6. Ranking of Drainage Areas

6.1 Rationale

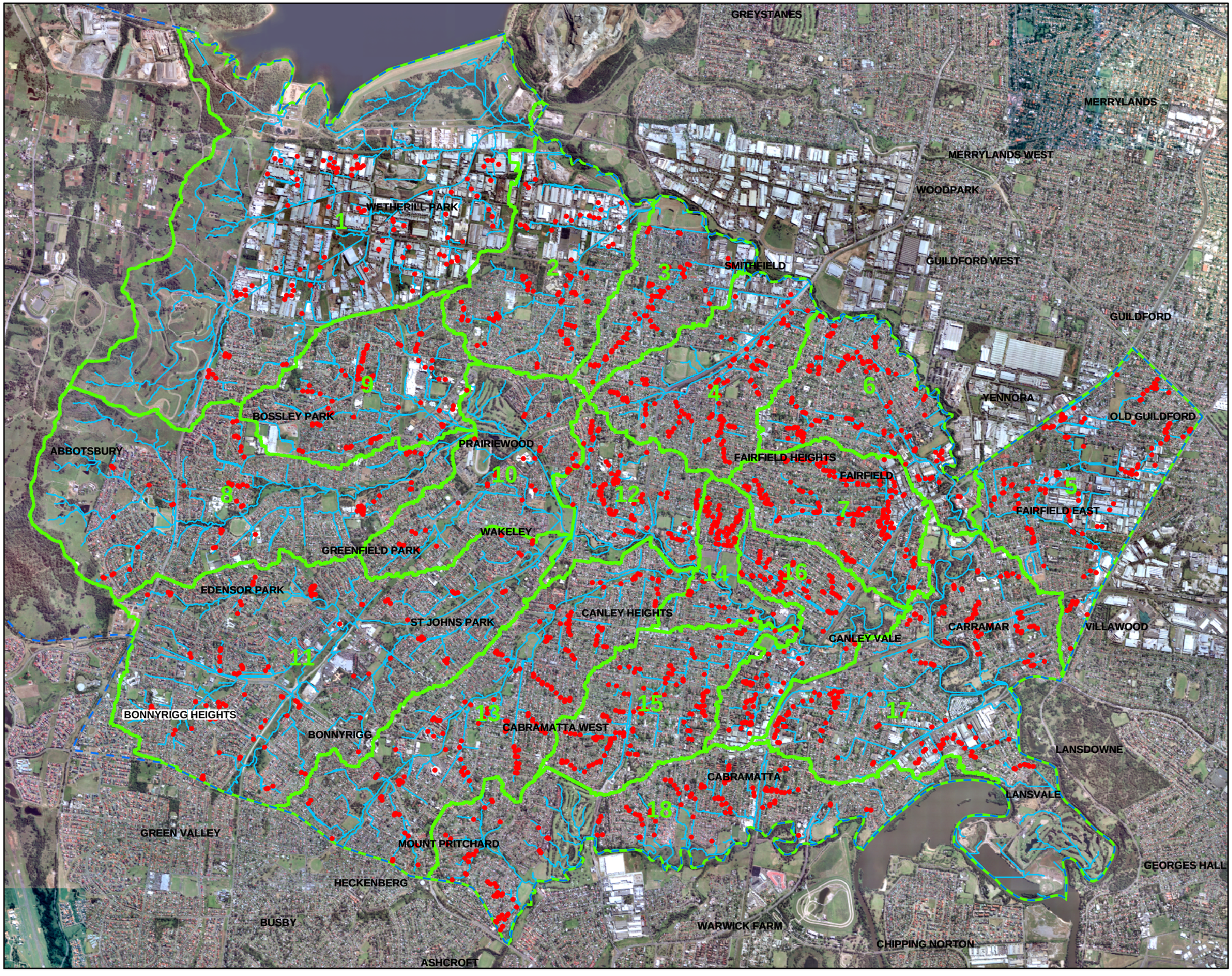
Hydrologic and hydraulic studies to identify overland flooding for the entire study area would be a major undertaking, would require a huge budget and take a long time to complete. Moreover, the distribution of provisional flood hazard within the study area is not uniform as illustrated in **Figure 5-2** to **Figure 5-4**. It will therefore be far more cost effective to establish priority areas for detailed overland flooding investigations within the LGA.

It should be noted that to meet the objectives of this scoping study, only hydraulic hazard criteria were used. The 2001 NSW Floodplain Management Manual recommends an approach that takes into consideration both hydraulic hazard and flood risk to life and property. More detailed studies arising from this scoping study will define areas of flood risk by the approach proposed in the Manual.

In order to establish priority for detailed investigations, it was necessary to split the study area into a number of sub-catchments or drainage areas. The study area was sub-divided into eighteen sub-catchments as shown in **Figure 6-1**. All properties identified in this study at risk of overland flooding are also shown in **Figure 6-1**. Boundaries for the sub-catchments generally follow the boundaries of the drainage areas. The distribution of the identified properties at risk of overland flooding was also considered in identifying the boundaries for the sub-catchments.

Areas covered by each sub-catchments and number of properties under different provisional flood hazard categories for the selected flood events are shown in **Table 6-1**. Number of properties under the high hazard category for the selected flood events are shown in **Figure 6-2**.

Table 5-1 shows that 41% of the identified properties would be under the high hazard category for the 5% AEP flood event. In a 1% AEP event, these properties would be subject to even more serious flood and so this category needs to be given the highest priority. Hence, ranking of sub-catchments in this study was based primarily on the number of properties under the high hazard category for the 5% AEP flood event. Secondary consideration was given to the number of properties under the high hazard category for the 1% AEP in the overall ranking.



Fairfield City Overland Flood Study

Figure 6-1

Identified Sub-Catchments

Legend

- Properties at Risk of Overland Flooding (Based on Preliminary Hydraulic Analysis Only)
- Automatically generated flowpaths (No. of cells for a flowpath = 5000)
- Sub-Catchments
- Fairfield LGA Boundary

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Table 6-1 Number of Properties under the Selected Provisional Flood Hazard Categories

Sub-catchment		No. of	Number of Properties under Different Flood Hazard Categories								
ID	Area	Identified	PMF			1% AEP			5% AEP		
	ha	Properties	LH	MH	HH	LH	MH	HH	LH	MH	HH
1	1156	89	15	0	74	46	0	43	50	0	39
2	343	76	6	0	70	41	0	35	42	0	34
3	187	58	3	2	53	26	0	32	28	0	30
4	292	106	7	0	99	37	3	66	49	0	57
5	385	122	8	2	112	40	0	82	44	7	71
6	268	114	0	4	110	56	2	56	64	3	47
7	232	141	3	0	138	53	3	85	72	6	63
8	617	56	5	0	51	31	0	25	33	0	23
9	304	77	11	0	66	33	0	44	33	8	36
10	290	34	2	0	32	23	0	11	23	2	9
11	836	103	8	0	95	66	0	37	66	0	37
12	197	91	3	0	88	32	9	50	39	8	44
13	551	149	11	2	136	86	5	58	102	3	44
14	110	64	3	0	61	24	0	40	27	0	37
15	258	116	5	3	108	47	1	68	53	12	51
16	217	104	12	7	85	66	2	36	79	0	25
17	662	165	5	0	160	110	6	49	121	7	37
18	491	128	2	0	126	74	0	54	85	3	40
Total	**7396**	**1793**	**109**	**20**	**1664**	**891**	**31**	**871**	**1010**	**59**	**724**

Notes:

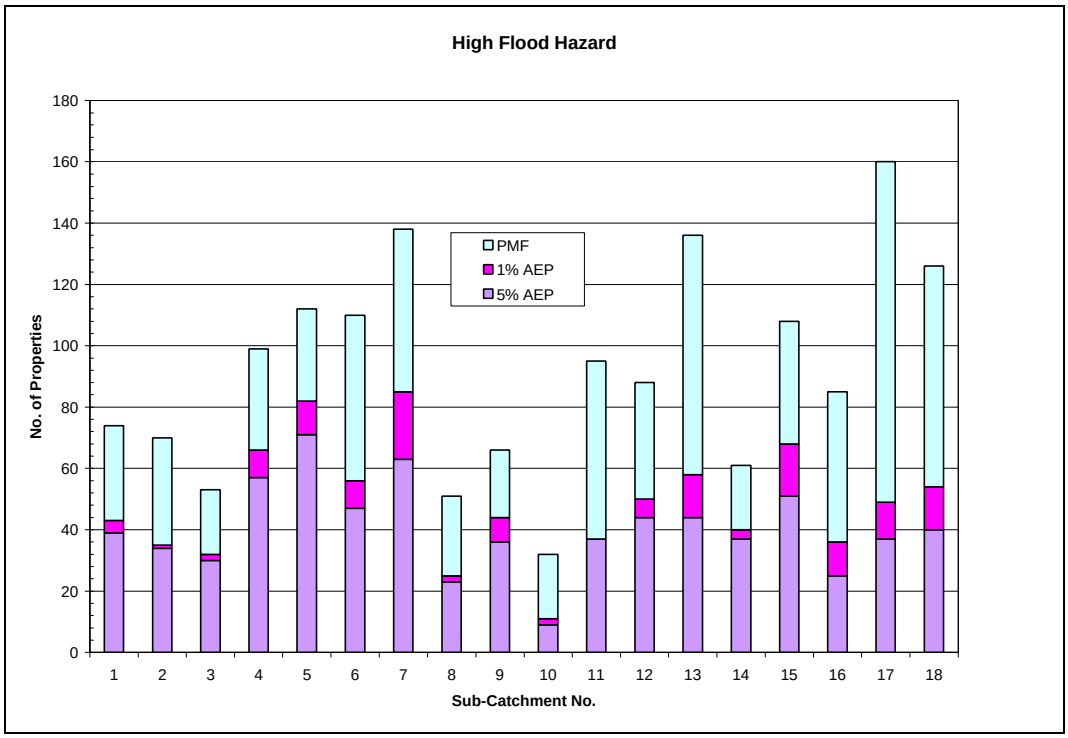
(Based on Preliminary Hydraulic Analysis Only)

LH – Low Hazard;

MH – Medium Hazard (Depth of flooding more than 0.5m);

HH – High Hazard (Depth of flooding greater than 1.2m or flow velocity greater than 2 m/s or the product of flow velocity and depth of flooding greater than 1 m^2/s)

- **Figure 6-2 Properties Subjected to Provisional High Flood Hazards for the Selected Flood Events**



6.2 Results

Ranking of sub-catchments was based primarily on the number of properties under the high hazard category for the 5% AEP flood event. Secondary consideration was given to the number of properties under the high hazard category for the 1% AEP in the overall ranking.

Results on the ranking are given in **Table 6-2**. Sub-catchment No. 5 received the highest priority for detailed investigation followed by Sub-catchment No. 7. Sub-catchment No. 4 was ranked third followed by Sub-catchment No. 15.

If the ranking was based on the number of properties under the high hazard category for the 1% AEP event, Sub-catchments 4,5, 7 and 15 would be the top four sub-catchments getting priority for detailed investigations.

Table 6-2 Ranking of Sub-Catchments

Rank for Detailed Investigation	Sub-Catchment ID	Sub-Catchment Area ha	No. of Identified Properties	Number of Properties Under High Hazard Category 5% AEP	1% AEP	PMF
1	5	385	122	71	82	112
2	7	232	141	63	85	138
3	4	292	106	57	66	99
4	15	258	116	51	68	108
5	6	268	114	47	56	110
6	13	551	149	44	58	136
7	12	197	91	44	50	88
8	18	491	128	40	54	126
9	1	1156	89	39	43	74
10	17	662	165	37	49	160
11	14	110	64	37	40	61
12	11	836	103	37	37	95
13	9	304	77	36	44	66
14	2	343	76	34	35	70
15	3	187	58	30	32	53
16	16	217	104	25	36	85
17	8	617	56	23	25	51
18	10	290	34	9	11	32
Total		**7396**	**1793**	**724**	**871**	**1664**

7. Conclusions and Recommendations

The 2001 NSW Floodplain Management Manual requires all Councils to address local overland flooding within their LGA. This has increased Council's responsibility and risk considerably.

Fairfield LGA covers an area of around 102.5 km^2 and so undertaking an overland flood study for the entire LGA would be a massive undertaking. Conseqently FCC commissioned SKM to undertake a scoping study of local overland flow paths for the Prospect Creek catchment covering an area of approximately 70 km^2 within the LGA. The main objective of this study is to establish priorities for detailed overland flood studies in future floodplain risk management study and plan. Following acceptance of this report detailed flood studies and flood mitigation studies will be undertaken to address local overland flooding based on the priority ranking provided by this report.

A cost effective technically advanced approach was adopted in this study to identify properties at risk of local overland flooding. The Airborne Laser Survey data was utilised in a GIS environment to identify overland flow paths for the entire study area. A 2.5m buffer on each side of the overland flow paths was used to identify buildings that encroached the 5m wide overland flow paths. In total, 1 793 buildings within the study area were identified being at risk of overland flooding.

A simple and a transparent process were used to estimate provisional flood hazards to the identified buildings for the 5% AEP, 1% AEP and the PMF event. It was estimated that approximately 40% of the identified buildings would be subjected high provisional flood hazards for the 5% AEP flood event. Approximately 48% of the identified buildings would be in the high hazard category for the 1% AEP event.

The study area was sub-divided into eighteen sub-catchments for detailed investigations. The sub-catchments were ranked on the basis of the number of buildings that were under the high hazard category in each of the sub-catchments for the 5% AEP event. Secondary consideration was given to buildings under the high hazard category for the 1% AEP flood event in the overall ranking process.

A transparent technique was utilised to rank the sub-catchments. The study being a screening level study, changes in the methods or assumptions made in this study may result in different outcomes.

It is recommended that FCC:

- Review this study and adopt the methodology used;
- Endorse the catchment priorities identified; and
- Proceed with detailed overland flood studies and floodplain risk management study and plan for the sub-catchments.

8. References

Bureau of Meteorology (1994, 1996 and 2003) Bulletin 53, *The Estimation of Probable Maximum Precipitation in Australia: Generalised Short Duration Method*

Institution of Engineers Australia (1987) *Australian Rainfall and Runoff, Vol II*

NSW Government (2001) *Floodplain Management Manual*

Shackel Avenue Drainage Analysis (1991)

Crown and Seville Streets Flood Study (undated)

Smithfield West Drainage Study Chifley Street to the Horsley Drive (1996)

The Avenue, Canley Vale (Intersection The Avenue/Sackville St) Stormwater Drainage Study (1998)

Airborne Laser Survey for Fairfield LGA (February 2003)

Appendix A Estimation of Design Floods

The purpose of the hydrological analysis is to establish empirical relationships between the design peak flows (5% AEP and 1% AEP events and the PMF) and catchment characteristics that can be used for the analysis of the behaviour of overland flows.

The hydrological analysis was carried out based on the Prospect Creek RAFTS model (supplied by Fairfield City Council) and other relevant information.

A.1 RAFTS model for Prospect Creek

The RAFTS model for Prospect Creek catchment was developed by Cardno Willing for the FCC. This model consists of some 140 nodes covering a total area of 105 km^2 (see Figure A-1). The RAFTS model used ARBM to estimate rainfall losses.

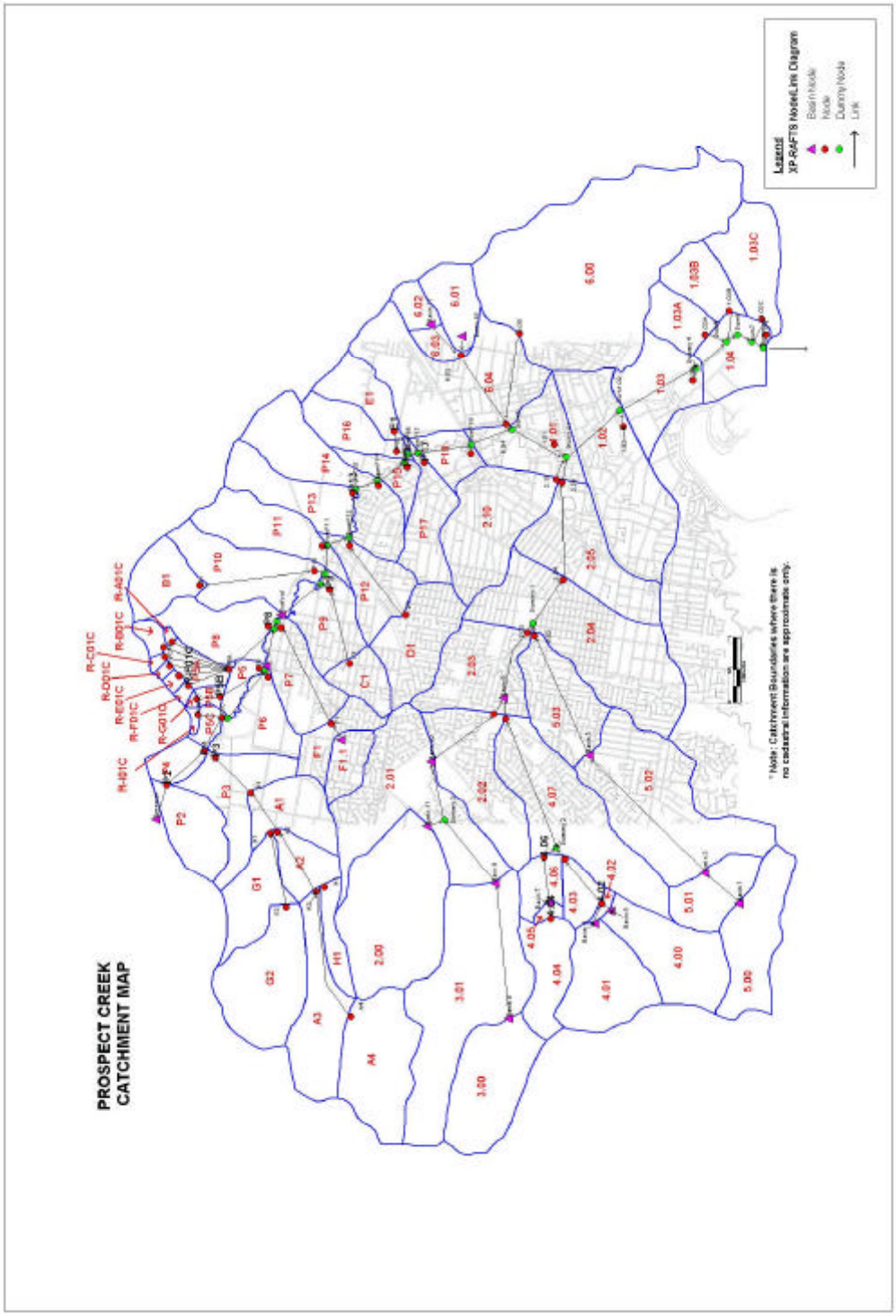
Since the focus of this study is the overland flow paths, not the creeks downstream, the headwater catchments – catchments at the top of the creek systems without receiving inflows from any other catchments were selected for the establishment of the relationships between the peak flows and the catchment characteristics. There were 44 headwater catchments in the RAFTS model for Prospect Creek.

The RAFTS Model for Prospect Creek collected from FCC did not contain the all design rainfall Intensity-Frequency-Duration (IFD) data of interest to this study. Hence, the IFD data for the catchment was extracted from the latest version of Australian Rainfall and Runoff. The extracted data agreed well with the data supplied by FCC. The IFD data adopted in this study for the 1:20 Year ARI (Average Recurrence Interval) and 1:100 Year ARI storm events are shown in **Table A-1**.

- **Table A-1 Design Rainfall Intensities**

Storm duration (minute)	1 :20 Year ARI Intensity (mm/hr)	1 :100 Year ARI Intensity (mm/hr)
15	109.0	139.0
30	77.0	98.0
45	62.0	79.0
60	52.0	67.0
90	41.4	53.0
120	34.9	45.0
180	27.4	35.5
360	18.1	23.6
540	14.2	18.6

- **Figure A-1 RAFTS Model Schematic for Prospect Creek**



A.2 Estimation of Design Floods

The design flows of the headwater catchments for the 1:20 Year ARI and 1:100 Year ARI events were estimated using the RAFTS model for Prospect Creek Catchment. The ARBM (Australian Representatives Basin Model) was used to estimate rainfall losses for both flood events.

The PMF for the headwater catchments were also estimated using the RAFTS model and the Generalised Short Duration Method presented in the latest version of Bulletin 53. Instead of the ARBM, a 0mm initial loss and a 1mm/hour continuing loss rate were adopted in the RAFTS Model.

For each of these catchments, the maximum peak discharges corresponding to the critical storm for the 1:20 Year ARI and 1:100 Year ARI events were extracted from the model results. These values together with catchment characteristics, including area, slope and impervious area are presented in **Table A-2**. The results for the Probable Maximum Flood (PMF) are also listed in **Table A-2**.

- **Table A-2 Summary Results for Headwater Catchments**

Node ID Refer Figure A-1	Area (ha)	Slope (%)	Impervious (%)	5%AEP		1%AEP		PMF	
				Peak Flow (m^3/s)	Critical storm	Peak Flow (m^3/s)	Critical storm	Peak Flow (m^3/s)	Critical storm
ReC8	25.3	3.0	0.0	2.61	6hr	3.41	6hr	27.82	60m
ReC10	45.6	3.0	0.0	4.40	9hr	5.82	6hr	47.12	60m
ReC1	46.6	3.0	0.0	4.50	9hr	5.94	6hr	48.02	60m
ReC5	49.7	3.0	0.0	4.77	9hr	6.27	6hr	50.70	60m
ReC4	50.7	3.0	0.0	4.86	9hr	6.38	6hr	51.60	60m
ReC9	51.7	3.0	0.0	4.95	9hr	6.50	6hr	52.51	60m
ReC3	53.7	3.0	0.0	5.12	9hr	6.73	6hr	54.26	60m
ReC2	68.9	3.0	0.0	6.38	9hr	8.36	6hr	67.22	60m
ReC6&7	68.9	3.0	0.0	6.38	9hr	8.36	6hr	67.22	60m
R-I01C	4.7	22.2	1.1	1.27	2hr	1.64	2hr	10.18	15m
R-F01C	7.3	22.0	1.4	1.89	2hr	2.44	2hr	15.41	15m
R-B01C	14.2	14.4	2.0	2.65	2hr	3.63	2hr	24.93	15m
R-E01C	7.0	21.4	2.0	1.80	2hr	2.36	2hr	14.83	15m
R-D01C	5.7	22.0	2.3	1.52	2hr	2.00	2hr	12.30	15m
R-C01C	4.5	14.6	2.4	1.08	2hr	1.43	2hr	9.10	15m
R-G01C	3.0	27.0	3.3	0.91	2hr	1.15	2hr	6.89	15m
R-A01C	3.6	11.2	3.8	0.81	2hr	1.11	2hr	7.01	15m
A4	143.0	2.5	20.7	13.40	2hr	17.32	2hr	116.99	60m
P5	33.0	2.5	25.0	3.99	2hr	5.20	2hr	34.38	60m
1.04	88.2	0.4	30.0	8.94	6hr	11.65	6hr	92.67	60m
1.03A	74.3	3.0	30.0	15.93	2hr	21.52	2hr	132.87	15m
1.03	144.5	1.3	30.0	19.60	2hr	26.69	2hr	194.91	30m

Table A-3 (Continued from Previous Page)

Node ID Refer Figure A-1	Area (ha)	Slope (%)	Impervious (%)	5%AEP		1%AEP		PMF	
				Peak Flow (m^3/s)	Critical storm	Peak Flow (m^3/s)	Critical storm	Peak Flow (m^3/s)	Critical storm
P15	90.0	1.6	39.0	13.71	2hr	17.16	2hr	94.53	15m
G2	106.0	2.5	39.2	16.80	2hr	20.95	2hr	114.92	15m
1.03B	71.3	2.6	40.0	17.18	2hr	22.42	2hr	135.27	15m
4.04	98.5	2.0	40.0	20.03	2hr	26.58	2hr	163.70	15m
1.03C	109.6	2.1	40.0	22.13	2hr	29.39	2hr	181.37	15m
2.05	172.1	1.0	40.0	24.12	2hr	32.56	2hr	221.79	30m
1.02	307.0	1.7	40.0	46.62	2hr	62.87	2hr	400.63	45m
P17	107.0	1.0	44.9	17.60	2hr	21.82	2hr	121.22	15m
D1	169.0	1.3	45.0	27.95	2hr	34.67	2hr	181.20	15m
1.01	149.6	0.8	45.0	20.98	2hr	28.27	2hr	191.03	30m
2.1	217.0	1.0	45.0	31.35	2hr	42.45	2hr	283.54	30m
6	784.2	1.3	45.0	97.70	2hr	132.43	2hr	839.66	45m
C1	85.1	1.2	45.0	14.38	2hr	17.88	15m	99.98	15m
B1	95.1	1.8	49.2	17.83	2hr	22.29	15m	123.68	15m
P18	59.0	0.8	56.3	11.89	2hr	14.70	2hr	82.04	15m
P14	176.1	1.2	61.2	37.83	2hr	46.85	2hr	245.34	15m
P6	103.0	1.2	62.6	23.20	2hr	28.59	15m	160.10	15m
H1	66.0	1.4	63.6	15.44	2hr	19.54	15m	107.71	15m
P13	132.0	1.7	66.8	32.00	2hr	40.43	15m	223.60	15m
P11	147.0	1.6	69.7	36.72	2hr	45.92	15m	256.05	15m
U128.5	114.0	1.8	72.4	29.93	2hr	37.87	15m	209.08	15m
E1	94.0	1.1	76.9	25.33	2hr	31.10	2hr	174.57	15m

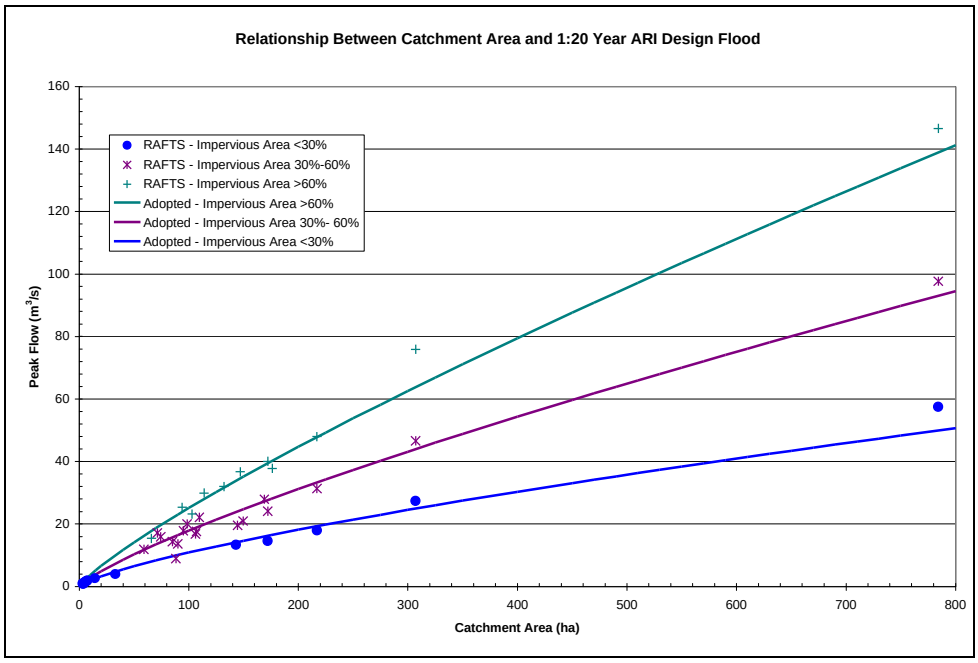
A.3 Relationships Between Design Flood and Catchment Characteristics

The impervious fractions for the headwater catchments were grouped into three classes. These classes were:

- 0-30% Impervious
- 30-60% Impervious; and
- >60% Impervious.

Empirical relationships were established between catchment area and the peak design floods for the 1:20 Year ARI and 1:100 Year ARI events for the three selected impervious classes. These relationships are shown in **Figure A-2** and **Figure A-3**. As the rainfall loss associated with the PMF is very low, the degree of impervious has almost no influence on the PMF. The relationship between catchment area and the PMF is shown in **Figure A-4**.

- **Figure A-2 Relationship Between Catchment Area and 1:20 Year ARI Flood**



- **Figure A-3 Relationship Between Catchment Area and 1:100 Year ARI Flood**

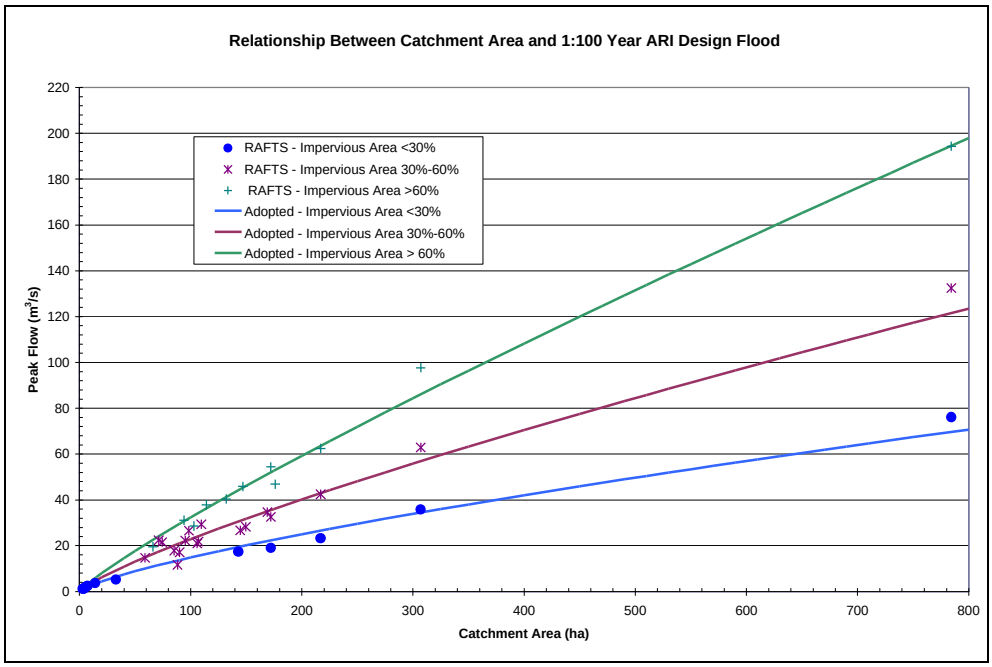
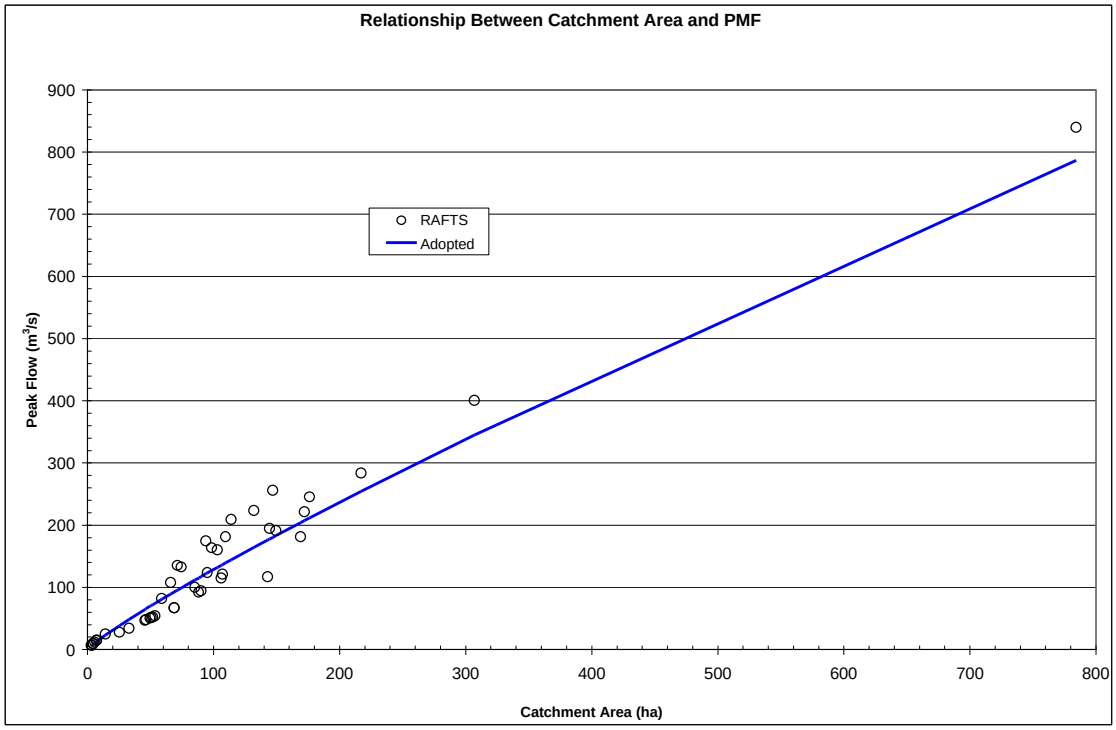


Figure A-4 Relationship Between Catchment Area and PMF



Empirical relationships adopted between the design peak flows and the catchment characteristics were established using the information listed in **Table A-2**. These adopted relationships are shown in **Table A-4**.

- **Table A-4 Adopted Empirical Relationships Between Catchment Area and Design Flow**

1:20 Year ARI	Impervious Area <30 %	$Q = 0.36A^{0.74}$
	Impervious Area 30% - 60%	$Q = 0.45A^{0.80}$
	Impervious Area >60%	$Q = 0.55A^{0.83}$
1:100 Year ARI	Impervious Area <30%	$Q = 0.47A^{0.75}$
	Impervious Area 30%-60 %	$Q = 0.55A^{0.81}$
	Impervious Area >60%	$Q = 0.59A^{0.87}$
PMF	All Catchments	$Q = 2.25A^{0.88}$

Where Q is the peak flow in m^3/s and A is the catchment area in hectare.

A.4 Adjustment of Impervious Areas

Impervious areas within the 756 catchment areas were initially estimated using the SKM Building Data set. As the approximate footprints of buildings and roads were included in the SKM Building Data set, the data set did not contain information on other pervious areas within the properties eg. sheds, driveways etc. Hence, it can be expected that the impervious areas estimated using the SKM Building Data set would underestimate the actual impervious areas within the catchments.

Three catchments were selected to check the difference in impervious areas. The selected catchments are shown in **Figure A-5** to **Figure A-7**. Impervious areas within the catchments included in SKM Building data set are also shown in the same figures. Impervious areas for the three selected catchments were measured using a planimeter. Measured impervious areas were then compared against those estimated using SKM Building Data set in GIS. Results of the comparison are given in **Table A-5**.

- **Table A-5 Comparison of Impervious Fractions**

Catchment No.	Catchment Area (ha)	% Impervious (SKM Building Data Set)	% Impervious (Measured)
515	4.460	39	53
612	3.062	32	55
633	4.102	34	56

Fairfield City Overland Flood Study

Figure A-5

Comparison of Impervious Area: Catchment No 515

Legend

- Key Property for Group 515
- Automatically Generated Flowpaths (No. of cells for a flowpath = 5000)
- Catchment Area for Group 515
- Catchment 515 Impervious Areas
- Catchment 515 Pervious Areas

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Metres

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Fairfield City Overland Flood Study

Figure A-6

Comparison of Impervious Area: Catchment No 612

Legend

- Key Property for Group 612
- Automatically Generated Flowpaths (No. of cells for a flowpath = 5000)
- Catchment Area for Group 612
- Catchment 612 Impervious Areas
- Catchment 612 Pervious Areas

N

1:2,000

0 10 20 40 60

Metres

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Fairfield City Overland Flood Study

Figure A-7

Comparison of Impervious Area: Catchment No 633

Legend

- Key Property for Group 633
- Automatically Generated Flowpaths (No. of cells for a flowpath = 5000)
- Catchment Area for Group 633
- 633_Impervious
- 633_Pervious

N

1:2,000

0 10 20 40 60

Metres

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Table A-5 shows that impervious areas were significantly underestimated using the SKM Building Data set. Hence, it was necessary to adjust impervious areas for the catchments. The adjustment was undertaken on the basis of the three selected impervious categories (ie. <30%, 30%-60% and >60%) used in the estimation of design floods. If the estimated impervious fraction was greater than 20.5% but less than 40%, then impervious fraction was increased by 10%. If the estimated impervious fraction was greater than 40% but less than 60% then the impervious fraction was increased by 20%.

Appendix B Validation of Overland Flow Paths

B.1 Trouble Spot 1

The first area highlighted is an area between The Promenade, Antill St and Junction St in Yennora. A number of properties have been highlighted just west of this area. However, the main flow paths that were generated (and used in the analysis) in this area run along the road network. Potential flow paths, that were below the threshold used in the analysis, do intersect with properties in both the north and the south of the area, but the catchment area of these was below the threshold used in the analysis. It is possible that blockages of local drainage pipes and pits may have caused flooding problems in the past.

B.2 Trouble Spot 2

The second area centres around the intersections between Carcoola St and West St and Carcoola St and Second Av in Canley Vale. Some properties have been highlighted just west of this area, but none in this area were identified as potentially affected. The flow paths that were generated in this area run along the road network and are below the catchment area threshold used in the analysis and therefore no properties were identified. However, the area is fairly flat and therefore any blockages in the area may caused flooding problems in the past.

B.3 Trouble Spot 3

This area covers a number of properties on O'Shannassy St, Mt Pritchard. No properties in this area were identified as being potentially at risk from overland flooding in this study. This is because all the generated flow paths that intersect with the building footprints were below the catchment area threshold used in the analysis. However, there are a number of smaller automatically generated flow paths that converge in this area, potentially affecting one or more properties.

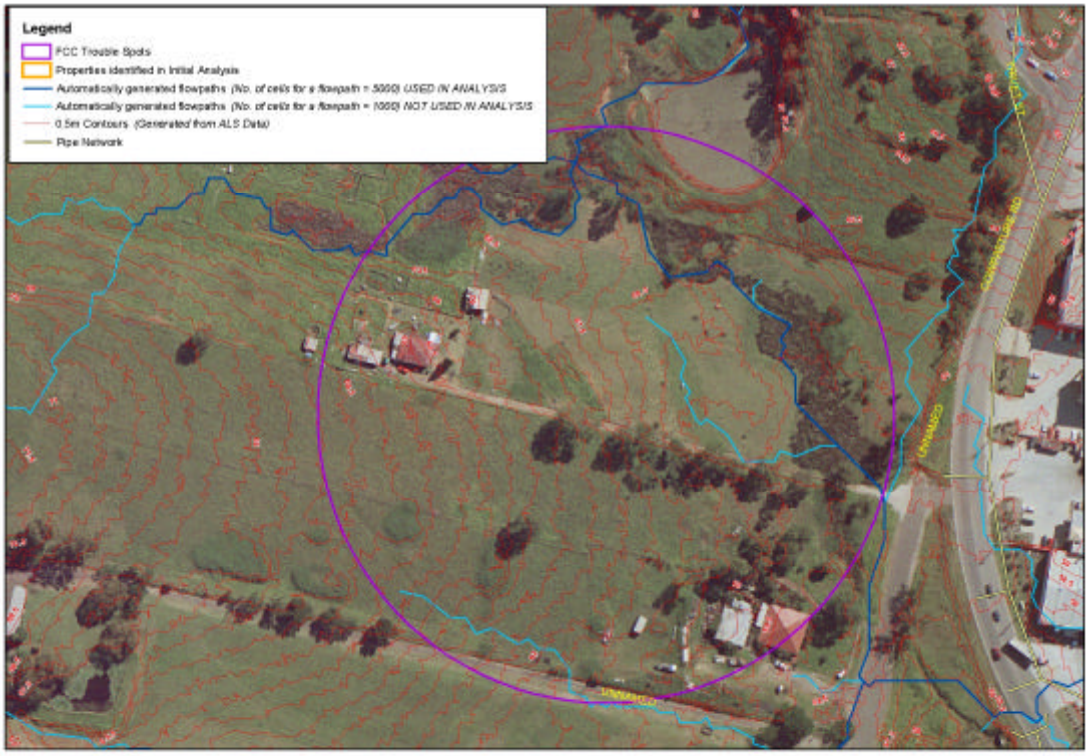
Although there may be a number of properties at this location that may be at risk of overland flooding, the catchment area threshold that was used in this study was too coarse to identify these properties. If a smaller catchment threshold was used, a number of properties could be identified as being at risk of overland flooding. This being a screening level study, it was considered appropriate to use a consistent approach for the entire study area.

B.4 Trouble Spot 4

This area covers a group of properties on Bulls Road, Linden Place and Runcorn Street, St Johns Park. No properties were identified as being potentially at risk from overland flooding in this area, in this study. The majority of flow paths that were automatically generated in this area were flowing along the road network and were also below the minimum catchment area threshold for flow paths used in the analysis. One flow path was that was generated from the ground surface would have the potential to affect properties (in the north-east of the area), but this was also below the minimum catchment area threshold used in the analysis.

It is possible that blockages of the drainage system in this area in the past could have been the reason that this area was highlighted by Fairfield City Council as a trouble spot, as it does not appear to be particularly at risk from the analysis methods used.

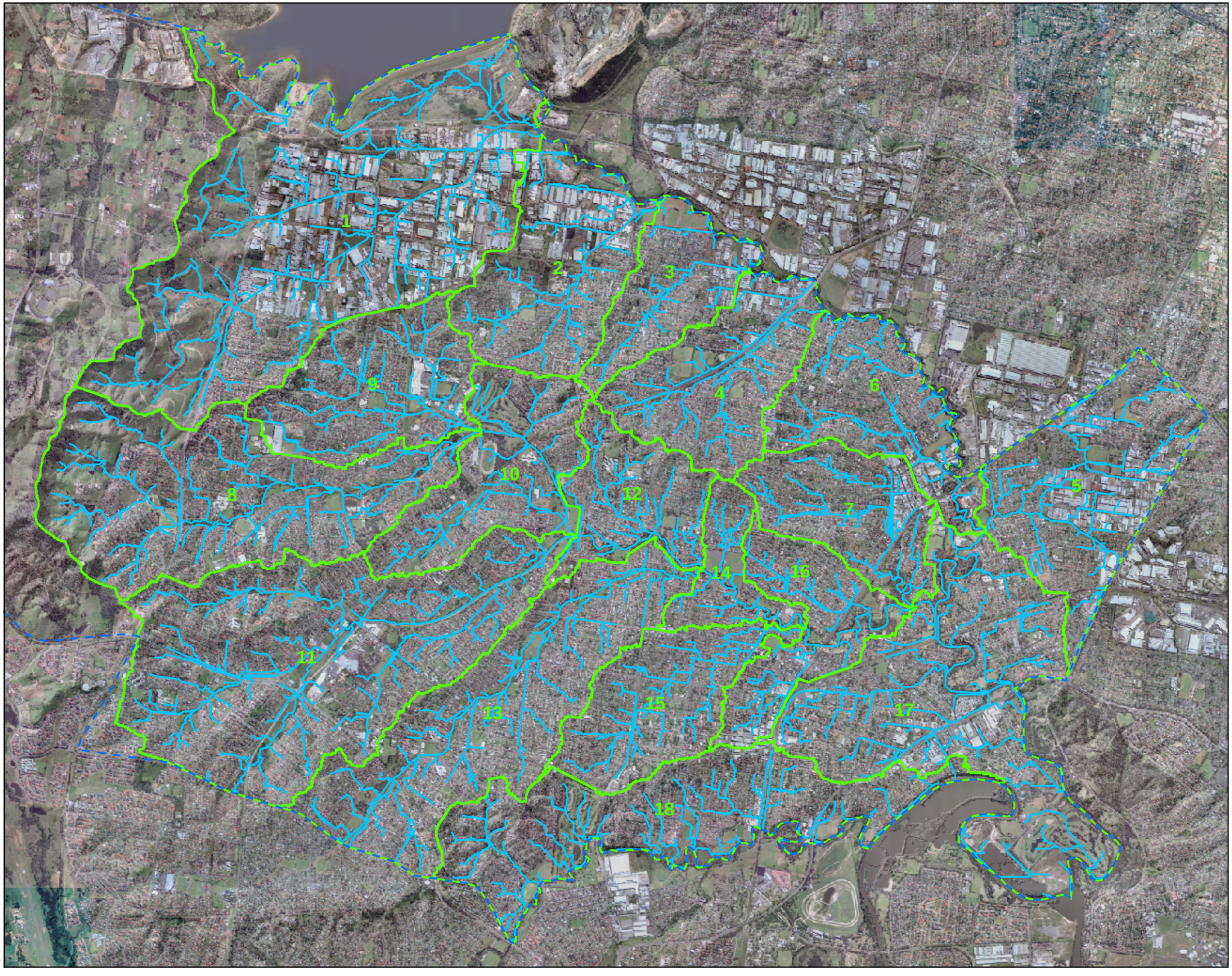
B.5 Trouble Spot 5



This area is a largely rural area to the west of Cowpasture Road (just south of the junction with Trivet St in Horsley Park). No properties in this area were highlighted as being at risk from overland flooding in this study. All flow paths generated (both above and below the threshold catchment area used for the analysis) do not appear to have any affect on properties.

It is possible that the property to the west of the area could have been affected by overland flooding if the flow path was artificially diverted along tracks that have been created. However from the ground surface data alone the property would appear unlikely to be at risk of overland flooding.

Appendix C Overland Flow Path Map



Fairfield City Overland Flood Study

Appendix C

Local Overland Flowpath Map

Legend

- Automatically generated flowpaths (No. of cells for a flowpath = 5000)
- Sub-Catchments
- Fairfield LGA Boundary

N

0 0.25 0.5 1 1.5

Kilometres

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File: U:\Projects\IN25501_200_FairfieldOverlandFlows\Report_Figures\Updated_130104\AppendixC_Flowpaths_A3.mxd

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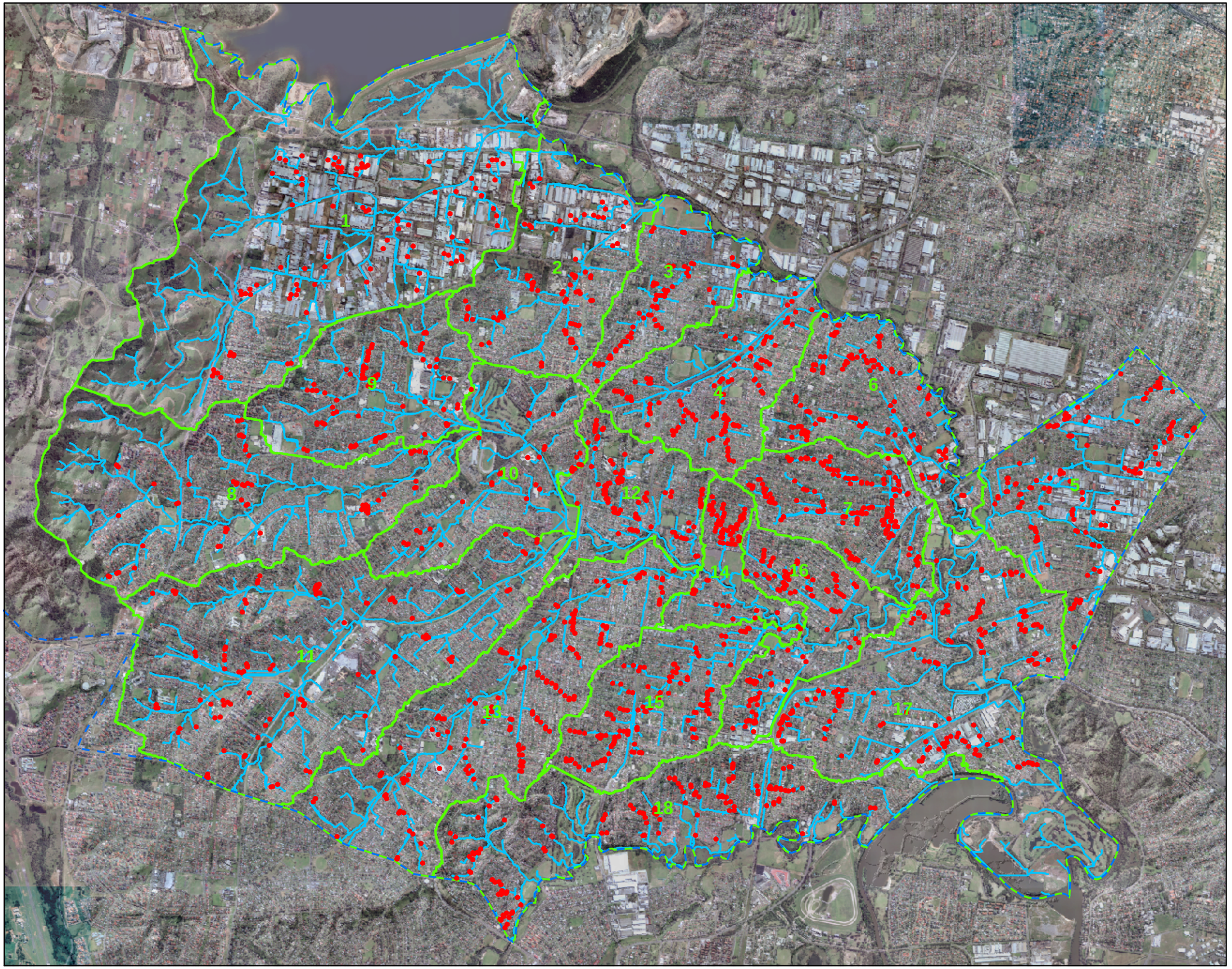
Appendix D Properties at Risk of Overland Flooding (based on preliminary hydraulic analysis only)



Fairfield City Overland Flood Study

Appendix D

Properties at Risk of Overland Flooding

Legend

- Properties at Risk of Overland Flooding
- Automatically generated flowpaths (No. of cells for a flowpath = 5000)
- Sub-Catchments
- Fairfield LGA Boundary

N

0 0.25 0.5 1 1.5

Kilometres

Job No.: IN25501.200
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