Flood Study are also high compared to ARR recommendations. Table 1 below summarises the adopted values.

**Table 1: Initial loss values adopted for calibration and design events in the NBFS (2016)**

Ground cover	Initial Loss (mm)			Continuing Loss (mm/hr)		
	Calibration events	Design Events	ARR Recommended Median Values	Calibration events	Design Events	ARR Recommended Median Values
Urban	0	0	38 (ARR2016)	1	1	2.5 (ARR2016 and ARR1987)
Rural	30 (May 1987) 15 (June 2005) 5 (Jan. 2012)	5		4	4	
Forested	100 (June 2005, May 1987) 80 (Jan. 2012)	20	10 to 35 (ARR1987)	6	6	

28% of the total catchment area is classed as 'forested' land use, located mainly in the upper Brunswick River catchment. Thus, Forested IL and CL values may have an impact on modelled flows in upper Brunswick River localities such as Main Arm and Mullumbimby. Sensitivity analysis on this value has been undertaken to determine the influence it may have on the resulting flows.

This memo presents the findings of the sensitivity analysis on the IL and CL values of the XP-RAFTS hydrologic model. Four different IL values were studied: 20, 40, 80 and 100 mm. Three different CL values were studied: 4, 5 and 6 mm/hr. Results are analysed for the 20% AEP, 1% AEP and PMF design flood events.

## 2. INITIAL LOSS SENSITIVITY ANALYSIS

### 2.1. 1% AEP DESIGN EVENT

Table 2 and Figure 1 show the modelled flow at various locations in the catchment, for the four IL scenarios, for the 1% AEP design event.

Adjustment to the 'forested' IL value has a significant impact on Brunswick River flow. At Durrumbul, flow varies from 440m<sup>3</sup>/s to 740m<sup>3</sup>/s depending on IL. It corresponds to a flow increase of 41% for an IL value decrease from 100mm to 20mm. A similar difference is calculated at Federation Bridge in Mullumbimby (730m<sup>3</sup>/s to 1140m<sup>3</sup>/s, 36%) and on Brunswick Mouth (830m<sup>3</sup>/s to 1250 m<sup>3</sup>/s, +34%).

The impact is less for Marshalls Creek ( $\pm$ 40m<sup>3</sup>/s, 9% difference at Billinudgel) and for Yelgun Creek ( $\pm$ 30m<sup>3</sup>/s, 27% difference at Kallaroo Circuit). There is no impact on Simpsons Creek flow as the catchment is almost exclusively classed as Rural.

Forested IL values have a notable impact on Brunswick River modelled flow that leads to a reduction of 420m<sup>3</sup>/s for the 1% AEP design event.

**Table 2: Impact of Initial Loss values on 1% AEP peak flow at specified locations**

Location	1% AEP Peak Flow (m <sup>3</sup> /s)			
	Forested IL 20mm	Forested IL 40mm (% change from 20mm)	Forested IL 80mm (% change from 20mm)	Forested IL 100mm (% change from 20mm)
<b>Durrumbul Gauge (Brunswick River)</b>	740	670 (-10%)	520 (-30%)	440 (-41%)
<b>Federation Bridge (Brunswick River)</b>	1140	1060 (-7%)	840 (-26%)	730 (-36%)
<b>Brunswick Head (Brunswick River)</b>	1250	1170 (-6%)	950 (-24%)	830 (-34%)
<b>Billinudgel (Marshalls Creek)</b>	360	350 (-3%)	330 (-8%)	320 (-9%)
<b>Kallaroo Circuit (Yelgun Creek)</b>	110	110 (0%)	90 (-18%)	80 (-27%)
<b>Sth Beach Rd (Simpsons Creek)</b>	520	520 (0%)	520 (0%)	520 (0%)

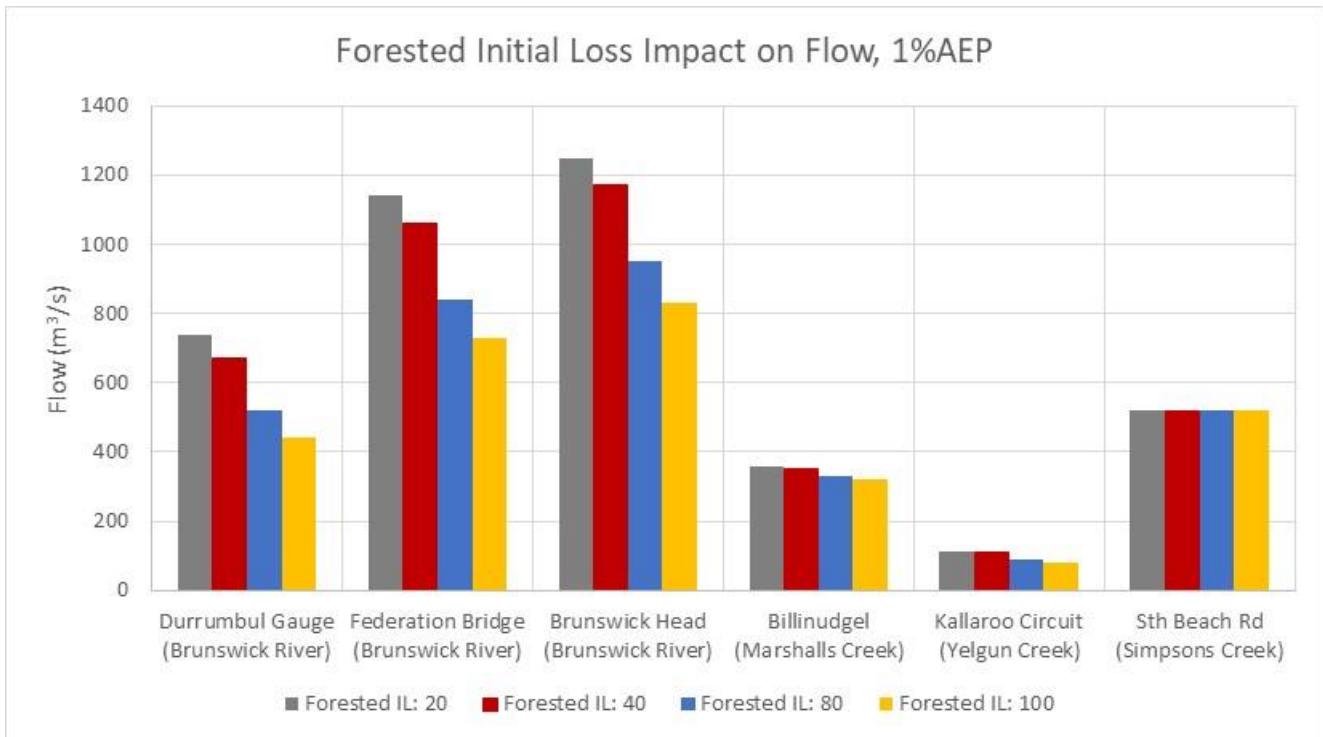


Figure 1: Initial Loss Sensitivity Analysis results, 1% AEP event

## 2.2. 20% AEP DESIGN EVENT

For the 20% AEP design event, the impact on flow is still substantial in the Brunswick River. Flow varies from 170m³/s to 280m³/s (+39%) at Durrumbul Gauge.

Similar to the 1% AEP event, flow is less sensitive to IL changes for Marshalls Creek and Yelgun Creek and is non-existent for Simpsons Creek.

Table 3: Impact of Initial Loss values on 20% AEP peak flow at specified locations

Location	5% AEP Peak Flow (m³/s)			
	Forested IL 20mm	Forested IL 40mm (% change from 20mm)	Forested IL 80mm (% change from 20mm)	Forested IL 100mm (% change from 20mm)
Durrumbul Gauge (Brunswick River)	280	260 (-7%)	210 (-25%)	170 (-39%)
Federation Bridge (Brunswick River)	470	440 (-6%)	340 (-28%)	290 (-38%)
Brunswick Head (Brunswick River)	540	500 (-7%)	400 (-26%)	350 (-35%)
Billinudgel (Marshalls Creek)	170	170 (0%)	150 (-12%)	150 (-12%)
Kallaroo Circuit (Yelgun Creek)	50	50 (0%)	40 (-20%)	30 (-40%)
Sth Beach Rd (Simpsons Creek)	260	260 (0%)	260 (0%)	260 (0%)

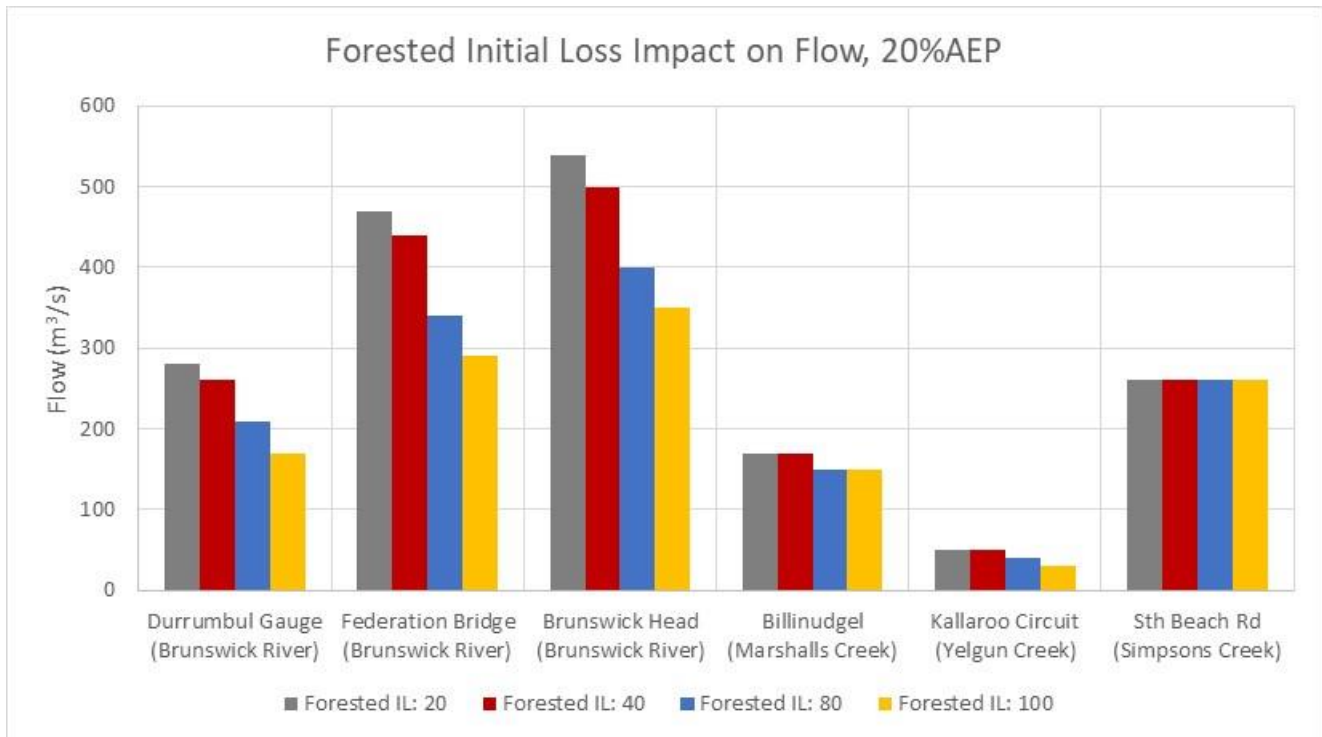


Figure 2: Initial Loss Sensitivity Analysis results, 20% AEP event

### 2.3. PMF DESIGN EVENT

For the PMF event, sensitivity tests show that whilst an IL value change can cause an increase of 250m<sup>3</sup>/s on the downstream part of Brunswick River (Brunswick Head), this only represents 5% of the total flow. Thus, changes in IL values results in a less significant flow change (varying between 4750m<sup>3</sup>/s and 5000m<sup>3</sup>/s). There is almost no impact on Marshall's Creek and Yelgun Creek.

Table 4: Impact of Initial Loss values on PMF peak flow at specified locations

Location	PMF Peak Flow (m <sup>3</sup> /s)			
	Forested IL 20mm	Forested IL 40mm (% change from 20mm)	Forested IL 80mm (% change from 20mm)	Forested IL 100mm (% change from 20mm)
Durrumbul Gauge (Brunswick River)	2930	2910 (<-1%)	2830 (-3%)	2780 (-5%)
Federation Bridge (Brunswick River)	4450	4440 (<-1%)	4390 (-1%)	4360 (-2%)
Brunswick Head (Brunswick River)	5000	4960 (-1%)	4840 (-3%)	4750 (-5%)
Billinudgel (Marshall's Creek)	1510	1490 (-1%)	1460 (-3%)	1450 (-4%)
Kallaroo Circuit (Yelgun Creek)	470	460 (-2%)	440 (-6%)	420 (-7%)
Sth Beach Rd (Simpsons Creek)	2510	2510 (0%)	2510 (0%)	2510 (0%)

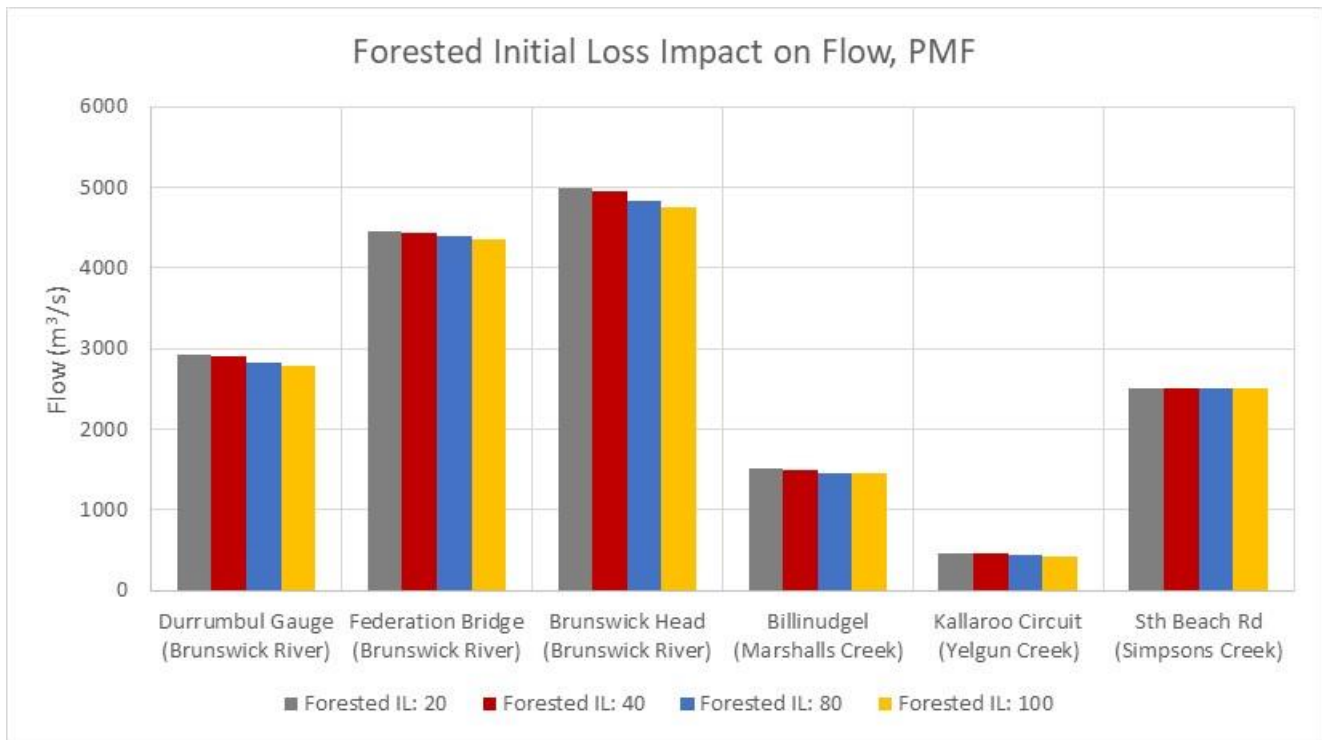


Figure 3: Initial Loss Sensitivity Analysis results, PMF event

### 3. CONTINUING LOSS SENSITIVITY ANALYSIS

#### 3.1. 1% AEP DESIGN EVENT

Table 5 and Figure 4 show the modelled flow at various locations in the catchment, for the three CL scenarios, for the 1% AEP design event.

Adjustment to the Forested CL value has minimal impact on Brunswick River flow. At Durrumbul, flow varies from 670m³/s to 690m³/s depending on CL. It corresponds to a flow increase of only 3% between 6mm/hr and 4mm/hr. A similar difference is calculated at Federation Bridge in Mullumbimby (1060m³/s to 1090m³/s, 3%) and on Brunswick Mouth (1170m³/s to 1200m³/s, 3%).

There is no impact for Marshalls Creek, Yelgun Creek and Simpsons Creek.

Table 5: Impact of Continuing Loss values on 1% AEP peak flow at specified locations

Location	1% AEP Peak Flow (m³/s)		
	Forested CL 4 mm/hr	Forested CL 5 mm/hr	Forested CL 6 mm/hr
Durrumbul Gauge (Brunswick River)	690	680	670
Federation Bridge (Brunswick River)	1090	1080	1060
Brunswick Head (Brunswick River)	1200	1180	1170
Billinudgel (Marshalls Creek)	350	350	350
Kallaroo Circuit (Yelgun Creek)	110	110	110
Sth Beach Rd (Simpsons Creek)	520	520	520

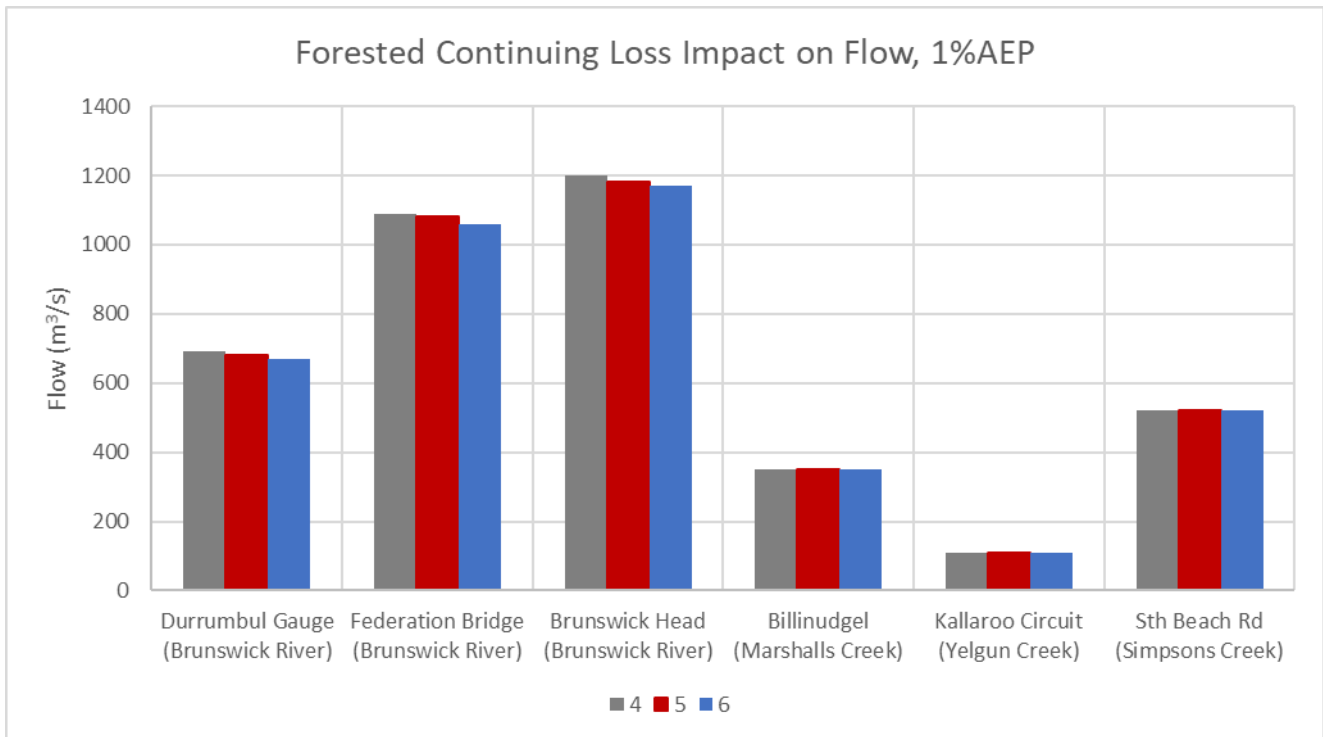


Figure 4: Continuing Loss Sensitivity Analysis results, 1% AEP event

### 3.2. 20% AEP DESIGN EVENT

For the 20% AEP design event, there is almost no impact on flow. The most important impact occurs at Durrumbul Gauge (260m³/s to 270m³/s, 4%).

Table 6: Impact of Continuing Loss values on 20% AEP peak flow at specified locations

Location	5% AEP Peak Flow (m³/s)		
	Forested CL 4 mm/hr	Forested CL 5 mm/hr	Forested CL 6 mm/hr
Durrumbul Gauge (Brunswick River)	270	270	260
Federation Bridge (Brunswick River)	450	440	440
Brunswick Head (Brunswick River)	510	500	500
Billinudgel (Marshalls Creek)	170	170	170
Kallaroo Circuit (Yelgun Creek)	50	50	50
Sth Beach Rd (Simpsons Creek)	260	260	260

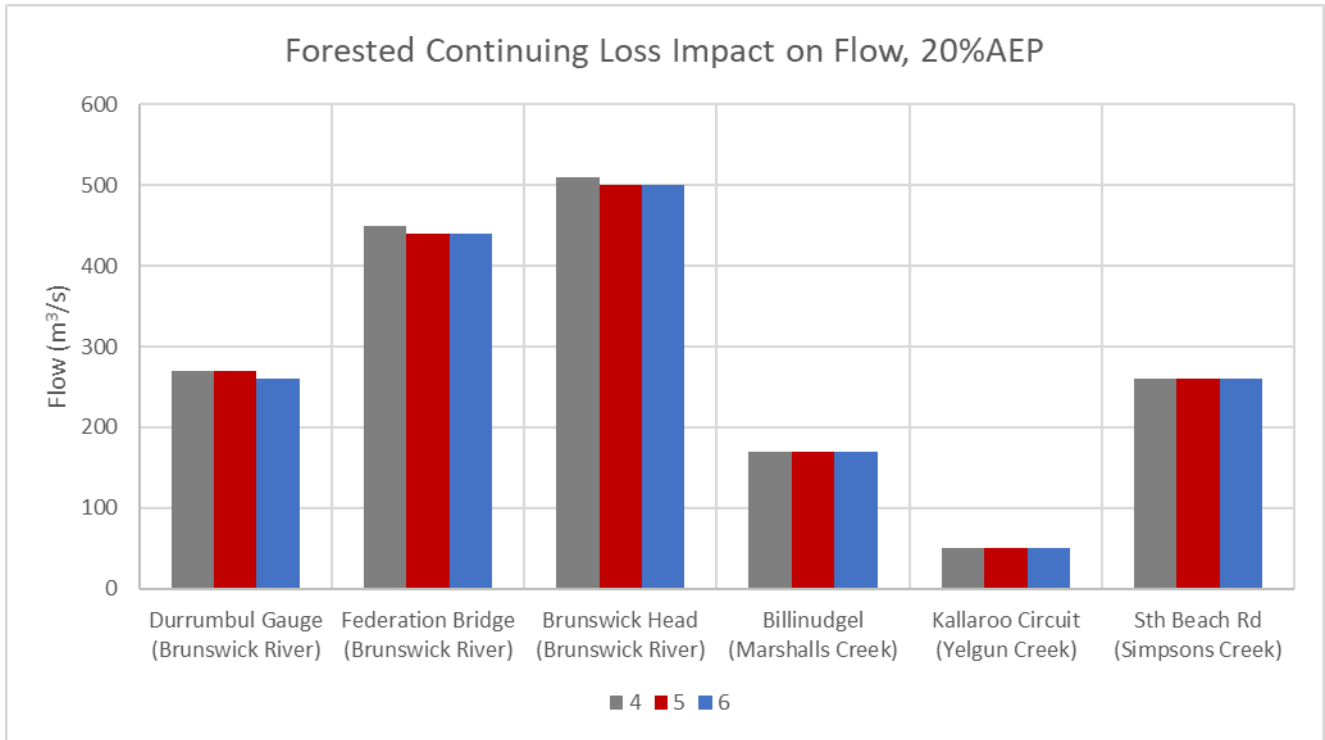


Figure 5: Continuing Loss Sensitivity Analysis results, 20% AEP event

### 3.3. PMF DESIGN EVENT

For the PMF, sensitivity tests show that a CL value change can cause an increase of only 20m³/s on Brunswick River. It represents less than 1% of the total flow.

Table 7: Impact of Continuing Loss values on PMF peak flow at specified locations

Location	PMF Peak Flow (m³/s)		
	Forested CL 4 mm/hr	Forested CL 5 mm/hr	Forested CL 6 mm/hr
Durrumbul Gauge (Brunswick River)	2930	2920	2910
Federation Bridge (Brunswick River)	4460	4450	4440
Brunswick Head (Brunswick River)	4980	4970	4960
Billinudgel (Marshalls Creek)	1500	1490	1490
Kallaroo Circuit (Yelgun Creek)	460	460	460
Sth Beach Rd (Simpsons Creek)	2510	2510	2510



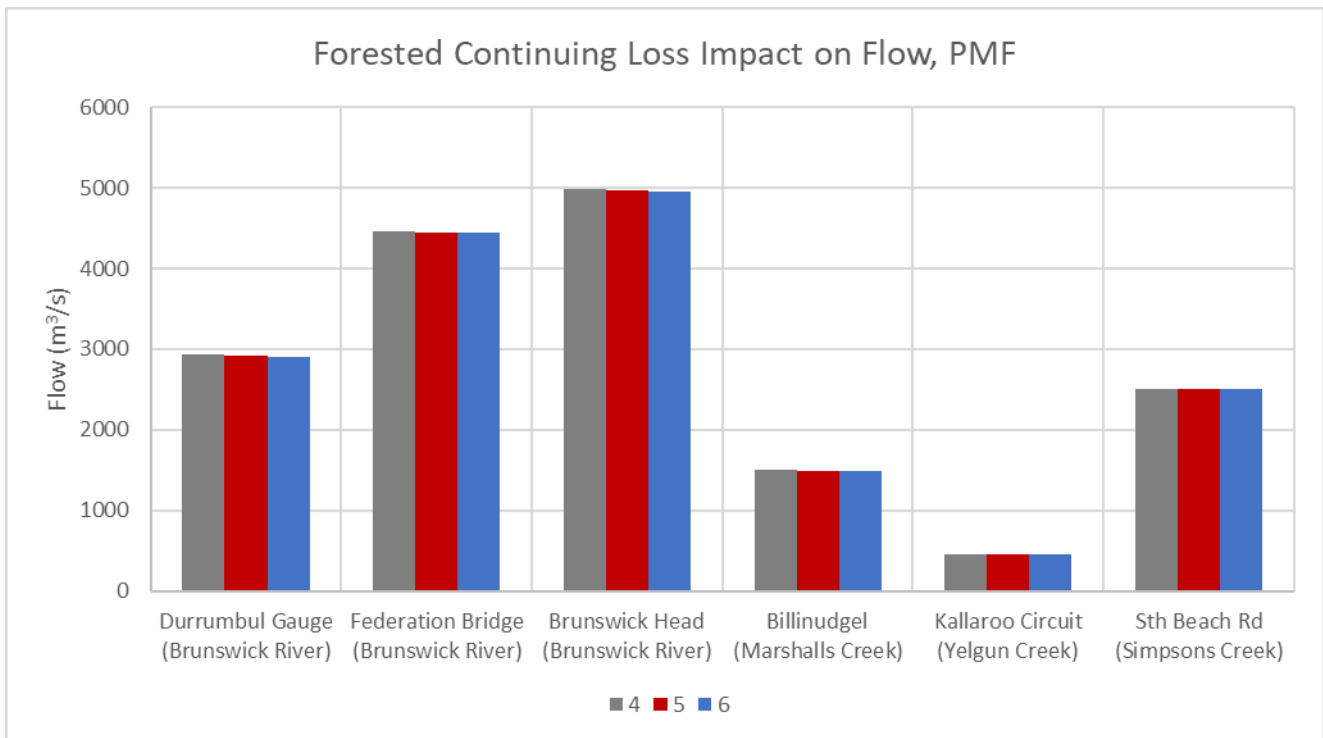


Figure 6: Continuing Loss Sensitivity Analysis results, PMF event

## 4. CONCLUSION

### 4.1. Initial Loss values

Sensitivity tests on the XP-RAFTS hydrologic model show that altering 'forested' IL value has a greater impact on the flows of smaller design events, than the larger more extreme events like the PMF. They also show that the impact is significant for Brunswick River as the majority of forested areas are located on upper Brunswick River catchment.

For the Brunswick River, an IL value decrease from 100mm to 20mm causes a 41% flow increase in Main Arm and 36% in Mullumbimby for the 1% AEP design event.

Forested IL adopted by BMT WBM for calibration and design events are significantly different. For calibration events, the IL values are often an artefact of limited rainfall temporal pattern data and the adopted high IL values may be compensating for rainfall data limitations. Thus, IL values adopted for the design events are lower to ensure an element of conservatism. However, the hydrologic model is particularly sensitive to changes in the 'forested' IL value especially in the Brunswick River. An IL value of 20mm is not only much lower than the calibration values (80mm and 100mm) but also lower than ARR2016 recommended value for the area (38mm). The heavily vegetated tropical nature of the vegetation in the North Byron catchment also suggests that the IL value should be higher.

It is recommended to use an IL value of 40mm for forested area for the design events. This value is still conservative regarding the adopted value for calibration events and is more consistent with the ARR2016 adopted value and the type of vegetation in the area.

### 4.2. Continuing Loss values

Sensitivity tests show that the 'forested' CL value does not have a significant impact on peak flows. A CL decrease from 6mm/hr to 4mm/hr only results in a 3% peak flow increase for the 1% AEP design event. As such, it is recommended that the CL value is unchanged.

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## Reference

North Byron Shire Flood Study (BMT WBM, 2016)