

# APPENDIX A - FLOOD THREATS FOR CARDINIA SHIRE

## General

The Cardinia municipality is an outer metropolitan fringe Council located east of Melbourne, its western boundary approximately 55 km from the CBD and with an area of just over 1,281 km<sup>2</sup>. The first European settlements within the municipality were in the late 1830s and since then the region has changed from a predominantly rural district to one that is a mixture of agriculture, lifestyle farming and urban areas. Cardinia Shire Council is home to over 116,000 residents, living in approximately 35,000 houses. 39,000 of these residents live in Pakenham, the Shire's largest town.

Cardinia Shire straddles the eastern portion of the Dandenong Ranges, being part of the Great Dividing Range. The Shire is bounded by Bunyip River to the east, Cardinia Creek to the West and Western Port Bay to the south. Parts of the upper Woori Yallock Creek catchment fall within the Shire's boundary to the north around Cockatoo and Emerald.

The dominant features are the steep ranges in the north and the lowlands of the extensive Koo Wee Rup Swamp, formed from a depressed basin between the Tyabb Fault and Heath Hill Fault. While these features extend outside the municipal boundary, the Great Swamp of the lowland is a dominant landscape feature of the region; covering over 400 km<sup>2</sup> with extensive flat areas surrounding the Swamp.

The northern region of the municipality contains the southern slopes of the Dandenong Ranges. These steep slopes are the headwaters for a number of waterways in the municipality.

The southern catchments include the Lang Lang River and its tributaries. These stream systems descend onto the plains around Koo Wee Rup Swamp. The waterways of the lower catchments have been directed into channels which have overbank flows across the floodplains.

Typically, the flatter regions became a deposition zone for the larger catchments that drain into the area. This has formed a series of connected wetlands and continuous network of channels across the terrain that gave rise to the extensive peat swamps and lowland terrain of today.

## Description of Major Waterways and Drains

The major waterways and drains within or bordering Cardinia Shire are:

Melbourne Water Drains & Waterways	Suburb/s	Melbourne Water Drains & Waterways	Suburb/s
Adams Creek	Lang Lang	Macclesfield Creek	Avonsleigh
Adams Creek North Branch	Lang Lang	Maisey Drain	Iona & Modella
Adams Creek South Branch	Lang Lang	Maisey Extension Drain	Iona & Modella
Adams Drain	Cardinia	Malcolms Rd Ext Drain	Catani
Ararat Creek	Nar Nar Goon, Nar Nar Goon North, Pakenham Upper & Tynong	Manks Rd Drain East	Dalmore & Koo Wee Rup
Avonsleigh Creek	Avonsleigh	Manks Rd Drain West	Dalmore
Back Creek	Gembrook	Martin Drain	Longwarry
Back Creek South East	Maryknoll, Nar Nar Goon, Nar Nar Goon North & Tynong North	Maryknoll Trib Of Back Creek	Nar Nar Goon North & Tynong North
Ballarto Rd East Drain	Pakenham South	Mc Gregors Drain	Koo Wee Rup, Pakenham & Pakenham South
Ballarto Rd West Drain	Pakenham South & Rythdale	Mcclures Drain	Bayles
Bastin #1 Drain	Bunyip & Longwarry	Mcdermids Drain	Modella
Bastin #2 Drain	Bunyip	Mcdonalds Catch Drain	Koo Wee Rup & Pakenham South
Batchelor Drain	Bunyip & Longwarry	Mcdonalds Drain	Koo Wee Rup & Pakenham South
Battys Island Drain	Cora Lynn & Tynong	Mcdonalds Drain #6	Catani
Beaconsfield Reservoir Drain	Beaconsfield Upper & Officer	Mcdonalds Rd Drain	Pakenham
Beaconsfield Township Catchment Drain	Beaconsfield	Mcdonalds Rd Drain North	Catani & Iona
Beaconsfield Township Corridor Drain	Beaconsfield	Mcgregor Rd D.S.	Officer South & Pakenham
Bennets Rd Drain	Catani	Mcgregors Catch Drain	Dalmore, Koo Wee Rup & Pakenham South
Berry Lane Drain	Bunyip	Mcivor Rd & Miles Rd Drain	Bunyip
Bessie Creek	Nar Nar Goon North & Pakenham Upper	Mckays Drain	Koo Wee Rup
Bethunes Rd Drain	Koo Wee Rup	Mckenzie's & Twelve-Ten Drains	Vervale
Billow Creek	Gembrook	Mckillops Drain	Cora Lynn
Bladens Drain	Koo Wee Rup	Mcnabs Rd Drain	Bayles & Catani
Bourke Creek	Cockatoo, Dewhurst, Emerald, Mount Burnett & Pakenham Upper	Mcnamaras Drain	Koo Wee Rup
Bowdens Drain	Cardinia & Dalmore	Menzies Creek	Emerald
Brisbane Creek	Beaconsfield, Beaconsfield Upper & Guys Hill	Milligans Rd Drain	Cora Lynn
Brownbills Drain	Garfield	Modella Rd Drain	Modella
Bunyip Main Outfall Drain	Bayles, Bunyip, Cora Lynn, Garfield, Iona, Koo Wee Rup, Koo Wee Rup North, Long Warry, Nar Nar Goon & Vervale	Monomeith Drain	Caldermeade, Catani, Monomeith & Yannathan
Bunyip Modella Rd Drain	Bunyip, Iona & Modella	Moomba Creek	Gembrook

Melbourne Water Drains & Waterways	Suburb/s	Melbourne Water Drains & Waterways	Suburb/s
Bunyip River (Lower)	Bunyip, Bunyip North, Gembrook, Longwarry, Longwarry North & Tonimbuk	Morris Creek	Gembrook
Bunyip Showground Drain	Bunyip	Mount Ararat Drain	Nar Nar Goon & Pakenham
Calverts Drain	Tynong	Muddy Creek	Emerald
Camerons Drain	Catani & Cora Lynn	Muddy Creek	Menzies Creek
Cannibal Creek	Bunyip North, Garfield North & Tynong North	Murray Rd Drain	Bunyip, Cora Lynn, Iona & Vervale
Cardinia Catch Drain	Cardinia, Dalmore & Koo Wee Rup	No. 6 Yallock Drain	Bayles, Catani, Iona & Modella
Cardinia Creek (Lower)	Beaconsfield, Beaconsfield Upper, Cardinia, Emerald, Guys Hill, Officer & Officer South	Nash Creek	Gembrook
Cardinia Rd Drain	Officer, Officer South, Pakenham & Pakenham South	No.5 Yallock Drain	Bayles, Catani, Monomeith & Yannathan
Carses Drain	Iona	North West Catch Drain	Cora Lynn, Koo Wee Rup, Koo Wee Rup North, Nar Nar Goon & Vervale
Catani Drain	Catani	Northern Boundary Drain	Nar Nar Goon, Pakenham & Pakenham South
Clark Creek	Gembrook	Northern Boundary Extn Drain	Garfield, Nar Nar Goon & Tynong
Coast Rd Drain	Koo Wee Rup	No. 4 Yallock Drain	Bayles, Cora Lynn, Koo Wee Rup & Monomeith
Cochranes Drain	Koo Wee Rup	No. 7 Yallock Drain	Bayles, Cora Lynn, Iona & Modella
Cockatoo Creek	Avonsleigh, Cockatoo, Gembrook, Mount Burnett & Nangana	O'Briens Drain	Bayles & Yannathan
Coles Drain	Bayles	Officer Creek	Officer
Convent Rd Drain	Cora Lynn & Nar Nar Goon	Officer South Drain	Officer & Officer South
Cook Drain	Bunyip & Longwarry	Old Deep Creek Levee	Pakenham & Pakenham South
Costellos Drain	Cora Lynn	Old Lang Lang River	Caldermeade, Heath Hill, Lang Lang & Yannathan
Coxs Drain	Bayles	O'Neils Drain	Catani & Yannathan
Creek 2504	Lang Lang	O'Neils Rd Drain	Beaconsfield
Cruddens Grip	Iona	Pakenham Creek Drain	Pakenham
Cunninghams Drain	Tynong	Pancake Creek	Cockatoo, Gembrook & Nangana
Curries Drain	Iona & Modella	Parish Rd Drain	Iona, Longwarry & Modella
Daleys Rd Drain	Koo Wee Rup	Pattersons Drain	Koo Wee Rup
Davidsons Creek	Beaconsfield & Officer	Pecks Rd Drain	Bayles
Dawson Rd Ext Drain	Modella	Phillips Rd Drain	Bayles
Deep Creek (Lower)	Dalmore, Koo Wee Rup, Pakenham, Pakenham South & Rythdale	Pitts Rd Drain	Iona & Vervale
Deep Creek Catch Drain	Dalmore, Koo Wee Rup, Pakenham South & Rythdale	Quigleys Rd Drain	Cora Lynn
Deep Creek South Drain	Pakenham	Quirks Creek	Officer & Pakenham

Melbourne Water Drains & Waterways	Suburb/s	Melbourne Water Drains & Waterways	Suburb/s
Denhams Rd Drain	Koo Wee Rup	Railway Borrow Drain	Bayles & Catani
Diamond Creek South East	Gembrook, Tonimbuk & Tynong North	Railway Rd Drain	Koo Wee Rup
Dingo Creek	Tonimbuk	Regans Rd Drain	Nar Nar Goon
Dyer Creek	Gembrook	Ridgeways Drain	Cardinia
Eastern Drain Drain	Pakenham	Roxburghs Drain	Cora Lynn & Iona
Egans Drain (2962)	Bayles & Koo Wee Rup	Russell Creek	Gembrook
Egertons Rd Drain	Dalmore	Rythdale Drain	Pakenham South & Rythdale
Eight Mile Drain	Nar Nar Goon	Sandy Creek	Heath Hill
Eleven Mile Drain	Cora Lynn, Garfield, Tynong & Vervale	Sardine Creek	Gembrook
Ellet Rd Drain	Pakenham South	Scanlons Drain	Bayles & Catani
Endicotts Drain	Bunyip	Searle Gully	Gembrook
Fallon Drain	Iona	Seven Acres Creek	Gembrook
Fifteen Mile Drain	Bunyip	Seven Mile Drain	Nar Nar Goon
Fincks Rd Drain	Bayles	Shepherd Creek	Gembrook & Nangana
Five Mile Drain	Koo Wee Rup North, Pakenham & Pakenham South	Shepherd Creek East Branch	Gembrook
Flanningans Creek	Gembrook	Shepherd Creek West Branch	Gembrook
Fogartys Drain	Pakenham South	Sidebottoms Rd Drain	Iona
Fogartys Rd Drain	Pakenham South	Simpsons Rd Drain	Iona & Vervale
Forbes Rd Trib Of Back Creek	Maryknoll, Nar Nar Goon North & Tynong North	Sinclairs Rd Drain	Cora Lynn
Fourteen Mile Drain	Garfield & Iona	Sixteen Mile Drain	Bunyip
Gardiners Drain	Modella	Smedleys Creek	Gembrook
Gembrook Creek	Cockatoo, Gembrook & Mount Burnett	Soldiers Drain	Longwarry
Giles Rd Drain	Dalmore & Koo Wee Rup	Soldiers Rd East Drain	Pakenham South & Rythdale
Gleasons Rd Drain	Tynong	Soldiers Rd West Drain	Rythdale
Grays Drain	Koo Wee Rup	South East Main Catch Drain	Bayles, Cora Lynn, Koo Wee Rup & Koo Wee Rup North
Greaves Drain	Catani	Southern Boundary Drain	Bayles & Koo Wee Rup
Griffiths Drain	Bayles, Cora Lynn, Koo Wee Rup & Koo Wee Rup North	Stanlakes Rd Drain	Lang Lang
Griggs Drain	Tynong	Stoney Creek	Beaconsfield Upper
Gully Drain	Bunyip & Longwarry	Strafford Lane Drain	Bunyip
Gum Scrub Creek	Cardinia, Dalmore, Officer, Officer South & Rythdale	Swains Drain	Catani & Yannathan
Gunns Drain	Garfield & Vervale	Taplins Rd Drain	Catani & Iona
Hagelthornes Drain	Koo Wee Rup, Pakenham South & Rythdale	Taylors East Drain	Catani
Hall Drain	Koo Wee Rup North & Nar Nar Goon	Taylors West Drain	Bayles & Yannathan
Hall Rd Yallock Drain	Bayles & Yannathan	Tea Tree Creek	Bunyip, Bunyip North & Garfield
Hamilton Creek	Garfield North	Ten Mile Drain (Nine Mile Rd)	Cora Lynn, Nar Nar Goon & Tynong
Hancocks Gully	Nar Nar Goon, Nar Nar Goon North & Pakenham	Thirteen Mile Drain	Garfield & Vervale

Melbourne Water Drains & Waterways	Suburb/s	Melbourne Water Drains & Waterways	Suburb/s
Harold Creek	Gembrook	Thompsons Drain	Bunyip & Longwarry
Haunted Gully Creek	Officer	Tomahawk Creek	Gembrook
Head Creek	Gembrook	Toomuc Creek (Lower)	Cardinia, Dalmore, Dewhurst, Koo Wee Rup, Officer South, Pakenham, Pakenham South, Pakenham Upper & Rythdale
Heads Rd (Osheas) Drain	Catani	Tooradin Inlet Drain	Cardinia & Dalmore
Hein Creek	Beaconsfield Upper & Pakenham	Tooradin Inlet East Catch Drain	Cardinia
Himbecks Drain	Koo Wee Rup	Tooradin Inlet West Catch Drain	Cardinia
Hogans Rd Drain	Bayles	Tooradin Rd Drain	Dalmore
Holts Drain	Heath Hill & Modella	Triangle Creek	Gembrook
Hornbuckles Rd & Extn Drain	Catani	Two Mile Creek West	Bunyip North, Garfield North & Tonimbuk
Humphries Rd Drain	Catani & Iona	Tynong Creek	Gembrook & Tynong North
Island Rd East Drain	Koo Wee Rup	Tynong Rd Drain	Nar Nar Goon & Tynong
Island Rd West Drain	Koo Wee Rup	Walford Creek	Beaconsfield Upper
Jetty Lane Drain	Lang Lang	Walford Creek	Dewhurst
Johnsons Drain	Koo Wee Rup	Walford Creek	Pakenham Upper
Jonas Creek	Gembrook	Walkers Rd Drain	Garfield & Vervale
Kennedy Creek	Pakenham	Walkers Rd Drain Extension	Bunyip & Garfield
Kitchen Creek	Beaconsfield Upper, Pakenham & Pakenham Upper	Walley Drain	Bunyip
Knights Rd Drain	Longwarry	Walshs Drain	Catani
Koo-Wee-Rup South Drain	Koo Wee Rup	Watsons Rd Drain	Bayles
Lang Lang River (Lower)	Caldermeade, Heath Hill, Lang Lang & Yannathan	Wattle Creek	Avonsleigh, Cockatoo & Emerald
Langridge St Drain	Beaconsfield Upper	West Dalmore Rd Drain	Cardinia, Dalmore & Koo Wee Rup
Lias Rd Drain	Nar Nar Goon & Pakenham South	Whittas Rd Drain	Nar Nar Goon
Linehams Drain	Iona & Modella	Wilkinsons Drain	Bayles
Link Creek	Gembrook	William Wallace Creek	Gembrook
Little Lang Lang River Sth Branch	Lang Lang	Worley Creek	Gembrook
Little Lang Lang River	Lang Lang & Lang Lang East	Worships Rd Drain	Pakenham South
Little Yannathan Rd Dr (2941)	Cora Lynn, Iona, Longwarry, Modella & Vervale	Wrights Drain	Bunyip & Longwarry
Lone Pine Rd Drain	Bunyip & Garfield	Yallock Creek	Bayles, Caldermeade, Koo Wee Rup & Monomeith
Longwarry Drain	Bunyip & Longwarry	Yallock Cut & Levee	Caldermeade & Monomeith
Longwarry Recreational Drain	Longwarry		

Table A1 – Melbourne Water Drains and Waterways within or bordering Cardinia Shire

The Bunyip River, also known as the Bunyip Main Drain, consists of the Tarago and Bunyip River systems which converge above the Princes Highway near the township of Bunyip. These systems extend from the head waters within the Bunyip State Forest and Black Snake Range. This part of the Bunyip River catchment is largely natural.

The Bunyip Main Drain, below the Princes Highway, is a mostly man-made channel which extends from just above the Princes Highway at Bunyip down through the Koo Wee Rup township to Western Port Bay. At Cora Lynn, the Yallock Outfall Drain (diversion channel) was constructed in 1956 to alleviate the pressure of high-level flood waters at Koo Wee Rup. This outfall drain diverts water directly to Western Port Bay at Monomeith.

The Lang Lang River is the second largest waterway in the municipality, and it extends from the head waters near Ranceby and Poowong and meets Western Port Bay near the Lang Lang township. The river's bed and banks are in semi-natural condition, but some man-made interventions are present along its course; mainly below Yannathan.

The Cardinia, Deep and Toomuc Creek catchments are also significant waterways within the municipality, in terms of flooding impacts to the community. These waterways have been significantly modified in their lower reaches.

See **Appendix F** for Catchment Schematics on these waterways.

## Historic Storms and Floods

Significant floods (with high flood gauge levels and likely flooding consequences to property and infrastructure) to have occurred within Cardinia Shire are as follows in the table below. Levels and rain totals in black indicate large-scale impacts to surrounding areas were recorded, whereas grey figures indicate localised impacts if any occurred. To view the locations of a selection of these severe weather events, see mapping in **Appendix F**.

Event	Bunyip River at Iona (228213A)		Bunyip River at Cora Lynn (228380A)	Bunyip River at Koo Wee Rup (228395A)		Cardinia Creek at Cardinia 228228A)		Gum Scrub Creek At Officer (228365A)		Toomuc Creek at Pakenham West (228217C)
	Rainfall	Stream Level	Stream Level	Rainfall	Stream Level	Rainfall	Stream Level	Rainfall	Stream Level	Stream Level
Normal Water Level	-			-		-		-		
<b>Minor Flood Class</b>	-	2.1m	3.1m	-	-	-	2.7m	-	2.1m	-
<b>Moderate Flood Class</b>	-	5.0m	4.1m	-	-	-	3.0m	-	2.6m	-
<b>Major Flood Class</b>	-	6.0m	4.5m	-	-	-	3.4m	-	-	-
1891	-	-	-	-	-	-	-	-	-	-
April 1900	-	-	-	-	-	-	-	-	-	-
April 1901	-	-	-	-	-	-	-	-	-	-
June 1911	-	-	-	-	-	-	-	-	-	-
October 1923	-	-	-	-	-	-	-	-	-	-
August 1924	-	-	-	-	-	-	-	-	-	-
1 <sup>st</sup> December 1934	170mm / 48hrs	-	-	-	-	-	-	192mm / 48 hrs	-	-
April 1935	-	-	-	-	-	-	-	-	-	-
October 1937	-	-	-	-	-	-	-	-	-	-
November 1956	-	-	-	-	-	-	-	-	-	-
September 1956	-	-	-	-	-	-	-	-	-	-
8 <sup>th</sup> November 1971	-	7.20m	-	-	-	-	-	-	-	-
15 <sup>th</sup> May 1974	-	4.14m	-	-	-	-	3.98m	-	-	-
18 <sup>th</sup> September 1975	-	3.03m	-	-	-	-	1.86m	-	-	-
29 <sup>th</sup> July 1977	-	3.20m	-	-	-	-	1.60m	-	-	-
10 <sup>th</sup> August 1978	-	3.17m	-	-	-	-	1.71m	-	-	0.75m
20 <sup>th</sup> November 1978	-	3.00m	-	-	-	-	2.42m	-	-	1.07m

Event	Bunyip River at Iona (228213A)		Bunyip River at Cora Lynn (228380A)	Bunyip River at Koo Wee Rup (228395A)		Cardinia Creek at Cardinia 228228A)		Gum Scrub Creek At Officer (228365A)		Toomuc Creek at Pakenham West (228217C)
	Rainfall	Stream Level	Stream Level	Rainfall	Stream Level	Rainfall	Stream Level	Rainfall	Stream Level	Stream Level
Normal Water Level	-			-		-		-		
<b>Minor Flood Class</b>	-	2.1m	3.1m	-	-	-	2.7m	-	2.1m	-
<b>Moderate Flood Class</b>	-	5.0m	4.1m	-	-	-	3.0m	-	2.6m	-
<b>Major Flood Class</b>	-	6.0m	4.5m	-	-	-	3.4m	-	-	-
22 <sup>nd</sup> August 1981	-	3.41m	-	-	-	-	1.85m	21mm / 18 hrs	1.85m	0.93m
14 <sup>th</sup> September 1983	-	3.40m	-	-	-	-	1.98m	25mm / 17 hrs	2.19m	0.95m
17 <sup>th</sup> October 1983	-	3.02m	-	-	-	-	2.92m	64mm / 30 hrs	2.43m	1.08m
29 <sup>th</sup> July 1984	-	3.24m	-	-	-	-	1.31m	30mm / 78 hrs	1.36m	0.90m
19 <sup>th</sup> September 1984	-	5.61m	-	-	-	-	4.44m	107mm / 60 hrs	2.68m	1.64m
7 <sup>th</sup> November 1985	-	3.68m	-	-	-	-	0.75m	61mm / 67 hrs	2.18m	1.28m
29 <sup>th</sup> July 1987	-	3.31m	-	-	-	-	3.50m	65mm / 25 hrs	2.44m	1.31m
11 <sup>th</sup> June 1989	-	3.10m	-	-	-	-	3.07m	74mm / 40 hrs	2.35m	1.28m
28 <sup>th</sup> October 1989	-	4.10m	-	-	-	-	2.07m	38mm / 29 hrs	2.43m	1.24m
31 <sup>st</sup> October 1989	-	4.18m	-	-	-	-	2.47m	35mm / 16 hrs	2.36m	1.15m
12 <sup>th</sup> October 1990	-	6.28m	-	-	-	-	4.09m	71mm / 20 hrs	2.43m	1.59m
18 <sup>th</sup> September 1991	-	3.27m	-	-	-	-	2.03m	42mm / 36 hrs	2.17m	1.06m
11 <sup>th</sup> October 1992	-	3.27m	-	-	-	-	1.72m	50mm / 60 hrs	2.05m	0.99m
16 <sup>th</sup> September 1993	-	5.28m	-	-	-	-	2.81m	45mm / 33 hrs	2.07m	1.16m
12 <sup>th</sup> June 1995	40mm / 73 hrs	3.25m	-	-	-	-	0.95m	24mm / 79 hrs	1.57m	0.78m
23 <sup>rd</sup> October 1995	60mm / 83 hrs	3.81m	-	-	-	55mm / 83 hrs	1.26m	55mm / 84 hrs	2.33m	0.97m
6 <sup>th</sup> November 1995	33mm / 50 hrs	3.32m	-	-	-	-	1.41m	62mm / 72 hrs	2.06m	1.03m
30 <sup>th</sup> July 1996	40mm / 19 hrs	5.95m	2.62m	-	-	31mm / 13 hrs	3.62m	39mm / 21 hrs	2.41m	1.49m
8 <sup>th</sup> August 1996	29mm / 46 hrs	3.33m	1.61m	-	-	25mm / 37 hrs	0.57m	15mm / 34 hrs	0.84m	0.78m
1 <sup>st</sup> October 1996	12mm / 22 hrs	3.16m	1.51m	-	-	27mm / 17 hrs	1.28m	25mm / 28 hrs	1.73m	1.14m
13 <sup>th</sup> November 2004	41mm / 7 hrs	5.36m	1.68m	34mm / 7 hrs	3.78m	30mm / 7 hrs	3.14m	41mm / 7 hrs	2.60m	1.46m
3 <sup>rd</sup> February 2005	78mm / 24 hrs	3.49m	-	101mm / 25 hrs	3.13m	118mm / 25 hrs	3.20m	148mm / 27 hrs	2.43m	1.57m



Event	Bunyip River at Iona (228213A)		Bunyip River at Cora Lynn (228380A)	Bunyip River at Koo Wee Rup (228395A)		Cardinia Creek at Cardinia 228228A)		Gum Scrub Creek At Officer (228365A)		Toomuc Creek at Pakenham West (228217C)
	Rainfall	Stream Level	Stream Level	Rainfall	Stream Level	Rainfall	Stream Level	Rainfall	Stream Level	Stream Level
Normal Water Level	-			-		-		-		
<b>Minor Flood Class</b>	-	2.1m	3.1m	-	-	-	2.7m	-	2.1m	-
<b>Moderate Flood Class</b>	-	5.0m	4.1m	-	-	-	3.0m	-	2.6m	-
<b>Major Flood Class</b>	-	6.0m	4.5m	-	-	-	3.4m	-	-	-
13 <sup>th</sup> September 2005	25mm / 19 hrs	2.27m	3.15m	19mm / 19 hrs	2.61m	15mm / 19 hrs	0.39m	19mm / 16 hrs	0.46m	0.54m
28 <sup>th</sup> September 2009	29mm / 19 hrs	2.66m	3.41m	17mm / 9 hrs	3.20m	16mm / 9 hrs	0.84m	30mm / 18 hrs	1.40m	0.86m
31 <sup>st</sup> October 2010	42mm / 16 hrs	2.56m	3.21m	46mm / 21 hrs	3.12m	51mm / 20 hrs	2.11m	69mm / 21 hrs	1.91m	1.11m
21 <sup>st</sup> December 2010	36mm / 17 hrs	2.65m	3.34m	16mm / 16 hrs	3.14m	12mm / 6 hrs	0.43m	10mm / 6 hrs	0.71m	0.59m
5 <sup>th</sup> February 2011	175mm / 28 hrs	7.33m	4.63m	77mm / 27 hrs	4.89m	99mm / 27 hrs	4.87m	203mm / 29 hrs	2.66m	2.19m
12 <sup>th</sup> April 2011	33mm / 7 hrs	2.29m	3.26m	42mm / 9 hrs	2.81m	29mm / 7 hrs	0.71m	33mm / 8 hrs	0.79m	0.81m
11 <sup>th</sup> August 2011	15mm / 8 hrs	2.27m	3.14m	14mm / 11 hrs	2.74m	13mm / 11 hrs	0.47m	14mm / 10 hrs	0.58m	0.62m
30 <sup>th</sup> September 2011	29mm / 6 hrs	2.27m	3.18m	27mm / 6 hrs	2.89m	31mm / 6 hrs	0.71m	36mm / 6 hrs	0.75m	0.72m
10 <sup>th</sup> November 2011	52mm / 7 hrs	3.87m	3.76m	32mm / 8 hrs	3.75m	22mm / 7 hrs	0.80m	27mm / 7 hrs	1.21m	0.91m
27 <sup>th</sup> November 2011	45mm / 17hrs	3.92m	3.78m	31mm / 15 hrs	3.81m	35mm / 16 hrs	1.29m	51mm / 17 hrs	1.52m	0.95m
26 <sup>th</sup> May 2012	32mm / 12 hrs	2.49m	3.73m	26mm / 11 hrs	3.13m	20mm / 8 hrs	0.78m	27mm / 13 hrs	0.84m	0.71m
5 <sup>th</sup> June 2012	12mm / 6 hrs	2.55m	3.41m	32mm / 16 hrs	3.09m	-	1.39m	-	1.97m	0.95m
22 <sup>nd</sup> June 2012	58mm / 26 hrs	4.91m	4.19m	75mm / 27 hrs	4.41m	76mm / 26 hrs	2.92m	-	2.34m	1.15m
2 <sup>nd</sup> July 2012	13mm / 11 hrs	2.23m	3.29m	6mm / 6 hrs	2.77m	11mm / 4 hrs	0.77m	-	1.29m	0.84m
28 <sup>th</sup> August 2015	46mm / 12 hrs	3.37m	3.90m	35mm / 9 hrs	4.04m	37mm / 10 hrs	0.97m	44mm / 11 hrs	1.63m	0.96m
22 <sup>nd</sup> July 2016	32mm / 29 hrs	2.08m	3.29m	27mm / 33 hrs	3.01m	24mm / 23 hrs	0.81m	23mm / 19 hrs	1.52	0.80m
20 <sup>th</sup> January 2020	16mm / 1 hr	0.92m	1.14m	14mm / 2 hrs	1.08m	9mm / 2 hrs	0.51m	28mm / 2 hrs	0.52m	0.73m
2 <sup>nd</sup> May 2020	37mm / 22 hrs	2.90m	3.91m	30mm / 24 hrs	3.39m	30mm / 18 hrs	1.41m	23mm / 15 hrs	1.18m	0.75m
23 <sup>rd</sup> August 2020	25mm / 25 hrs	3.05m	3.90m	24mm / 24 hrs	3.52m	9mm / 13 hrs	1.16m	16mm / 14 hrs	1.25m	0.75m
25 <sup>th</sup> October 2020	30mm / 10 hrs	2.07m	3.51m	29mm / 12 hrs	2.95m	32mm / 11 hrs	1.19m	36mm / 10 hrs	1.69m	0.96m

Table A2 – Selection of Historical Storm and Flood Events along Waterways in Cardinia Shire

## Large Flood Events

**1891** - Major regional rainfall and flooding.

**April 1900** – Two-day period of rainfall resulted in extensive flooding of the Koo Wee Rup Swamp that resulted in crop loss and inundation of roads and houses.

**April 1901** – Heavy rainfall over a three-day period in the upper catchments that caused extensive flooding of the Koo Wee Rup Swamp.

**June 1911** – Heavy rainfall in the upper catchments resulted in flooding in the southern and central parts of the Koo Wee Rup Swamp to a depth of 1.5 metres.

**October 1923** – Large flood event that destroyed crops and inundated the Koo Wee Rup Swamp, with water nearly two metres at Cora Lynn.

**August 1924** – Heavy rainfall over the northern ranges, exceeding 300 mm, caused most of the swamp area to be inundated to a depth of over 1.5 metres.

**November and December 1934** – Over 700 mm of rainfall across three days that caused extensive and prolonged flooding across the Koo Wee Rup Swamp area. Over 1,000 people were displaced and infrastructure including the Gippsland railway and major roads were severely damaged.

**April 1935** – Flood within five months of the previous flood.

**October 1937** – Rainfall in excess of 600 mm caused the Koo Wee Rup Swamp to be extensively flooded again.

**November 1956** – Heavy rain and flooding.

**September 1959** – Heavy rainfall in the upper catchments caused flood waters to cover key bridges with widespread flooding prevented through protection works.

**November 1971** – Heavy rainfall in excess of 200 mm over three days caused flooding in many tributaries and districts.

**July 1996** – Widespread flooding in the Koo Wee Rup Swamp with overbank flows upstream of Iona causing extensive flood damage to crops.

**February 2011** – Heavy rainfall across the Officer-Pakenham area with over 150 mm in 8 hours causing extensive flooding and resulting in 210 Requests for Assistance to VICSES over 48 hrs.

**June 2012** – Heavy rainfall with widespread flooding across Koo Wee Rup, Bayles, Lang Lang and Modella causing damage to crops and roads.

**January 2020** – A flash flood affecting Pakenham resulting in flooded properties.

## Dam Spilling / Failure

Flooding resulting from failure of the following dams is likely to cause significant structural and community damage within Cardinia Shire. See Dam Failure in Section 3 of this plan for more information. Note that if the storage capacity is reached and water flows over the spillway, this is not to be referred to as a flow release or a storage breach or failure.

Melbourne Water Dam	Location	Owner	Dam Capacity	Full Supply Level	Melway Reference
Cardinia Reservoir	Emerald	Melbourne Water	286,911 ML	167.03m AHD	126H12
Beaconsfield Nature Conservation Reserve Reservoir	O'Neil Road, Beaconsfield	Melbourne Water	Unavailable	Unavailable	212 H7

Table A3 – Melbourne Water Reservoirs that pose a risk to Cardinia Shire from Dam Failure

Service Reservoirs located within the Shire are listed below.

Service Reservoir	Location	Owner	Reservoir Capacity	Mapping Reference
Beaconsfield	Whiteside Road, Beaconsfield	South East Water	Unavailable	Melway 214 D1
Beaconsfield Upper	McKenzie Road, Beaconsfield Upper	South East Water	Unavailable	Melway 211 B10
Bunyip	Nar Nar Goon - Longwarry Road, Bunyip	South East Water	Unavailable	VicMap Central 6765 H8
Bunyip	Abeckett Road, Bunyip	South East Water	Unavailable	VicMap Central 6765 K7
Cockatoo	Aspect Avenue, Cockatoo	Yarra Valley Water	Unavailable	Melway 311 C7
Emerald	Emerald Lake Park	Cardinia Shire Council	24.4 ML	Melway 127 J4
Emerald North Tank	Oak Crescent, Emerald	Yarra Valley Water	Unavailable	Melway 125 G11
Garfield North	Princes Freeway, Garfield North	South East Water	Unavailable	VicMap Central 6765 D5
Gembrook	Main Street, Gembrook	Yarra Valley Water	Unavailable	Melway 312 H10
Koo Wee Rup	Tower Road, Koo Wee Rup	South East Water	Unavailable	VicMap Central 6822 H4
Lang Lang	McDonalds Track, Lang Lang	South East Water	Unavailable	VicMap Central 6823 E12
Lang Lang	Westernport Road, Lang Lang	South East Water	Unavailable	VicMap Central 6823 G11
Lilliput Lane Reserve	Lilliput Lane (off Army Road), Pakenham Upper	Cardinia Shire Council	17.6 ML	315 H10
Officer	Hughendon Road, Officer	South East Water	Unavailable	Melway 212 J4
Pakenahm Steel Tank	Mellane Road, Pakenham	Melbourne Water	16 ML	Melway 318 B2
Pakenahm Storage Reservoir	Mullane Road, Pakenham	Melbourne Water	Unavailable	Melway 318 B1
Pakenham	Ahern Road, Pakenham	South East Water	Unavailable	Melway 317 E2
Pepi's Land Dam Lower	West side of Beaconsfield-Emerald Road, Emerald	Cardinia Shire Council	9.3 ML	Melway 127 F6
Pepi's Land Dam Upper	West side of Beaconsfield-Emerald Road, Emerald	Cardinia Shire Council	4.05 ML	Melway 127 F6
Stewarts Road	Stewart's Road, Emerald	Cardinia Shire Council	5.4 ML	Melway 125 J10
Tynong Tank	Fogarty Road, Tynong North	South East Water	Unavailable	Melway 304 C12

Table A4 – Melbourne Water Service Reservoirs in Cardinia Shire