bushfire CRC

FIRE CONTAINMENT GUIDE

A GUIDE TO THE PROBABILITY OF FIRE CONTAINMENT WITH GROUND AND AERIAL FIRE FIGHTING RESOURCES

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BACKGROUND

This guide is to assist decision makers in Australia involved in the deployment of aerial firefighting appliances evaluate the probability (chance) of containing a single fire with and without aircraft. It predicts the probability of fire containment within 2, 4, 8, and 24 hours, using ground resources working alone compared with ground and aerial suppression resources working together. Predictions are given for forest, grassland and shrub environments.

This document can be used to as a quick reference in the deployment of aerial and ground based firefighting resources. It can provide probabilities of fire containment using Fire Danger Index and response time information.

There is also an interactive computer version of this guide, titled the 'Fire Containment Calculator'. The calculator version in Mircrosoft Excel format can use additional information about flame height and area already burnt to provide a more accurate assessment of probabilities.

To access this calculator go to www.bushfirecrc.com

It is intended that this guide will be used over the 2009-2010 bushfire season and subsequently reviewed with input from users.

INTRODUCTION

Aircraft are used in a range of active fire fighting roles including direct attack to slow or stop the edge of the fire, indirect attack through the use of retardant fuel breaks, and crew transport. Aircraft are also involved in operational support roles such as intelligence gathering, supervision and reconnaissance.

This guide provides an assessment of the probability of successful fire containment for a single fire. It is focused on the direct and indirect first attack roles of bombing aircraft delivering fire suppressants including water, foam, gel and retardant, rather than support roles.

The guide is based on models developed from data collected from surveys of more than 500 fires that used aircraft at a range of locations in Australia between 2004 and 2008. The data on each fire included an expert assessment of whether fire containment could have been achieved within 2, 4, 8, or 24 hours of first suppression work without aircraft - which is what the ground suppression models are based on.

USING THIS GUIDE

The probability of fire containment can be used to guide a range of decisions about the deployment of fire fighting resources. Differences between the estimates of probability of fire containment with and without aircraft can be used as a guide to quickly assess the potential benefit of deploying aircraft. These predictions can also be used to help prioritise the deployment of aircraft when there are multiple fires.

The estimated probabilities of fire containment can also be used as an indication of how many resources are required. If the probability of containment is low and the fire is in a high risk area, this may prompt dispatchers to send more resources than would normally be deployed in order to contain the fire as quickly as possible. In contrast it may be realistic for fires burning in remote areas to be contained within 24 hours.

ASSUMPTIONS AND LIMITATIONS

This guide is based on models developed from data from a broad range of conditions; hence there are a number of assumptions that should be considered. The most important assumption is that an 'adequate' number of resources have been deployed. This guide and the computer version do not define this level of resources.

This guide is not designed to be used for remote fires where ground access is not feasible. Helicopters are often used to transport ground crews to these fires, which cannot otherwise be contained during initial attack.

Given that this data comes from a large number of real fires using wide range of resources, it was not possible to provide a generalised description of these resources. Also, because this data was from the deployment of aircraft by experienced personnel, it can be assumed that it already incorporates expert assessment about sending the correct resources to a given fire.

Another limitation of this document is that important variables, such as fuel hazard, slope and fire behaviour could not be included in these graphs. The effects of these should be considered in the interpretation of the results. For example, if the fire is in heavy fuels or on a steep slope, then the probability of containment may be overestimated in this guide. If the fuel is light then it may be an underestimate. The computer version of this guide incorporates an assessment of some of these other factors.

The last significant note is that the data used to develop this guide is from real situations. Consequently, situations such as slow response times under extreme fire danger indices or the deployment of aircraft during low fire danger periods are not backed by substantial data because aircraft are not usually deployed in these situations.

Care should be taken when considering situations where the Fire Danger Index is less than 15 and when response time is more than an hour when the Fire Danger Index is more than 50.

OTHER CONSIDERATIONS FOR DEPLOYING AIRCRAFT

When deciding if aircraft should be deployed to a fire or not a number of considerations need to be made. These are outlined in the six steps listed below. The predictions from this guide fit with the second step. As aircraft have their greatest benefit during initial attack it is best that the deployment decision is made as quickly as possible.

Considerations for deploying aircraft to fires

Step 1) Assess practicality

Are aircraft an option? Consider issues such as aircraft availability, weather, and safe flying conditions.

If the conditions are not practical go straight to step 6.

Step 2) Assess the probability of success

Will aircraft improve the probability of containment? Consider issues such as fuel and weather.

Use fire containment guide or calculator to estimate the probability of success.

Step 3) Consider community impact

Is there a risk to life, property, or environment that aircraft could lower?

Step 4) Task the aircraft

Can aircraft be integrated with other resources in the incident action plan?

Step 5) Address sustainability issues

Have the other issues such as the needs of ground support and air operations team, community information and cost been addressed?

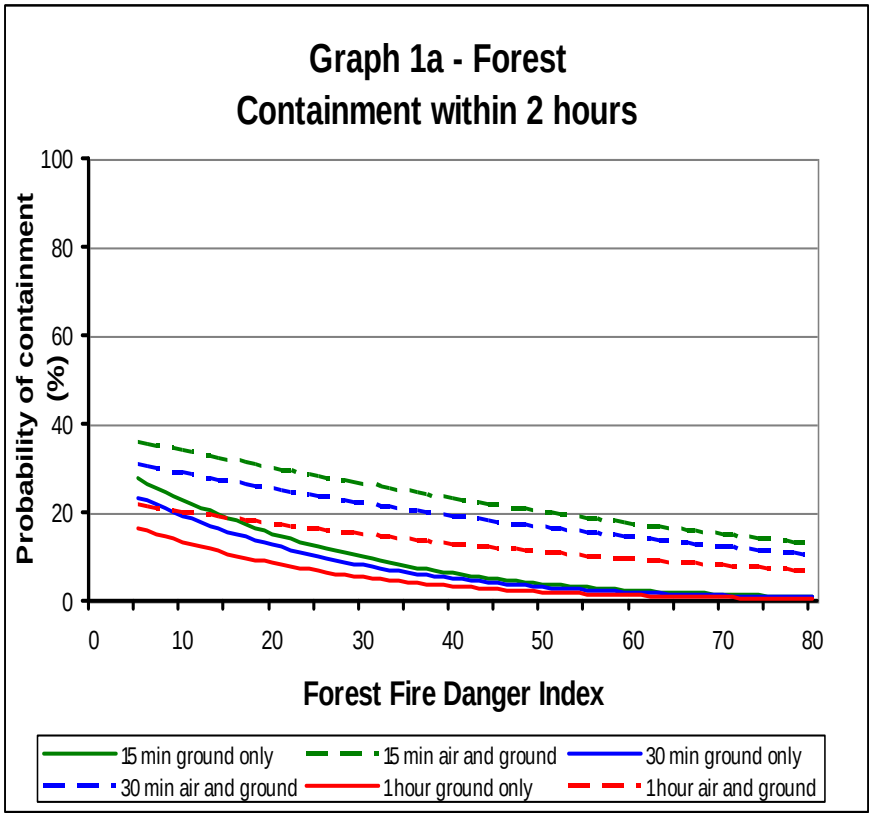
Step 6) Document decision

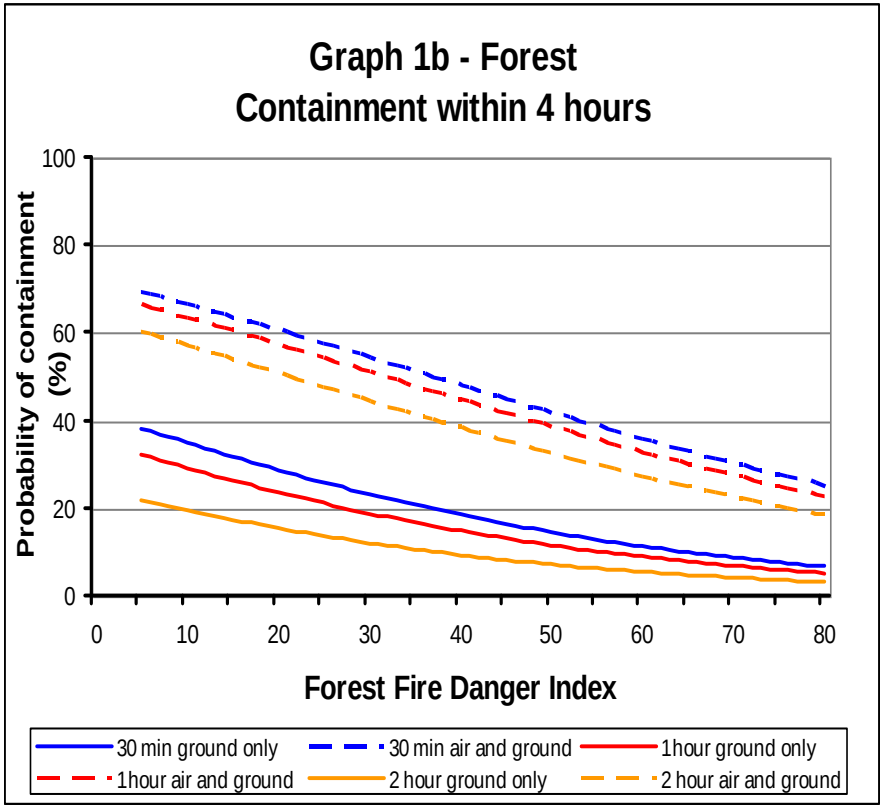
For accountability requirements and future reference.

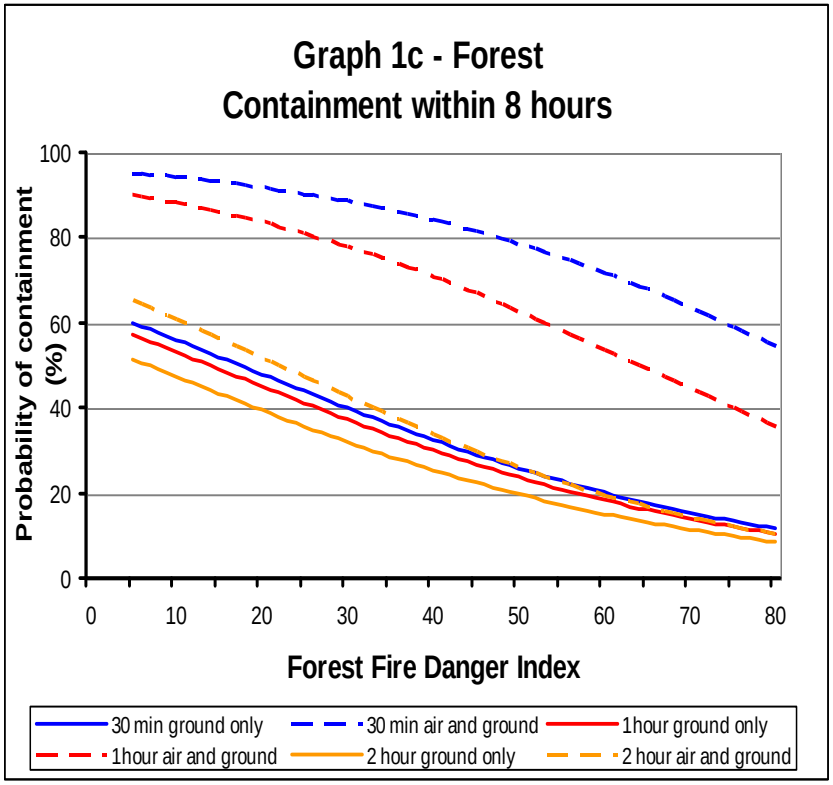
PROBABILITY TABLES AND GRAPHS

Instructions

- Select the relevant graphs for the fuel type: forest, shrubland or grassland. Read the estimated probability of fire containment by considering the following factors.
- Estimate the time between detection and first attack by either ground or aerial resources, including the time taken for resources to leave the base and travel to the fire.
- Use the maximum fire danger index rating that has been predicted for the day of the fire. The fire danger index used in this document is either the Grassland Fire Danger Index (GFDI) for grasslands, or the Forest Fire Danger Index (FFDI) for other fuel types including forests, heath, shrubs and plantations.
- Read the graphs or tables to obtain estimated probabilities within 2, 4, 8 or 24 hours. The curves on the graphs show the chance of the fire being contained. Zero percent is no chance of containment and 100 percent chance is being certain that the fire will be contained. Exact percentages are detailed in the tables below the graphs.


Graph 1a - Forest
Containment within 2 hours
Probability of containment (%)
100
80
60
40
20
0
0
10
20
30
40
50
60
70
80
Forest Fire Danger Index
15 min ground only
15 min air and ground
30 min ground only
30 min air and ground
1hour ground only
1hour air and ground


Graph 1b - Forest
Containment within 4 hours
Probability of containment (%)
100
80
60
40
20
0
0
10
20
30
40
50
60
70
80
Forest Fire Danger Index
30 min ground only
30 min air and ground
1hour ground only
1hour air and ground
2 hour ground only
2 hour air and ground


Graph 1c - Forest
Containment within 8 hours
Probability of containment (%)
100
80
60
40
20
0
0
10
20
30
40
50
60
70
80
Forest Fire Danger Index
30 min ground only
30 min air and ground
1hour ground only
1hour air and ground
2 hour ground only
2 hour air and ground

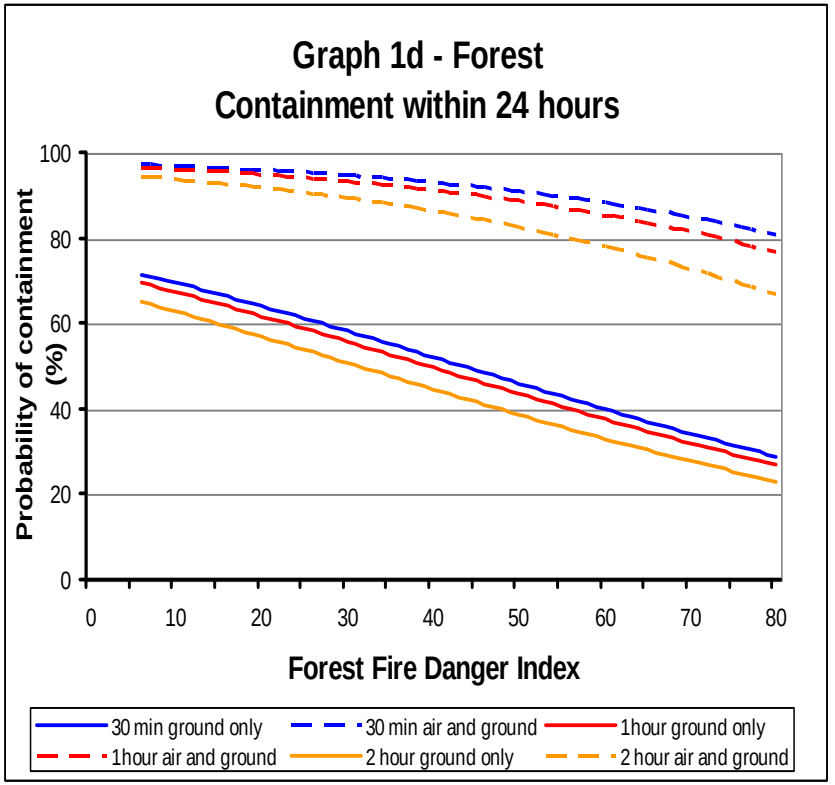
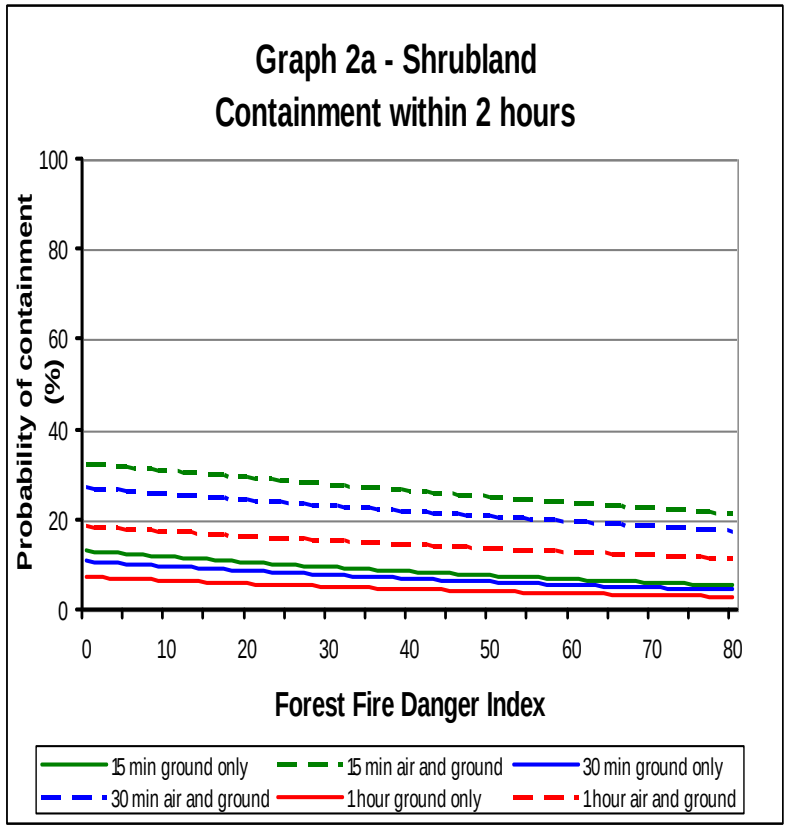
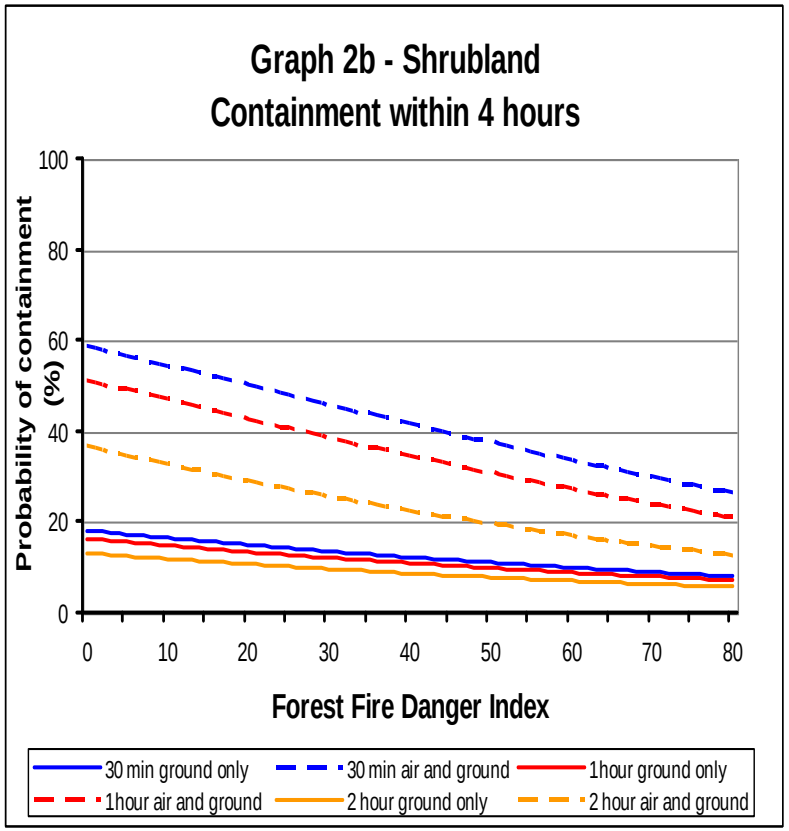
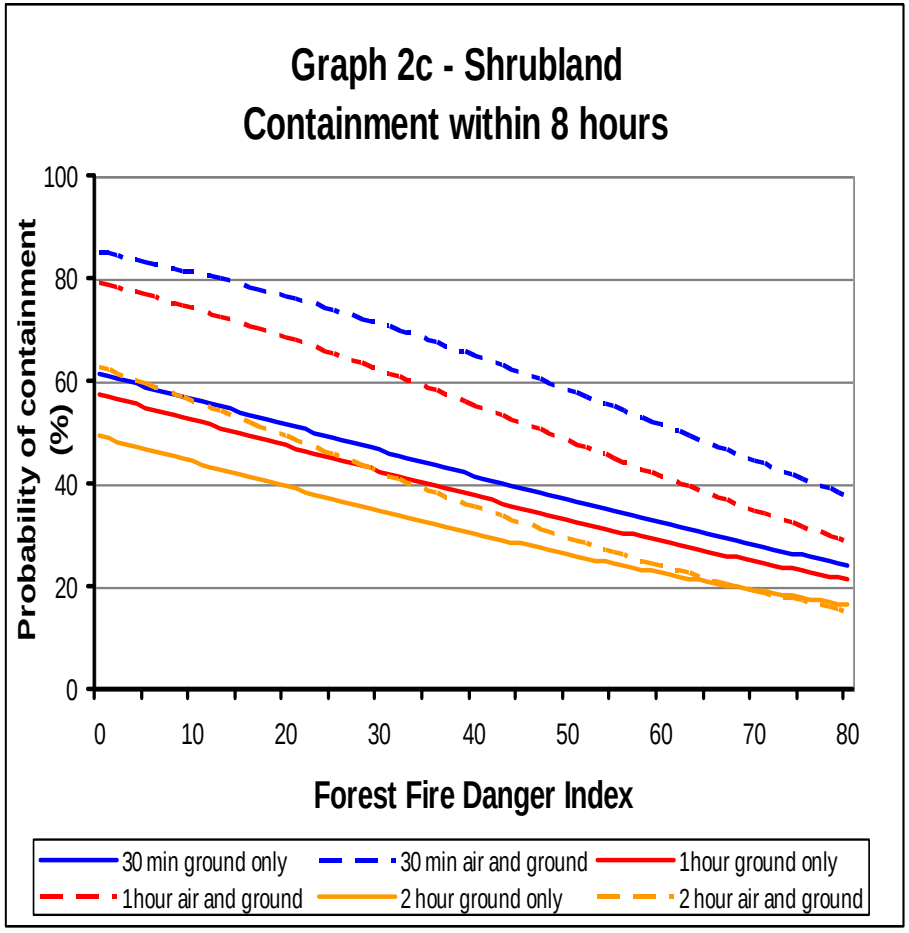

Graph 1d - Forest
Containment within 24 hours
Probability of containment (%)
100
80
60
40
20
0
0
10
20
30
40
50
60
70
80
Forest Fire Danger Index
30 min ground only
30 min air and ground
1hour ground only
1hour air and ground
2 hour ground only
2 hour air and ground

	Table 1a - Forest 2 hours Probability of fire containment within 2 hours (% chance)						Table 1b - Forest 4 hours Probability of fire containment within 4 hours (% chance)					
FFDI	15 min response ground only	15 min response **air and ground**	30 min response ground only	30 min response **air and ground**	1 hour response ground only	1 hour response **air and ground**	30 min response ground only	30 min response air and ground	1 hour response ground only	1 hour response air and ground	2 hour response ground only	2 hour response air and ground
5	28	36	23	31	16	22	38	69	32	66	22	60
10	23	34	19	29	13	20	35	66	29	63	19	57
15	19	32	16	27	11	19	32	64	26	60	17	54
20	15	30	13	25	8	17	29	61	24	57	15	51
25	12	28	10	24	7	16	26	58	21	54	14	48
30	10	27	8	22	5	15	23	54	19	51	12	44
35	8	25	6	21	4	14	21	51	17	48	11	41
40	6	23	5	19	3	13	18	48	15	45	9	38
45	5	22	4	18	3	12	16	45	13	42	8	35
50	4	20	3	17	2	11	14	42	11	39	7	33
55	3	19	2	15	2	10	13	39	10	36	6	30
60	2	17	2	14	1	9	11	36	9	33	5	27
65	2	16	1	13	1	9	10	33	8	30	5	25
70	1	15	1	12	1	8	9	30	7	27	4	22
75	1	14	1	11	1	7	8	28	6	25	4	20
80	1	13	1	11	0	7	7	25	5	23	3	18

	Table 1c - Forest 8 hours Probability of fire containment within 8 hours (% chance)						Table 1d - Forest 24 hours Probability of fire containment within 24 hours (% chance)					
FFDI	30 min response ground only	30 min response air and ground	1 hour response ground only	1 hour response air and ground	2 hour response ground only	2 hour response air and ground	30 min response ground only	30 min response air and ground	1 hour response ground only	1 hour response air and ground	2 hour response ground only	2 hour response air and ground
5	60	95	57	90	51	65	72	97	70	97	66	94
10	56	94	53	88	47	61	69	97	67	96	63	94
15	52	93	49	86	43	56	67	96	65	95	60	93
20	48	92	45	84	39	52	64	96	62	95	57	92
25	44	90	41	81	36	47	61	95	59	94	54	91
30	40	89	37	78	32	43	58	95	56	93	51	89
35	36	87	34	75	29	38	55	94	53	92	48	88
40	33	84	30	71	25	34	52	93	50	91	45	86
45	29	82	27	67	22	30	49	92	46	90	42	84
50	26	79	24	63	20	26	46	91	43	89	39	82
55	23	75	21	58	17	23	43	90	40	87	36	80
60	20	72	18	54	15	20	40	88	38	85	33	78
65	18	68	16	49	13	17	37	87	35	83	30	75
70	15	64	14	44	11	14	34	85	32	81	28	73
75	13	59	12	40	10	12	31	83	29	79	25	70
80	12	55	10	36	8	10	29	81	27	77	23	67


Graph 2a - Shrubland
Containment within 2 hours
Probability of containment (%)
100
80
60
40
20
0
0
10
20
30
40
50
60
70
80
Forest Fire Danger Index
15 min ground only
15 min air and ground
30 min ground only
30 min air and ground
1hour ground only
1hour air and ground


Graph 2b - Shrubland
Containment within 4 hours
Probability of containment (%)
100
80
60
40
20
0
0
10
20
30
40
50
60
70
80
Forest Fire Danger Index
30 min ground only
30 min air and ground
1hour ground only
1hour air and ground
2 hour ground only
2 hour air and ground


Graph 2c - Shrubland
Containment within 8 hours
Probability of containment (%)
100
80
60
40
20
0
0
10
20
30
40
50
60
70
80
Forest Fire Danger Index
30 min ground only
30 min air and ground
1hour ground only
1hour air and ground
2 hour ground only
2 hour air and ground

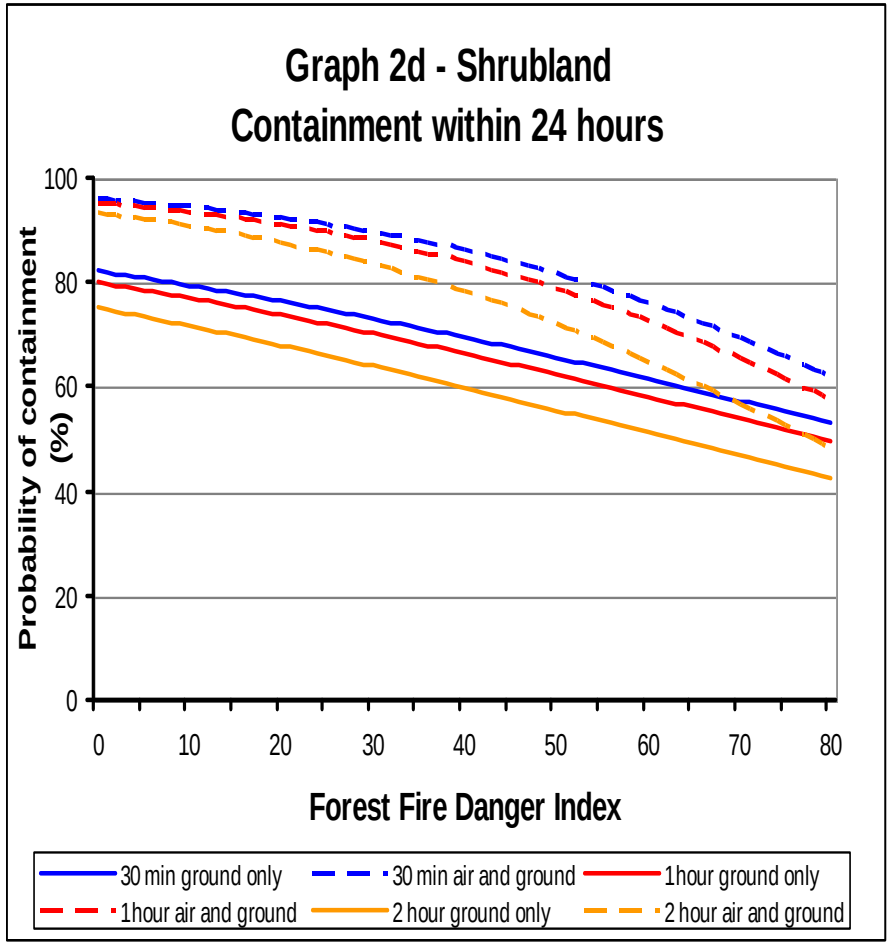
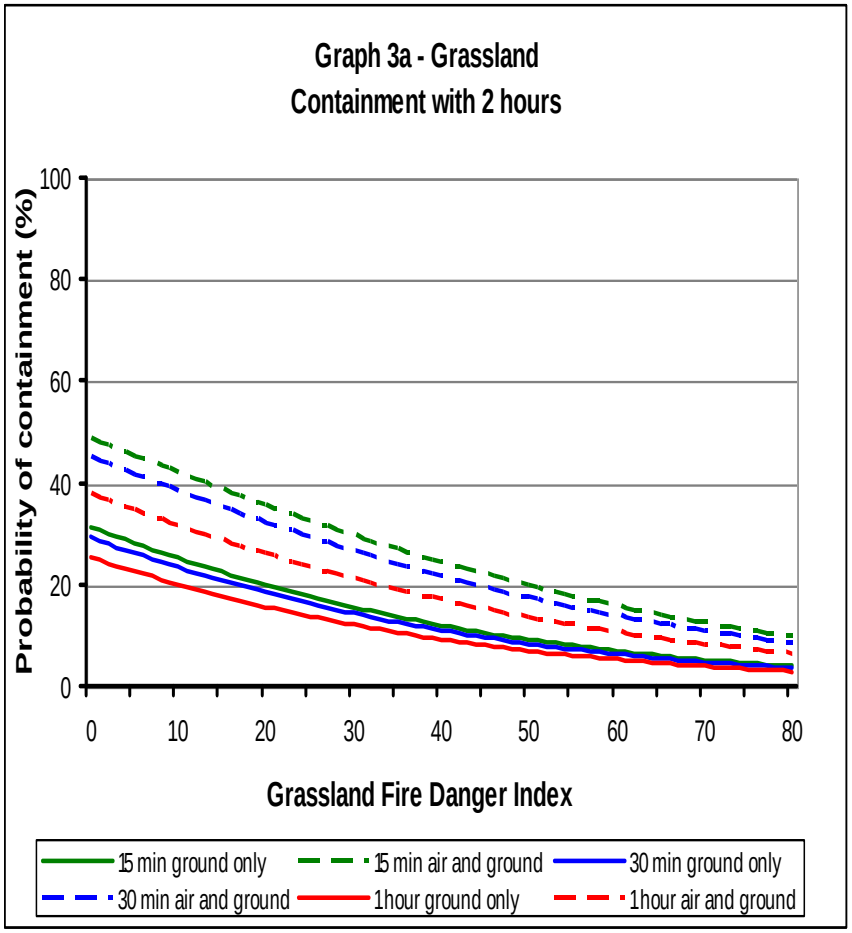
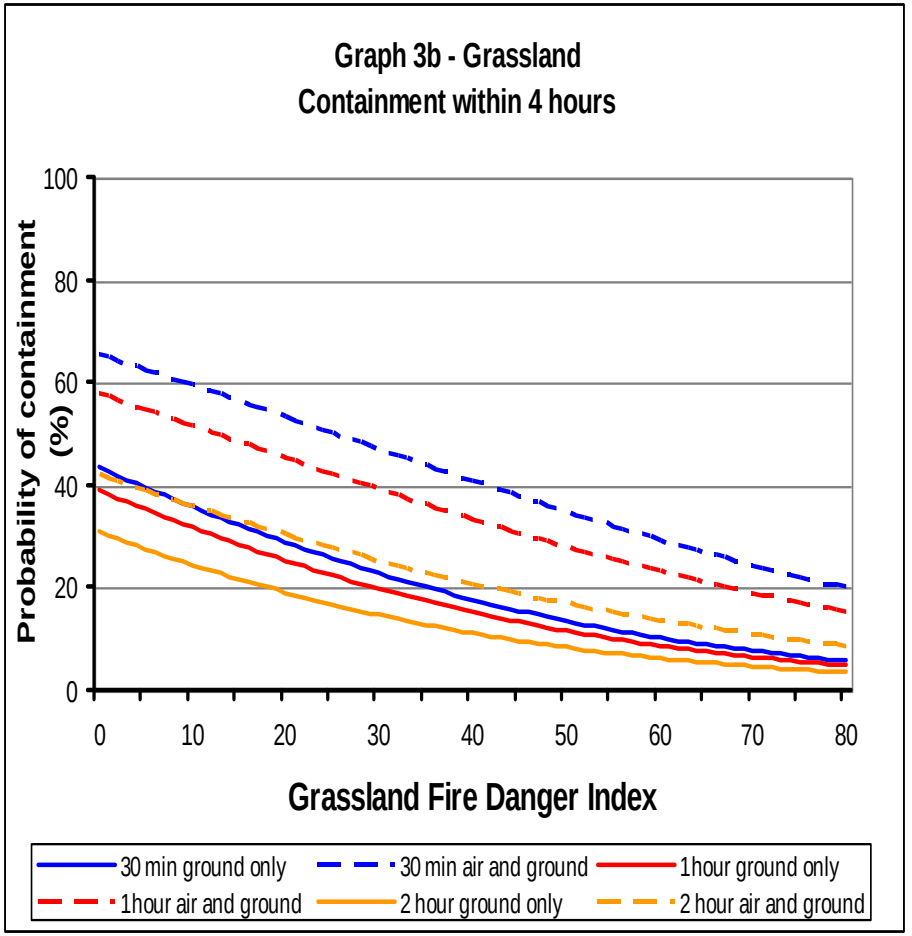
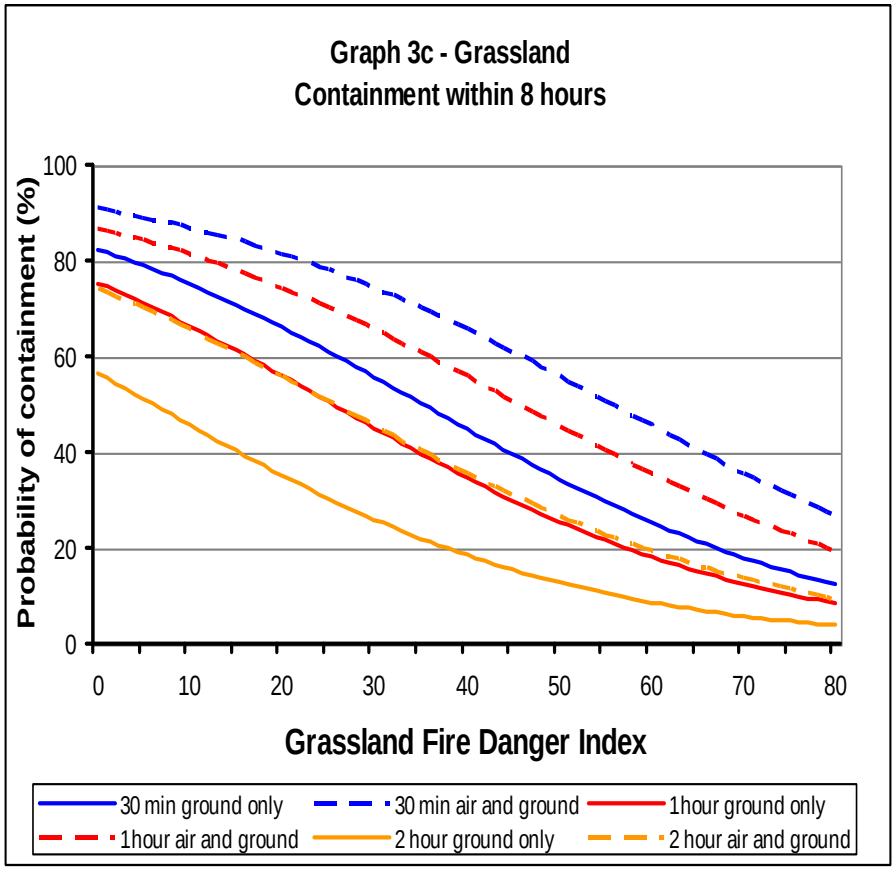

Graph 2d - Shrubland
Containment within 24 hours
Probability of containment (%)
100
80
60
40
20
0
0
10
20
30
40
50
60
70
80
Forest Fire Danger Index
30 min ground only
30 min air and ground
1hour ground only
1hour air and ground
2 hour ground only
2 hour air and ground

	Table 2a - Shrubland 2 hours Probability of fire containment within 2 hours (% chance)						Table 2b – Shrubland 4 hours Probability of fire containment within 4 hours (% chance)					
FFDI	15 min response ground only	15 min response air and ground	30 min response ground only	30 min response air and ground	1 hour response ground only	1 hour response air and ground	30 min response ground only	30 min response air and ground	1 hour response ground only	1 hour response air and ground	2 hour response ground only	2 hour response air and ground
5	12	31	10	26	7	18	17	57	15	49	12	35
10	12	31	10	26	6	17	16	54	15	47	12	33
15	11	30	9	25	6	17	16	52	14	45	11	31
20	10	29	9	24	6	16	15	50	13	43	11	29
25	10	28	8	24	5	16	14	48	13	41	10	27
30	9	28	8	23	5	15	13	46	12	39	10	26
35	9	27	7	22	5	15	13	44	11	37	9	24
40	8	26	7	22	5	14	12	42	11	35	9	22
45	8	26	6	21	4	14	12	40	10	33	8	21
50	8	25	6	21	4	14	11	38	10	31	8	20
55	7	24	6	20	4	13	10	36	9	29	7	18
60	7	24	5	19	4	13	10	34	9	27	7	17
65	6	23	5	19	3	12	9	32	8	26	7	16
70	6	22	5	18	3	12	9	30	8	24	6	15
75	6	22	5	18	3	12	8	28	8	22	6	14
80	5	21	4	17	3	11	8	26	7	21	6	13

	Table 2c - Shrubland 8 hours Probability of fire containment within 8 hours (% chance)						Table 2d – Shrubland 24 hours Probability of fire containment within 24 hours (% chance)					
FFDI	30 min response ground only	30 min response air and ground	1 hour response ground only	1 hour response air and ground	2 hour response ground only	2 hour response air and ground	30 min response ground only	30 min response air and ground	1 hour response ground only	1 hour response air and ground	2 hour response ground only	2 hour response air and ground
5	59	83	55	77	47	60	81	95	78	94	73	92
10	56	81	52	74	44	56	79	94	77	93	72	91
15	54	79	50	71	42	53	78	94	75	92	70	89
20	51	76	47	68	39	49	76	92	74	91	68	88
25	49	74	45	65	37	46	75	91	72	90	66	86
30	46	71	42	62	35	42	73	90	70	88	64	83
35	44	68	40	59	32	39	71	88	68	86	62	81
40	42	65	38	55	30	36	69	86	66	84	60	78
45	39	62	35	52	28	32	68	84	64	81	58	75
50	37	58	33	48	26	29	66	82	62	79	56	72
55	34	55	31	45	24	27	64	79	60	76	53	69
60	32	51	29	41	23	24	62	76	58	73	51	65
65	30	48	27	38	21	22	59	73	56	69	49	61
70	28	44	25	35	19	19	57	69	54	65	47	57
75	26	41	23	32	18	17	55	66	52	62	45	53
80	24	38	21	29	16	15	53	62	49	57	42	48


Graph 3a - Grassland
Containment with 2 hours
Probability of containment (%)
100
80
60
40
20
0
0
10
20
30
40
50
60
70
80
Grassland Fire Danger Index
15 min ground only
15 min air and ground
30 min ground only
30 min air and ground
1hour ground only
1hour air and ground


Graph 3b - Grassland
Containment within 4 hours
Probability of containment (%)
100
80
60
40
20
0
0
10
20
30
40
50
60
70
80
Grassland Fire Danger Index
30 min ground only
30 min air and ground
1hour ground only
1hour air and ground
2 hour ground only
2 hour air and ground


Graph 3c - Grassland
Containment within 8 hours
Probability of containment (%)
100
80
60
40
20
0
0
10
20
30
40
50
60
70
80
Grassland Fire Danger Index
30 min ground only
30 min air and ground
1hour ground only
1hour air and ground
2 hour ground only
2 hour air and ground

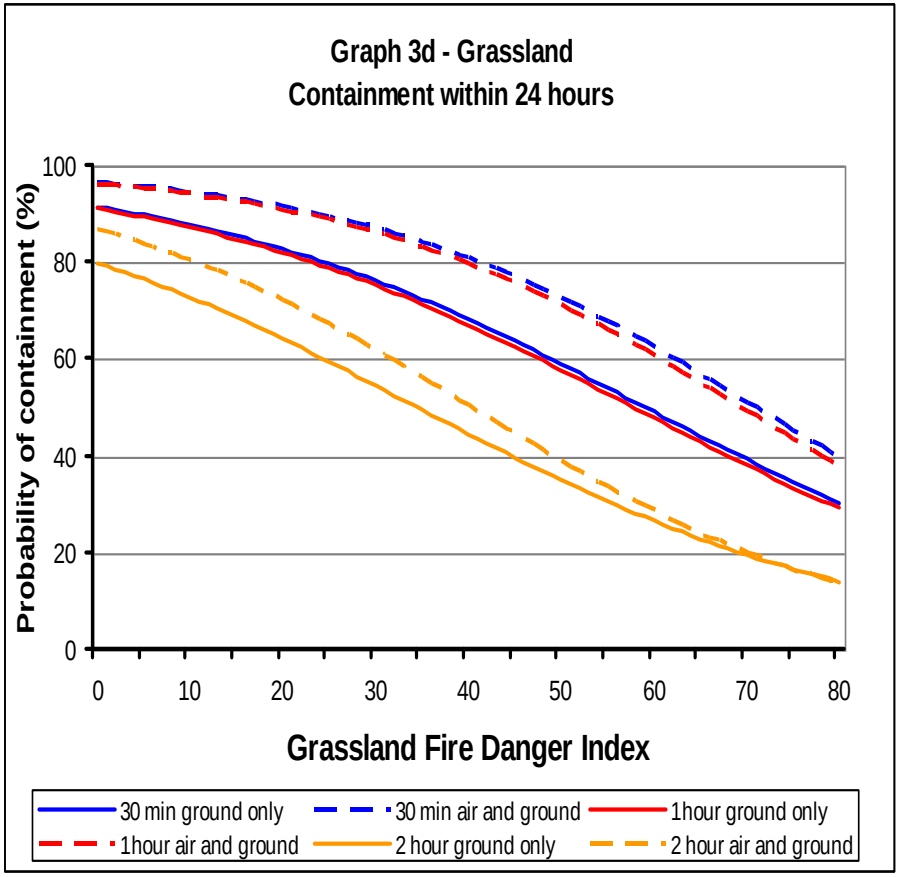

Graph 3d - Grassland
Containment within 24 hours
Probability of containment (%)
100
80
60
40
20
0
0
10
20
30
40
50
60
70
80
Grassland Fire Danger Index
30 min ground only
30 min air and ground
1hour ground only
1hour air and ground
2 hour ground only
2 hour air and ground

	Table 3a - Grassland 2 hours Probability of fire containment within 2 hours (% chance)						Table 3b – Grassland 4 hours Probability of fire containment within 4 hours (% chance)					
GFDI	15 min response ground only	15 min response air and ground	30 min response ground only	30 min response air and ground	1 hour response ground only	1 hour response air and ground	30 min response ground only	30 min response air and ground	1 hour response ground only	1 hour response air and ground	2 hour response ground only	2 hour response air and ground
5	28	45	26	42	23	35	39	63	35	55	27	39
10	25	42	23	39	20	32	36	60	32	52	24	36
15	22	39	21	35	18	29	32	56	28	48	22	33
20	20	36	18	32	16	26	29	53	25	45	19	30
25	18	33	16	29	14	24	26	50	22	42	17	28
30	16	30	14	27	12	21	23	47	20	39	15	25
35	14	27	13	24	11	19	20	44	17	36	13	23
40	12	24	11	22	9	17	18	41	15	33	11	21
45	10	22	10	20	8	15	15	38	13	31	10	19
50	9	20	8	17	7	14	13	35	12	28	8	17
55	8	18	7	16	6	12	12	32	10	25	7	15
60	7	16	6	14	5	11	10	29	9	23	6	14
65	6	14	5	12	5	9	9	27	7	21	5	12
70	5	13	5	11	4	8	8	24	6	19	5	11
75	4	11	4	10	3	7	7	22	6	17	4	10
80							6	20	5	15	3	9

	Table 3c - Grassland 8 hours Probability of fire containment within 8 hours (% chance)						Table 3d – Grassland 24 hours Probability of fire containment within 24 hours (% chance)					
G-FDI	30 min response ground only	30 min response air and ground	1 hour response ground only	1 hour response air and ground	2 hour response ground only	2 hour response air and ground	30 min response ground only	30 min response air and ground	1 hour response ground only	1 hour response air and ground	2 hour response ground only	2 hour response air and ground
5	79	89	71	84	51	70	90	96	89	95	76	84
10	75	87	66	81	46	66	88	94	87	94	73	80
15	71	84	61	78	40	61	85	93	85	93	69	76
20	66	81	56	74	35	56	83	91	82	91	64	72
25	61	78	51	70	30	51	80	89	79	89	59	67
30	56	74	45	66	26	45	76	87	75	86	54	62
35	50	70	40	61	22	40	72	84	71	83	49	56
40	45	66	35	56	18	36	68	81	67	80	44	50
45	40	61	30	51	15	31	59	73	58	71	35	39
50	34	56	26	46	13	27	49	62	48	61	26	29
55	30	51	22	40	11	23	39	51	38	49	19	20
60	25	46	18	36	9	19	68	81	67	80	44	50
65	21	40	15	31	7	16	59	73	58	71	35	39
70	18	36	13	27	6	14	49	62	48	61	26	29
75	15	31	10	23	5	11	39	51	38	49	19	20
80												

Further information

Definitions

Containment: Operations designed to restrict fire and stop it spreading to surrounding structures or areas.

Contained: A fire is contained when its spread has been halted, but it may still be burning feely within the perimeter or the control lines.

Fire Danger Index: A relative number denoting an evaluation of rate of spread, or suppression difficulty for specific combinations of temperature, relative humidity, drought effects and wind speed. The numbers range from 1 to 100.

Fire Danger Rating: A relative class denoting an evaluation of rate of spread, or suppression difficulty for specific combinations of temperature, relative humidity, drought effects and wind speed. Rated as low, moderate, high, very high, or extreme, indicating the relative evaluation of fire danger.

Response time: The time taken between the report of a fire or incident, and arrival at the scene. It includes both reaction time and travel time.

Suppression: The act of extinguishing fires.

Reference

Plucinski M., Gould J., McCarthy G., Hollis J. (2007) The Effectiveness and Efficiency of Aerial Firefighting in Australia, Part 1. Bushfire Co-operative Research Centre, Australia.

Acknowledgements

The data used to develop these tools came from a large number of operations personnel from most bushfire response and land management agencies across Australia.