



Upper Wimmera Flood Investigation Final Report

Reference: R.M8460.009.01.Final.docx
Date: 30 June 2014



Upper Wimmera Flood Investigation Final Report

Prepared for: Wimmera Catchment Management Authority

Prepared by: BMT WBM Pty Ltd (Member of the BMT group of companies)
In association with Michael Cawood and Associates

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Australian Government



Document Control Sheet

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	Title:	Upper Wimmera Flood Investigation Final Report
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	Author:	Joel Leister and Dexter Reynolds
	Client:	Wimmera Catchment Management Authority
	Client Contact:	Abdul Aziz
	Client Reference:	
Synopsis: This report documents the tasks undertaken as part of the Upper Wimmera Flood Investigation.		

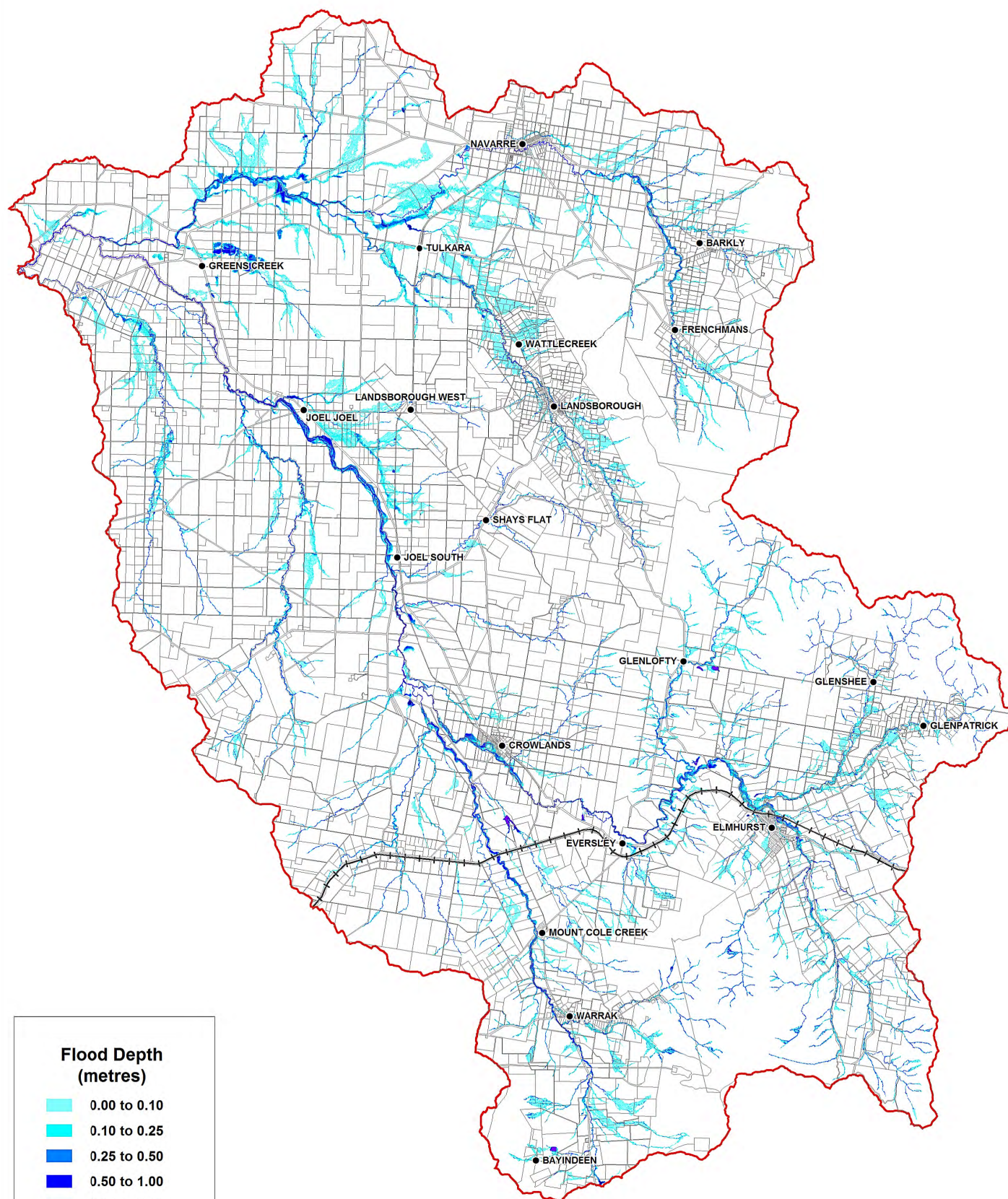
REVISION/CHECKING HISTORY

Revision Number	Date	Checked by	Issued by
0	7 February 2014	JGL	DR
1	30 June 2014	MAT	JGL

DISTRIBUTION

Destination	Revision										
	0	1	2	3	4	5	6	7	8	9	10
Wimmera Catchment Management Authority (PDF)	1	1									
BMT WBM File	1	1									
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Appendix A Existing Case – Depth Mapping



Title:
Upper Wimmera Flood Investigation
20% AEP Design Flood Depths - Catchment

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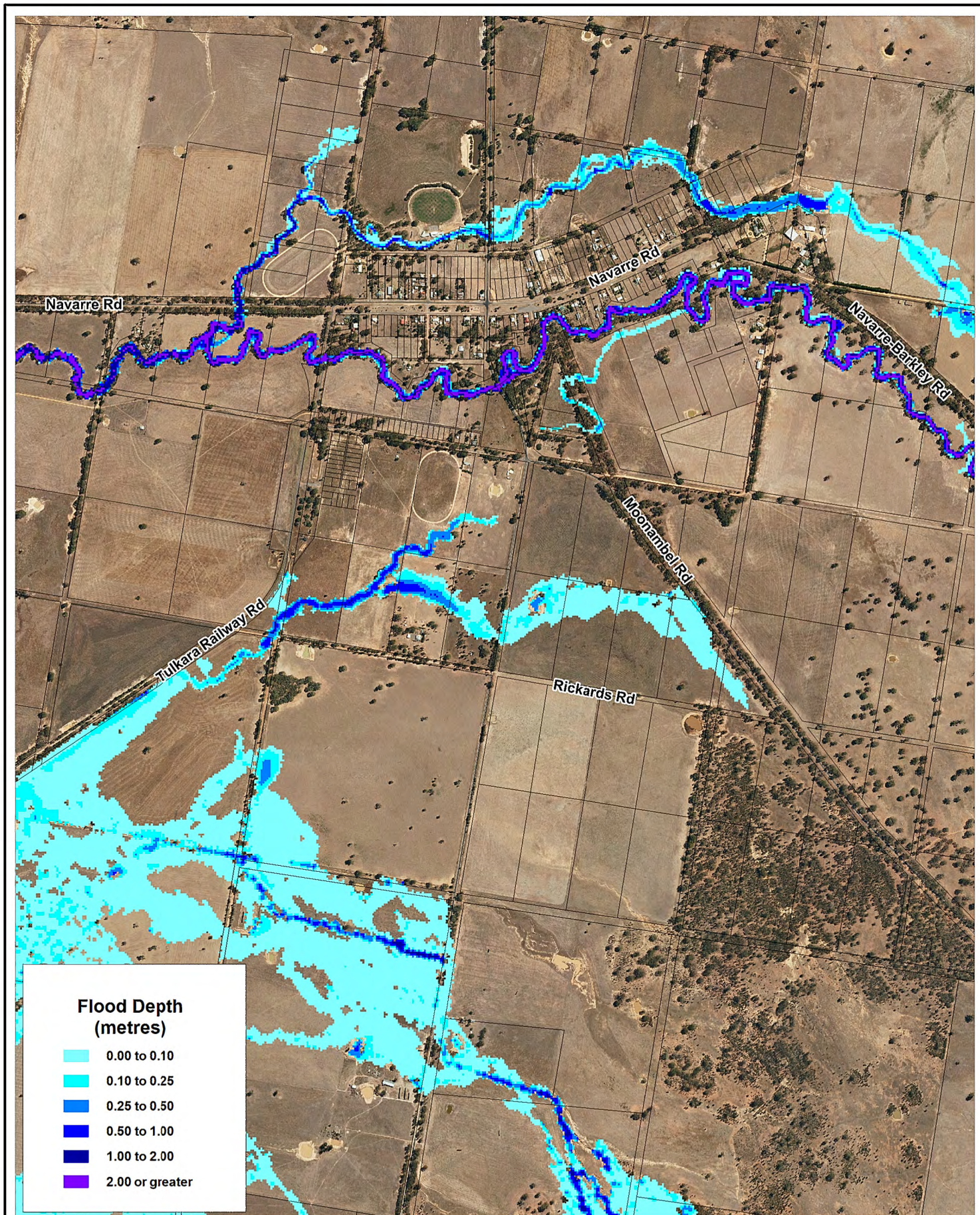
0 3.75 7.5km
 Approx. Scale

Figure:
A-1

Rev:
A



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Title:
Upper Wimmera Flood Investigation
20% AEP Design Flood Depths - Navarre

Figure:

A-2

Rev:

A

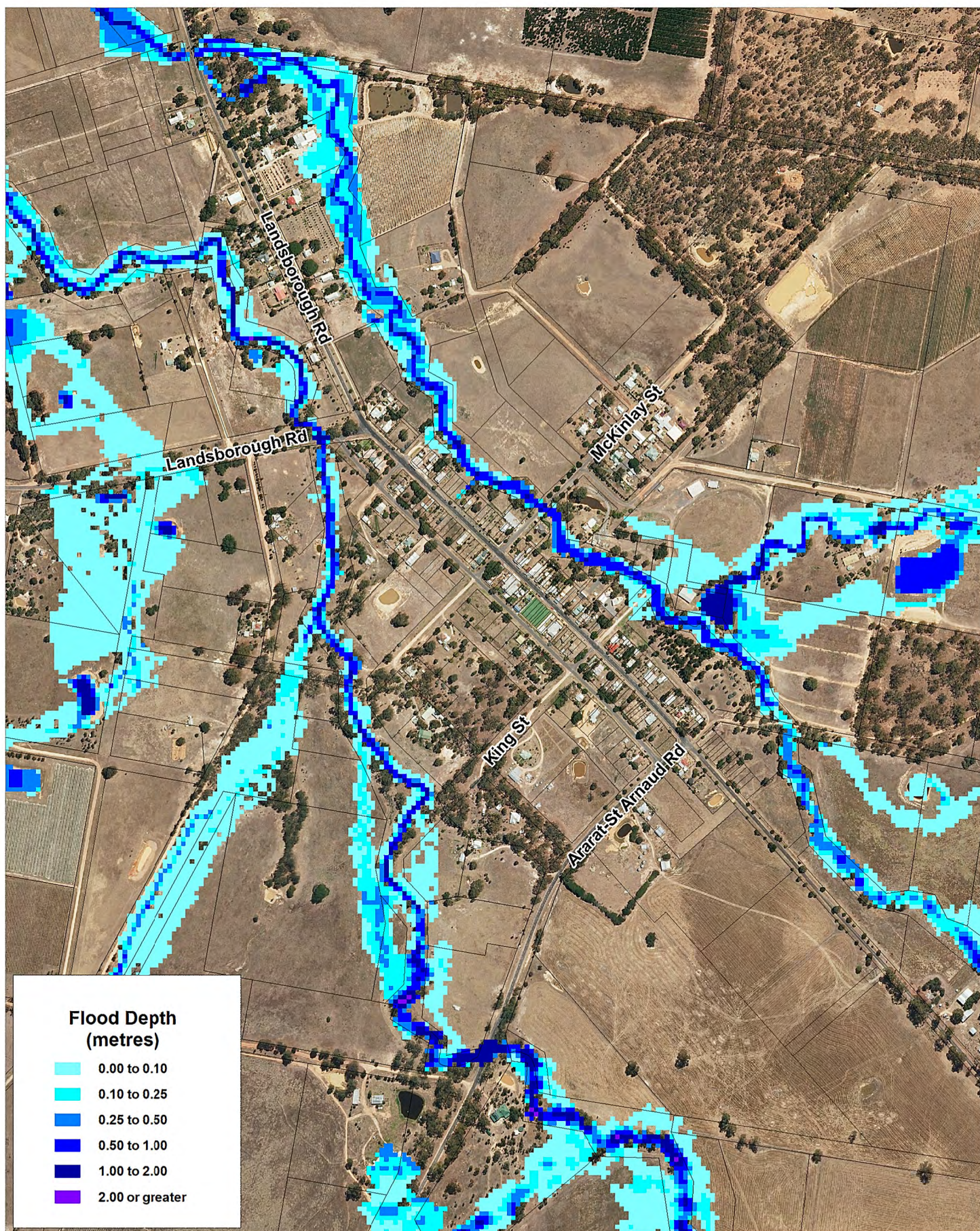
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0 250 500m
 Approx. Scale



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Title:
Upper Wimmera Flood Investigation
20% AEP Design Flood Depths - Landsborough

Figure:

A-3

Rev:

A

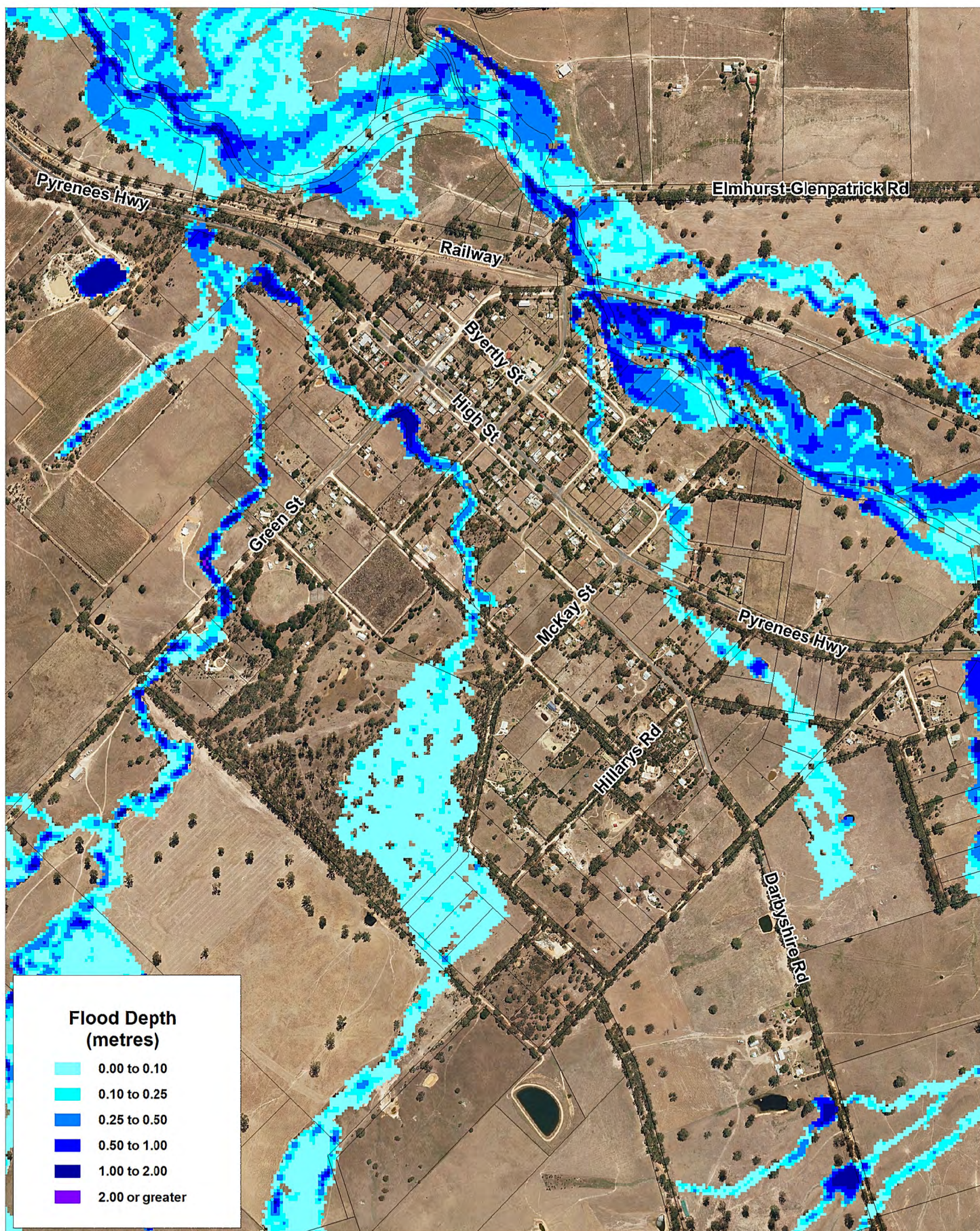
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0 100 200m
 Approx. Scale



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Title:
Upper Wimmera Flood Investigation
20% AEP Design Flood Depths - Elmhurst

Figure:

A-4

Rev:

A

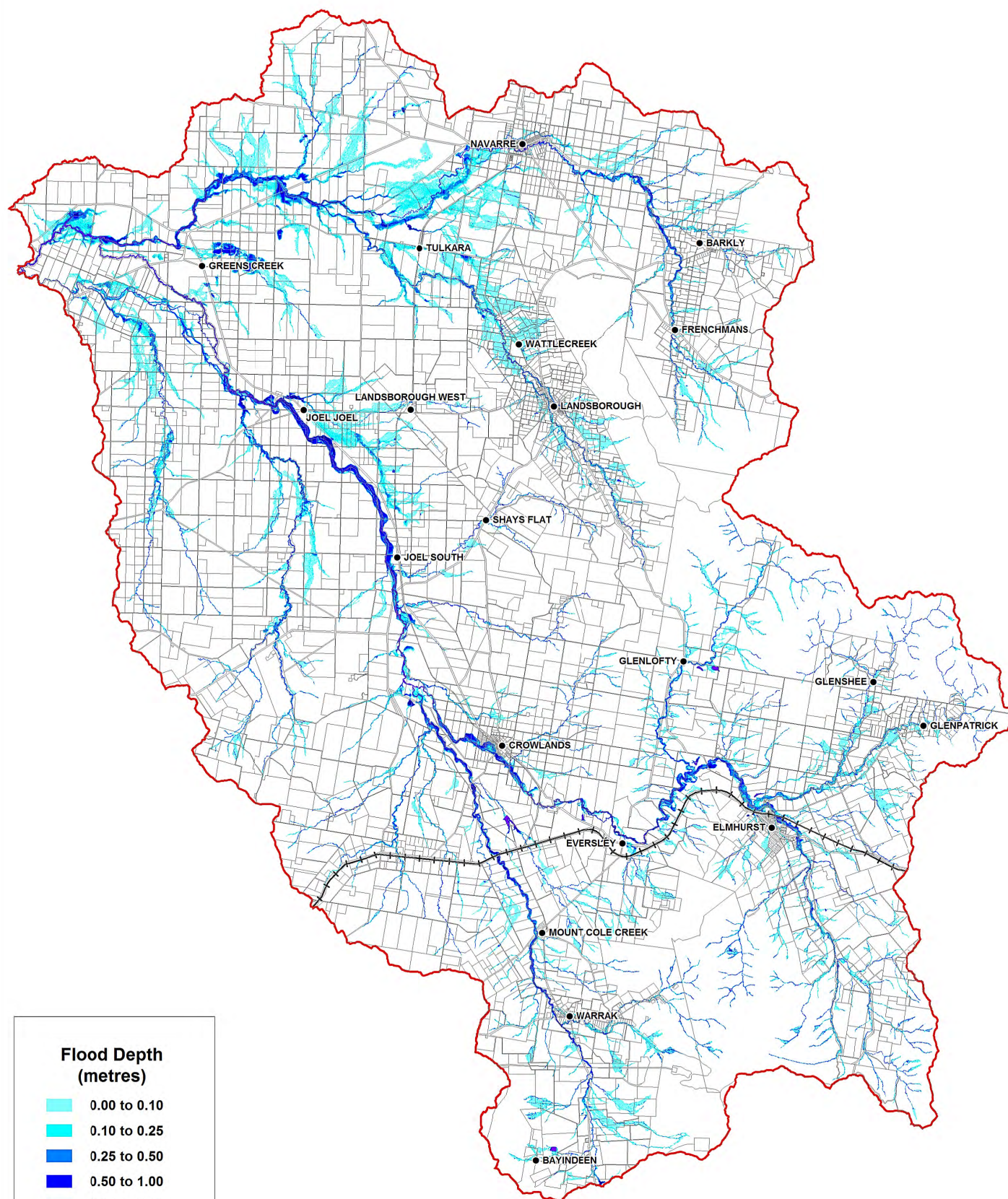
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Title:
**Upper Wimmera Flood Investigation
10% AEP Design Flood Depths - Catchment**

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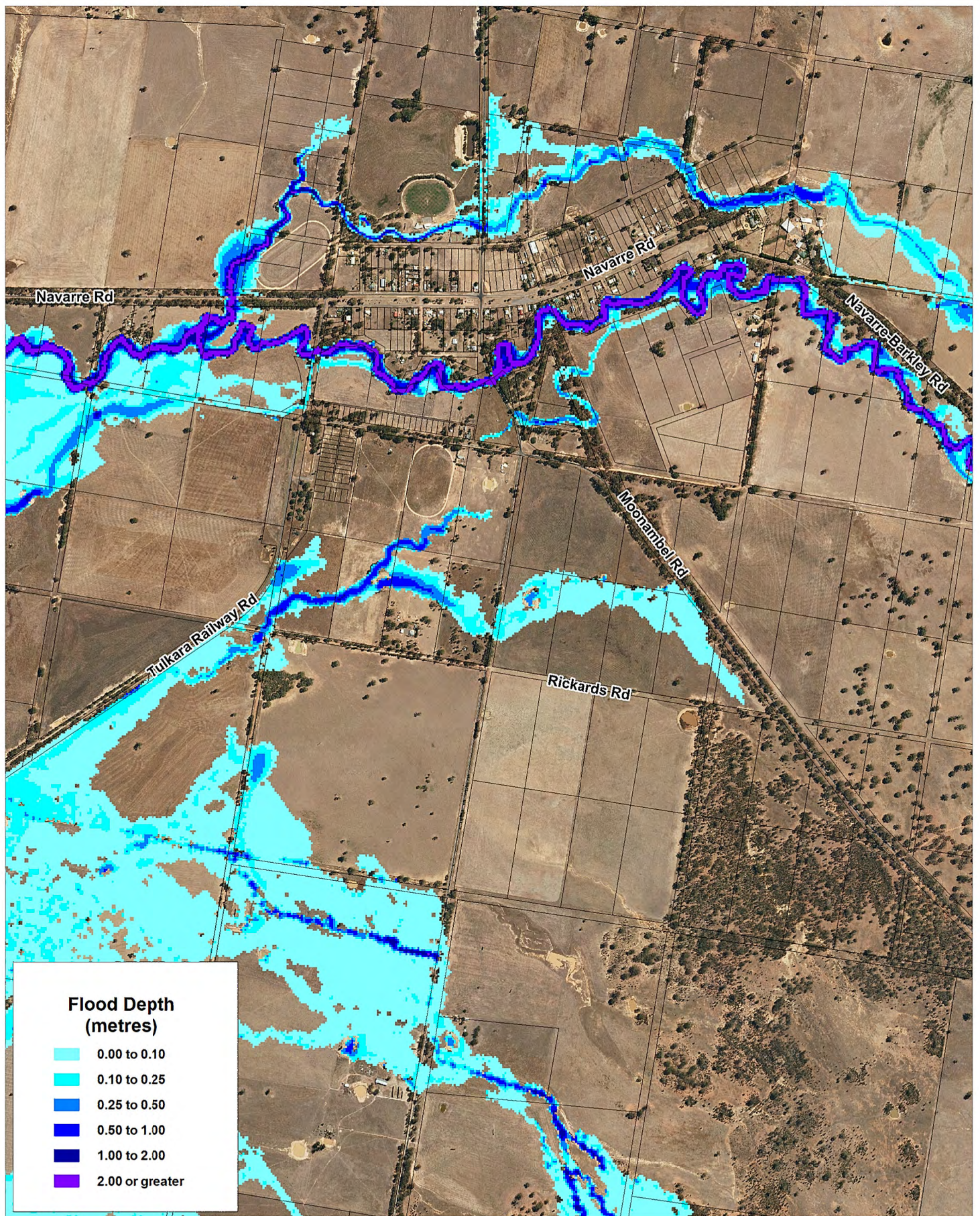
0 3.75 7.5km
Approx. Scale

Figure:
A-5

Rev:
A



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Title:
Upper Wimmera Flood Investigation
10% AEP Design Flood Depths - Navarre

Figure:
A-6

Rev:
A

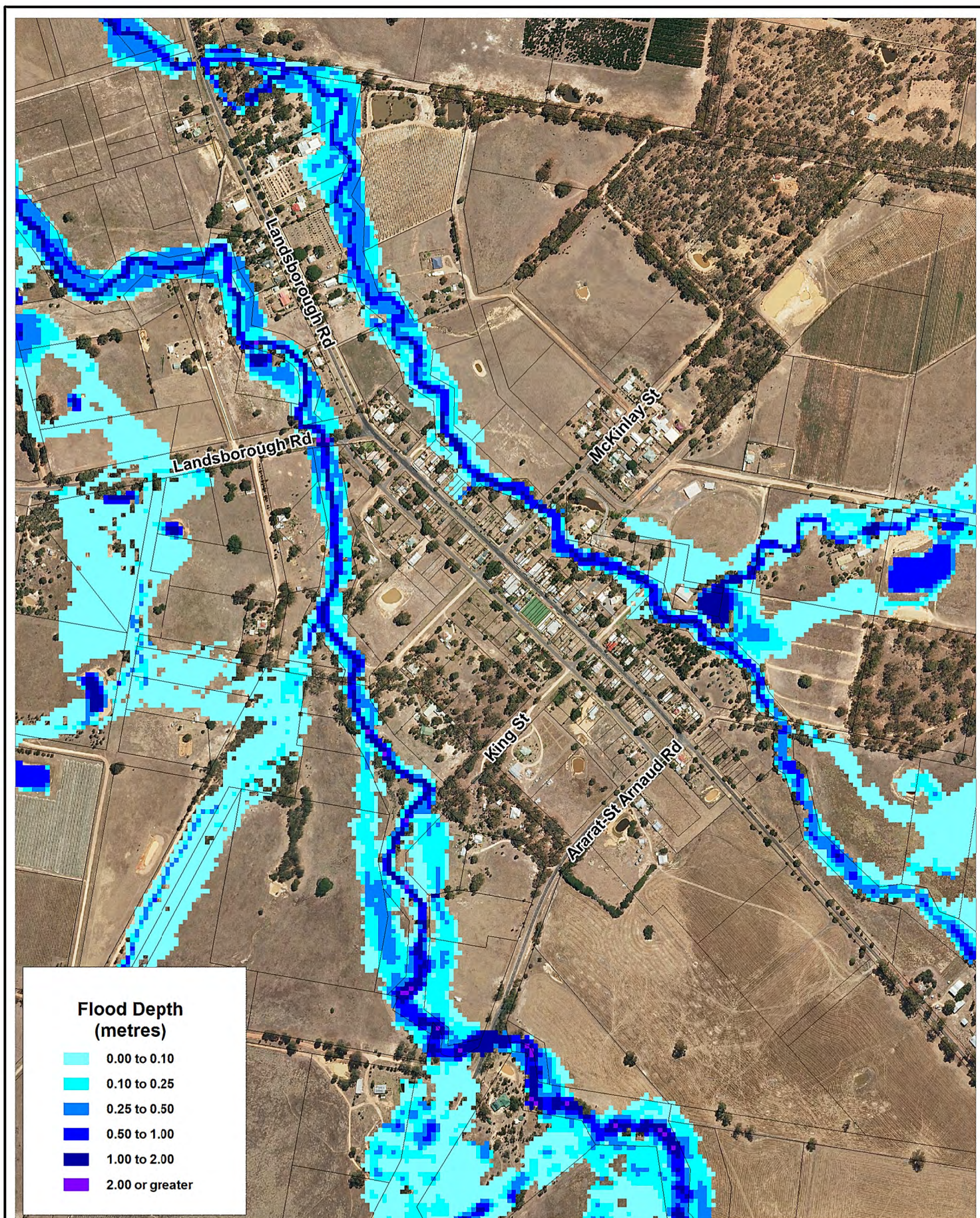
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0 250 500m
 Approx. Scale



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Title:
Upper Wimmera Flood Investigation
10% AEP Design Flood Depths - Landsborough

Figure:

A-7

Rev:

A

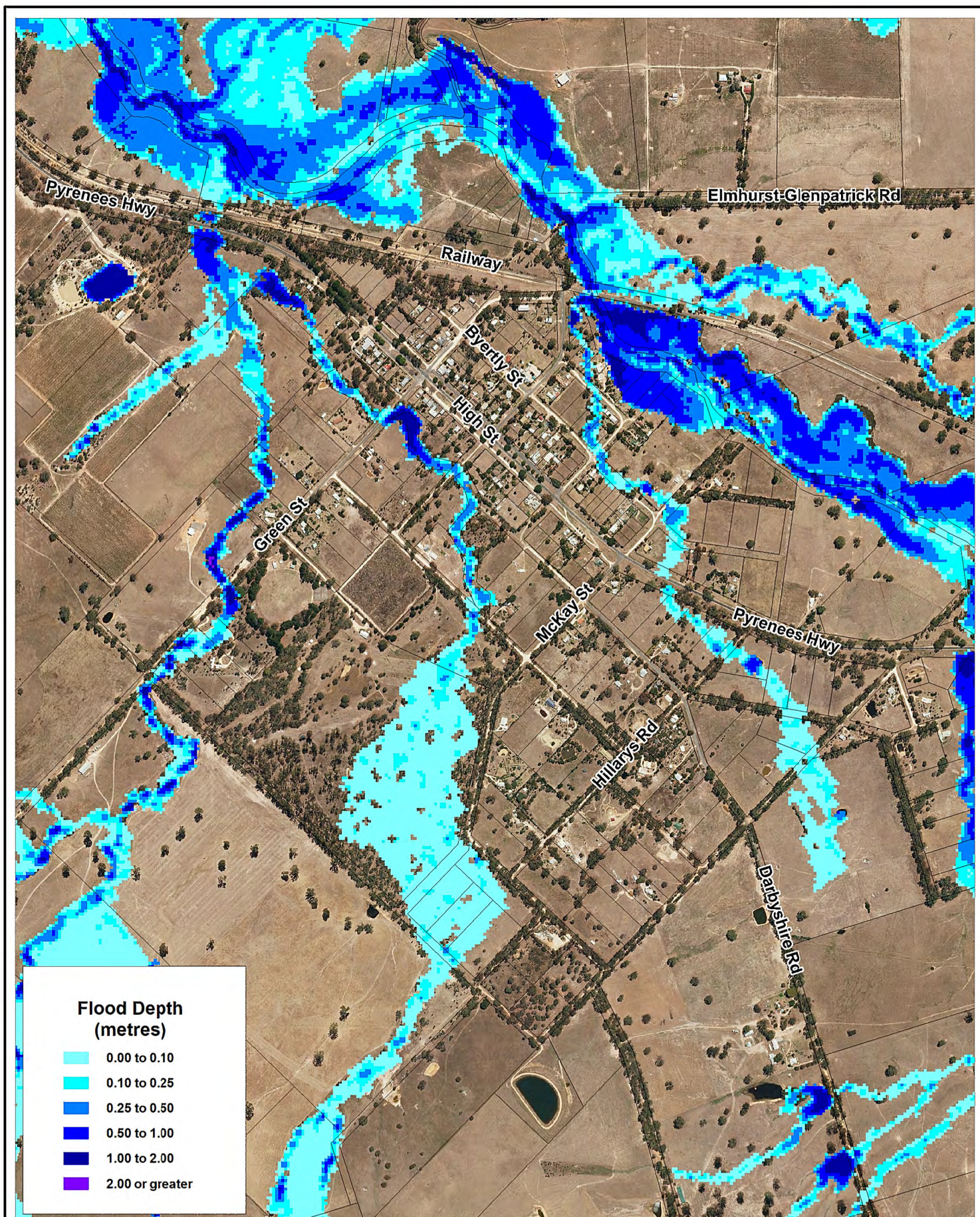
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0 100 200m
 Approx. Scale



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Title:
Upper Wimmera Flood Investigation
10% AEP Design Flood Depths - Elmhurst

Figure:

A-8

Rev:

A

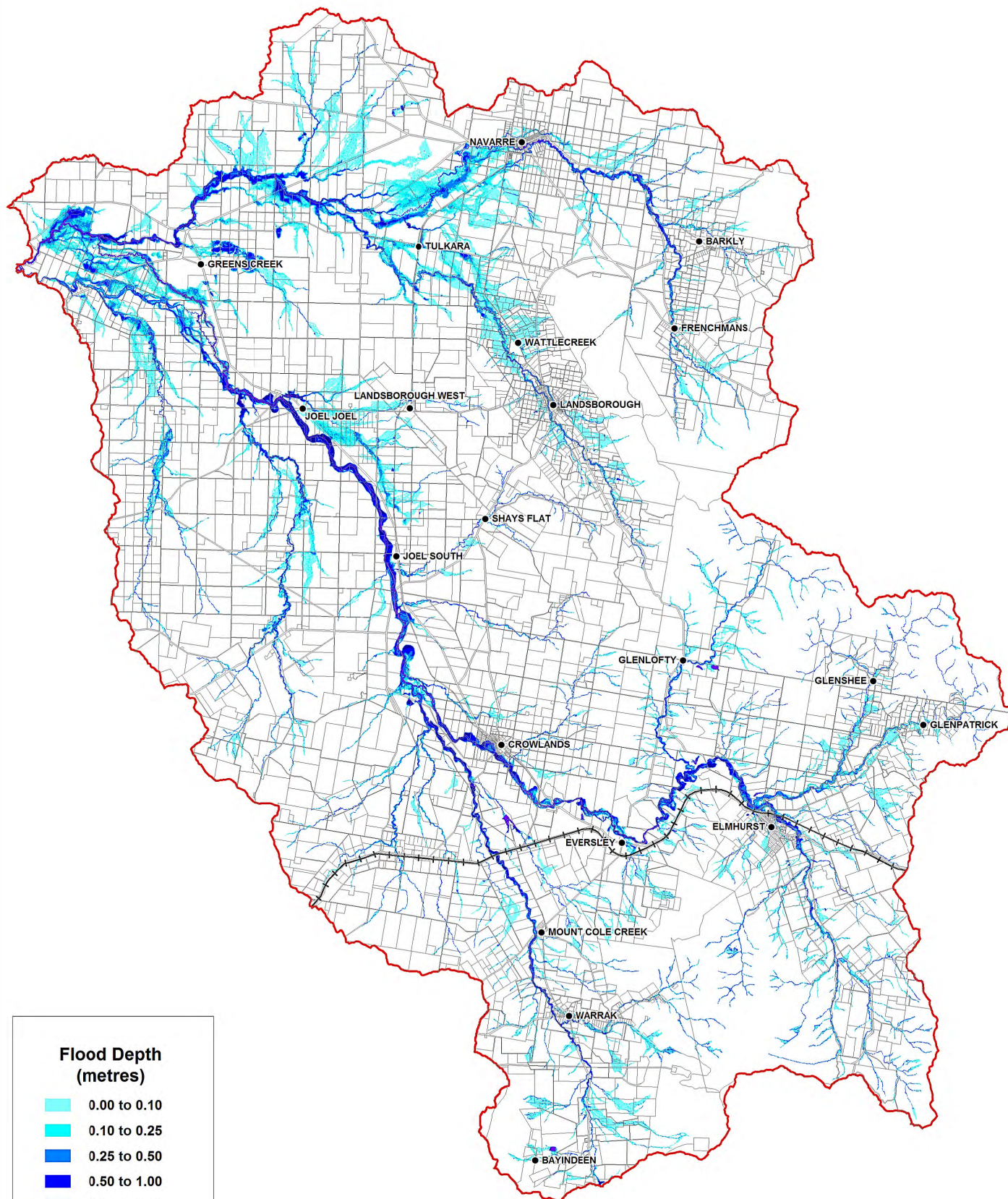
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0 200 400m
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Title:
Upper Wimmera Flood Investigation
5% AEP Design Flood Depths - Catchment

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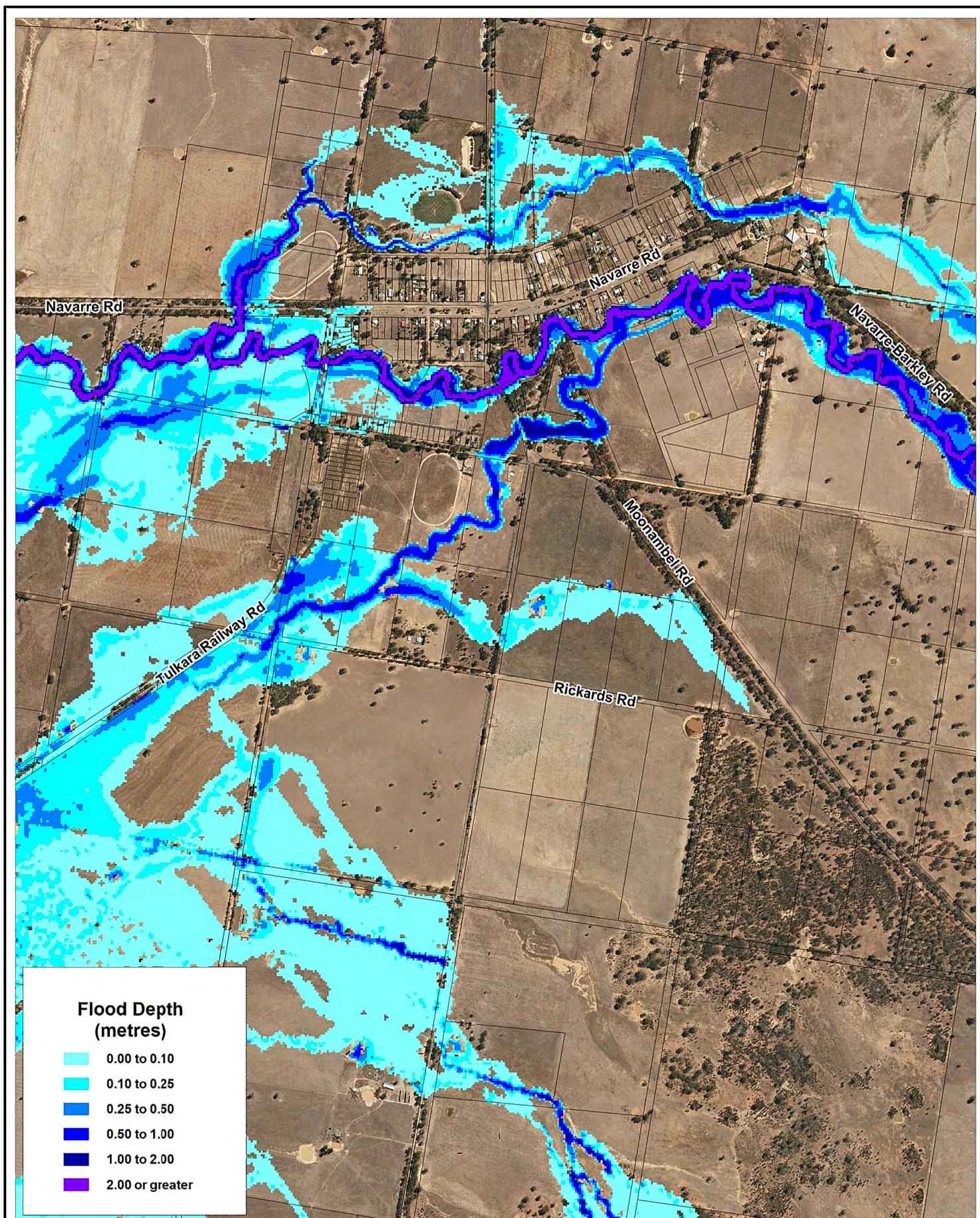


0 3.75 7.5km
 Approx. Scale

Figure:
A-9

Rev:
A





Title:
Upper Wimmera Flood Investigation
5% AEP Design Flood Depths - Navarre

Figure:

A-10

Rev:

A

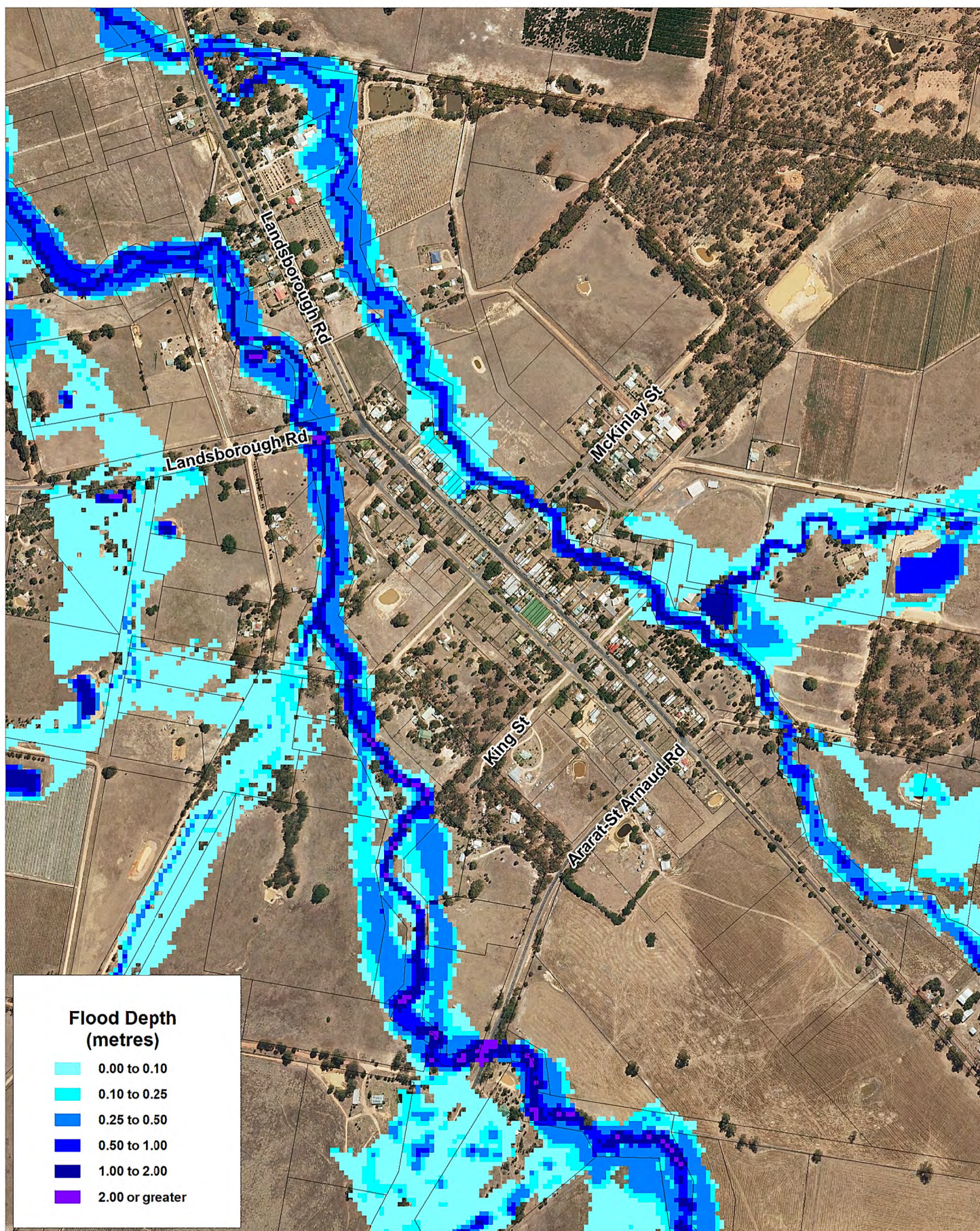
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0 250 500m
 Approx. Scale



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Flood Depth (metres)

- 0.00 to 0.10
- 0.10 to 0.25
- 0.25 to 0.50
- 0.50 to 1.00
- 1.00 to 2.00
- 2.00 or greater

Title:

Upper Wimmera Flood Investigation 5% AEP Design Flood Depths - Landsborough

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0 100 200m
Approx. Scale

Figure:

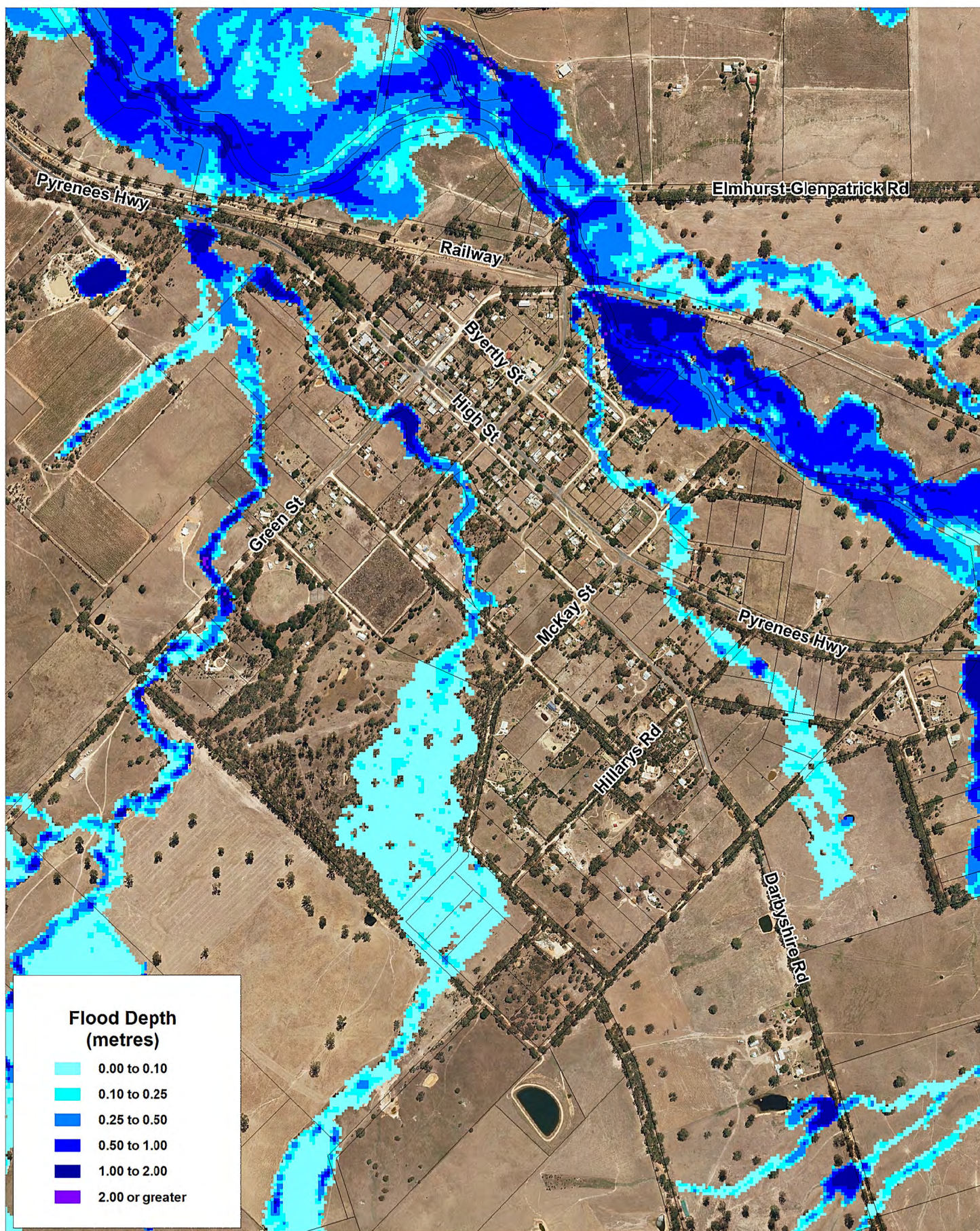
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Title:
Upper Wimmera Flood Investigation
5% AEP Design Flood Depths - Elmhurst

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0 200 400m
 Approx. Scale

Figure:

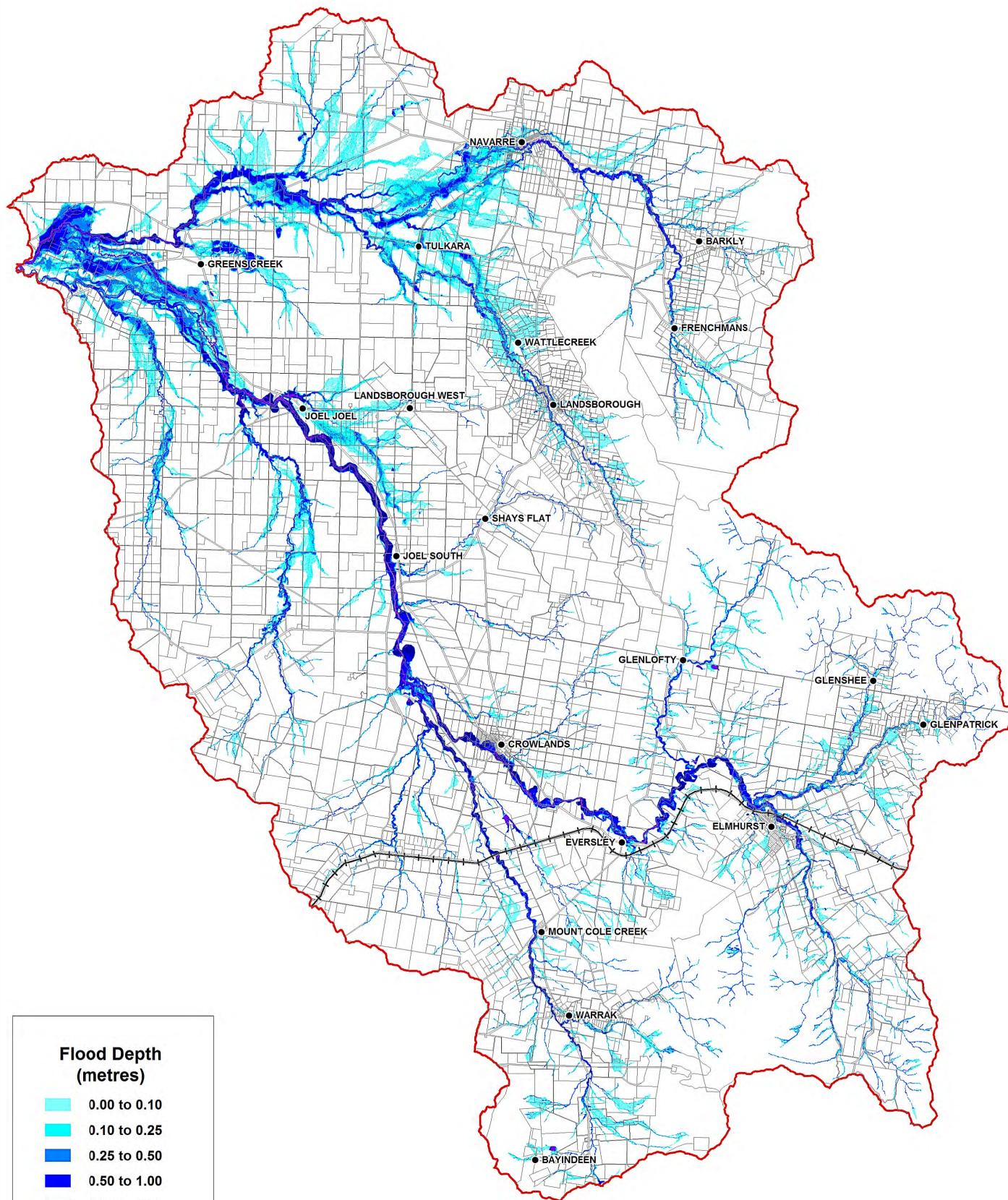
A-12

Rev:

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Title:
Upper Wimmera Flood Investigation
2% AEP Design Flood Depths - Catchment

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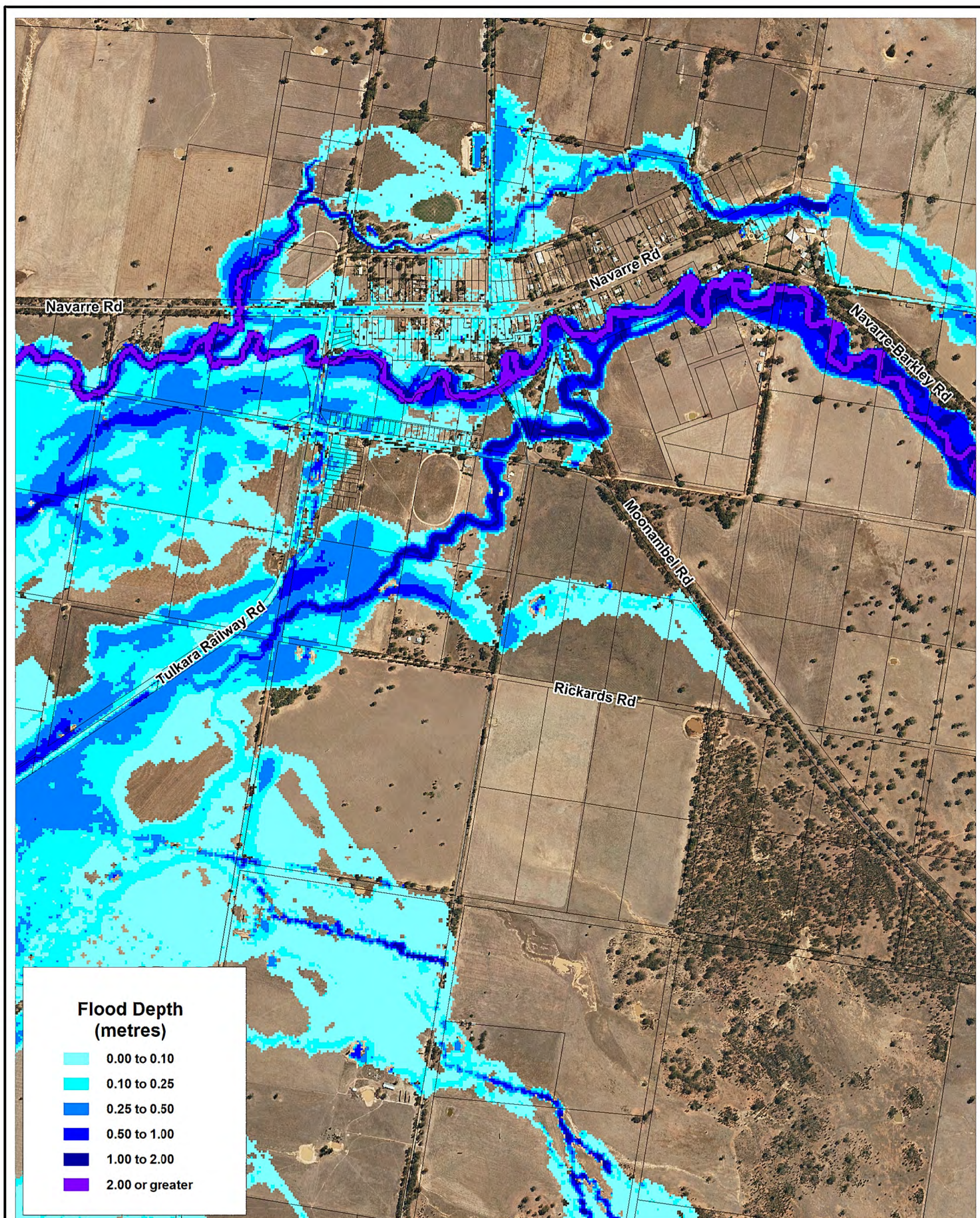


0 3.75 7.5km
 Approx. Scale

Figure:
A-13

Rev:
A





Title:
Upper Wimmera Flood Investigation
2% AEP Design Flood Depths - Navarre

Figure:
A-14

Rev:
A

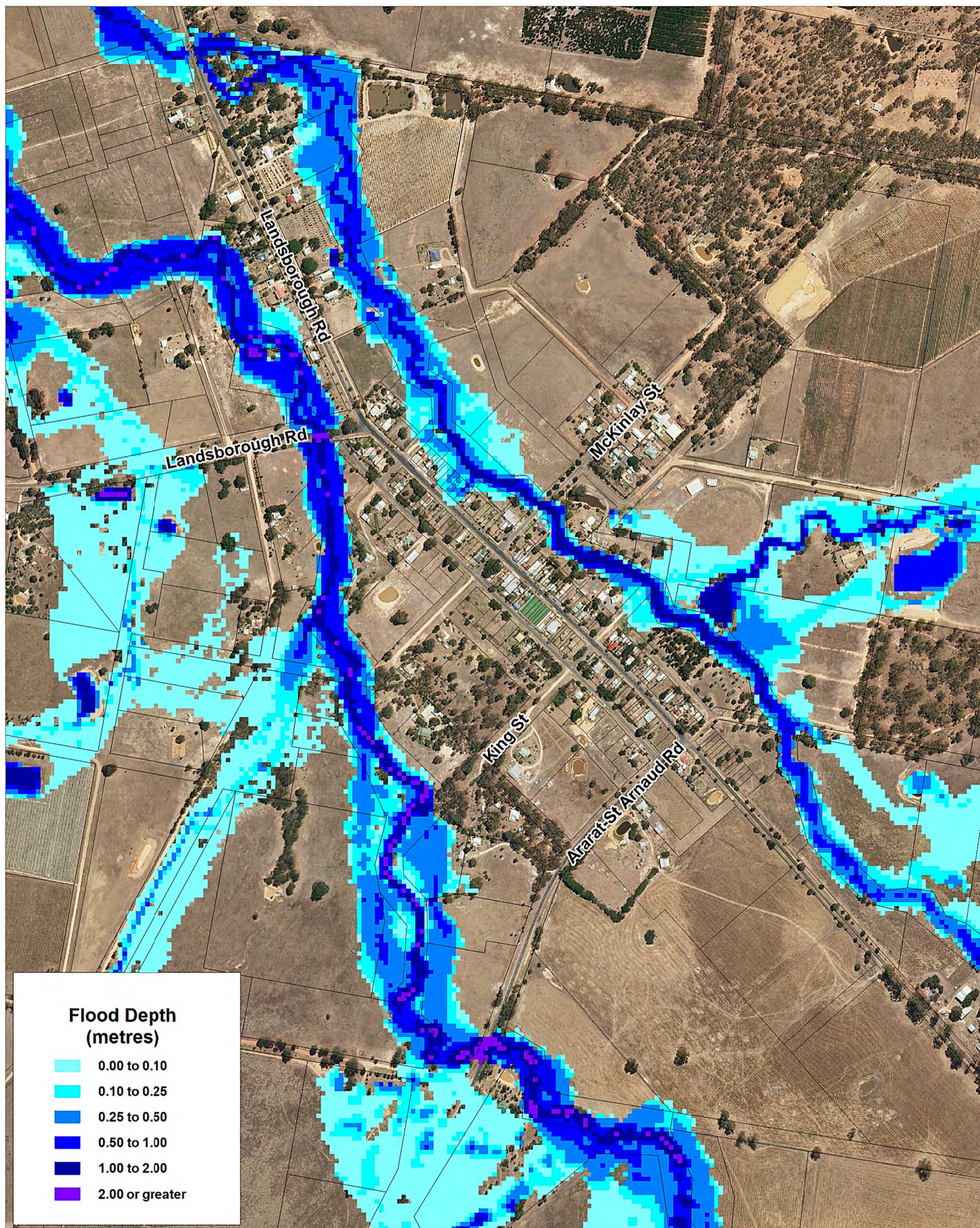
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0 250 500m
 Approx. Scale



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Title:
Upper Wimmera Flood Investigation
2% AEP Design Flood Depths - Landsborough

Figure:

A-15

Rev:

A

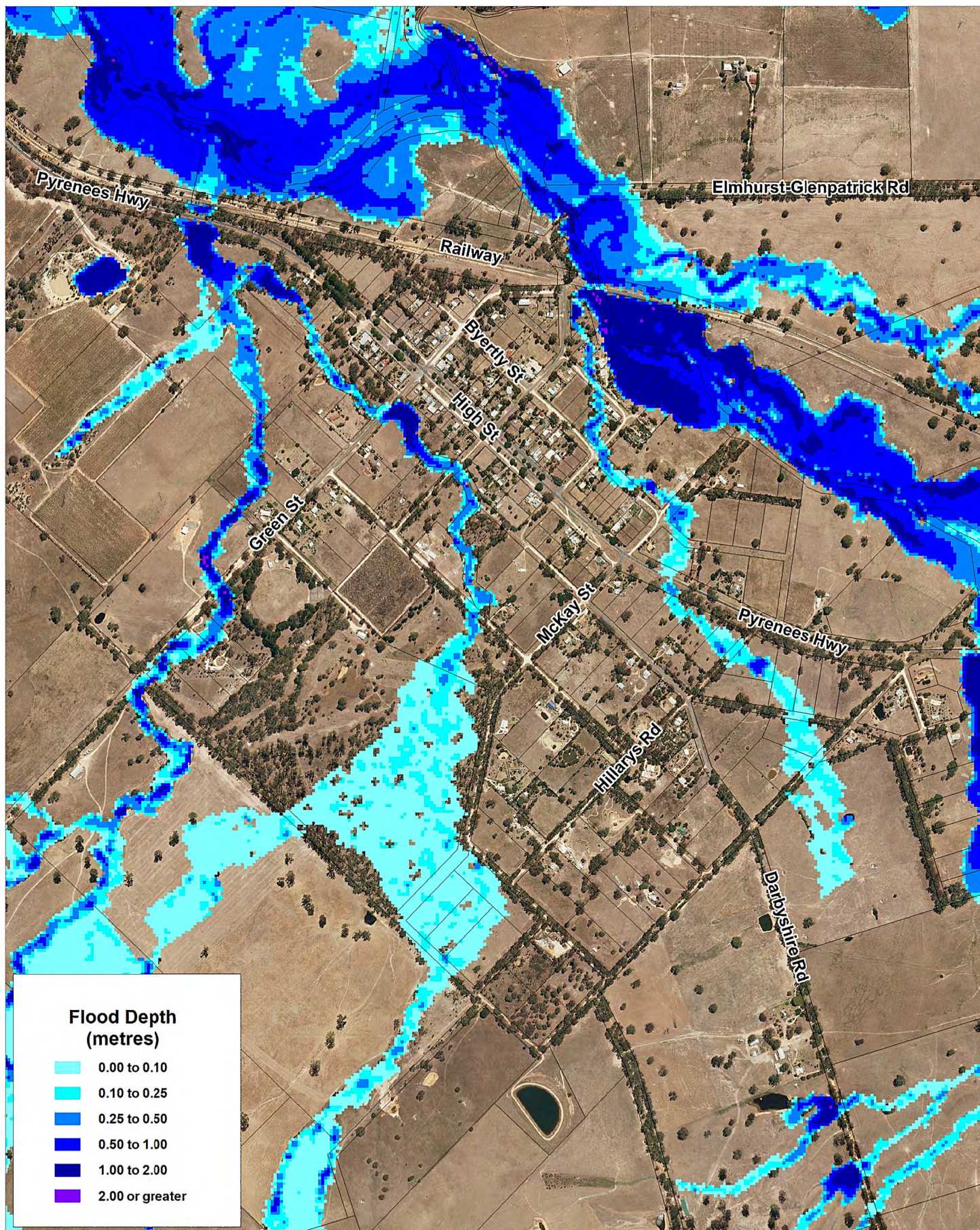
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0 100 200m
 Approx. Scale



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Flood Depth (metres)

- 0.00 to 0.10
- 0.10 to 0.25
- 0.25 to 0.50
- 0.50 to 1.00
- 1.00 to 2.00
- 2.00 or greater

Title:

Upper Wimmera Flood Investigation 2% AEP Design Flood Depths - Elmhurst

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0 200 400m
Approx. Scale

Figure:

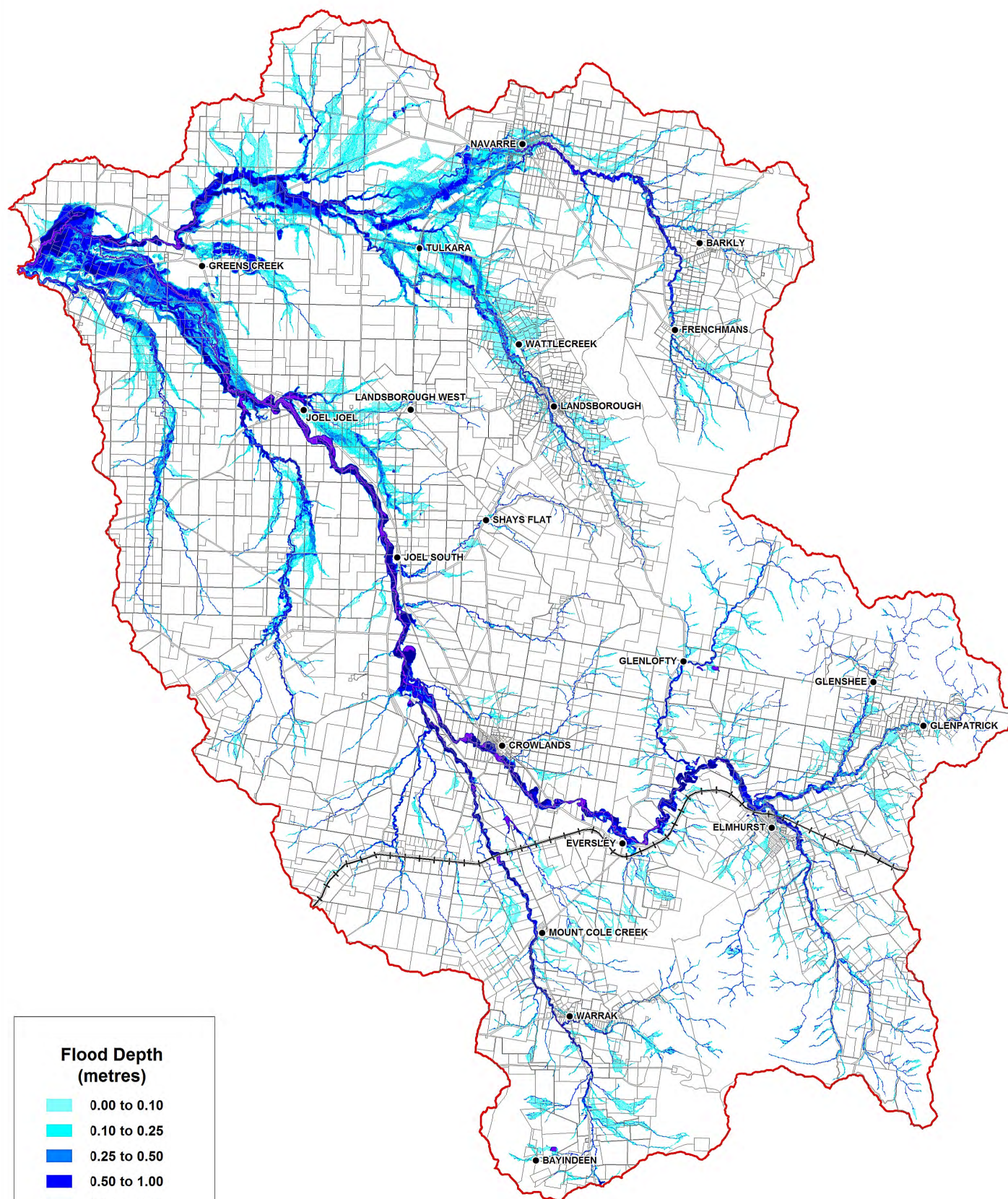
A-16

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Title:
Upper Wimmera Flood Investigation
1% AEP Design Flood Depths - Catchment

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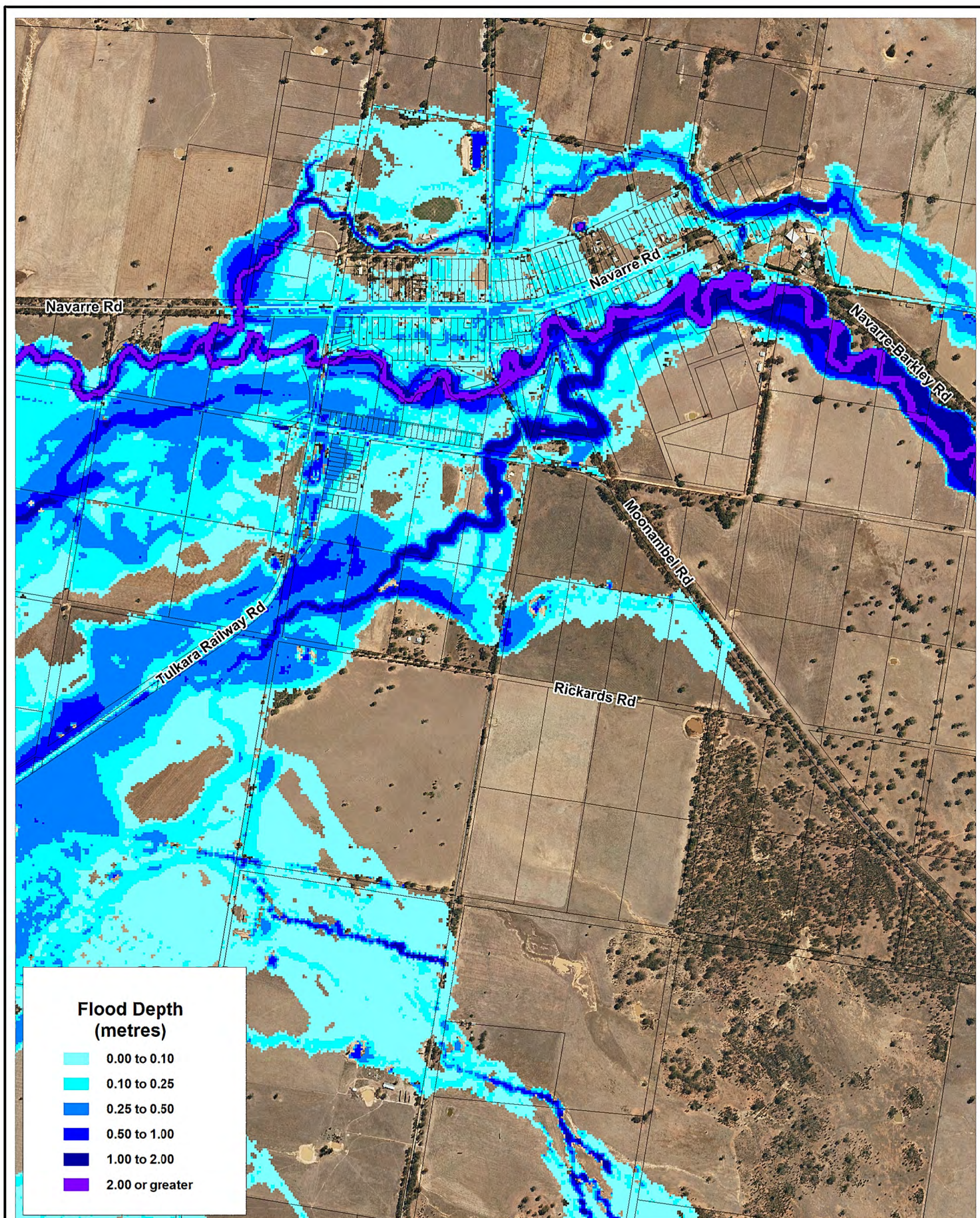


0 3.75 7.5km
 Approx. Scale

Figure:
A-17

Rev:
A





Title:
Upper Wimmera Flood Investigation
1% AEP Design Flood Depths - Navarre

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0 250 500m
 Approx. Scale

Figure:

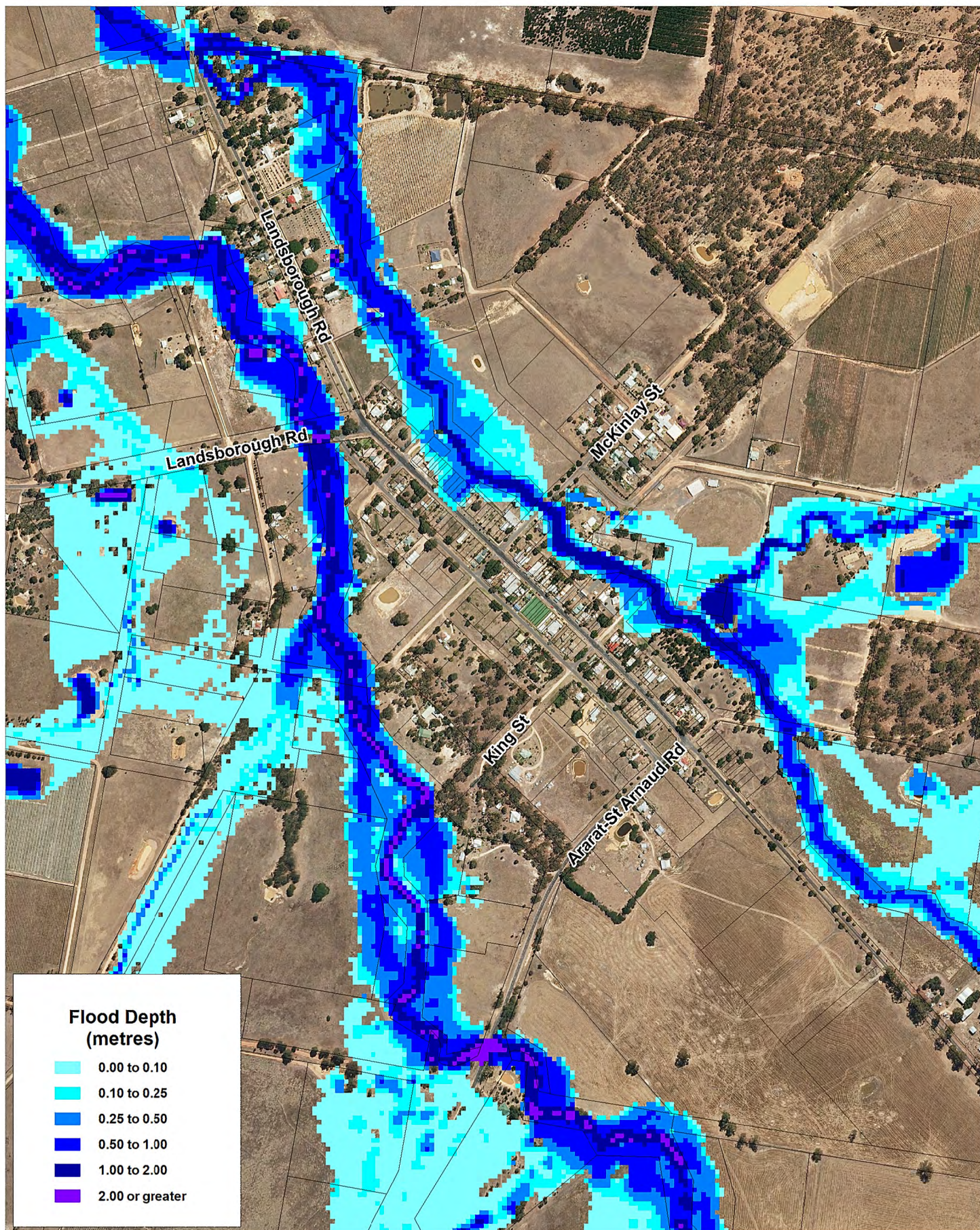
A-18

Rev:

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Title:
Upper Wimmera Flood Investigation
1% AEP Design Flood Depths - Landsborough

Figure:
A-19

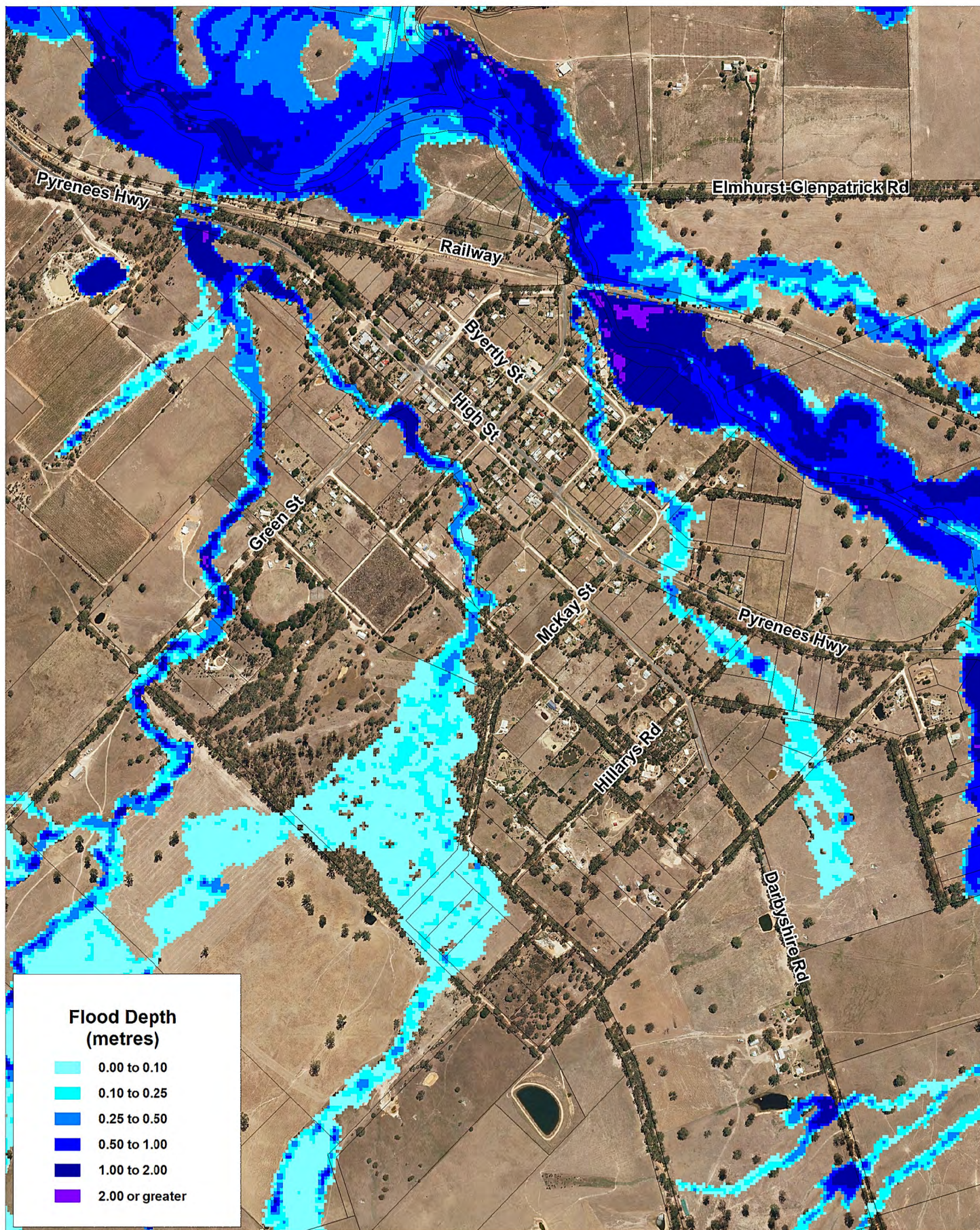
Rev:
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0 100 200m
 Approx. Scale





Flood Depth (metres)

0.00 to 0.10
0.10 to 0.25
0.25 to 0.50
0.50 to 1.00
1.00 to 2.00
2.00 or greater

Title:

Upper Wimmera Flood Investigation 1% AEP Design Flood Depths - Elmhurst

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0 200 400m
Approx. Scale

Figure:

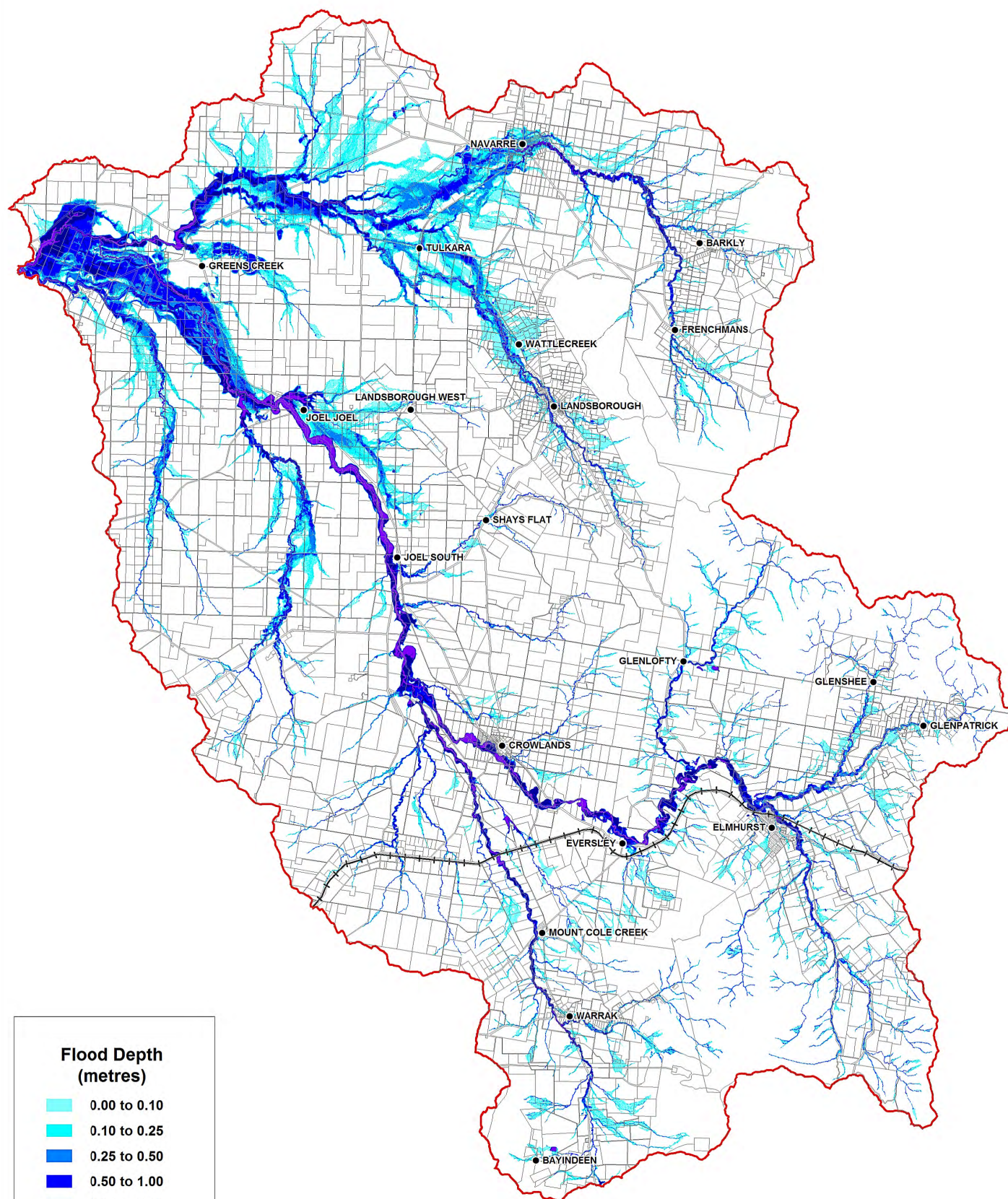
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Title:
Upper Wimmera Flood Investigation
0.5% AEP Design Flood Depths - Catchment

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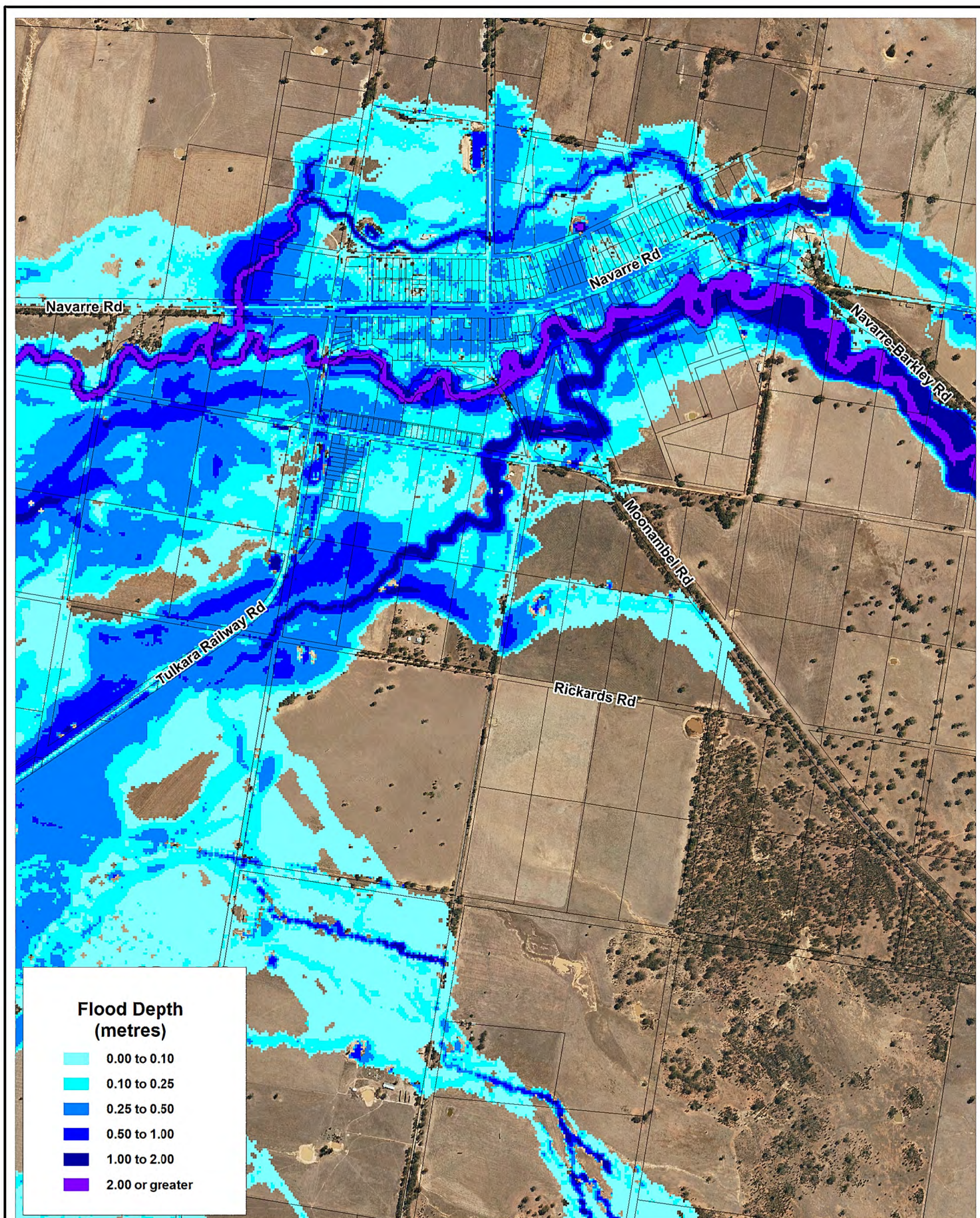


0 3.75 7.5km
 Approx. Scale

Figure:
A-21

Rev:
A





Title:
Upper Wimmera Flood Investigation
0.5% AEP Design Flood Depths - Navarre

Figure:

A-22

Rev:

A

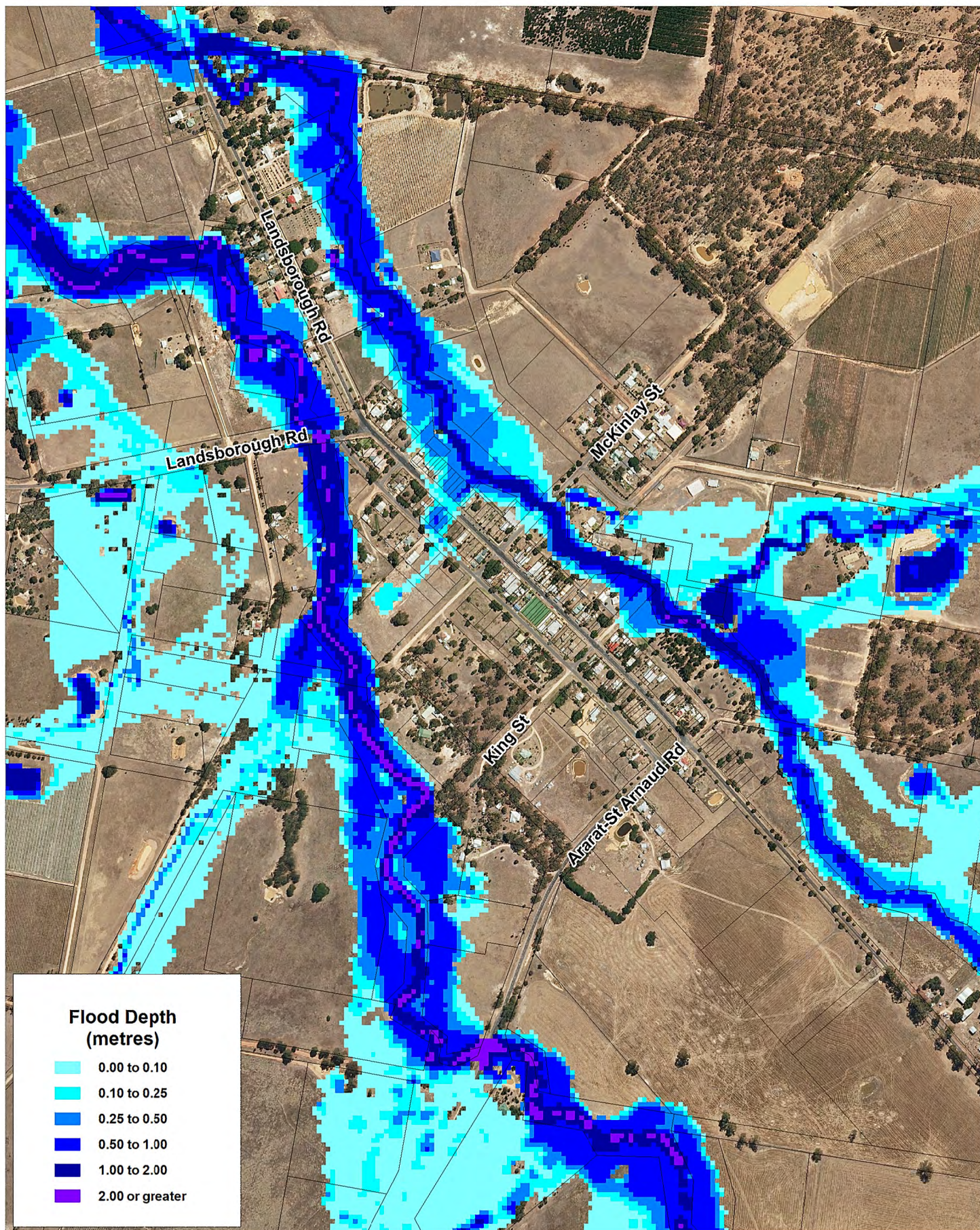
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0 250 500m
 Approx. Scale



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Title:
Upper Wimmera Flood Investigation
0.5% AEP Design Flood Depths - Landsborough

Figure:

A-23

Rev:

A

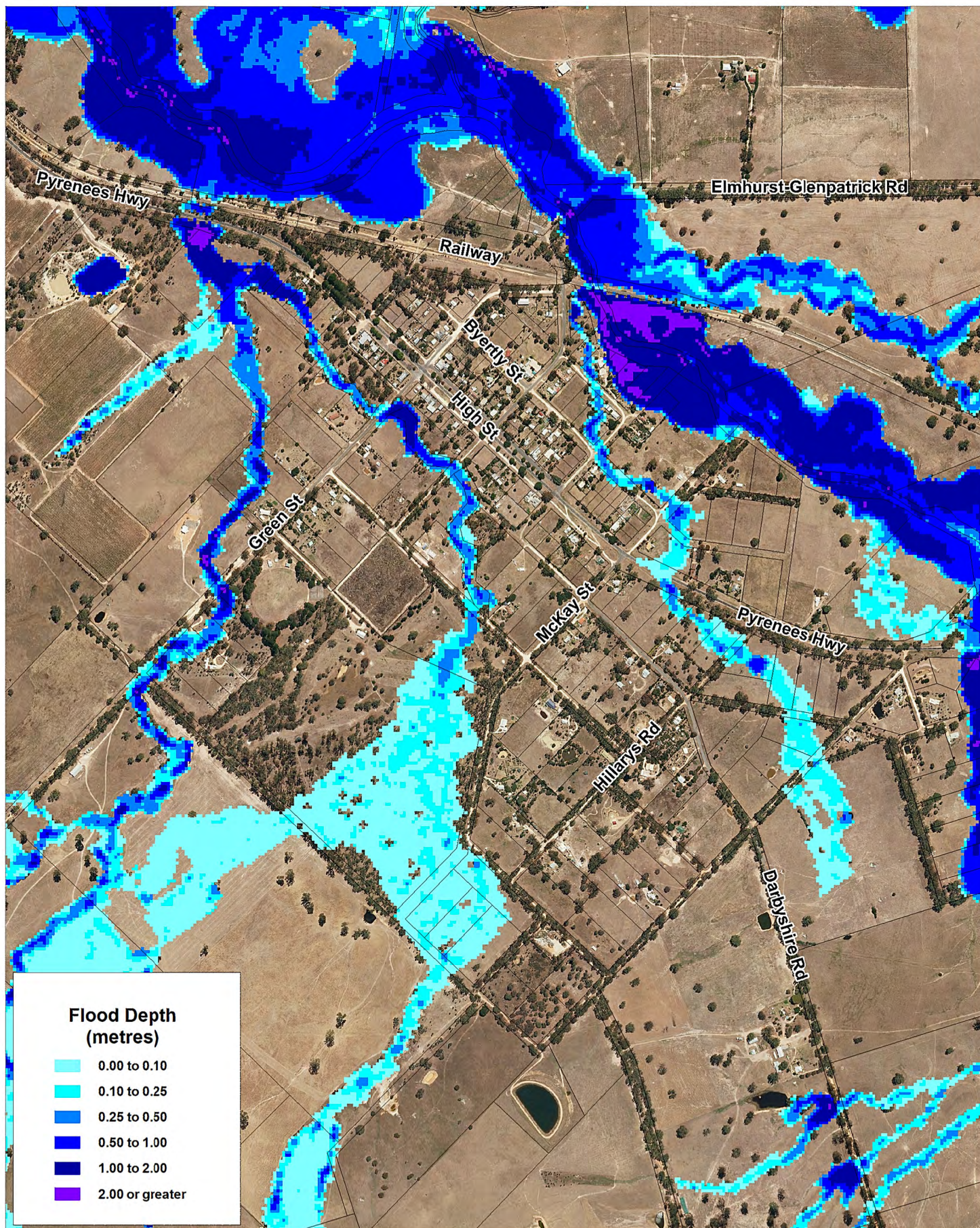
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0 100 200m
 Approx. Scale



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Title:
Upper Wimmera Flood Investigation
0.5% AEP Design Flood Depths - Elmhurst

Figure:
A-24

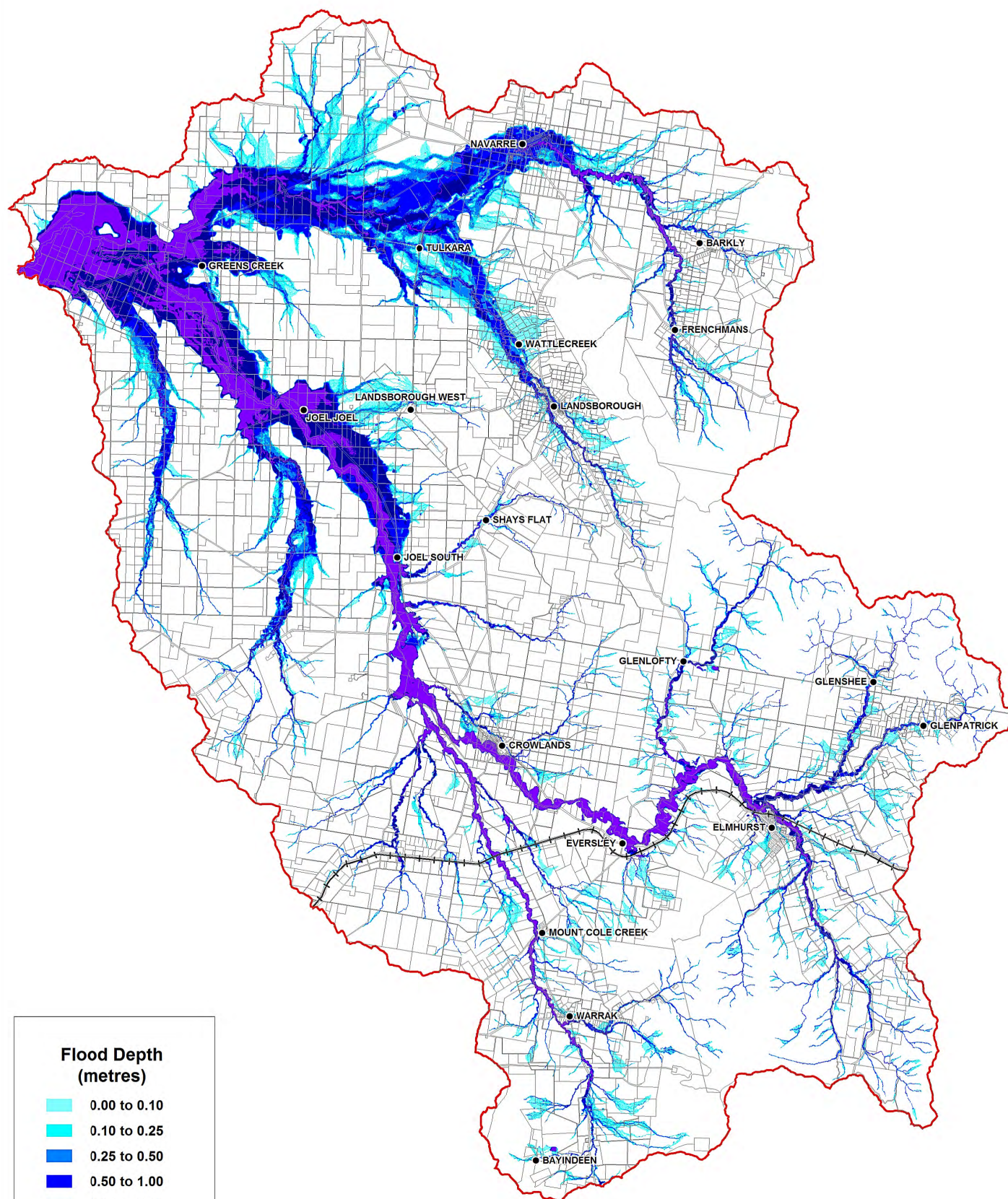
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0 200 400m
 Approx. Scale





Title:
Upper Wimmera Flood Investigation
Probable Maximum Flood Depths - Catchment

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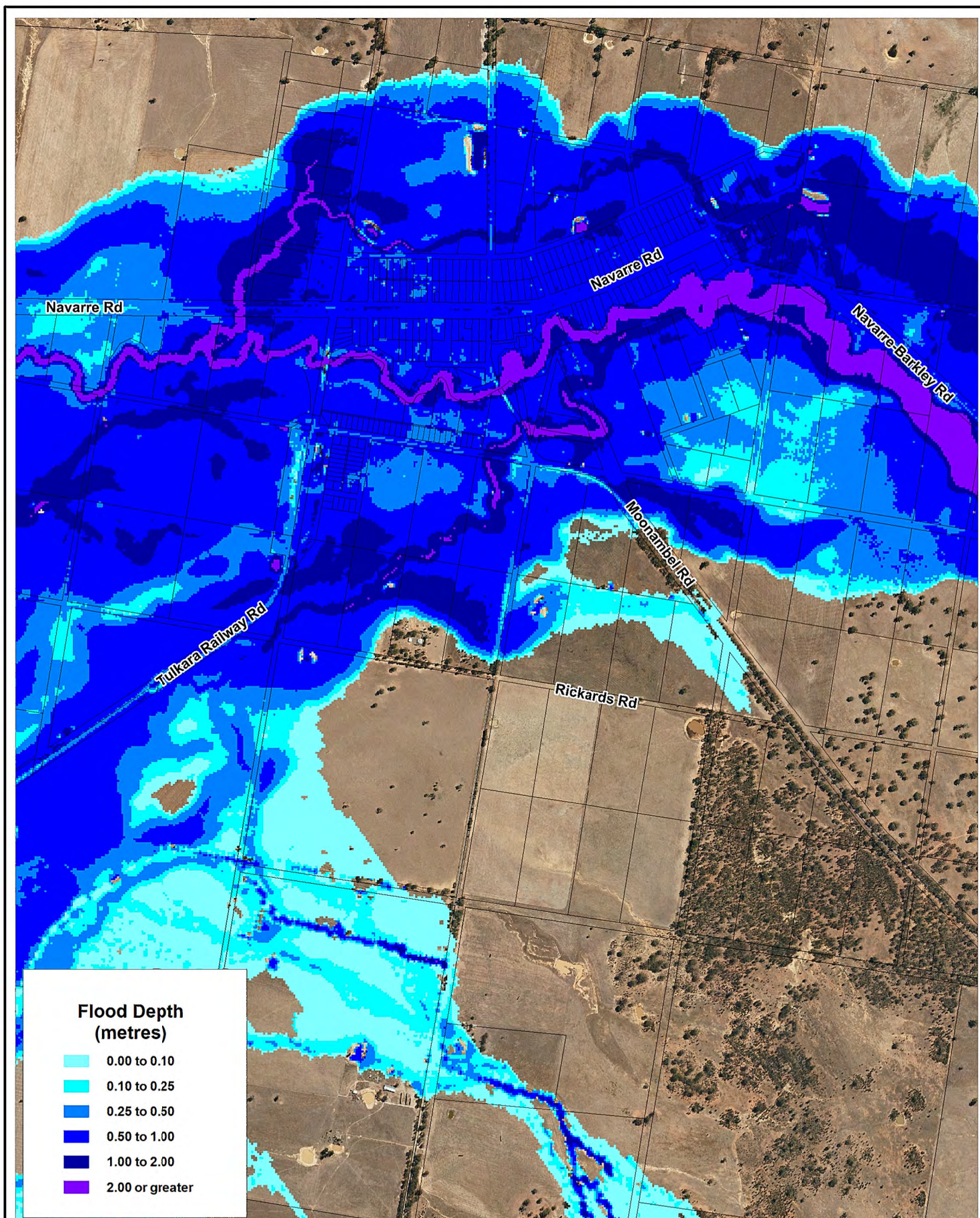
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 Approx. Scale

Figure:
A-25

Rev:
A



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Title:
Upper Wimmera Flood Investigation
Probable Maximum Flood Depths - Navarre

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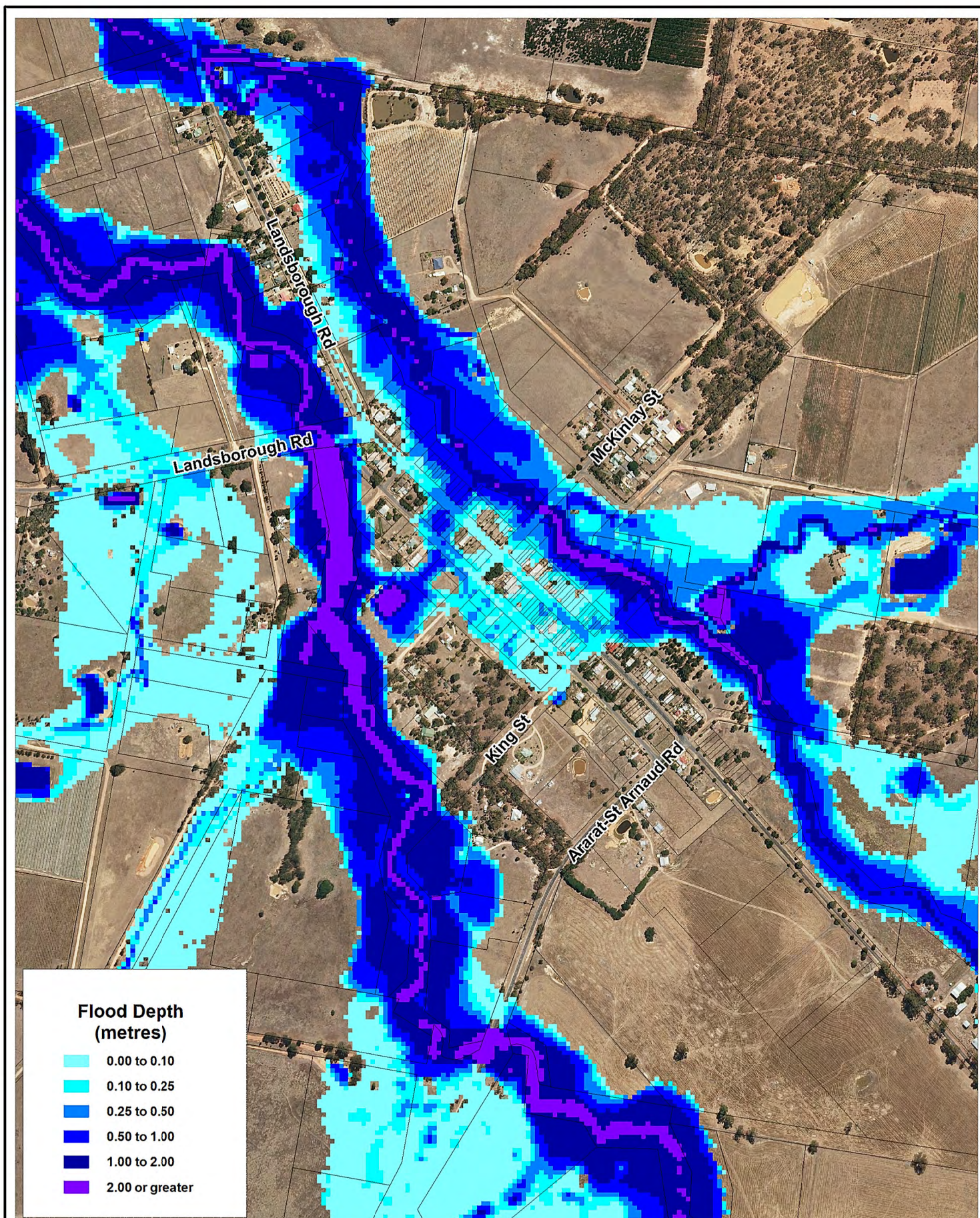
0 250 500m
 Approx. Scale

Figure:
A-26

Rev:
A



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Title:
Upper Wimmera Flood Investigation
Probable Maximum Flood Depths - Landsborough

Figure:
A-27

Rev:
A

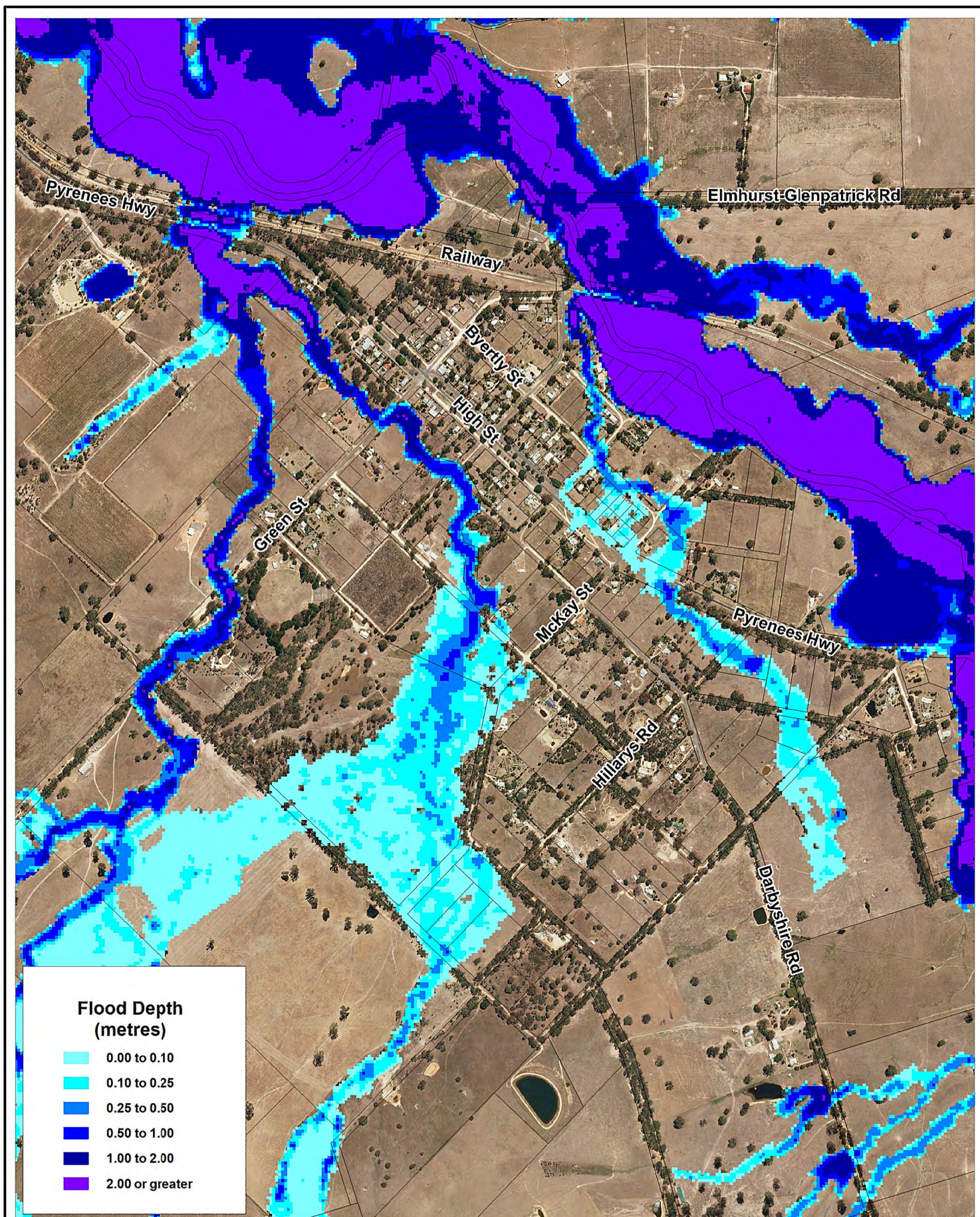
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0 100 200m
 Approx. Scale



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Title:
Upper Wimmera Flood Investigation
Probable Maximum Flood Depths - Elmhurst

Figure:

A-28

Rev:

A

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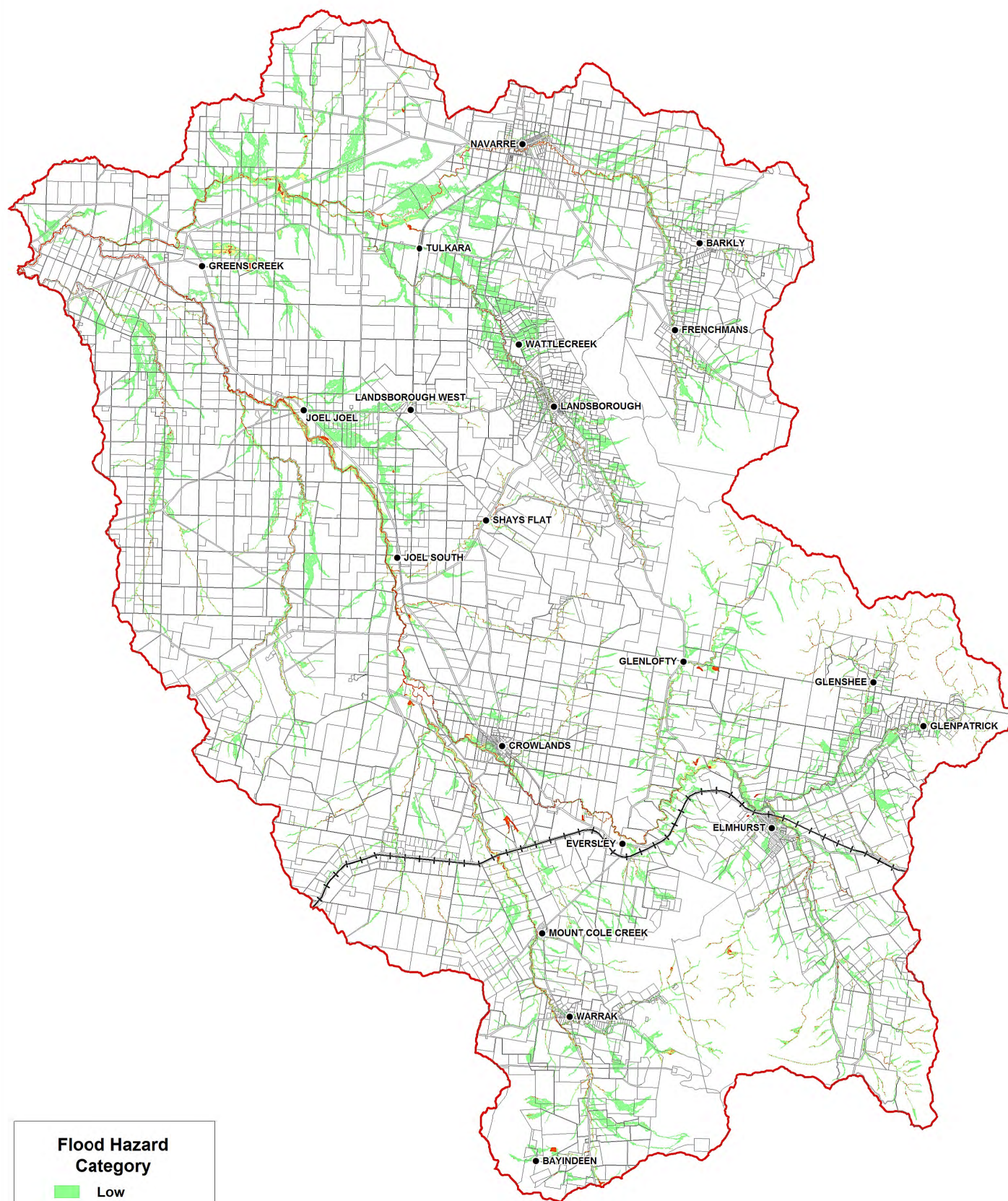


0 200 400m
 Approx. Scale



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Appendix B Existing Case – Hazard Mapping



Title:
Upper Wimmera Flood Investigation
20% AEP Design Flood Hazard - Catchment

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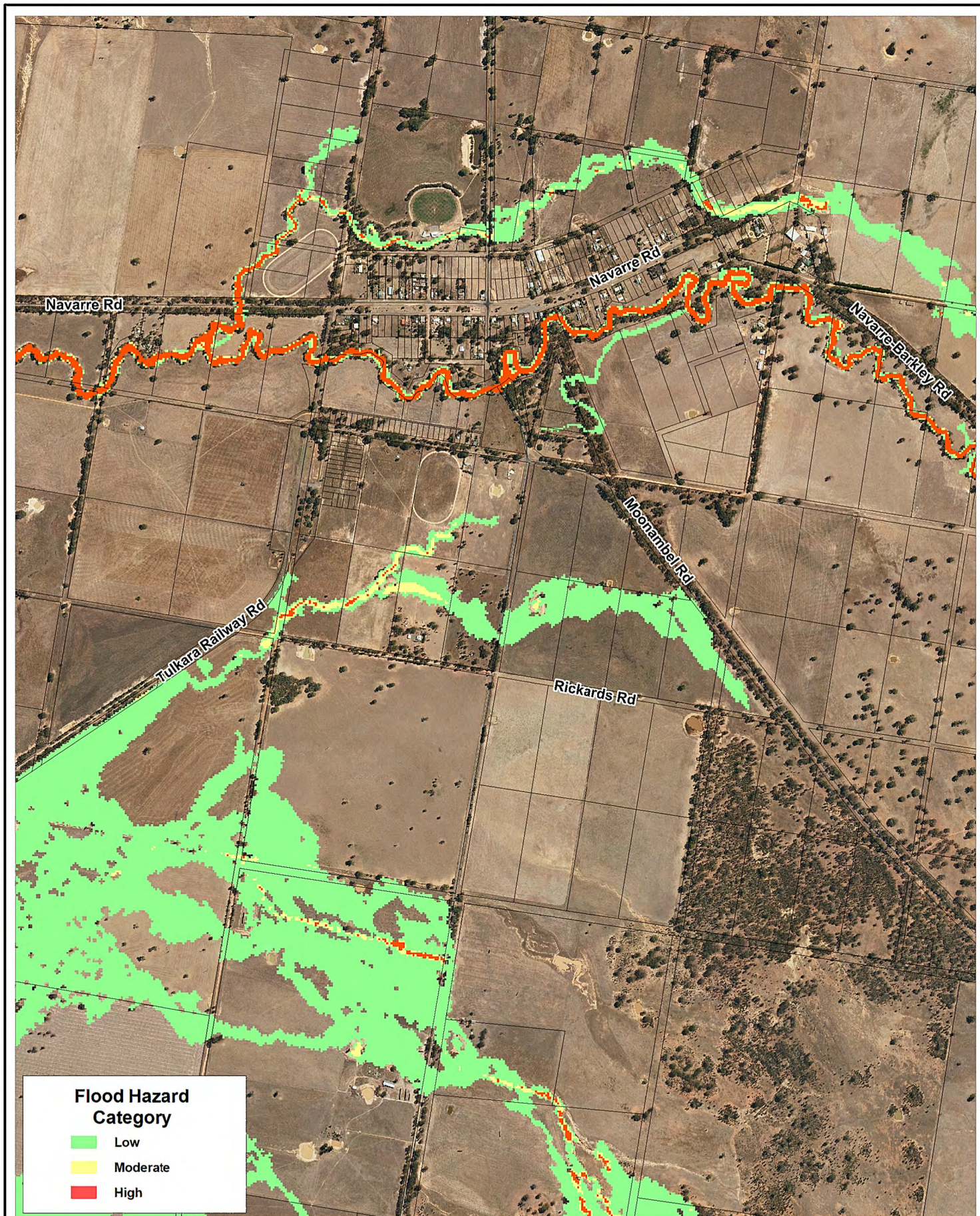
0 3.75 7.5km
 Approx. Scale

Figure:
B-1

Rev:
A



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Flood Hazard Category

- Low
- Moderate
- High

Title:

Upper Wimmera Flood Investigation 20% AEP Design Flood Hazard - Navarre

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0 250 500m
Approx. Scale

Figure:

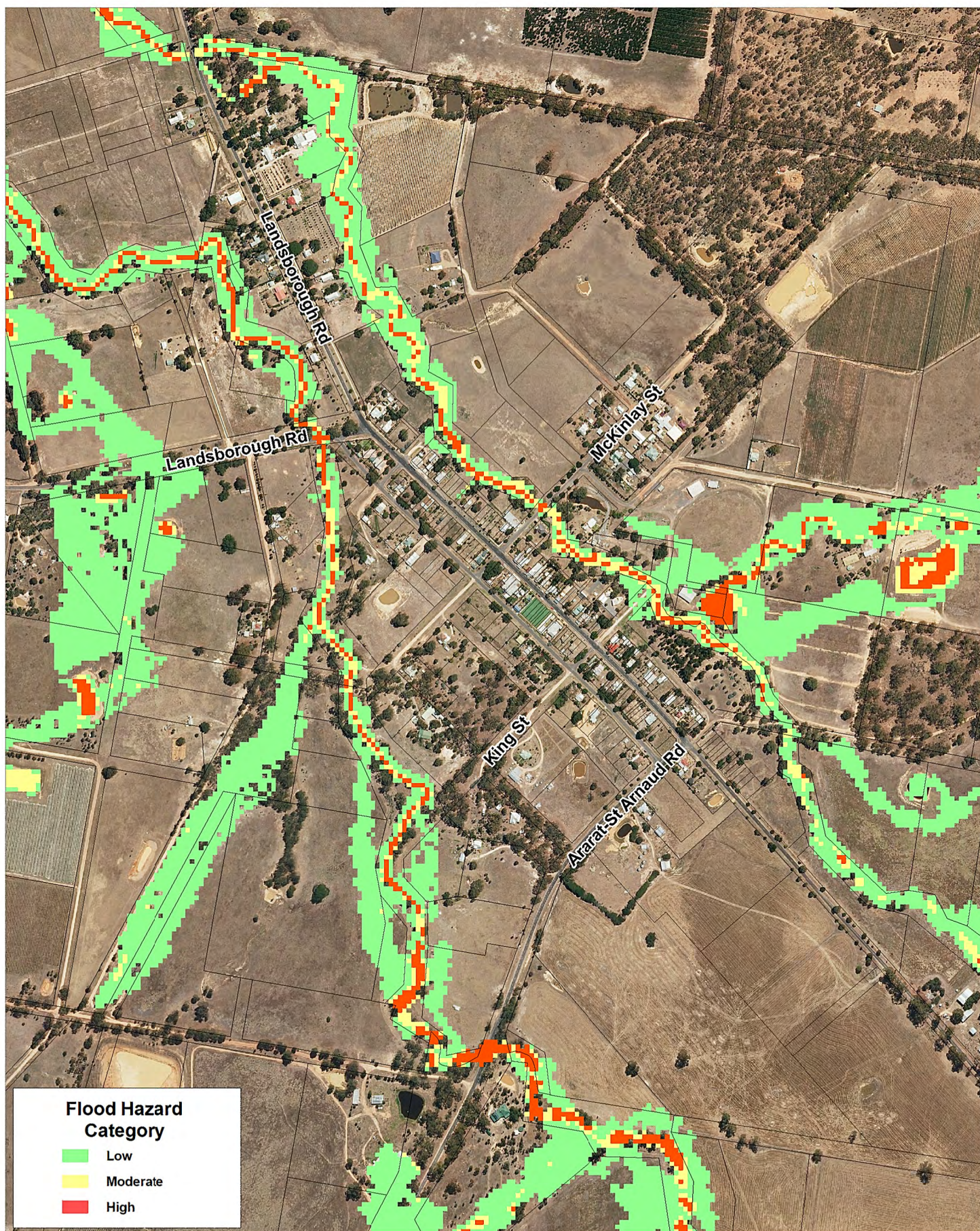
B-2

Rev:

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Title:
Upper Wimmera Flood Investigation
20% AEP Design Flood Hazard - Landsborough

Figure:
B-3

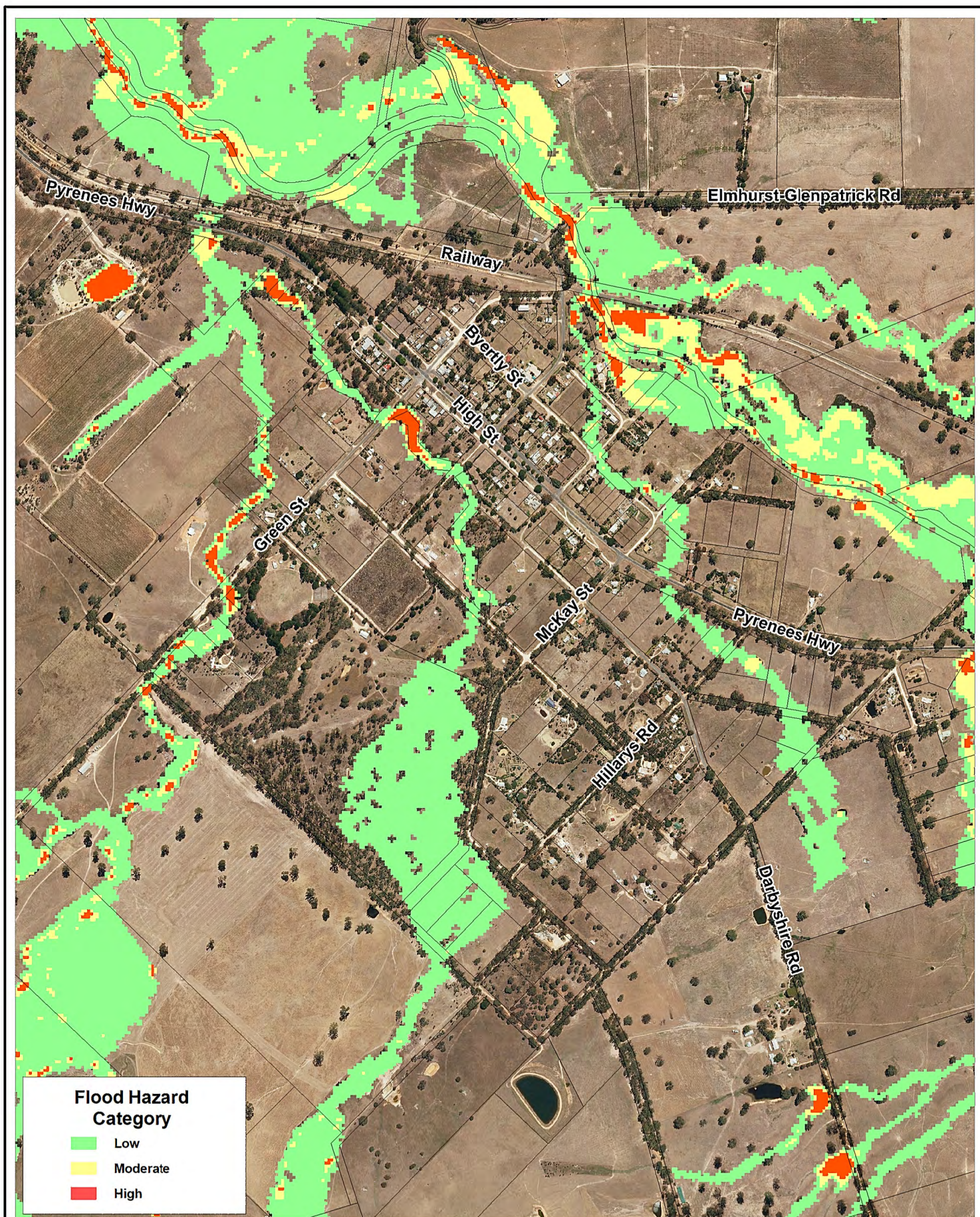
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A

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0 100 200m
 Approx. Scale





Title:
Upper Wimmera Flood Investigation
20% AEP Design Flood Hazard - Elmhurst

Figure:

B-4

Rev:

A

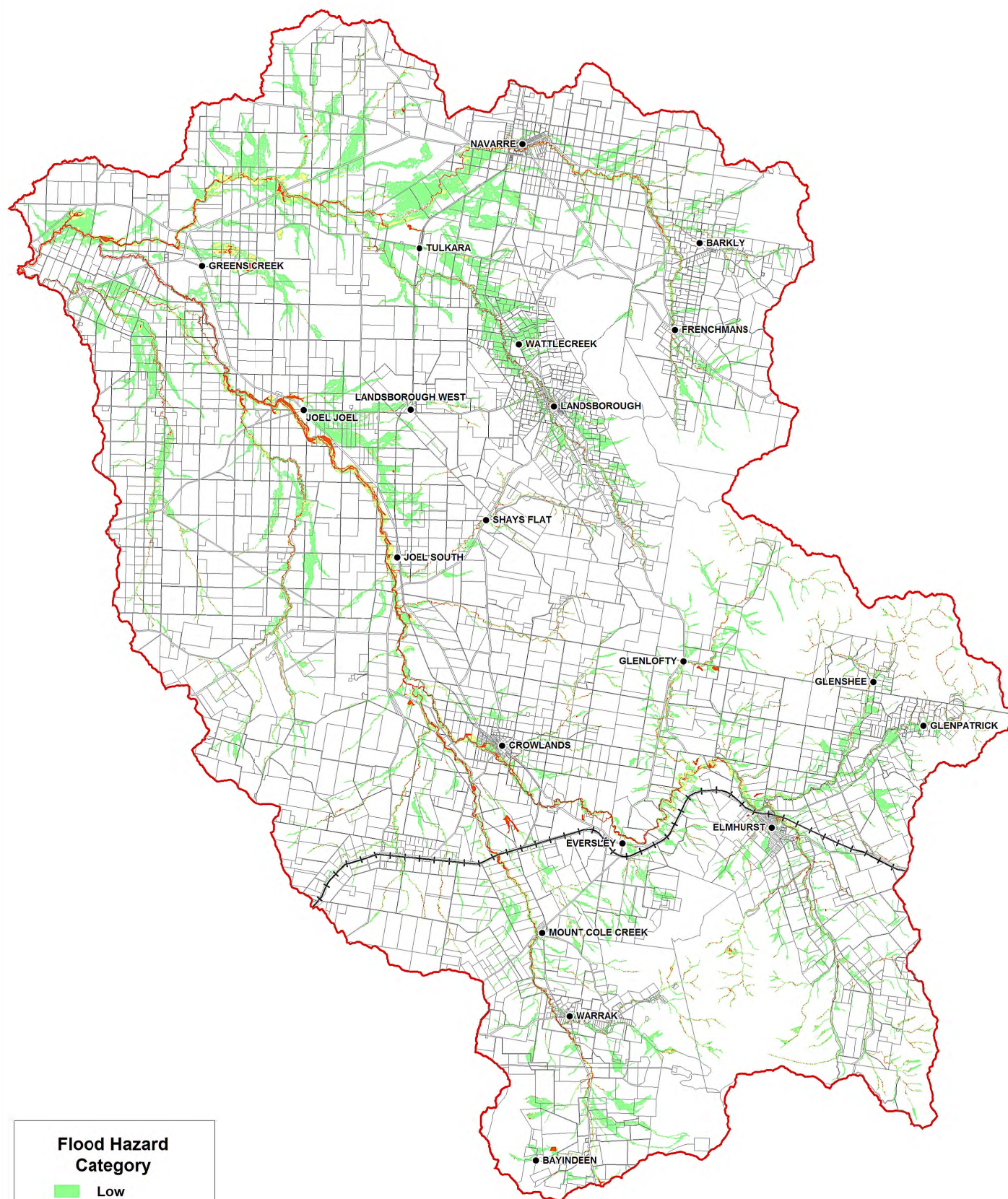
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 Approx. Scale



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Title:
Upper Wimmera Flood Investigation
10% AEP Design Flood Hazard - Catchment

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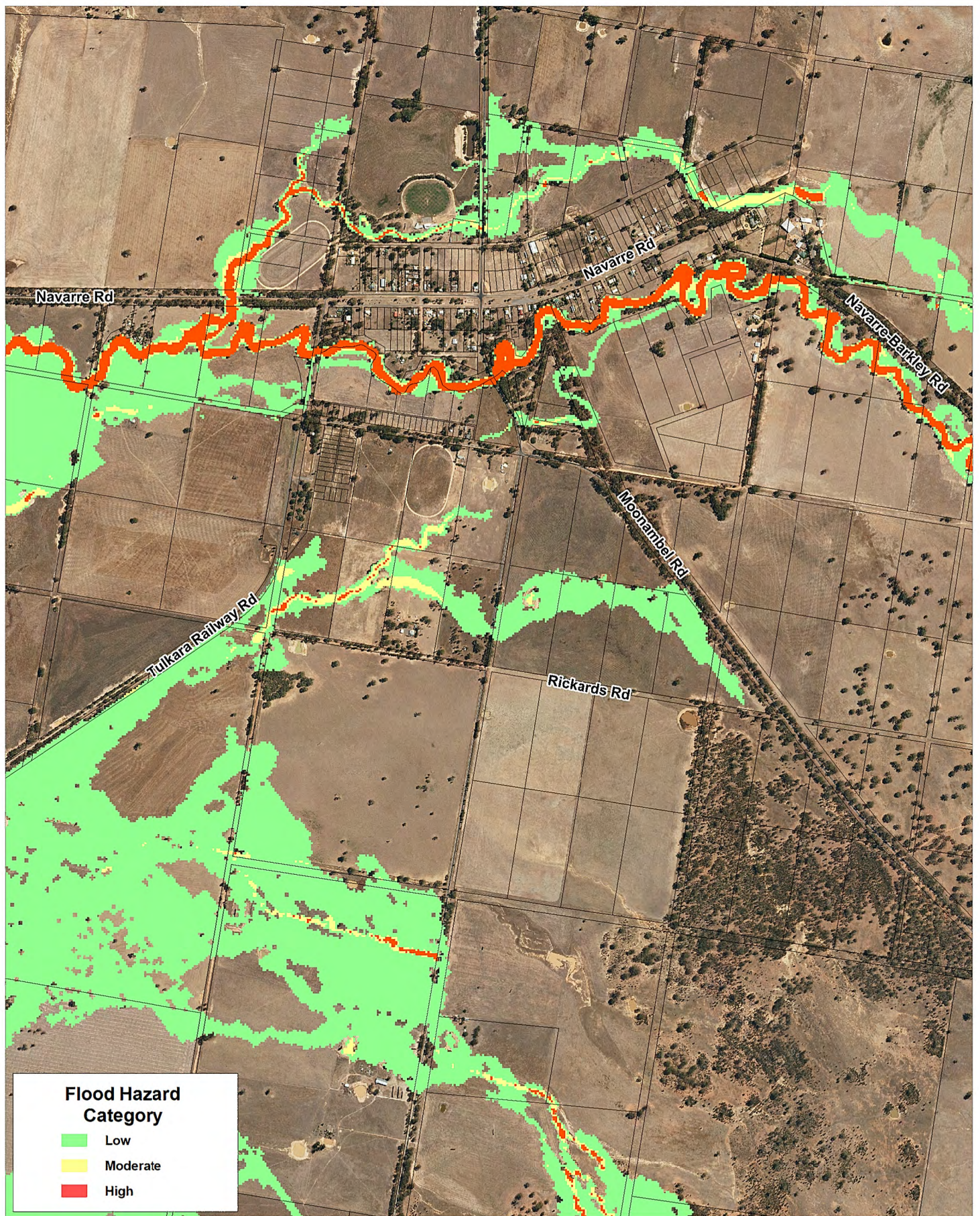
0 3.75 7.5km
 Approx. Scale

Figure:
B-5

Rev:
A



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Title:
Upper Wimmera Flood Investigation
10% AEP Design Flood Hazard - Navarre

Figure:
B-6

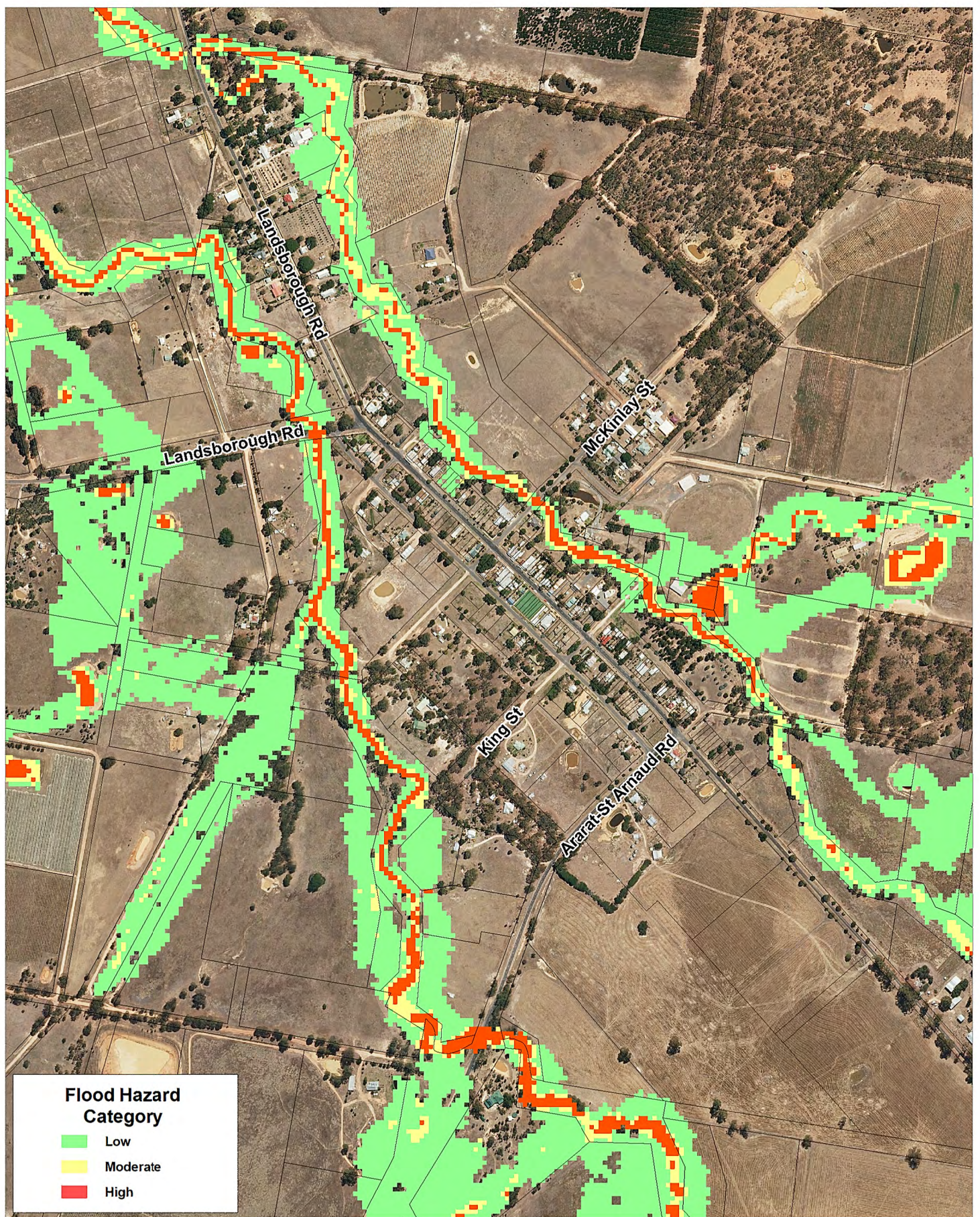
Rev:
A

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0 250 500m
 Approx. Scale





Title:
Upper Wimmera Flood Investigation
10% AEP Design Flood Hazard - Landsborough

Figure:
B-7

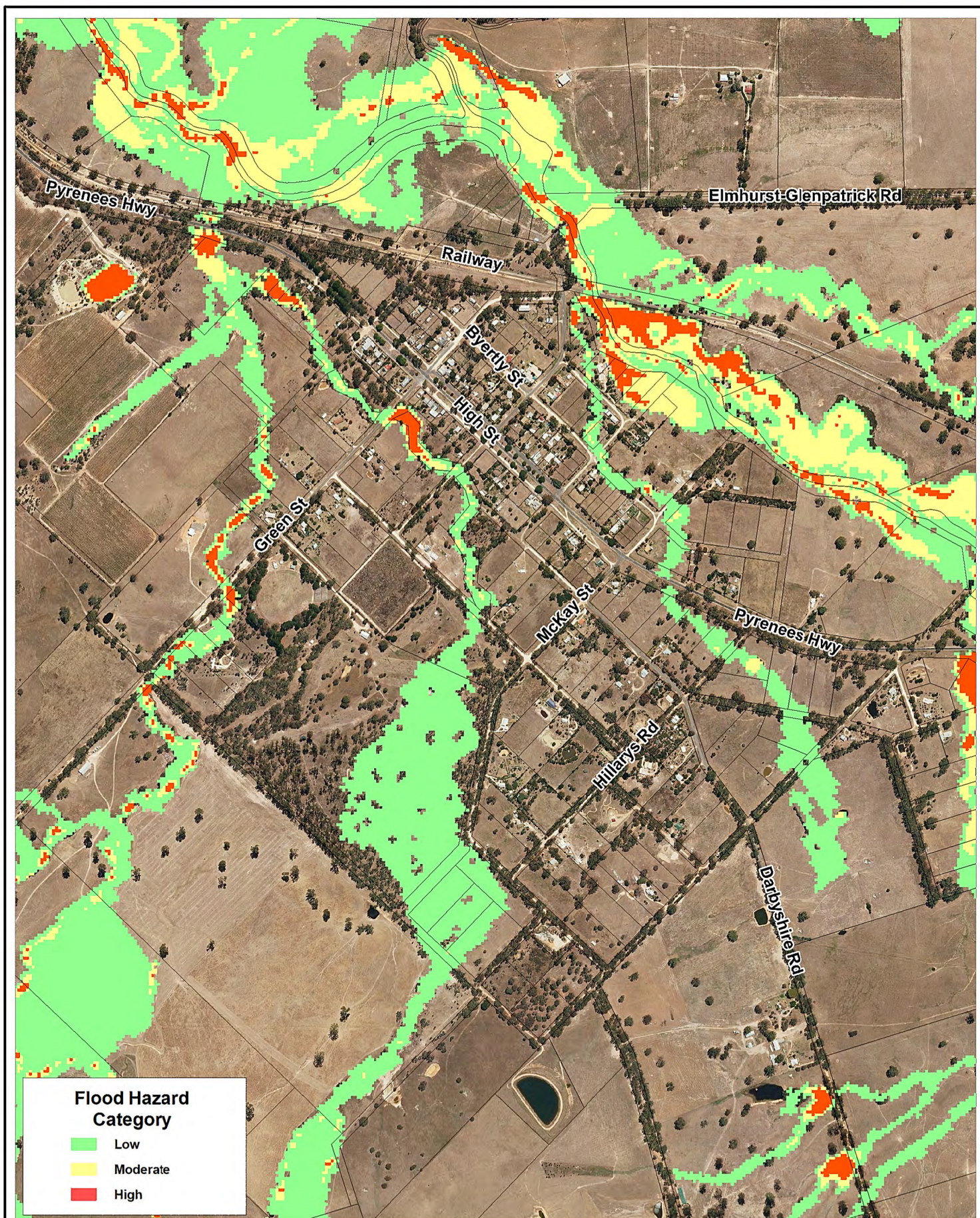
Rev:
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0 100 200m
 Approx. Scale





Title:
Upper Wimmera Flood Investigation
10% AEP Design Flood Hazard - Elmhurst

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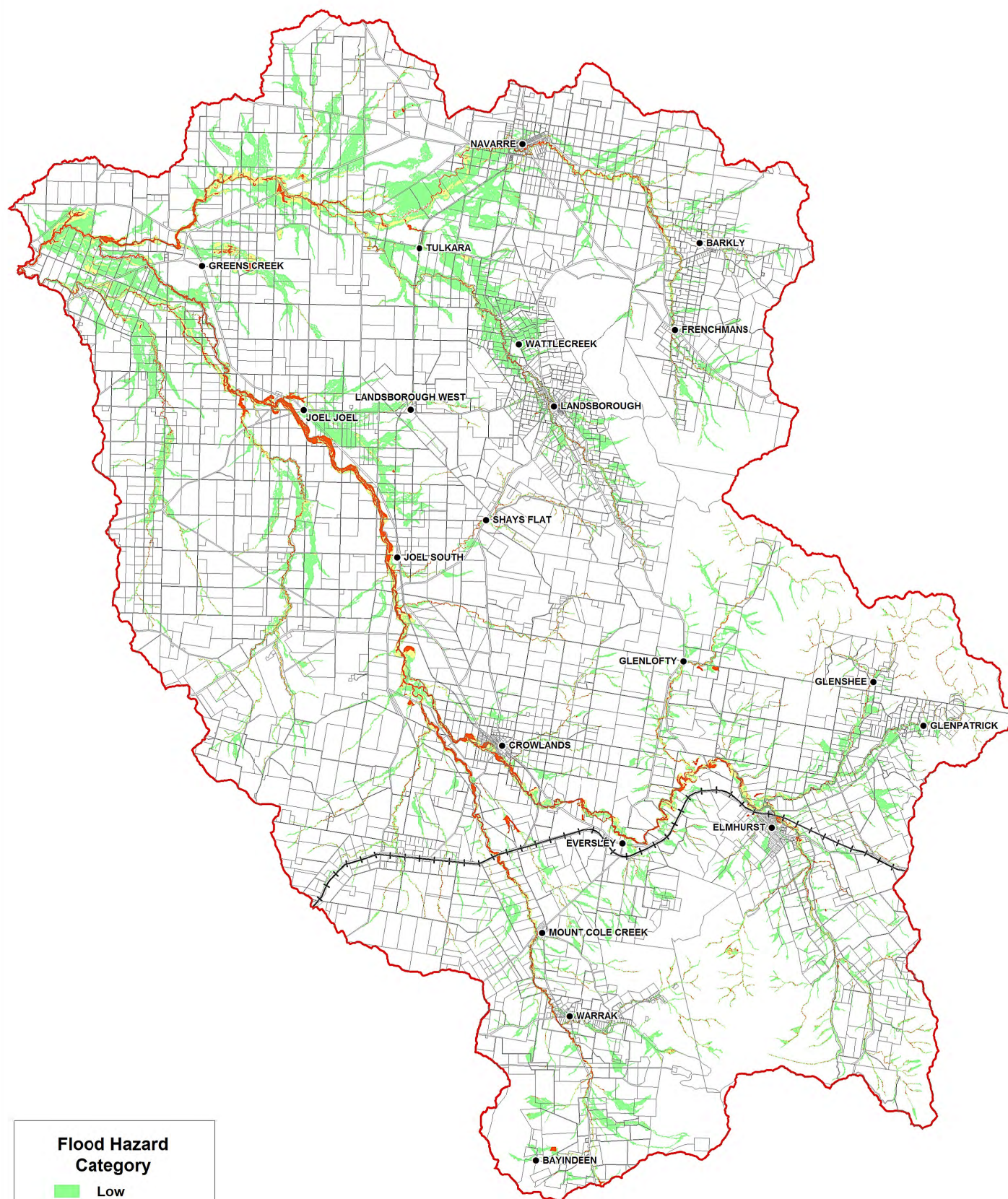
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 Approx. Scale

Figure:
B-8

Rev:
A



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Title:
Upper Wimmera Flood Investigation
5% AEP Design Flood Hazard - Catchment

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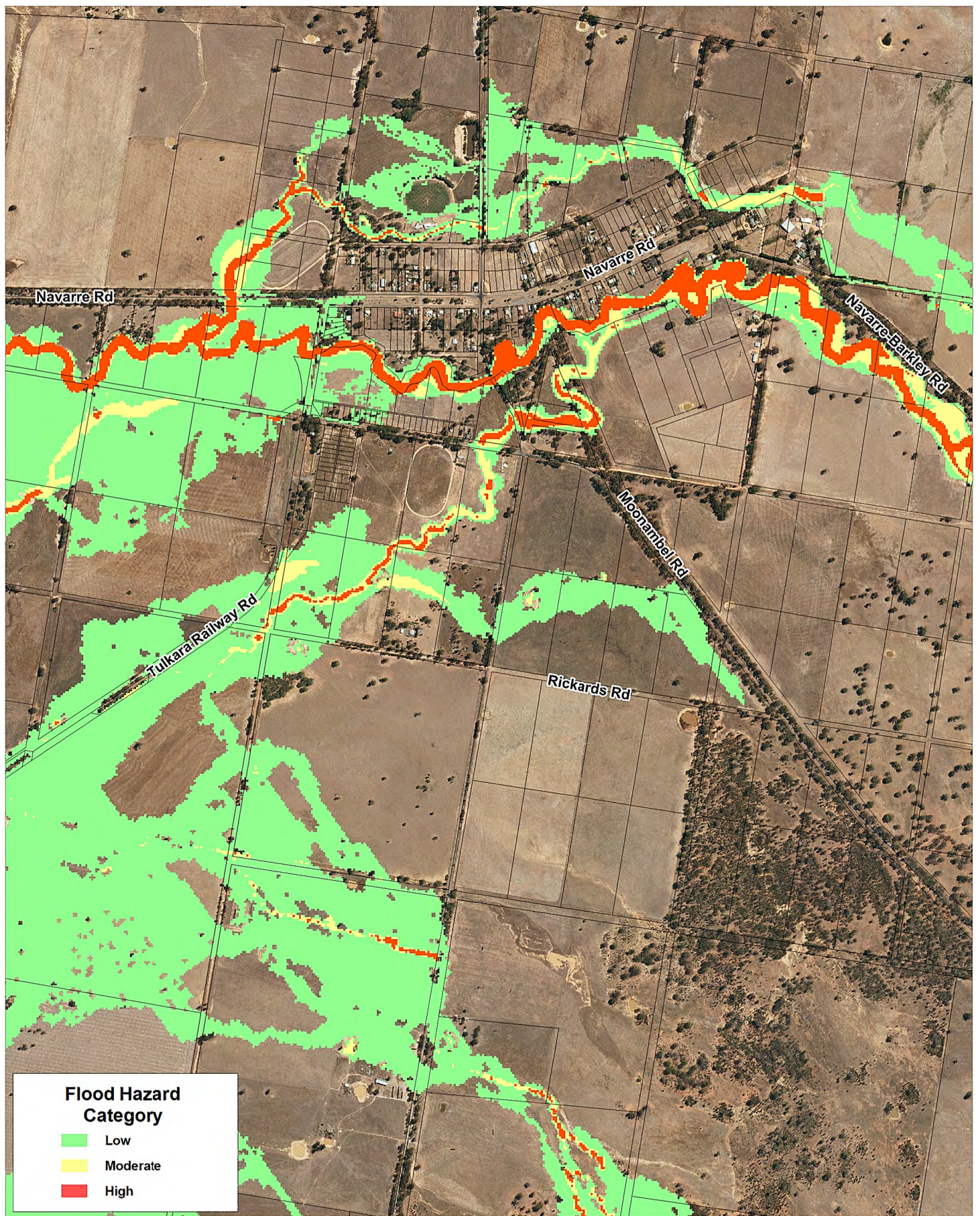
0 3.75 7.5km
 Approx. Scale

Figure:
B-9

Rev:
A



Filepath : T:\M8460.MT.WimmeraUpperFloodStudy\MapInfo\Drawings\R.M8460.009.01.Final\UW_Final_FigB-9_E01_5%_051_Haz_Catchment_RevA.WOR



Title:
Upper Wimmera Flood Investigation
5% AEP Design Flood Hazard - Navarre

Figure:
B-10

Rev:
A

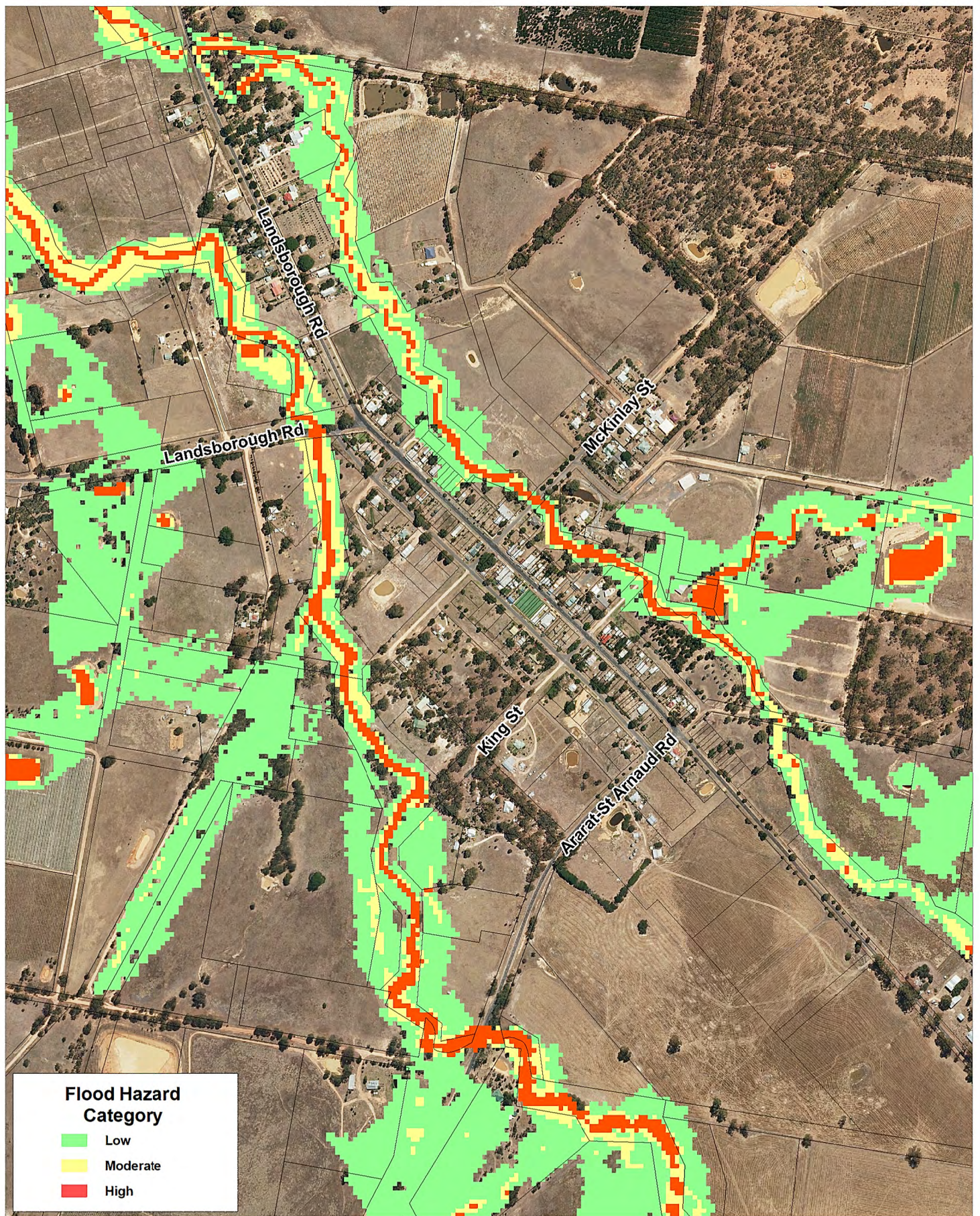
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0 250 500m
 Approx. Scale



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Title:
Upper Wimmera Flood Investigation
5% AEP Design Flood Hazard - Landsborough

Figure:
B-11

Rev:
A

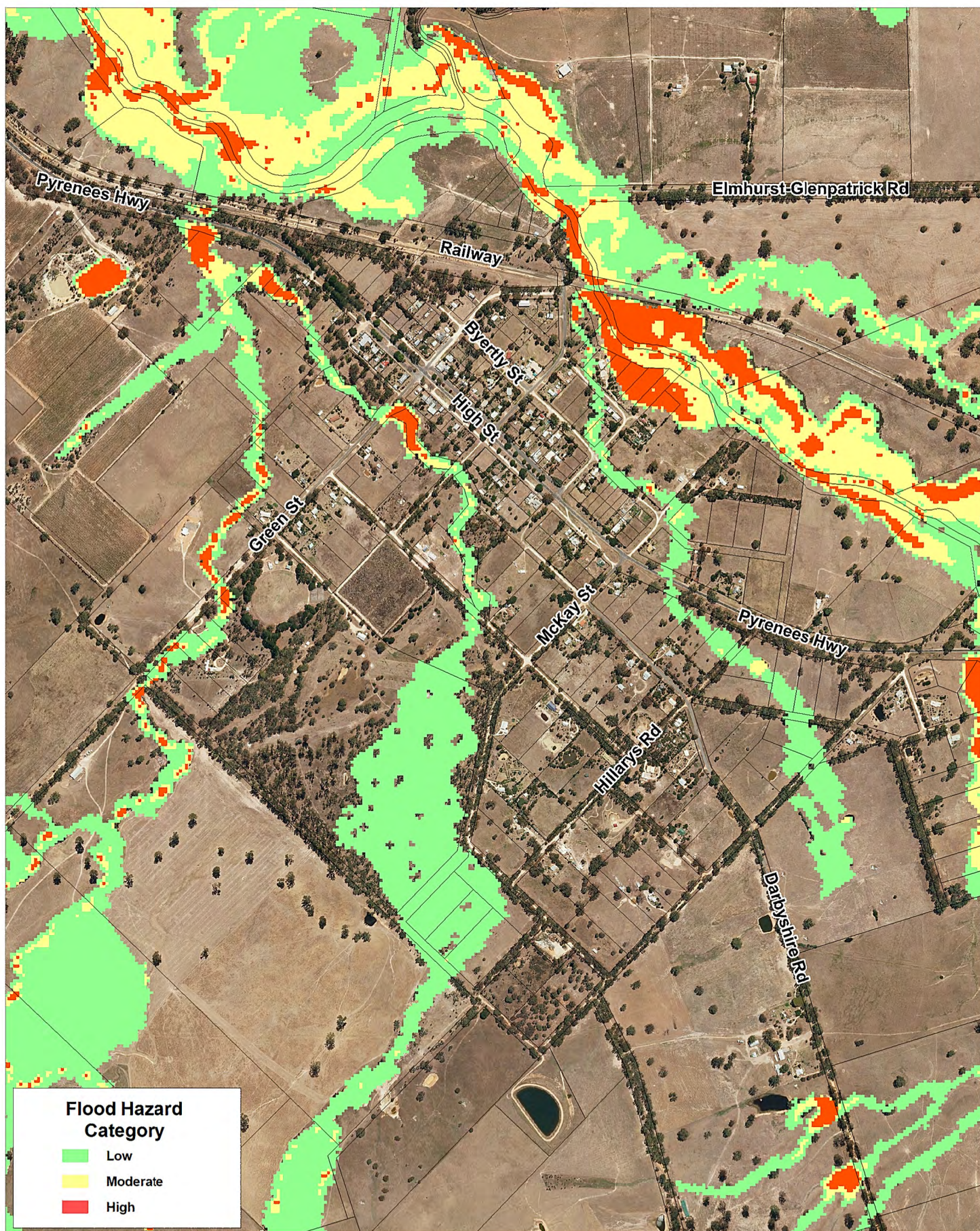
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0 100 200m
 Approx. Scale



Filepath : T:\M8460.MT.WimmeraUpperFloodStudy\MapInfo\Drawings\R.M8460.009.01.FinalUW_Final_FigB-11_E01_5%_051_Haz_Landsborough_RevA.WOR



Title:
Upper Wimmera Flood Investigation
5% AEP Design Flood Hazard - Elmhurst

Figure:
B-12

Rev:
A

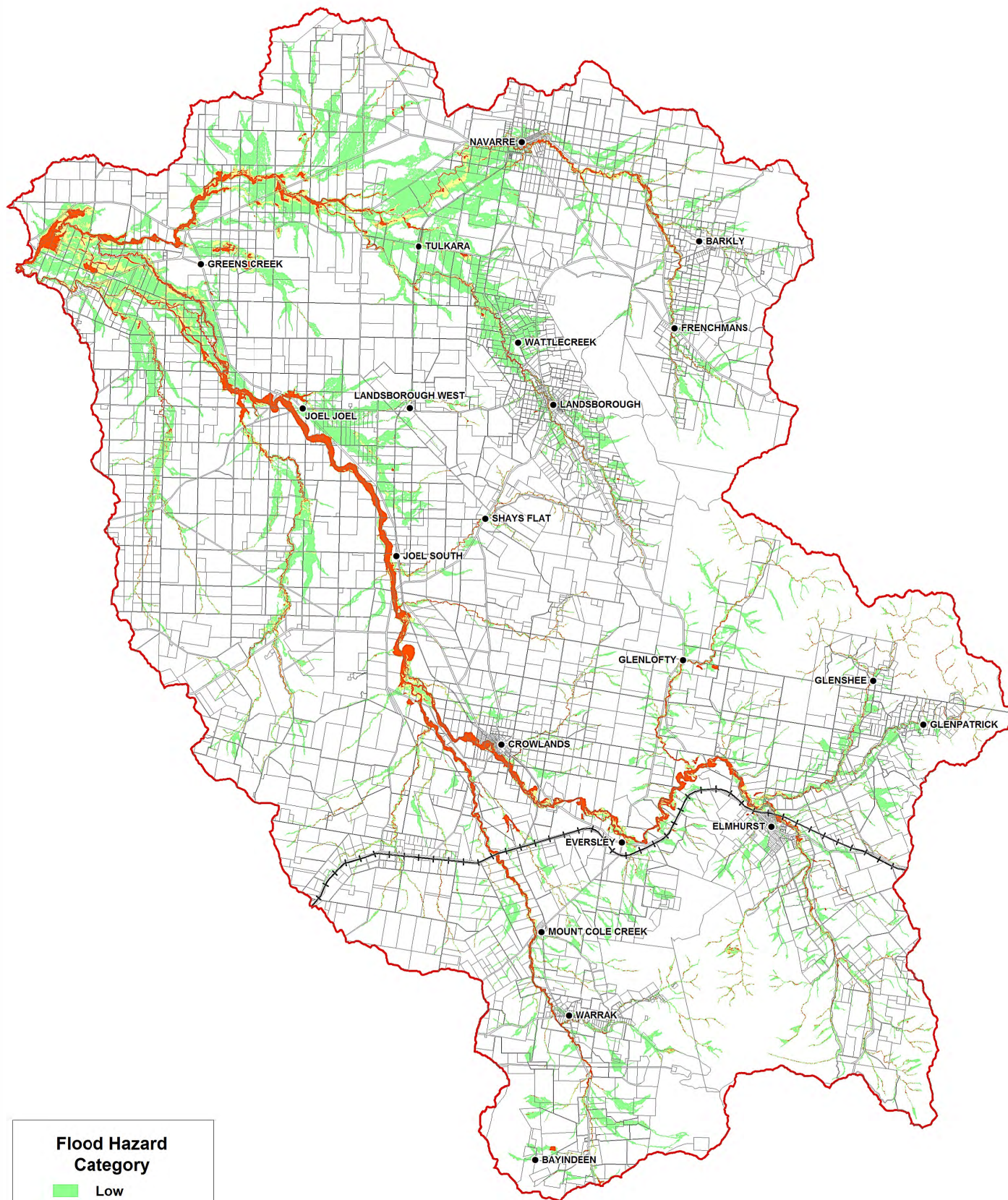
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0 200 400m
 Approx. Scale



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Flood Hazard Category

- Low
- Moderate
- High

Title:

Upper Wimmera Flood Investigation 2% AEP Design Flood Hazard - Catchment

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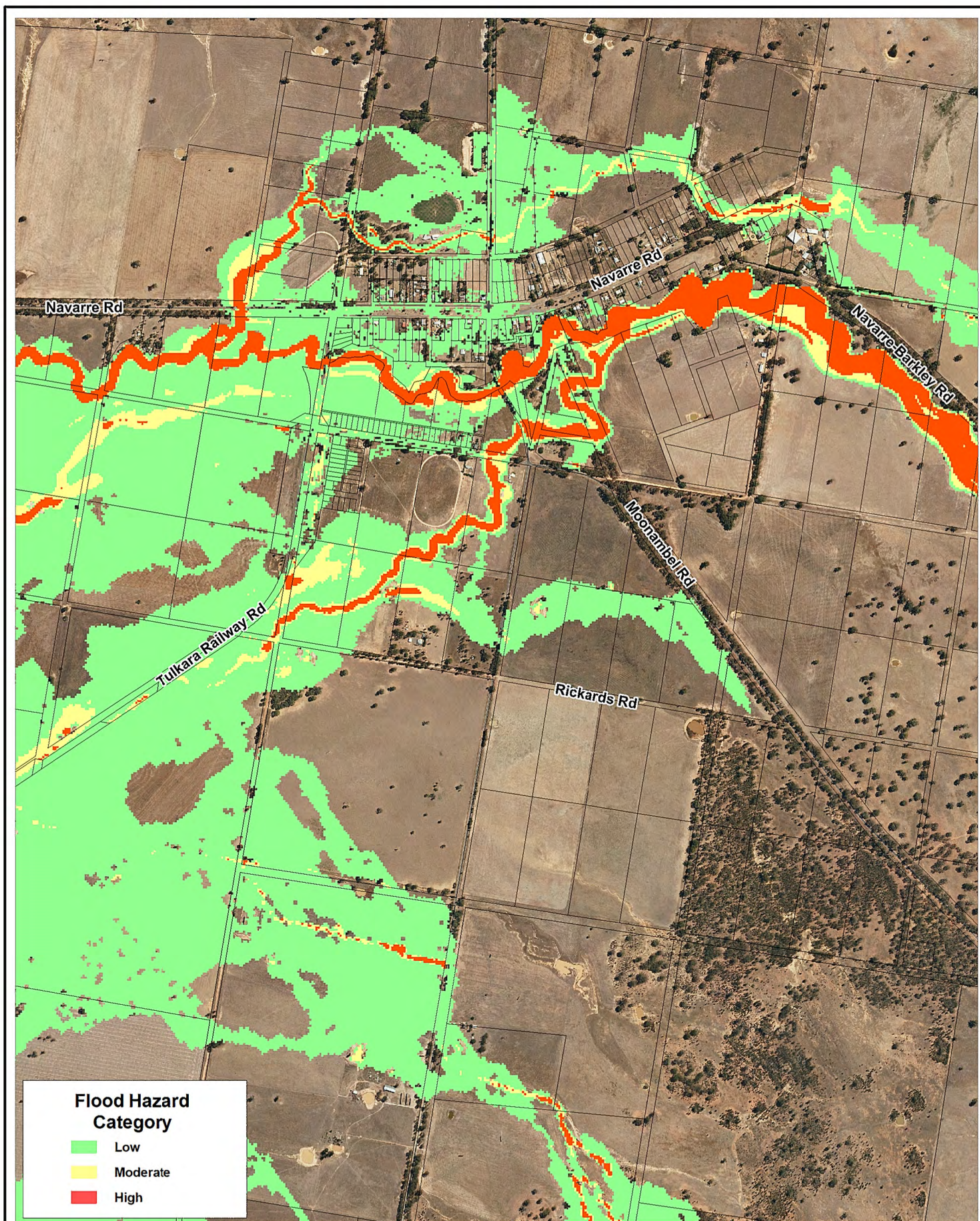
0 3.75 7.5km
Approx. Scale

Figure:
B-13

Rev:
A



Filepath : T:\M8460.MT.WimmeraUpperFloodStudy\MapInfo\Drawings\R.M8460.009.01.Final\UW_Final_FigB-13_E01_2%_051_Haz_Catchment_RevA.WOR



Title:
Upper Wimmera Flood Investigation
2% AEP Design Flood Hazard - Navarre

Figure:
B-14

Rev:
A

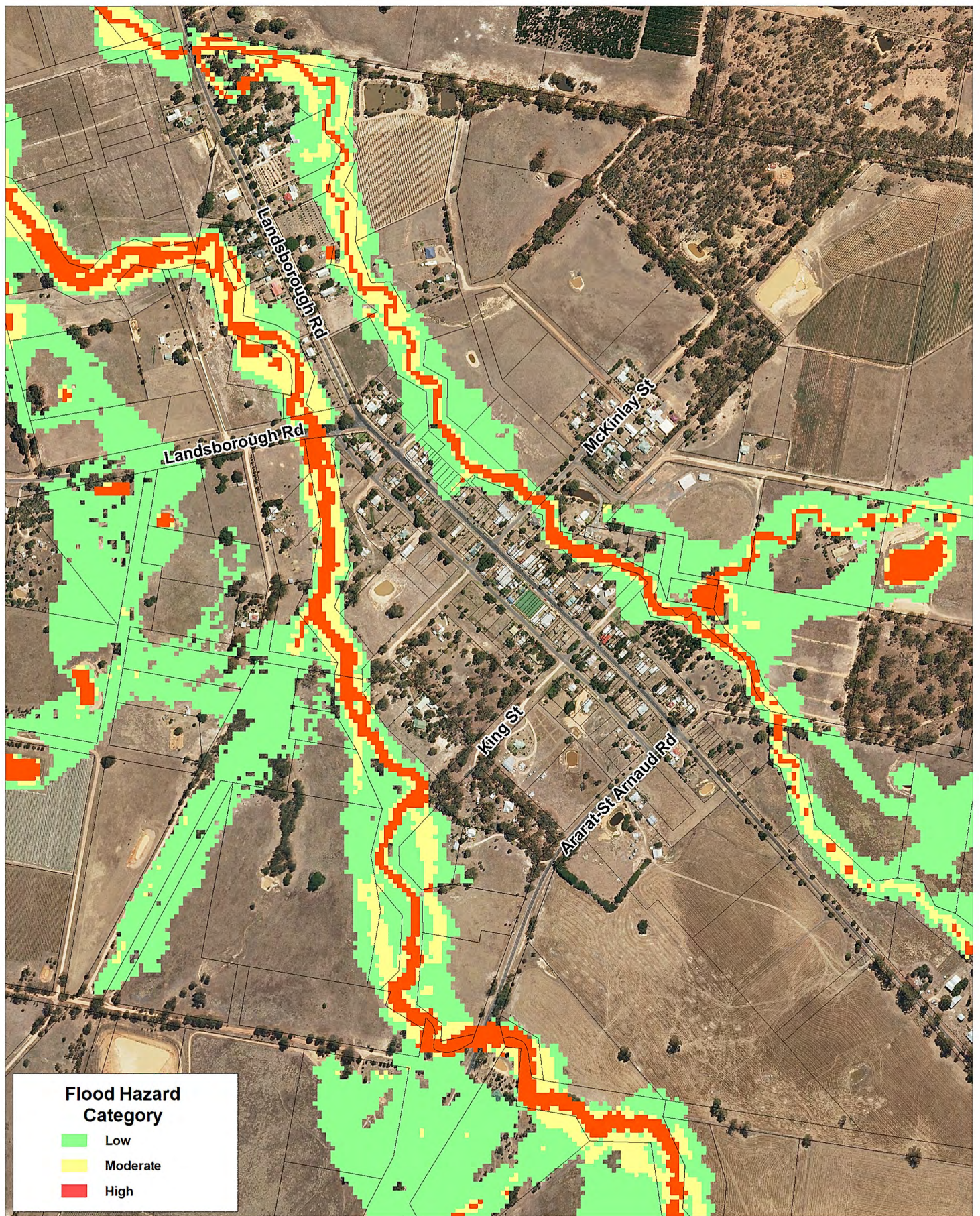
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0 250 500m
 Approx. Scale



Filepath : T:\M8460.MT.WimmeraUpperFloodStudy\MapInfo\Drawings\R.M8460.009.01.FinalUW_Final_FigB-14_E01_2%_051_Haz_Navarre_RevA.WOR



Title:
Upper Wimmera Flood Investigation
2% AEP Design Flood Hazard - Landsborough

Figure:
B-15

Rev:
A

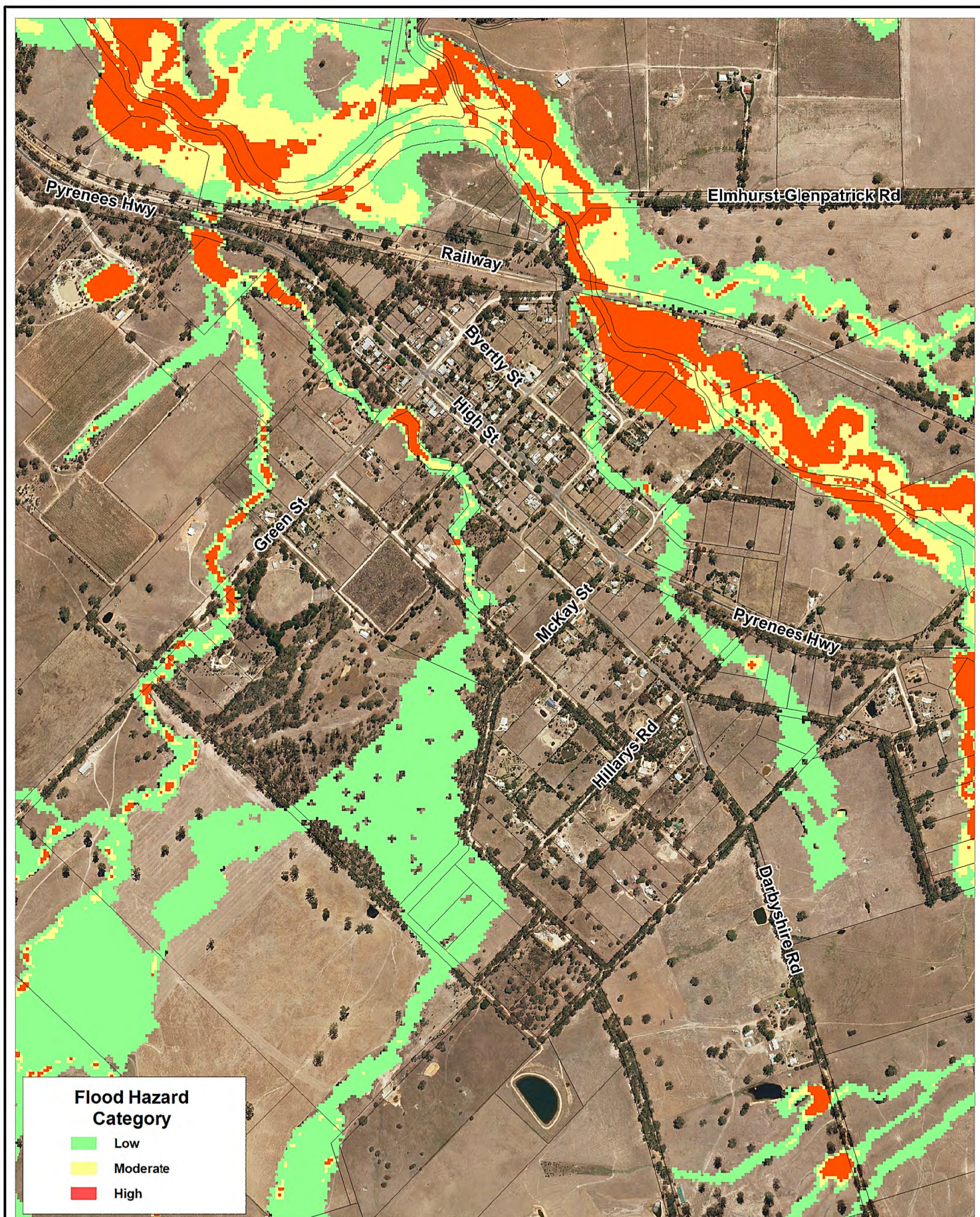
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0 100 200m
 Approx. Scale



Filepath : T:\M8460.MT.WimmeraUpperFloodStudy\MapInfo\Drawings\R.M8460.009.01.FinalUW_Final_FigB-15_E01_2%_051_Haz_Landsborough_RevA.WOR



Flood Hazard Category

- Low
- Moderate
- High

Title:
Upper Wimmera Flood Investigation
2% AEP Design Flood Hazard - Elmhurst

Figure:
B-16

Rev:
A

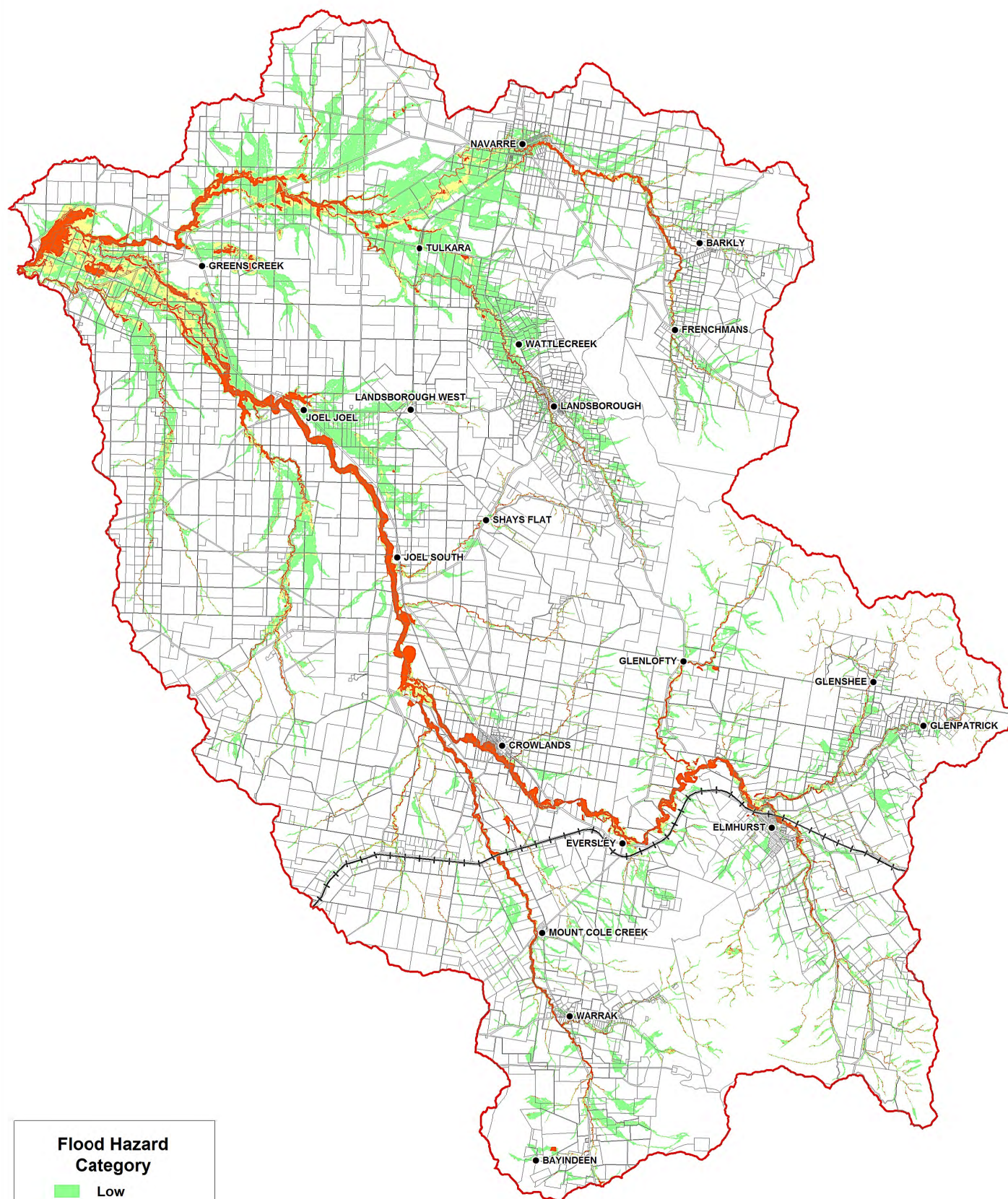
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0 200 400m
 Approx. Scale



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Title:
Upper Wimmera Flood Investigation
1% AEP Design Flood Hazard - Catchment

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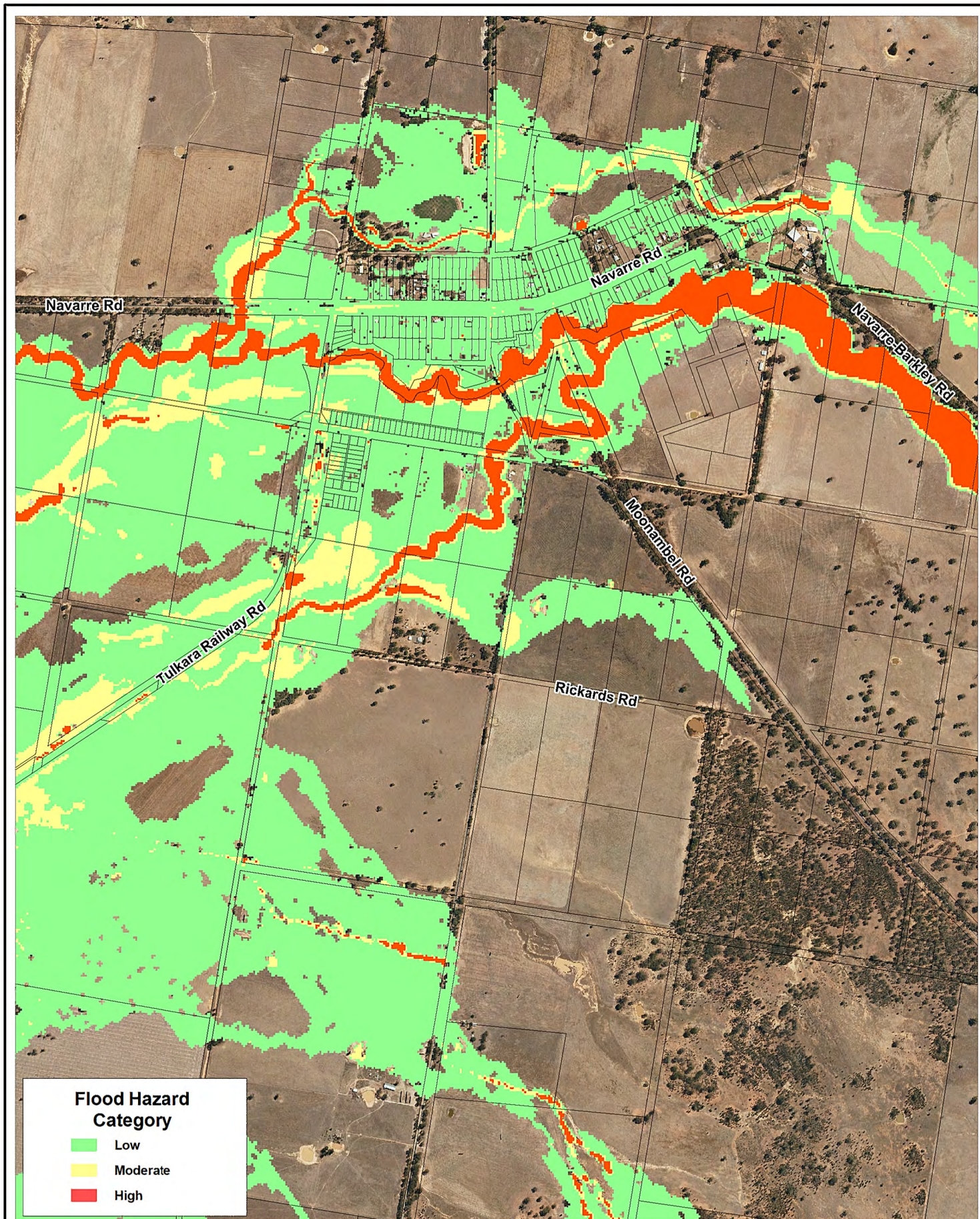
0 3.75 7.5km
 Approx. Scale

Figure:
B-17

Rev:
A



Filepath : T:\M8460.MT.WimmeraUpperFloodStudy\MapInfo\Drawings\R.M8460.009.01.Final\UW_Final_FigB-17_E01_1%_051_Haz_Catchment_RevA.WOR



Title:
Upper Wimmera Flood Investigation
1% AEP Design Flood Hazard - Navarre

Figure:
B-18

Rev:
A

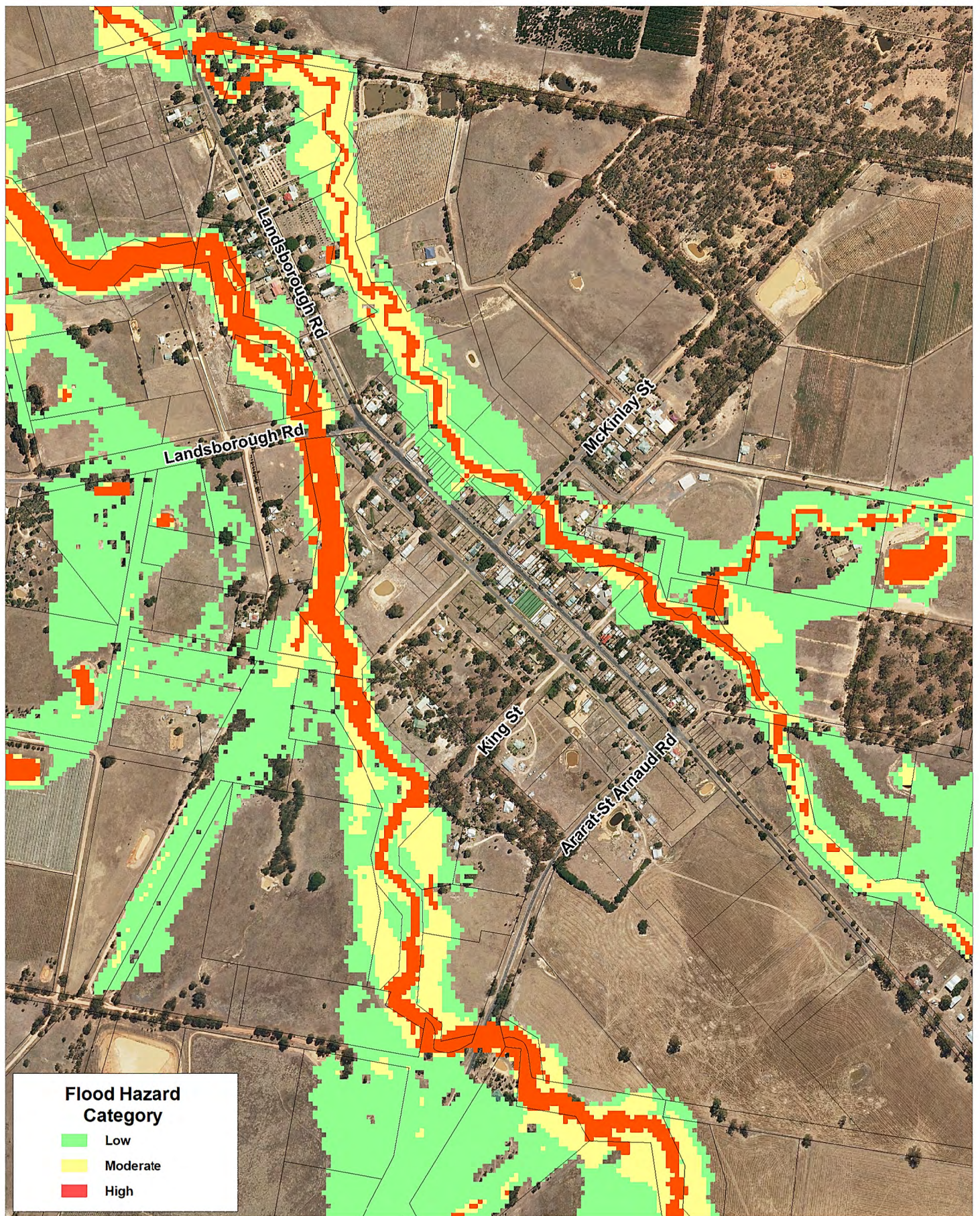
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0 250 500m
 Approx. Scale



Filepath : T:\M8460.MT.WimmeraUpperFloodStudy\MapInfo\Drawings\R.M8460.009.01.FinalUW_Final_FigB-18_E01_1%_051_Haz_Navarre_RevA.WOR



Flood Hazard Category

- Low
- Moderate
- High

Title:
Upper Wimmera Flood Investigation
1% AEP Design Flood Hazard - Landsborough

Figure:
B-19

Rev:
A

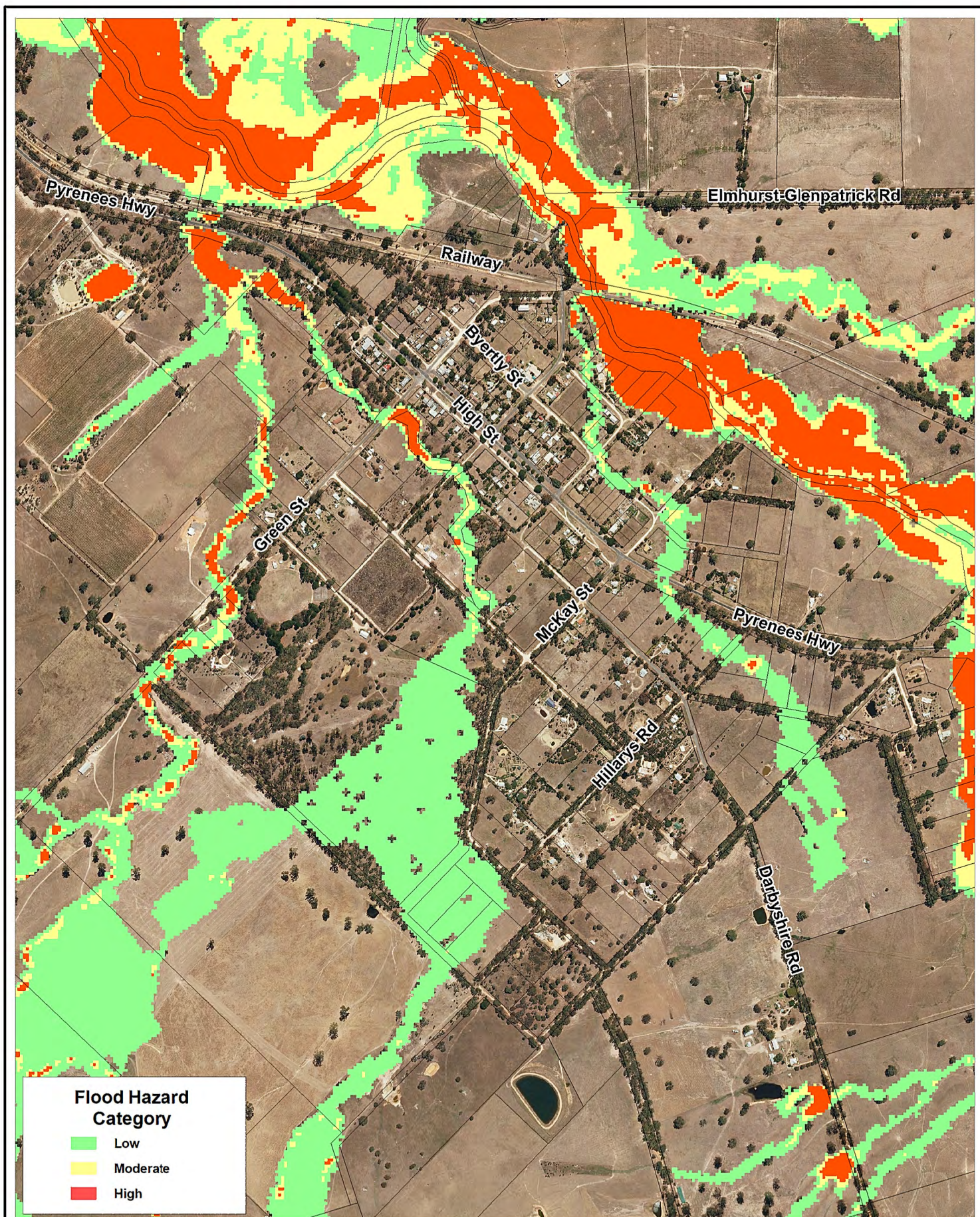
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0 100 200m
 Approx. Scale



Filepath : T:\M8460.MT.WimmeraUpperFloodStudy\MapInfo\Drawings\R.M8460.009.01.Final\UW_Final_FigB-19_E01_1%_051_Haz_Landsborough_RevA.WOR



Title:
Upper Wimmera Flood Investigation
1% AEP Design Flood Hazard - Elmhurst

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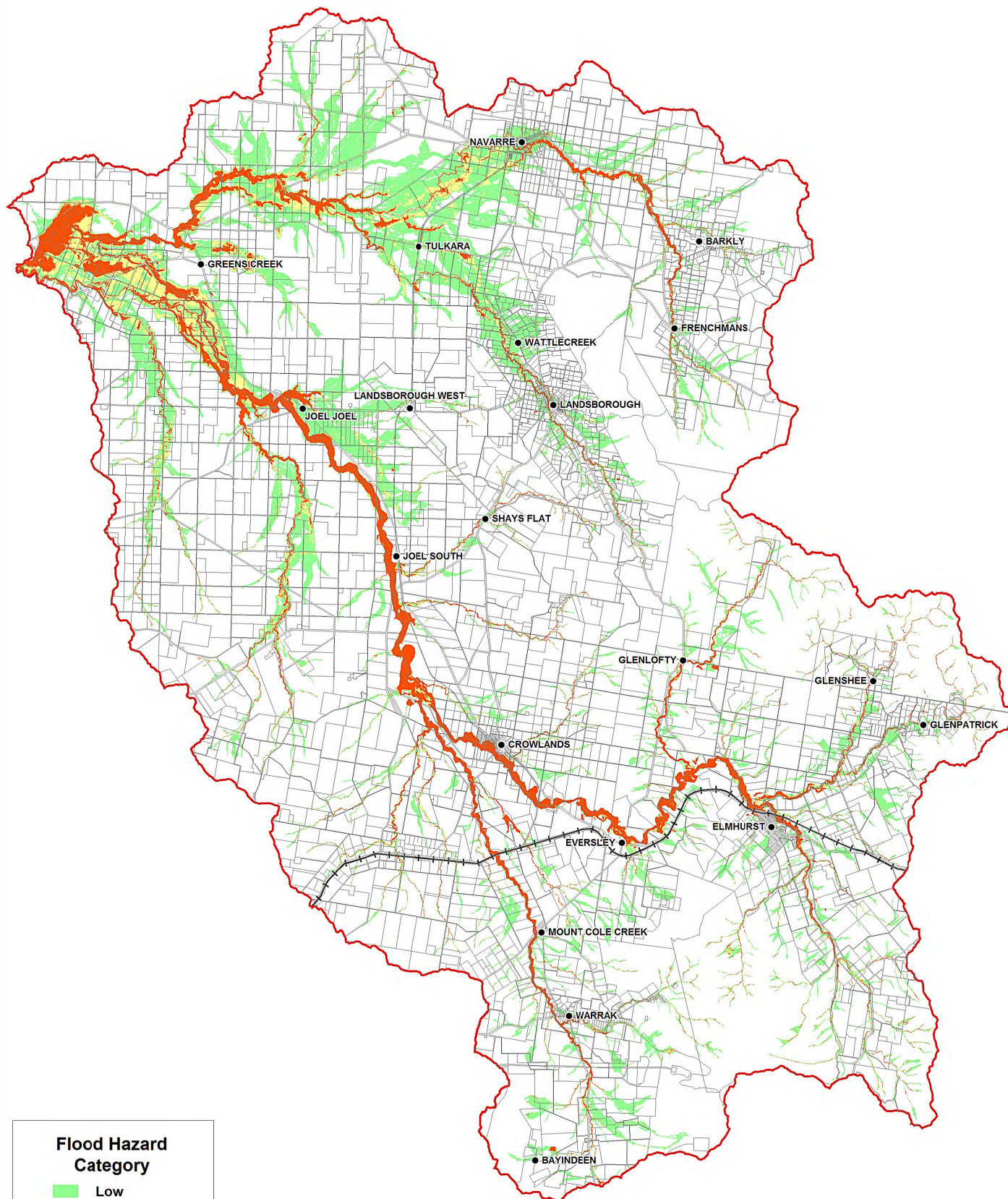
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 Approx. Scale

Figure:
B-20

Rev:
A



Filepath : T:\M8460.MT.WimmeraUpperFloodStudy\MapInfo\Drawings\R.M8460.009.01.Final\UW_Final_FigB-20_E01_1%_051_Haz_Elmhurst_RevA.WOR



Title:
Upper Wimmera Flood Investigation
0.5% AEP Design Flood Hazard - Catchment

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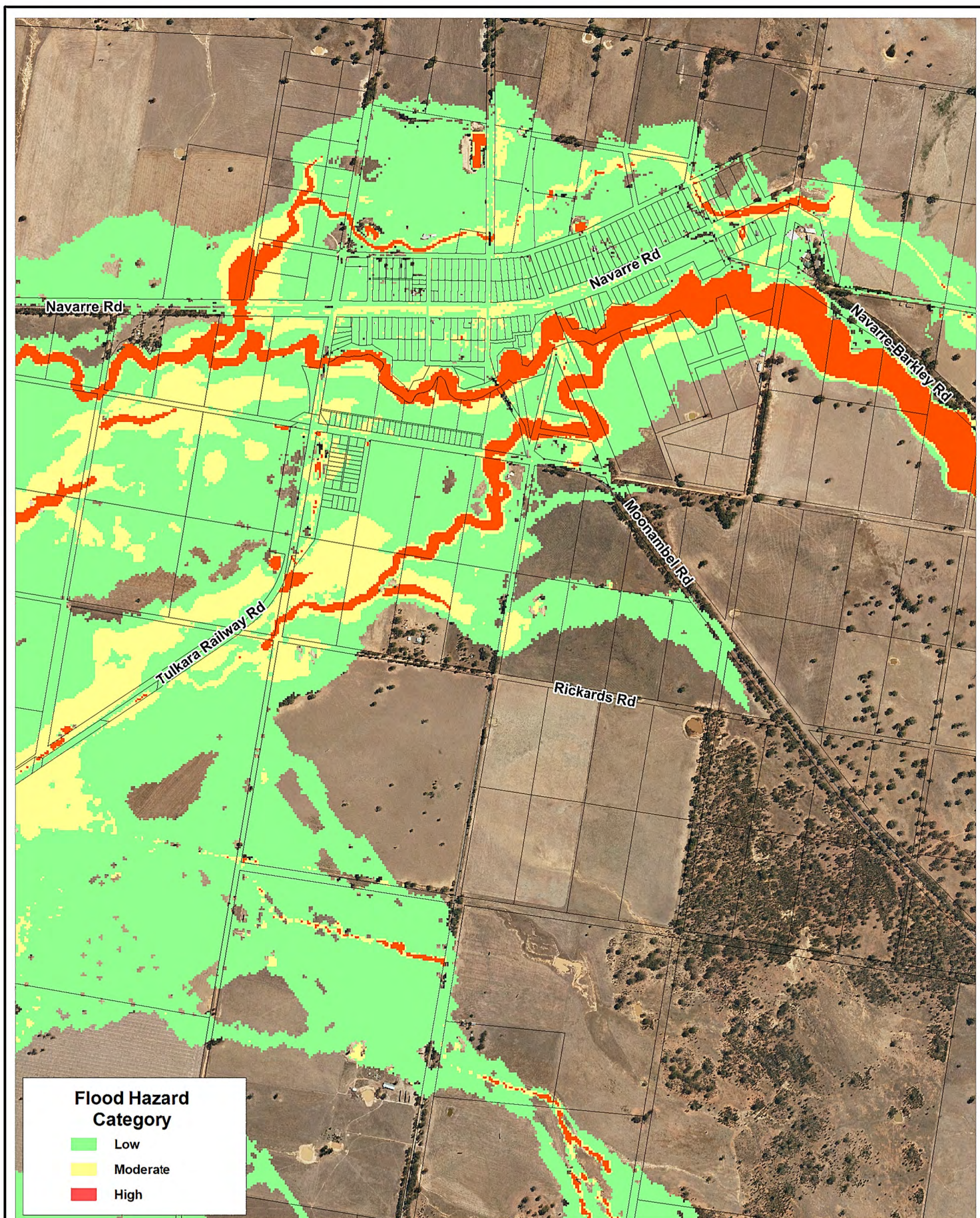
0 3.75 7.5km
 Approx. Scale

Figure:
B-21

Rev:
A



Filepath : T:\M8460.MT.WimmeraUpperFloodStudy\MapInfo\Drawings\R.M8460.009.01.Final\UW_Final_FigB-21_E01_0.5%_051_Haz_Catchment_RevA.WOR



Title:
Upper Wimmera Flood Investigation
0.5% AEP Design Flood Hazard - Navarre

Figure:
B-22

Rev:
A

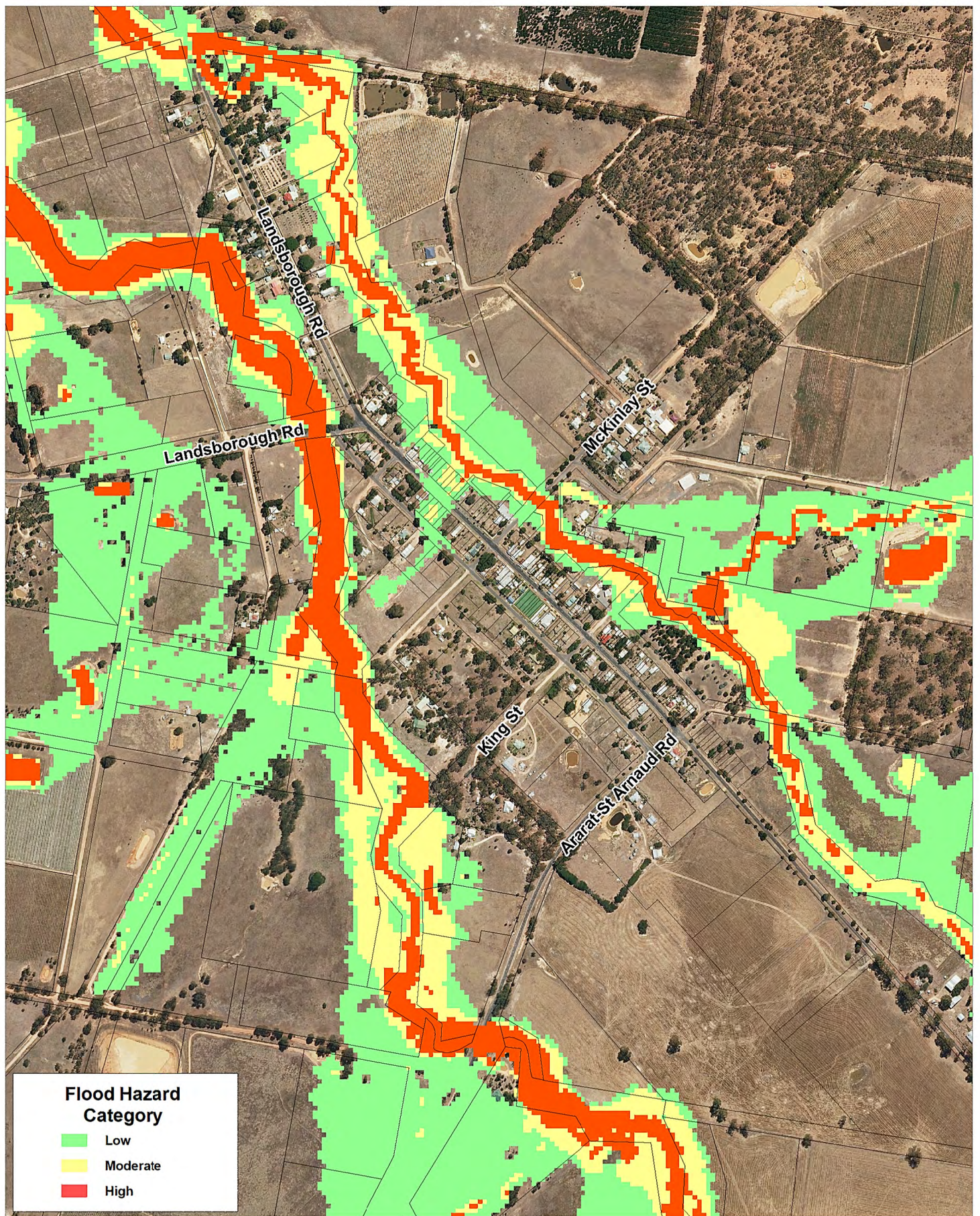
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0 250 500m
 Approx. Scale



Filepath : T:\M8460.MT.WimmeraUpperFloodStudy\MapInfo\Drawings\R.M8460.009.01.Final\UW_Final_FigB-22_E01_0.5%_051_Haz_Navarre_RevA.WOR



Title:
Upper Wimmera Flood Investigation
0.5% AEP Design Flood Hazard - Landsborough

Figure:
B-23

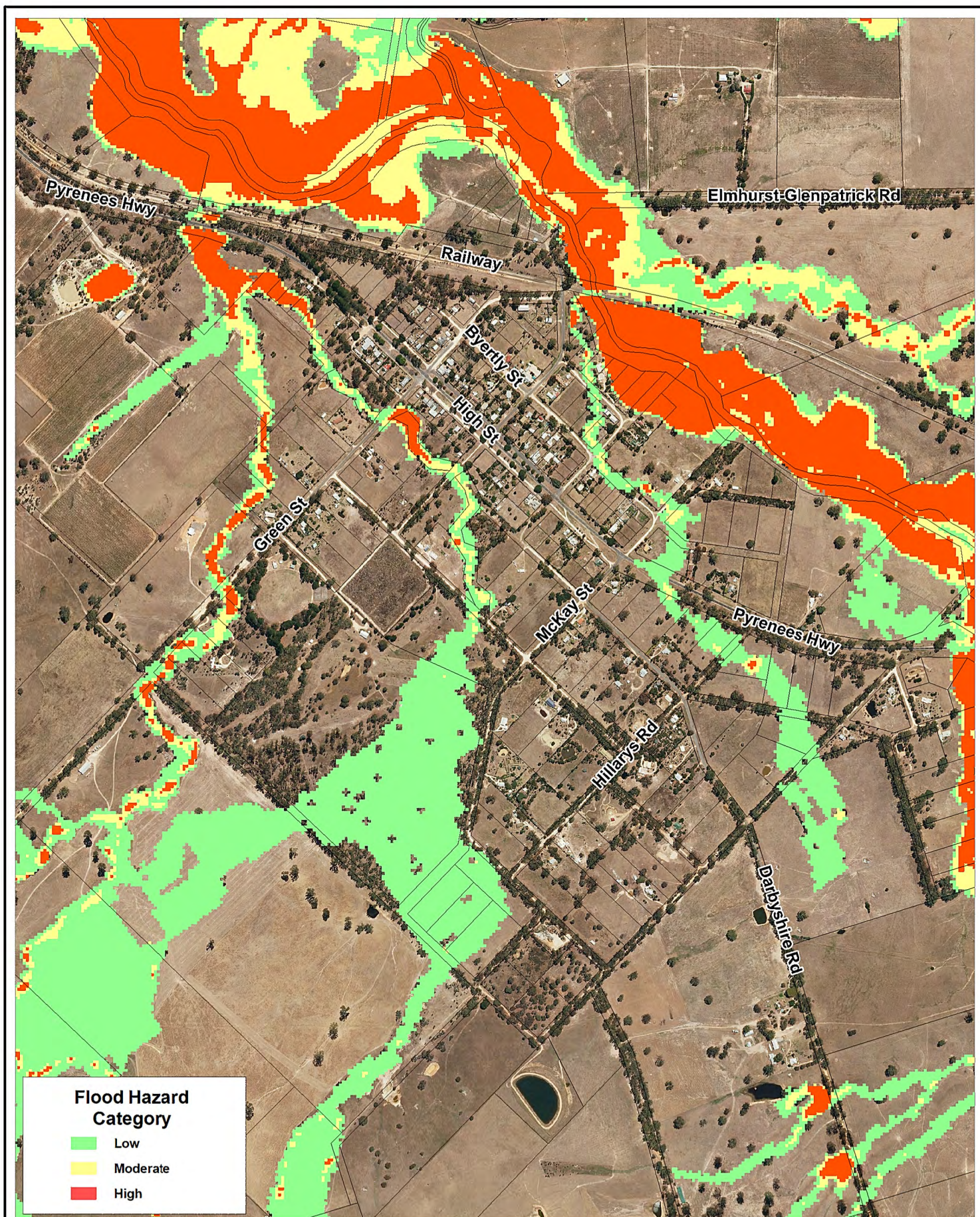
Rev:
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0 100 200m
 Approx. Scale





Title:
Upper Wimmera Flood Investigation
0.5% AEP Design Flood Hazard - Elmhurst

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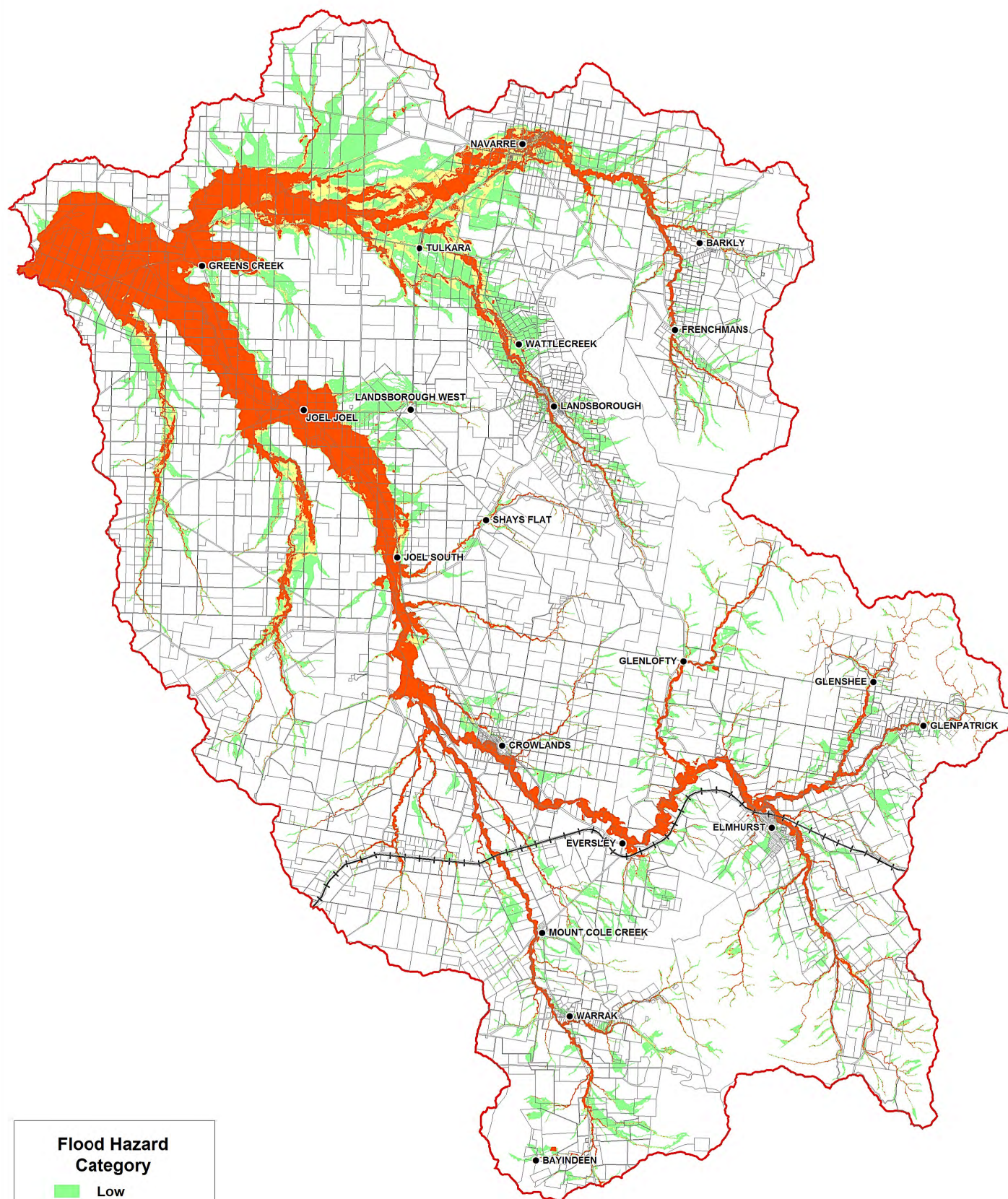
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 Approx. Scale

Figure:
B-24

Rev:
A



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Title:
**Upper Wimmera Flood Investigation
Probable Maximum Flood Hazard - Catchment**

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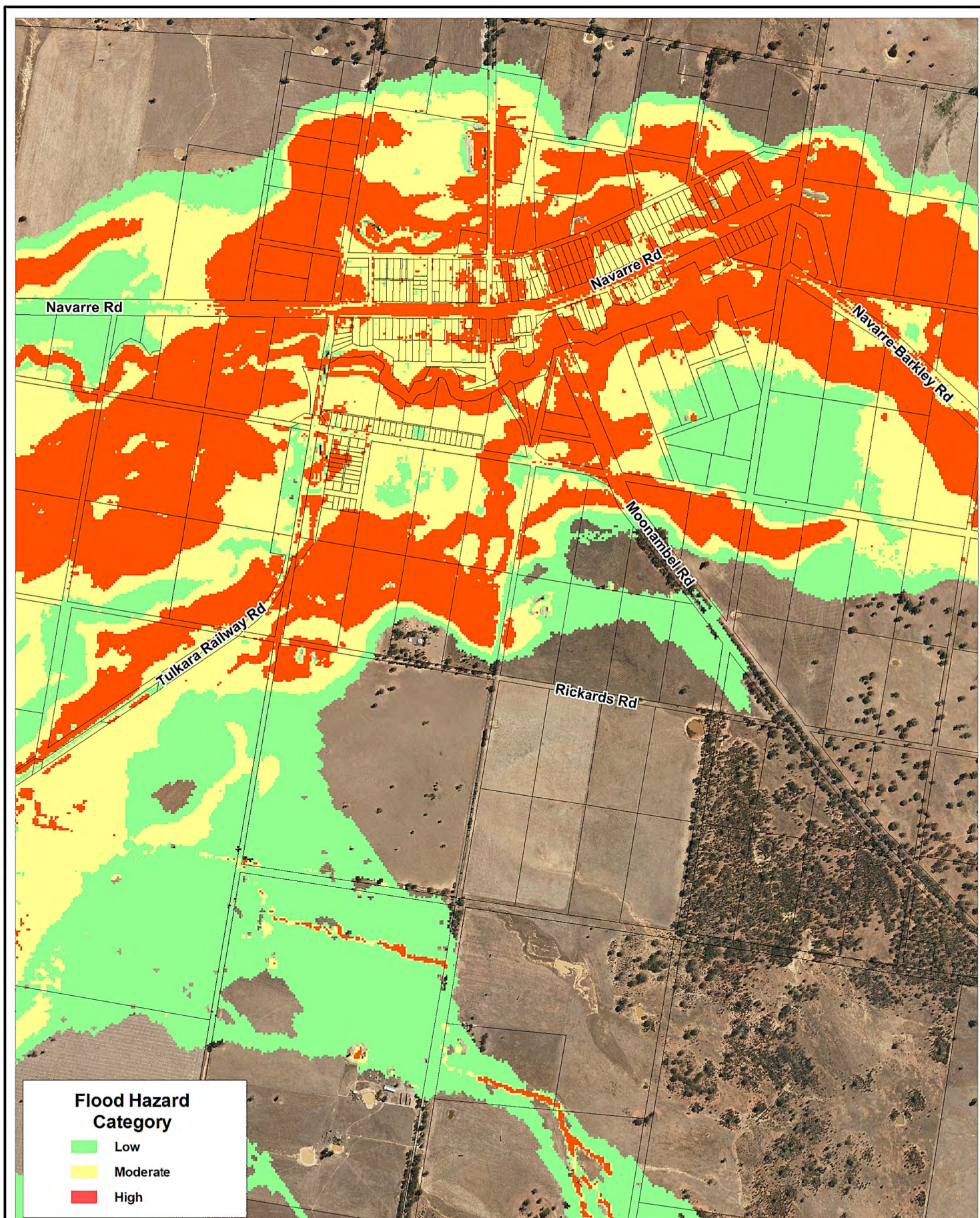
0 3.75 7.5km
Approx. Scale

Figure:
B-25

Rev:
A



Filepath : T:\M8460.MT.WimmeraUpperFloodStudy\MapInfo\Drawings\R.M8460.009.01.Final\UW_Final_FigB-25_E01_PMF_051_Haz_Catchment_RevA.WOR



Title:
Upper Wimmera Flood Investigation
Probable Maximum Flood Hazard - Navarre

Figure:
B-26

Rev:
A

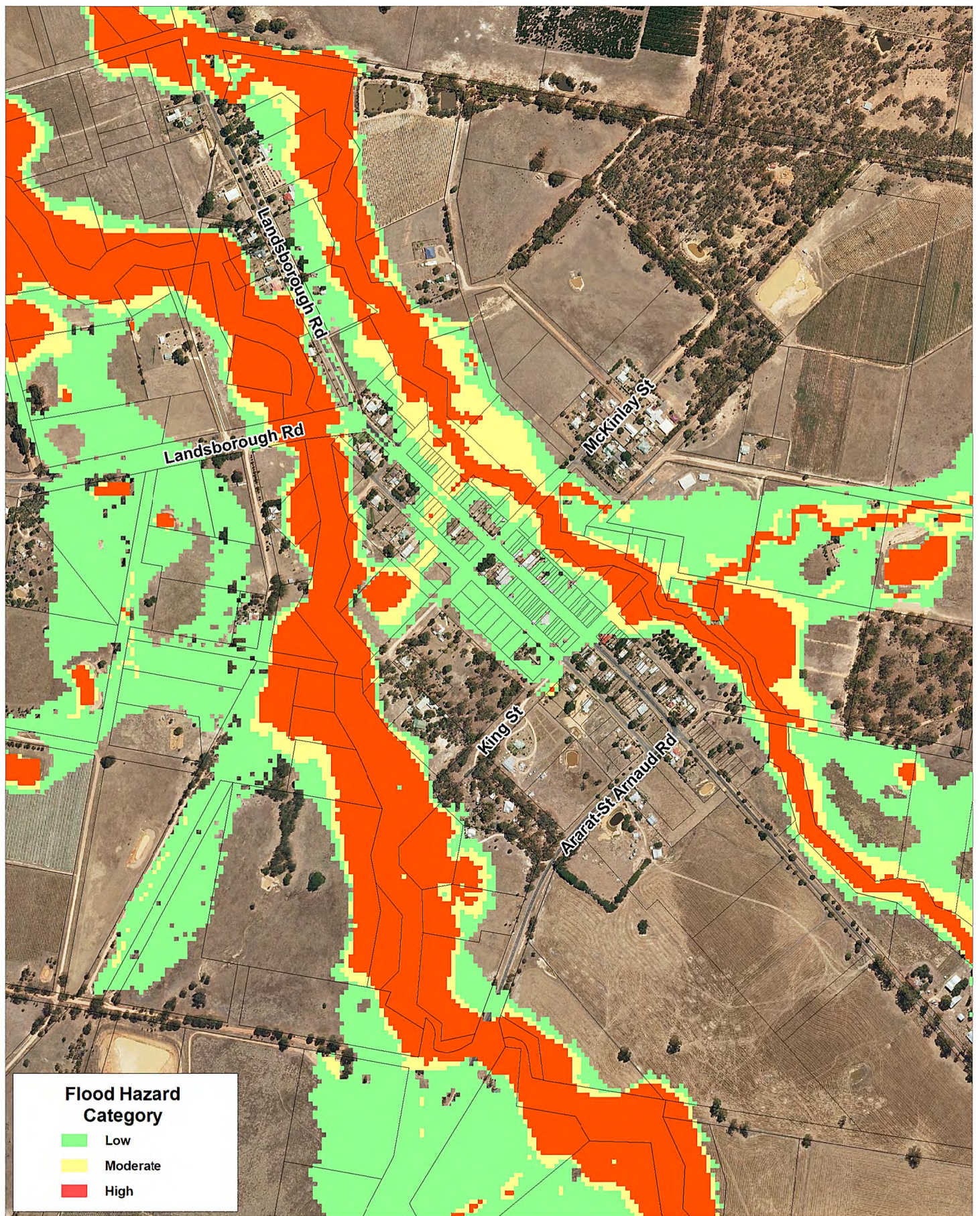
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0 250 500m
 Approx. Scale



Filepath : T:\M8460.MT.WimmeraUpperFloodStudy\MapInfo\Drawings\R.M8460.009.01.Final\UW_Final_FigB-26_E01_PMF_051_Haz_Navarre_RevA.WOR



Title:
Upper Wimmera Flood Investigation
Probable Maximum Flood Hazard - Landsborough

Figure:
B-27

Rev:
A

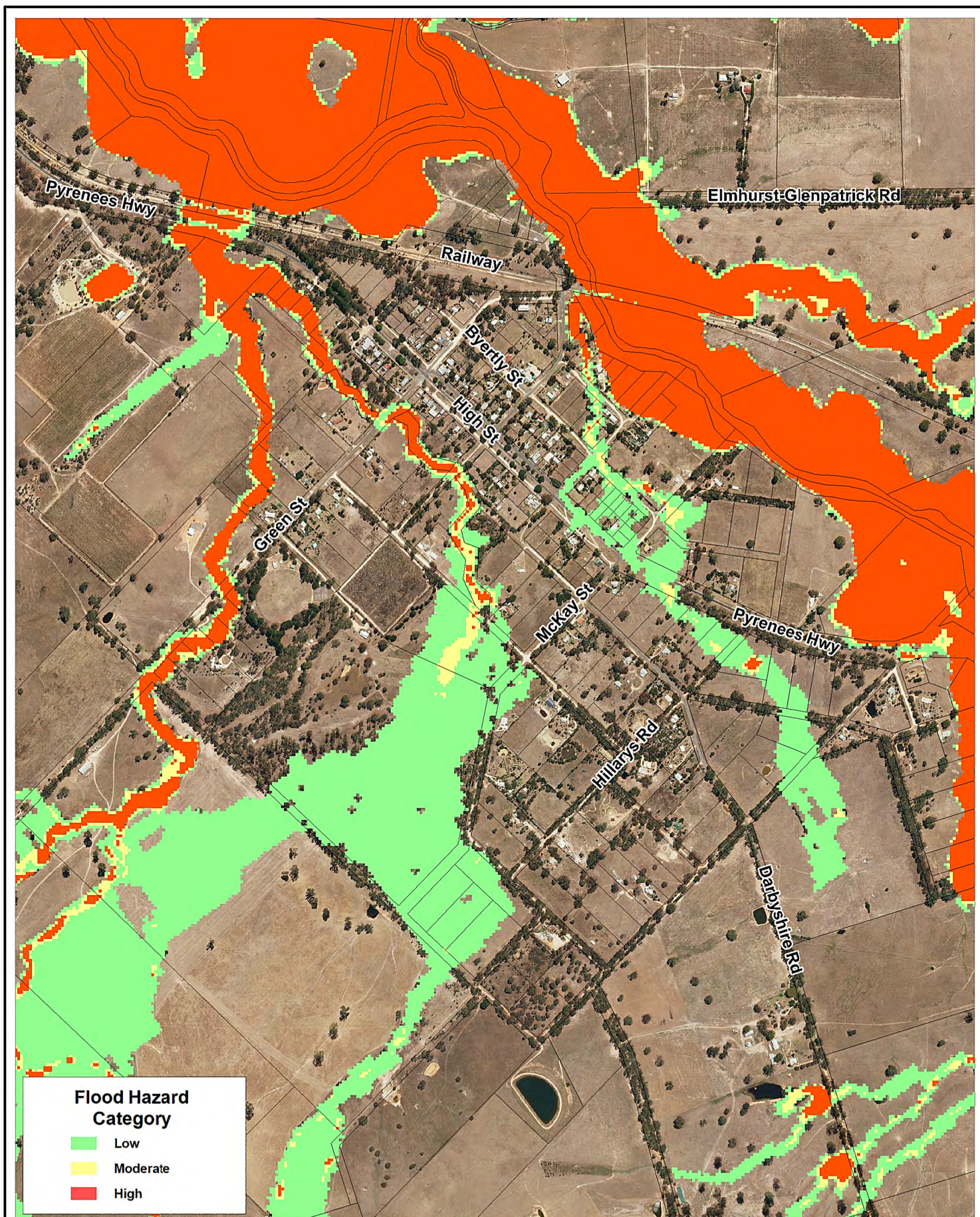
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0 100 200m
 Approx. Scale



Filepath : T:\M8460.MT.WimmeraUpperFloodStudy\MapInfo\Drawings\R.M8460.009.01.FinalUW_Final_FigB-27_E01_PMF_051_Haz_Landsborough_RevA.WOR



Title:
Upper Wimmera Flood Investigation
Probable Maximum Flood Hazard - Elmhurst

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0 200 400m
 Approx. Scale

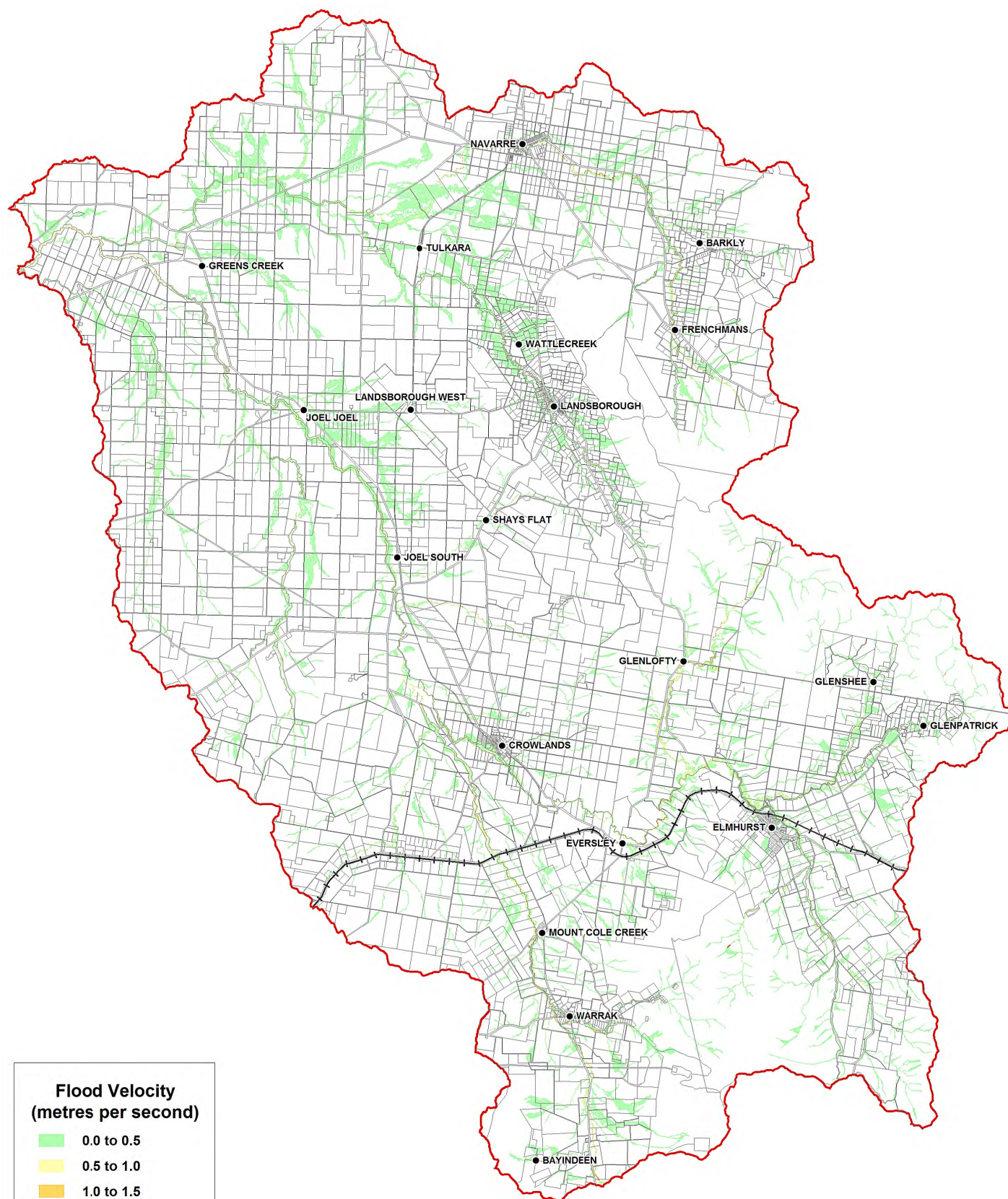
Figure:
B-28

Rev:
A



Filepath : T:\M8460.MT.WimmeraUpperFloodStudy\MapInfo\Drawings\R.M8460.009.01.FinalUW_Final_FigB-28_E01_PMF_051_Haz_Elmhurst_RevA.WOR

Appendix C Existing Case – Velocity Mapping



Title:
Upper Wimmera Flood Investigation
20% AEP Design Flood Velocity - Catchment

BMT WBM endeavours to ensure that the information provided in this map is correct at the time of publication. BMT WBM does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.



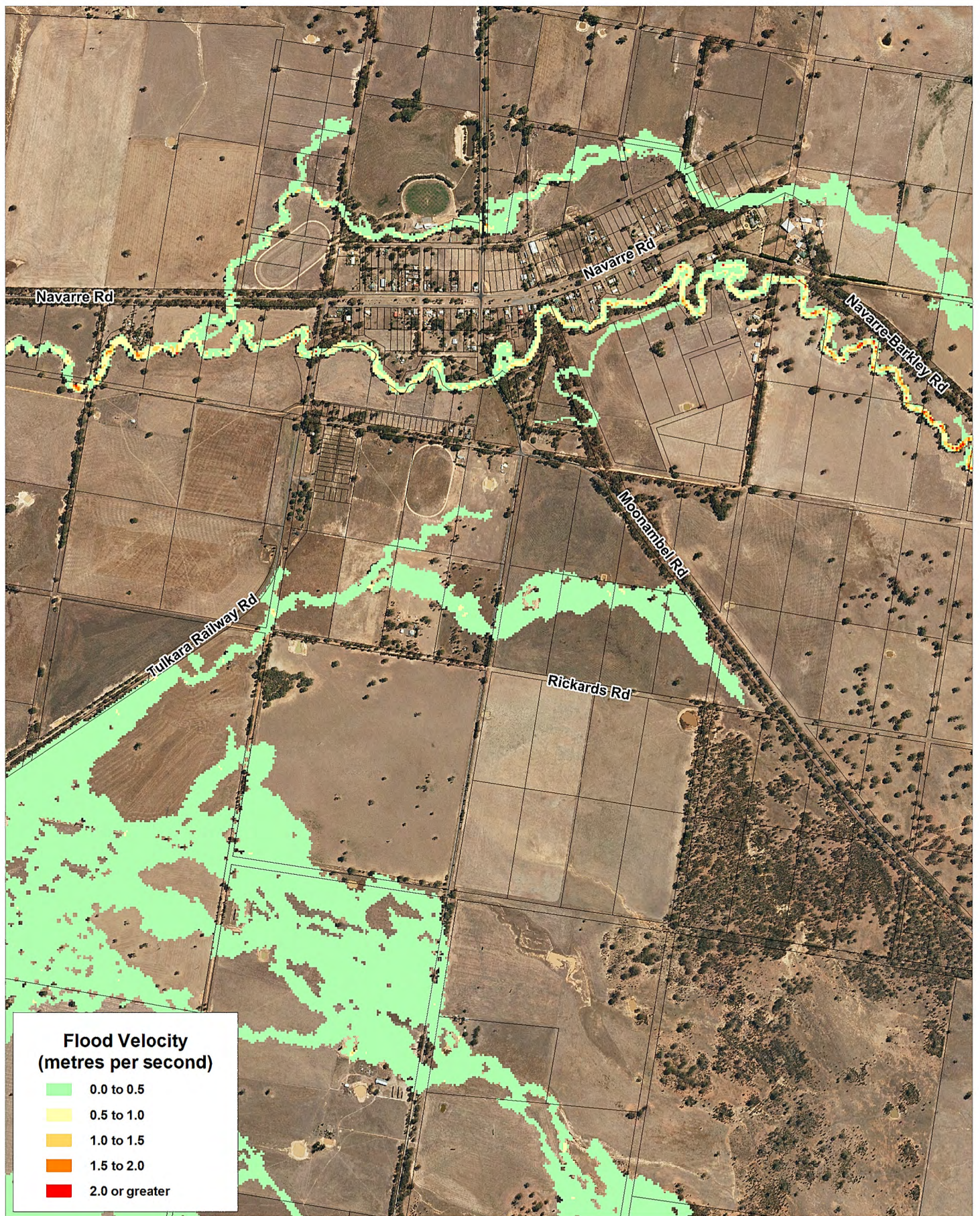
0 3.75 7.5km
 Approx. Scale

Figure:
C-1

Rev:
A



Filepath : T:\M8460.MT.WimmeraUpperFloodStudy\MapInfo\Drawings\R.M8460.009.01.Final\UW_Final_FigC-1_E01_20%_051_Dep_Catchment_RevA.WOR



Title:
Upper Wimmera Flood Investigation
20% AEP Design Flood Velocity - Navarre

Figure:
C-2

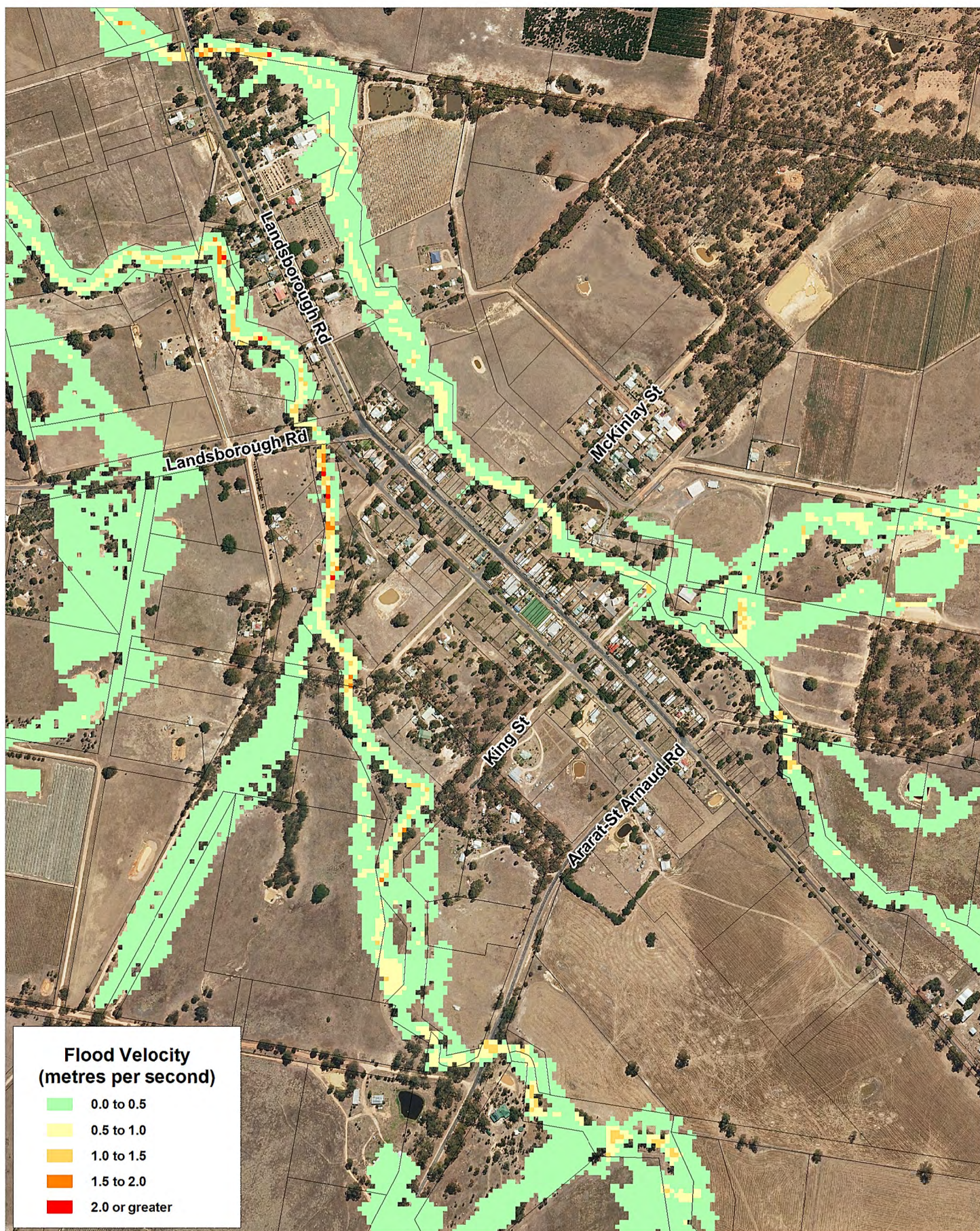
Rev:
A

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0 250 500m
 Approx. Scale





Title:
Upper Wimmera Flood Investigation
20% AEP Design Flood Velocity - Landsborough

Figure:
C-3

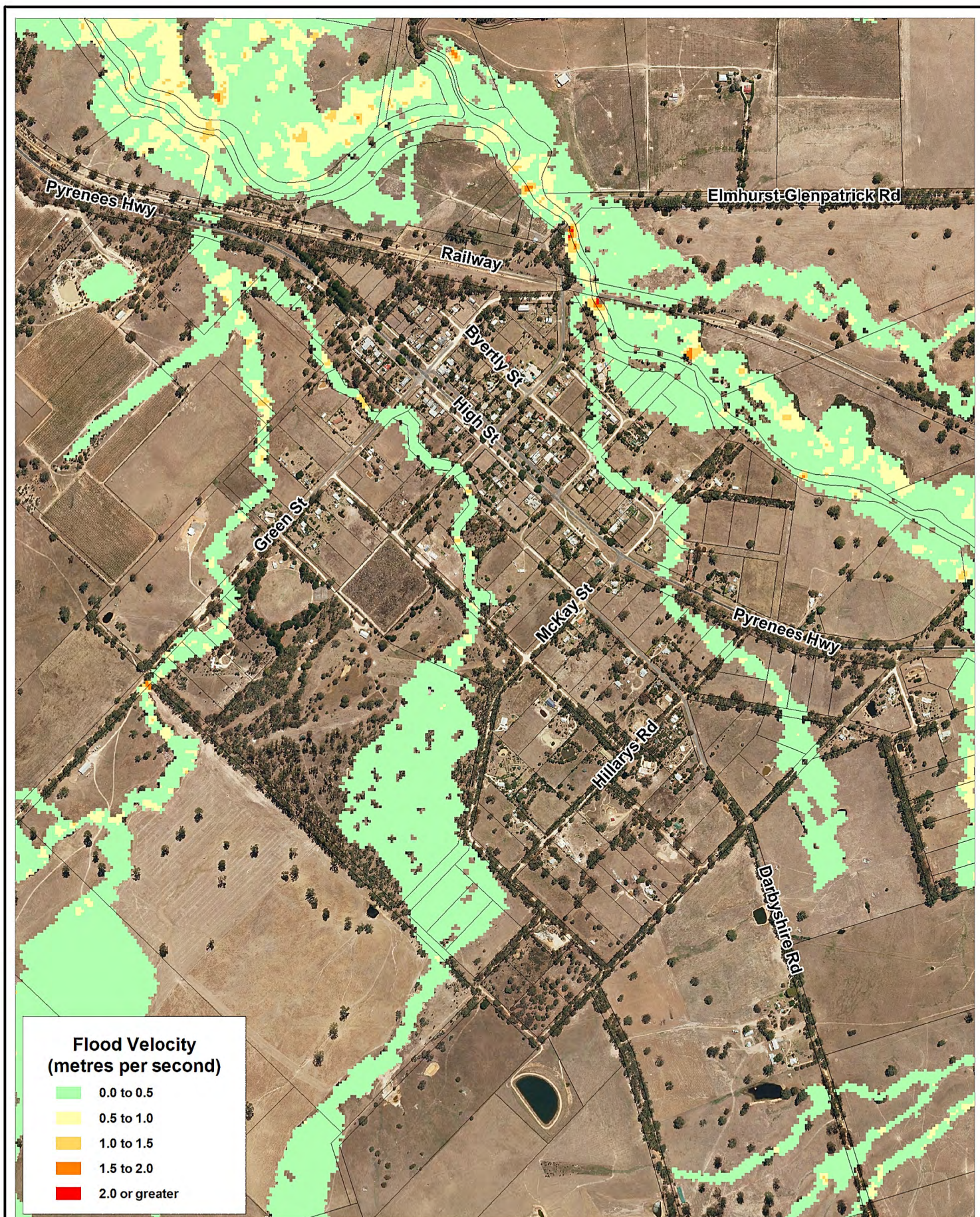
Rev:
A

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0 100 200m
 Approx. Scale





Title:
Upper Wimmera Flood Investigation
20% AEP Design Flood Velocity - Elmhurst

BMT WBM endeavours to ensure that the information provided in this map is correct at the time of publication. BMT WBM does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.



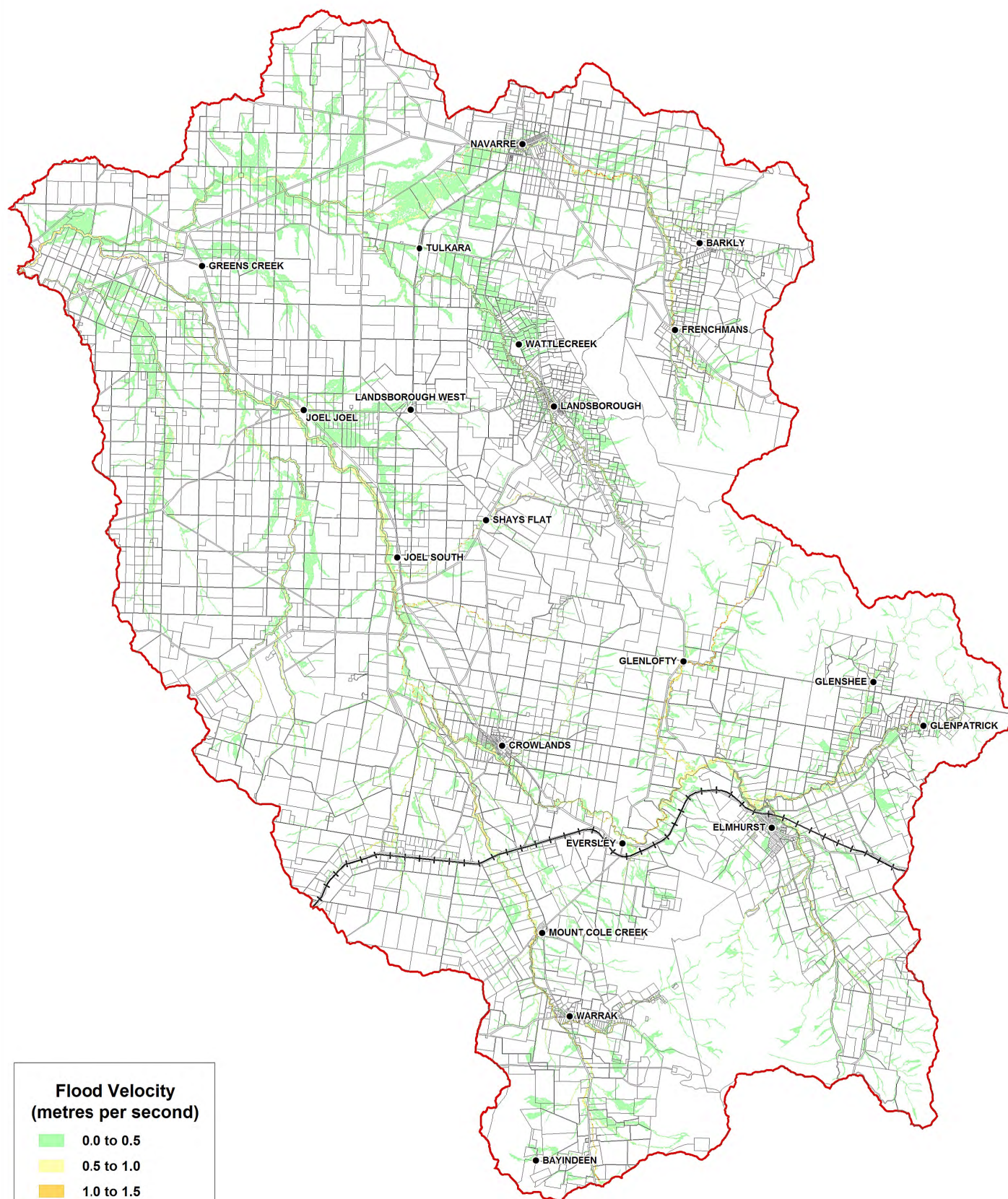
0 200 400m
 Approx. Scale

Figure:
C-4

Rev:
A



Filepath : T:\M8460.MT.WimmeraUpperFloodStudy\MapInfo\Drawings\R.M8460.009.01.Final\UW_Final_FigC-4_E01_20%_051_Dep_Elmhurst_RevA.WOR



Title:
Upper Wimmera Flood Investigation
10% AEP Design Flood Velocity - Catchment

BMT WBM endeavours to ensure that the information provided in this map is correct at the time of publication. BMT WBM does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.



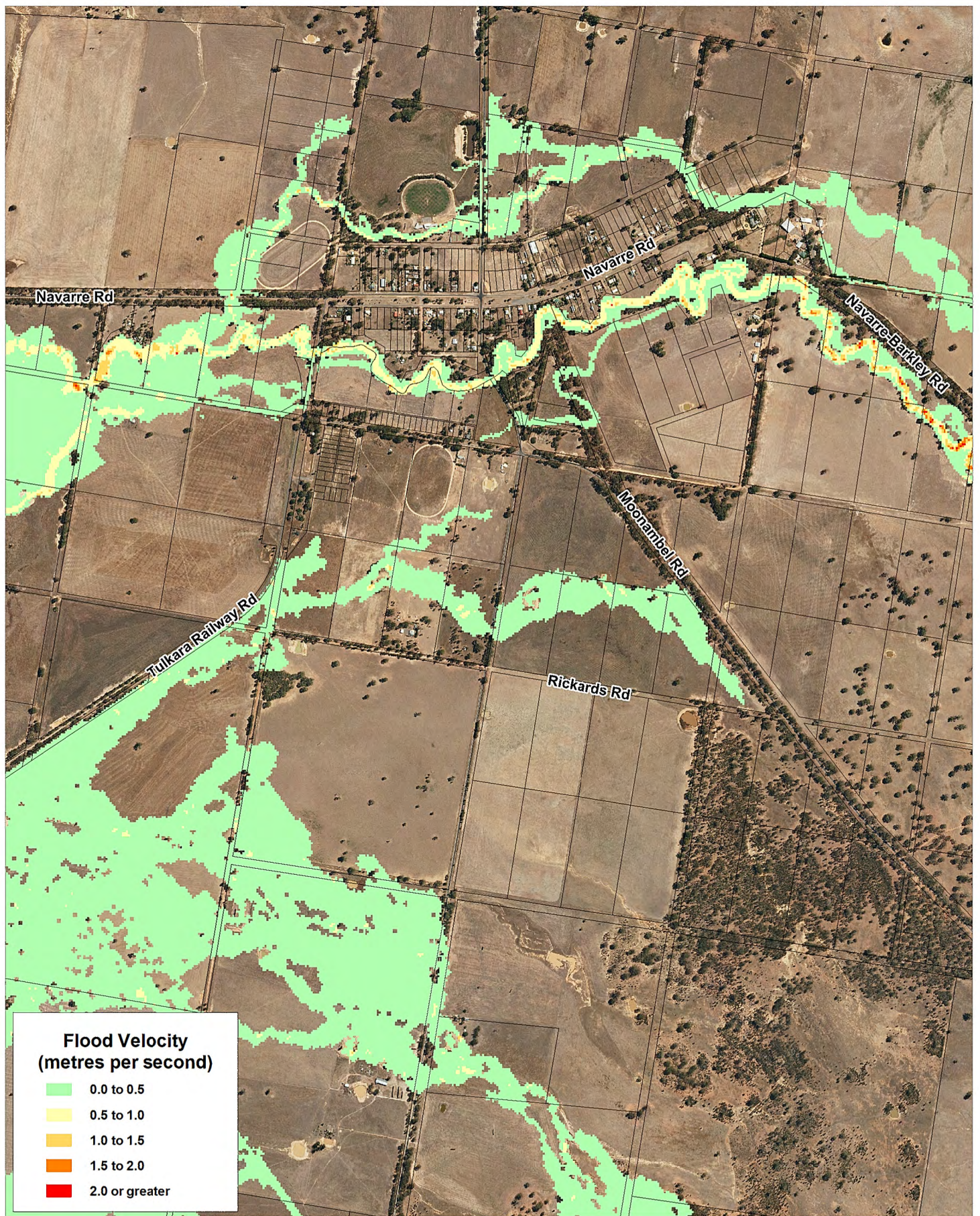
0 3.75 7.5km
 Approx. Scale

Figure:
C-5

Rev:
A



Filepath : T:\M8460.MT.WimmeraUpperFloodStudy\MapInfo\Drawings\R.M8460.009.01.Final\UW_Final_FigC-5_E01_10%_051_Dep_Catchment_RevA.WOR



Title:
Upper Wimmera Flood Investigation
10% AEP Design Flood Velocity - Navarre

Figure:
C-6

Rev:
A

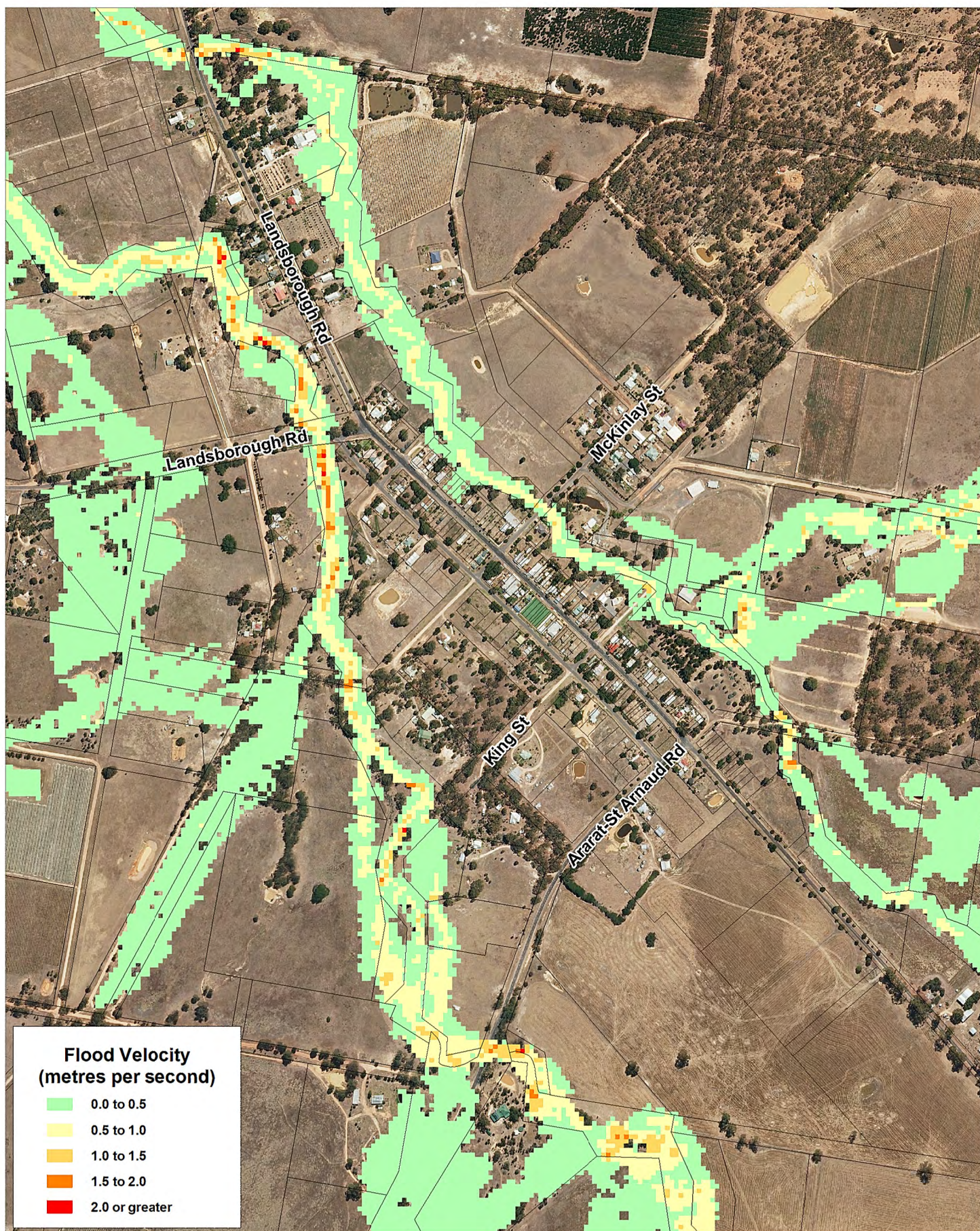
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0 250 500m
 Approx. Scale



Filepath : T:\M8460.MT.WimmeraUpperFloodStudy\MapInfo\Drawings\R.M8460.009.01.FinalUW_Final_FigC-6_E01_10%_051_Dep_Navarre_RevA.WOR



Title:
Upper Wimmera Flood Investigation
10% AEP Design Flood Velocity - Landsborough

Figure:
C-7

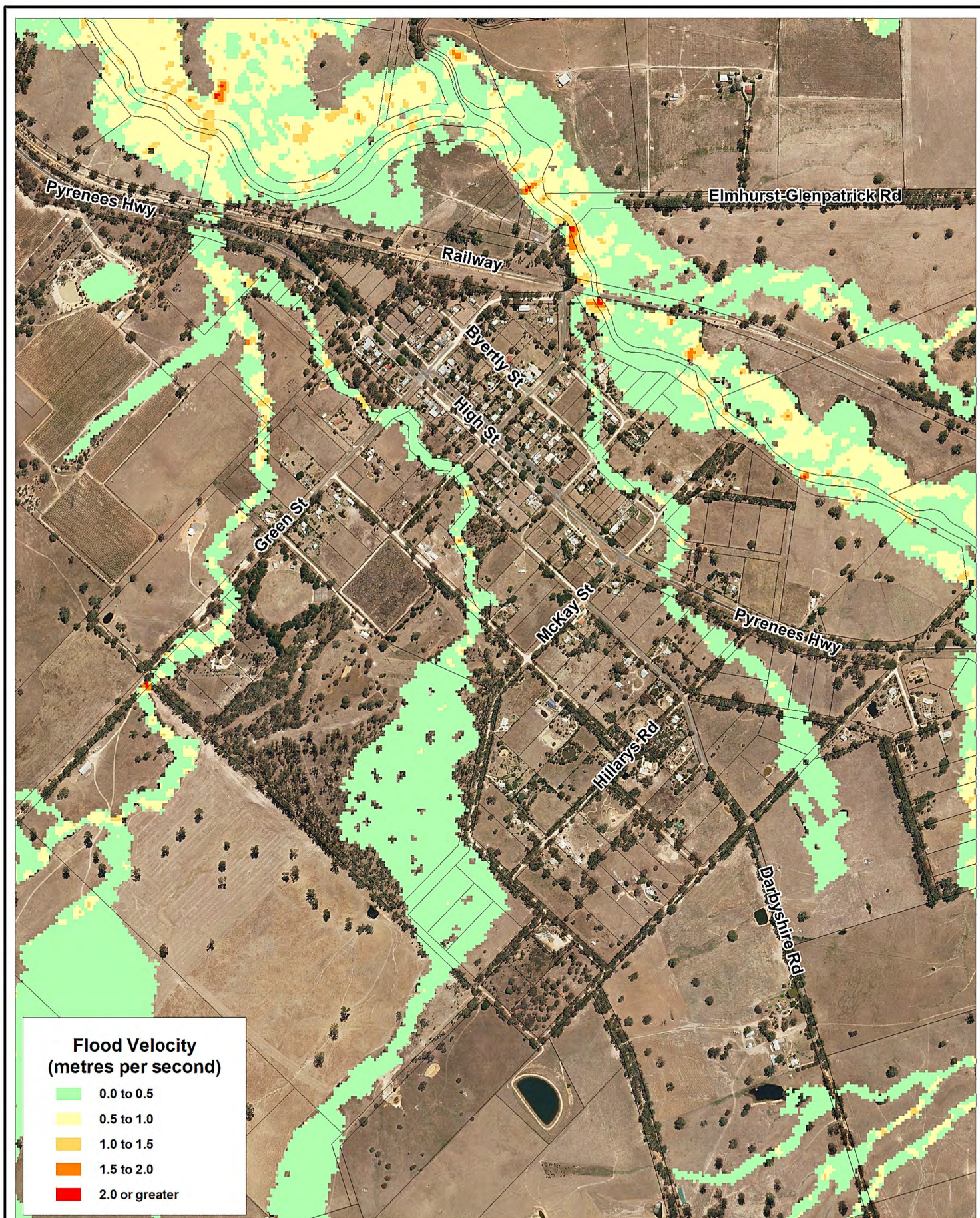
Rev:
A

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0 100 200m
 Approx. Scale





Title:
Upper Wimmera Flood Investigation
10% AEP Design Flood Velocity - Elmhurst

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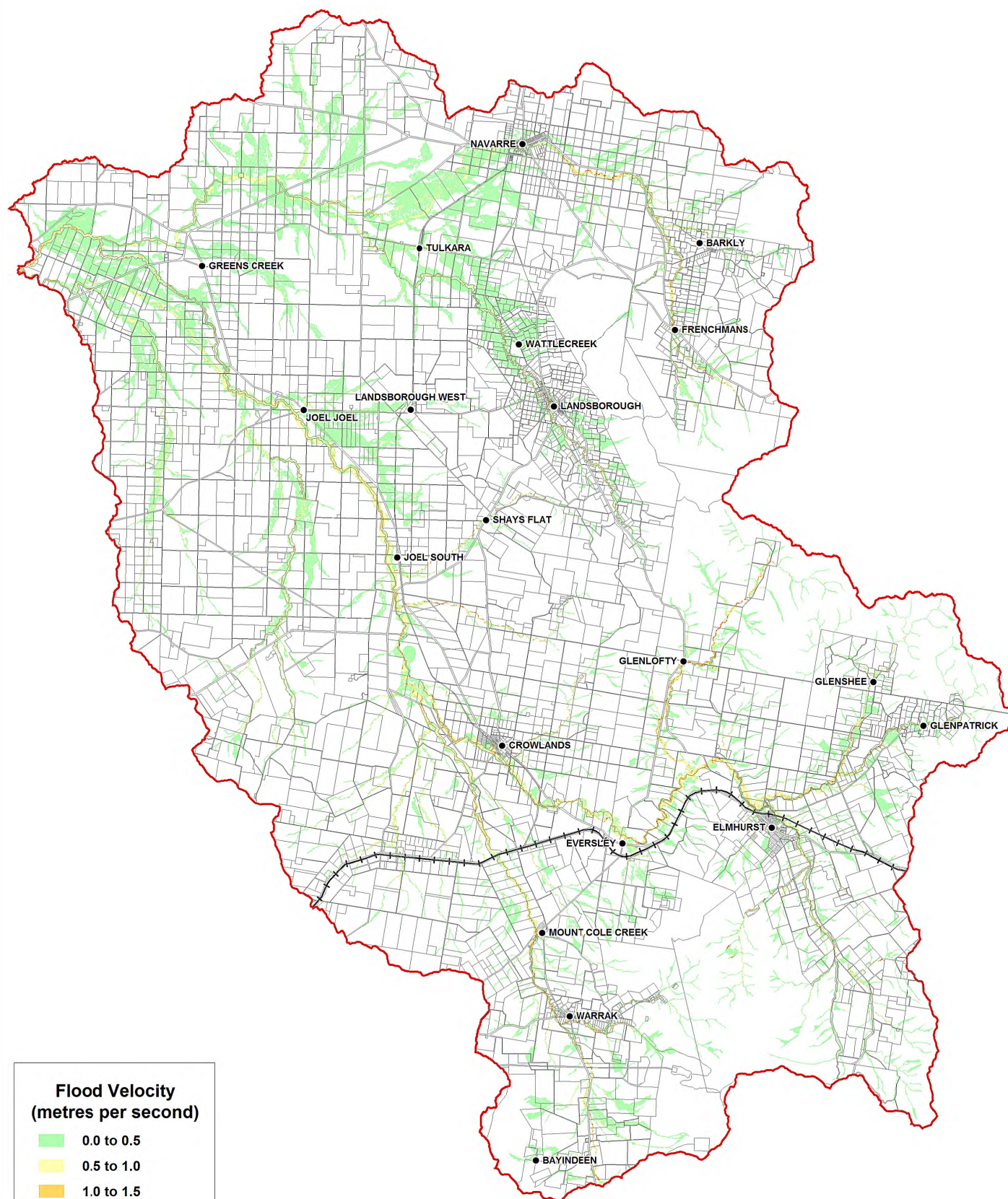
0 200 400m
 Approx. Scale

Figure:
C-8

Rev:
A



Filepath : T:\M8460.MT.WimmeraUpperFloodStudy\MapInfo\Drawings\R.M8460.009.01.Final\UW_Final_FigC-8_E01_10%_051_Dep_Elmhurst_RevA.WOR



Title:
Upper Wimmera Flood Investigation
5% AEP Design Flood Velocity - Catchment

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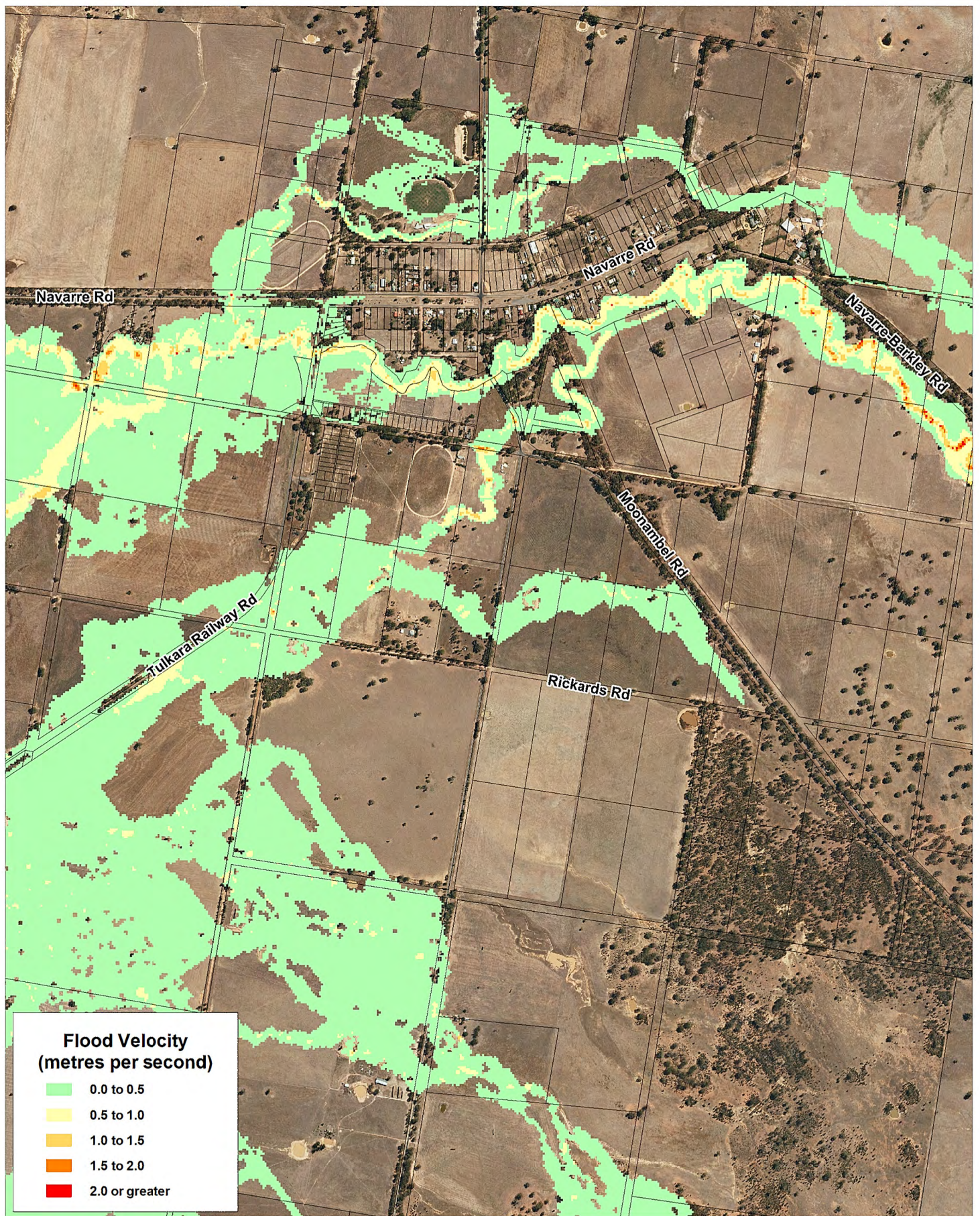
0 3.75 7.5km
 Approx. Scale

Figure:
C-9

Rev:
A



Filepath : T:\M8460.MT.WimmeraUpperFloodStudy\MapInfo\Drawings\R.M8460.009.01.Final\UW_Final_FigC-9_E01_5%_051_Dep_Catchment_RevA.WOR



Title:
Upper Wimmera Flood Investigation
5% AEP Design Flood Velocity - Navarre

Figure:
C-10

Rev:
A

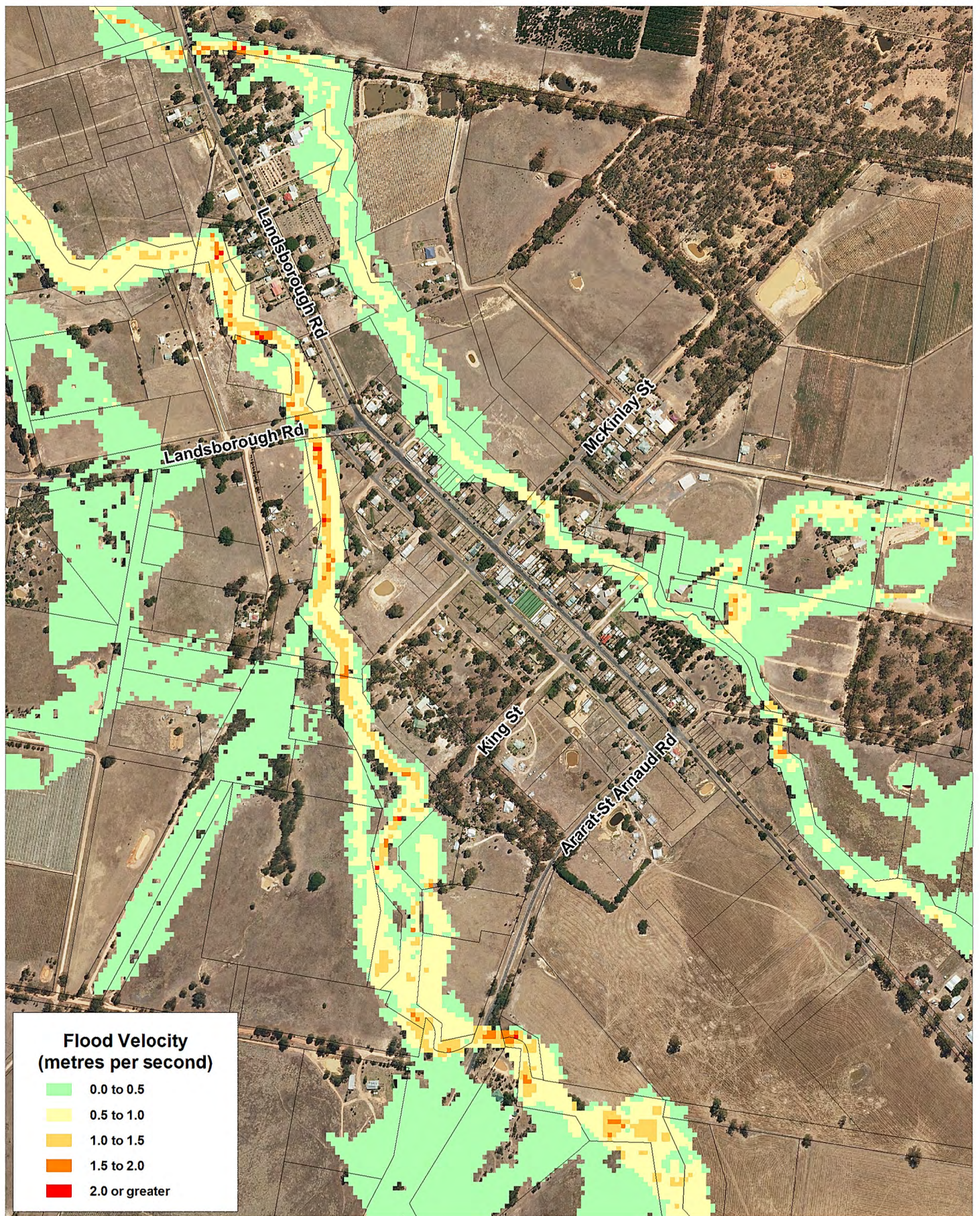
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0 250 500m
 Approx. Scale



Filepath : T:\M8460.MT.WimmeraUpperFloodStudy\MapInfo\Drawings\R.M8460.009.01.FinalUW_Final_FigC-10_E01_5%_051_Dep_Navarre_RevA.WOR



Title:
Upper Wimmera Flood Investigation
5% AEP Design Flood Velocity - Landsborough

Figure:
C-11

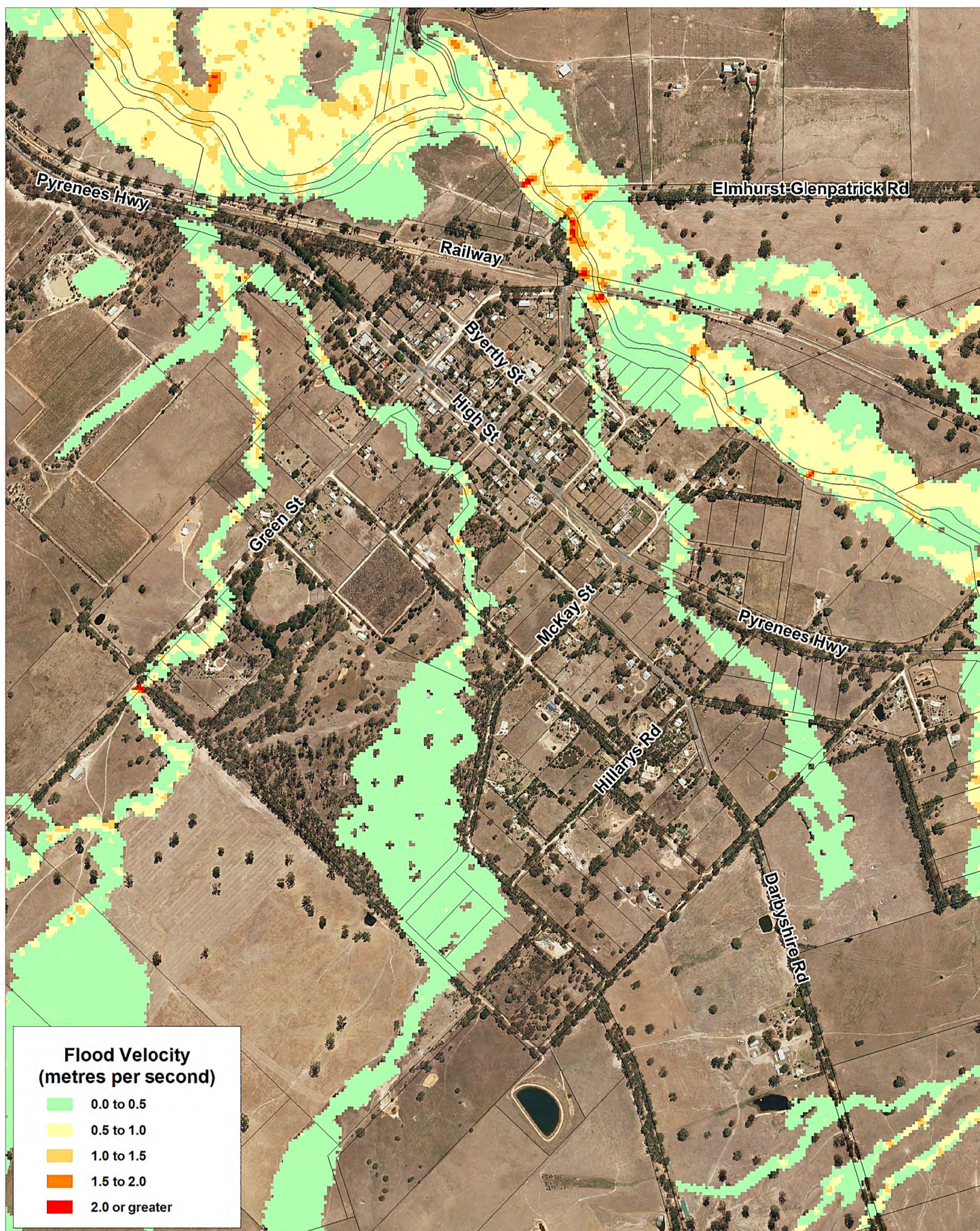
Rev:
A

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0 100 200m
 Approx. Scale





Title:
Upper Wimmera Flood Investigation
5% AEP Design Flood Velocity - Elmhurst

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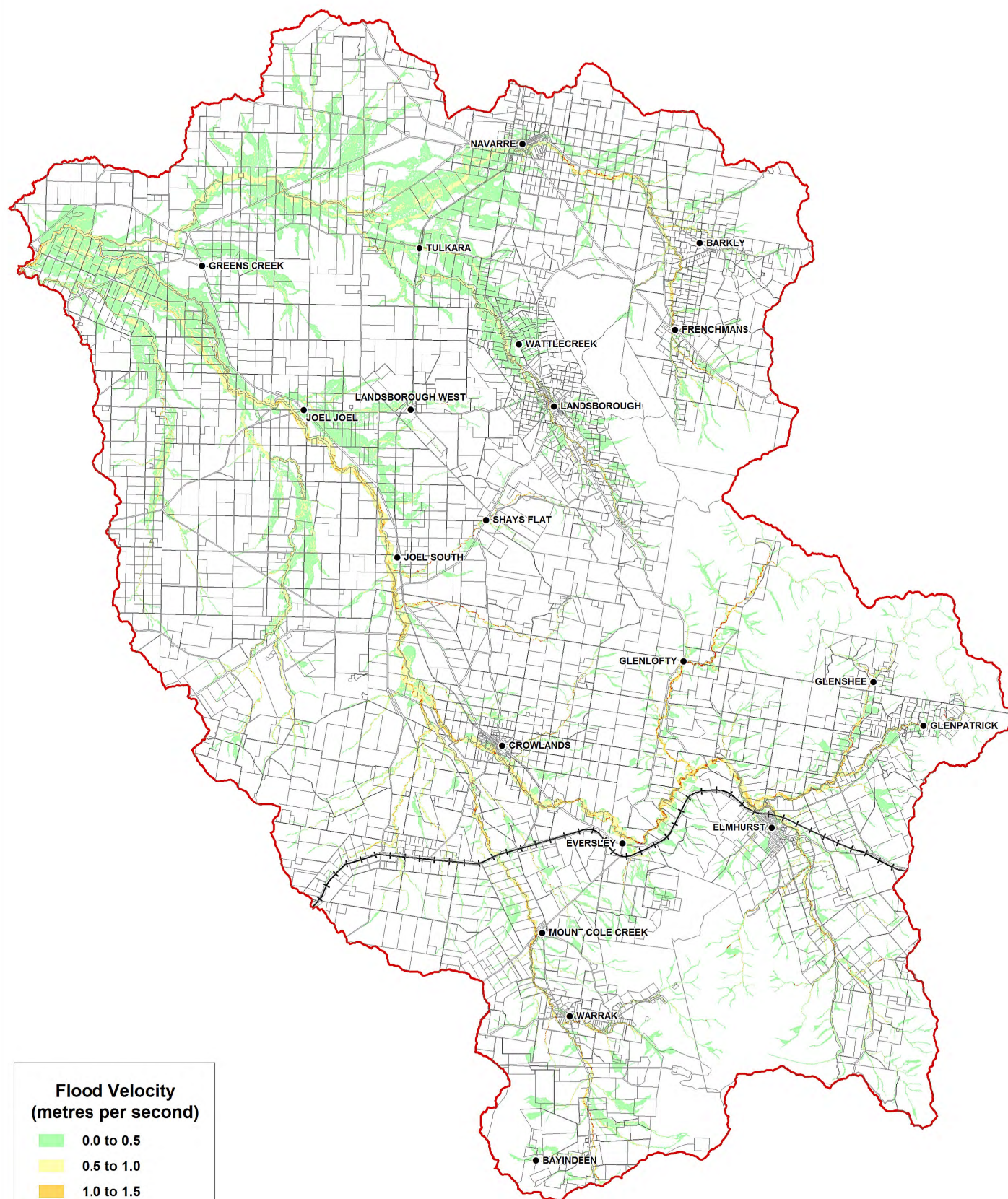
0 200 400m
 Approx. Scale

Figure:
C-12

Rev:
A



Filepath : T:\M8460.MT.WimmeraUpperFloodStudy\MapInfo\Drawings\R.M8460.009.01.Final\UW_Final_FigC-12_E01_5%_051_Dep_Elmhurst_RevA.WOR



- Flood Velocity
(metres per second)**
- 0.0 to 0.5
 - 0.5 to 1.0
 - 1.0 to 1.5
 - 1.5 to 2.0
 - 2.0 or greater

Title:
**Upper Wimmera Flood Investigation
2% AEP Design Flood Velocity - Catchment**

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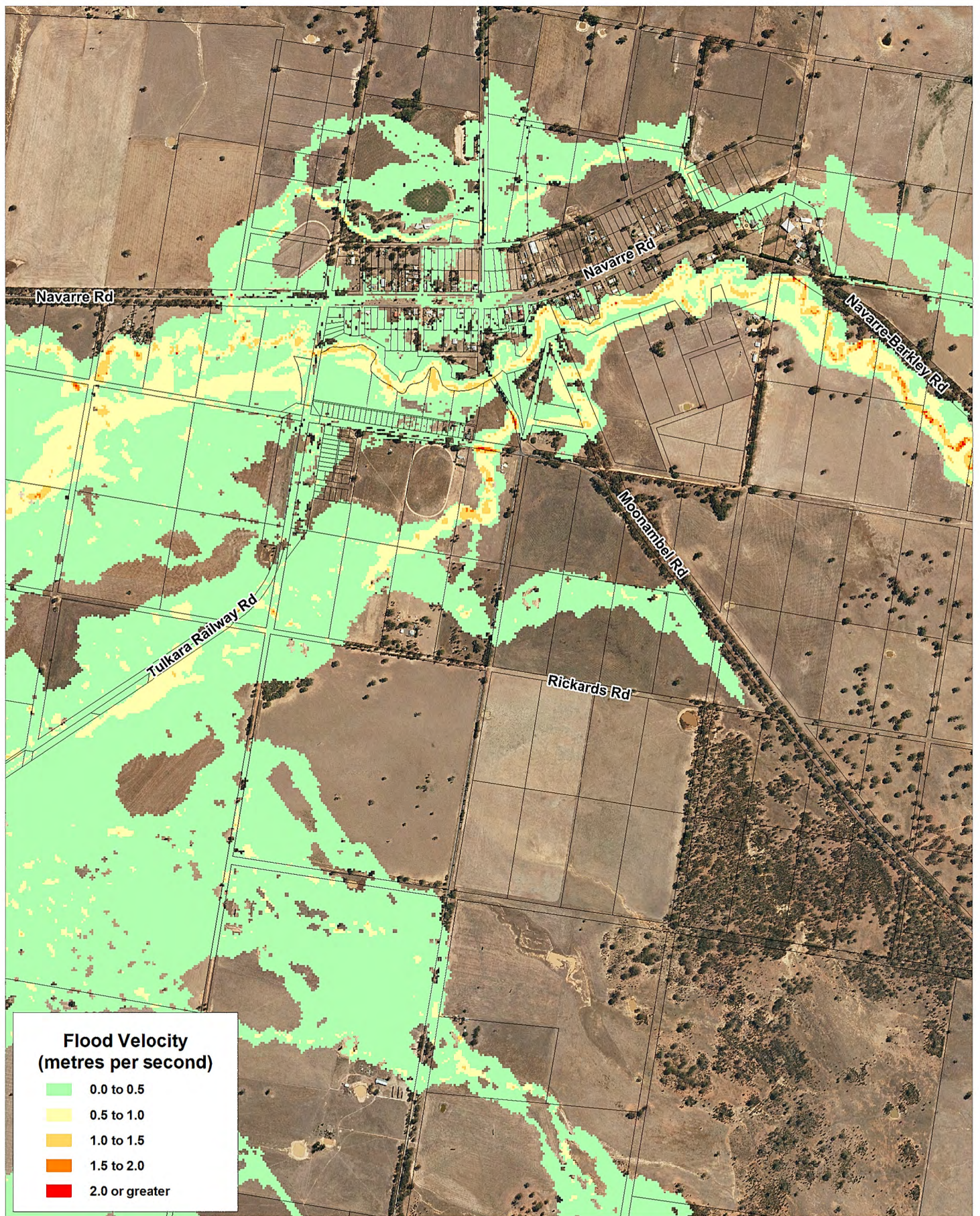
0 3.75 7.5km
Approx. Scale

Figure:
C-13

Rev:
A



Filepath : T:\M8460.MT.WimmeraUpperFloodStudy\MapInfo\Drawings\R.M8460.009.01.Final\UW_Final_FigC-13_E01_2%_051_Dep_Catchment_RevA.WOR



Title:
Upper Wimmera Flood Investigation
2% AEP Design Flood Velocity - Navarre

Figure:
C-14

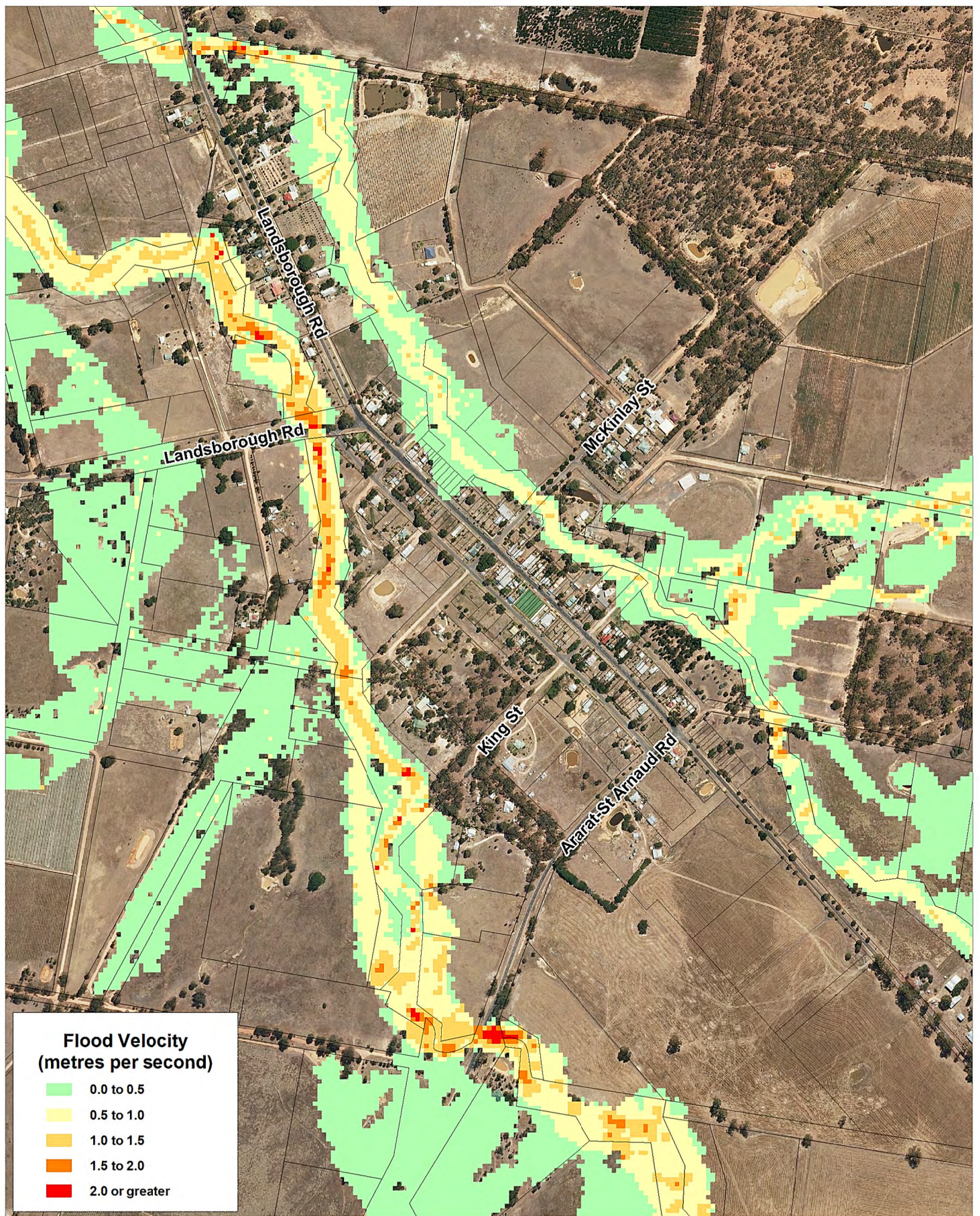
Rev:
A

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0 250 500m
 Approx. Scale





Title:
Upper Wimmera Flood Investigation
2% AEP Design Flood Velocity - Landsborough

Figure:
C-15

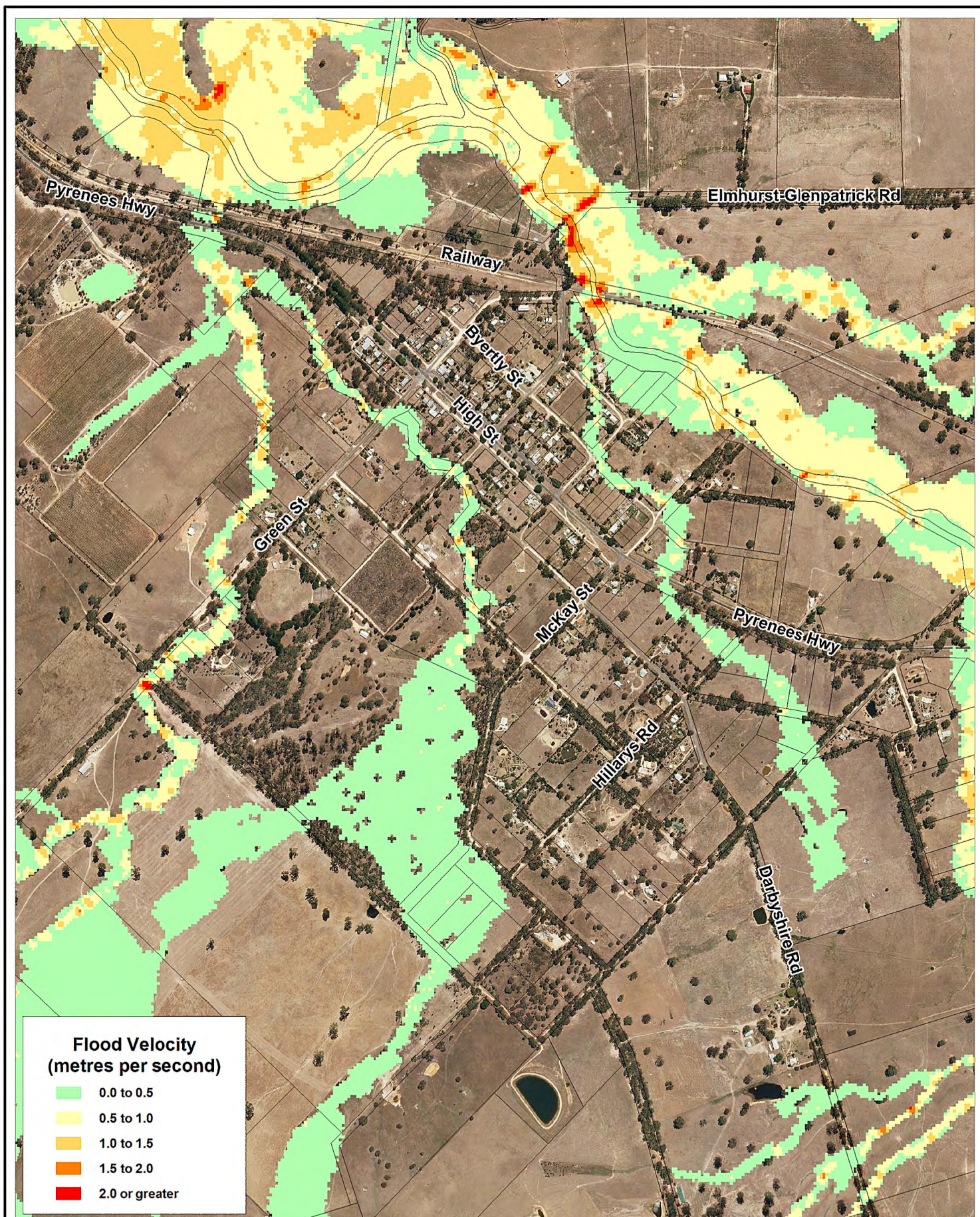
Rev:
A

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0 100 200m
 Approx. Scale





Title:
Upper Wimmera Flood Investigation
2% AEP Design Flood Velocity - Elmhurst

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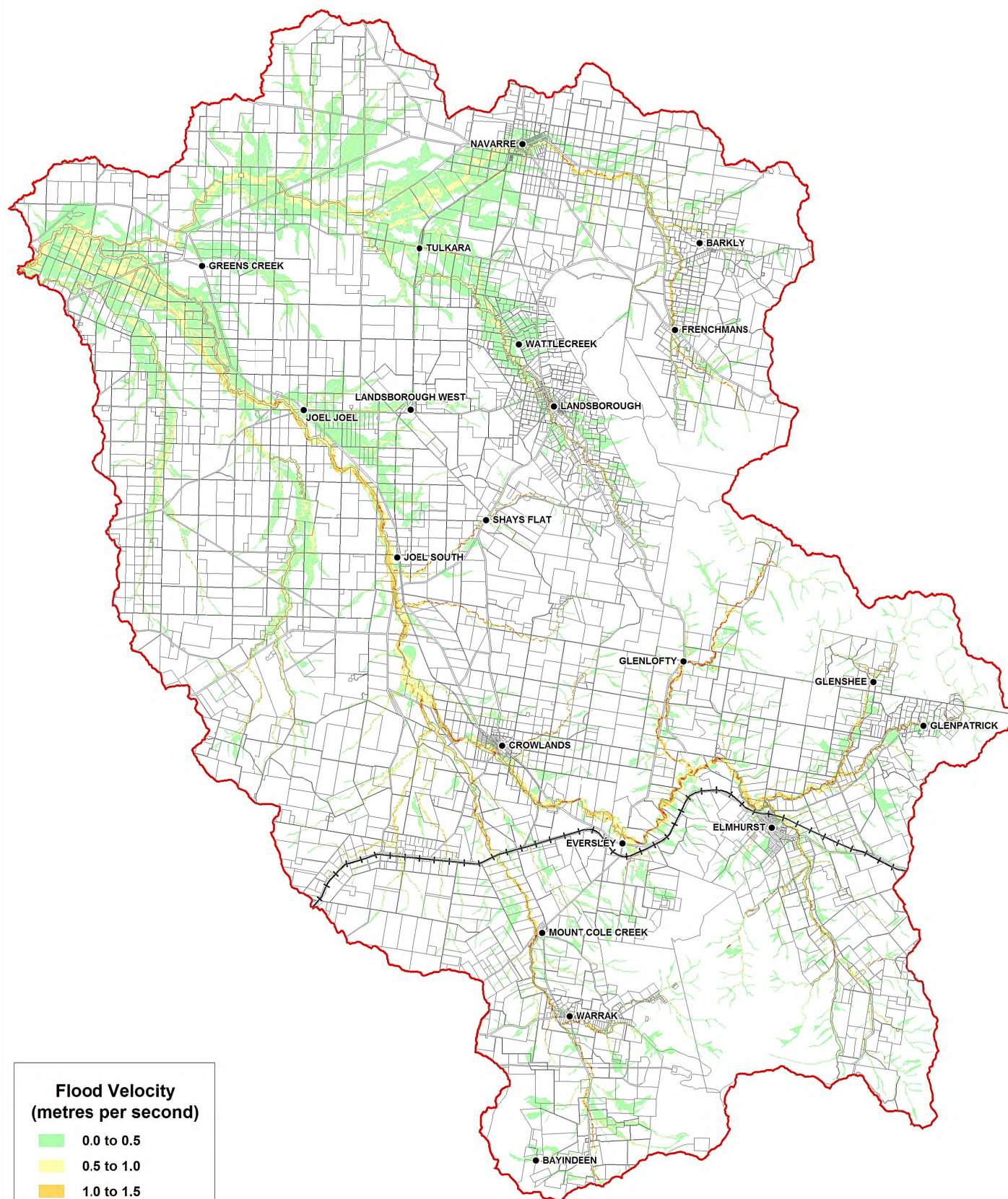
0 200 400m
 Approx. Scale

Figure:
C-16

Rev:
A



Filepath : T:\M8460.MT.WimmeraUpperFloodStudy\MapInfo\Drawings\R.M8460.009.01.Final\UW_Final_FigC-16_E01_2%_051_Dep_Elmhurst_RevA.WOR



Title:
Upper Wimmera Flood Investigation
1% AEP Design Flood Velocity - Catchment

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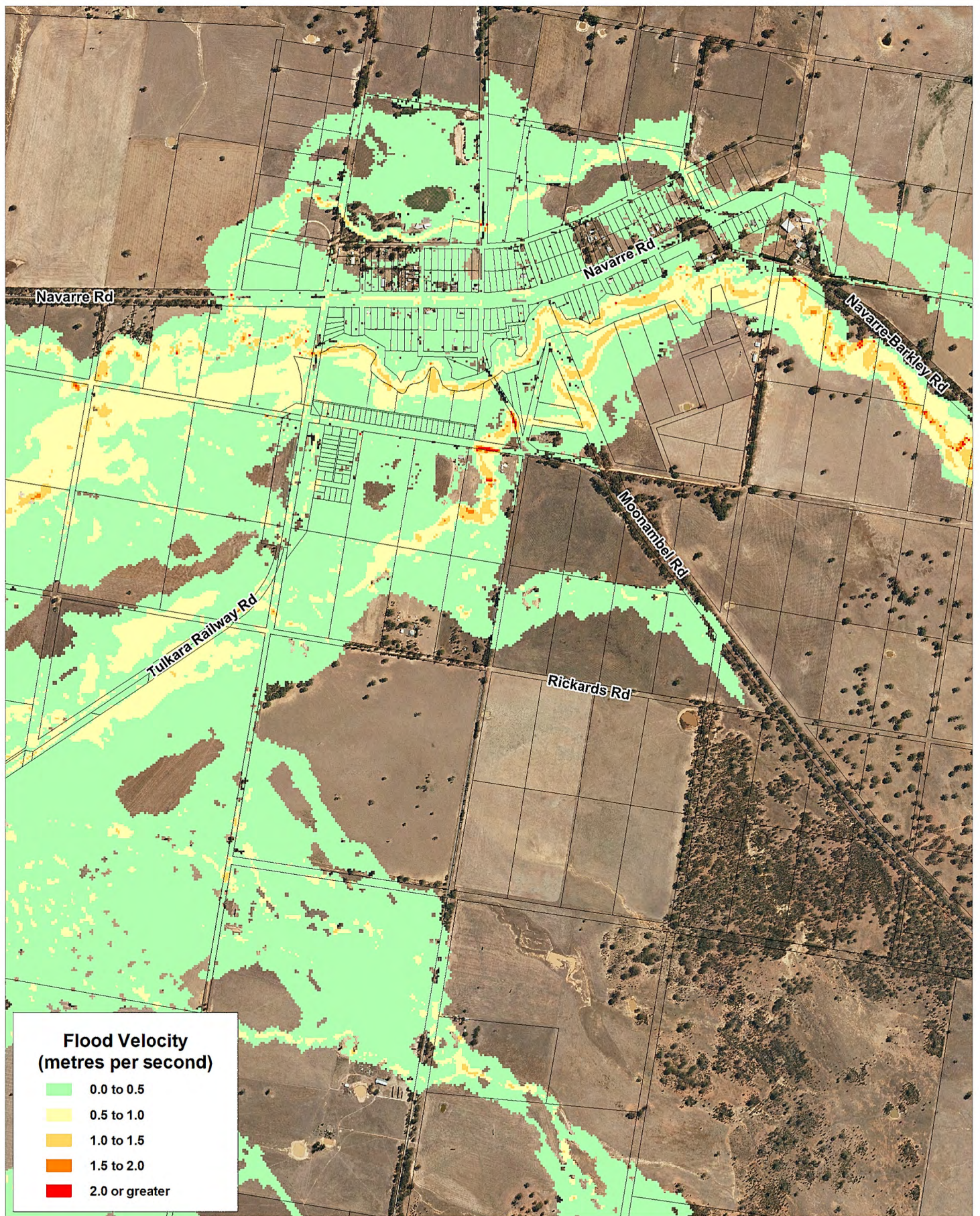
0 3.75 7.5km
 Approx. Scale

Figure:
C-17

Rev:
A



Filepath : T:\M8460.MT.WimmeraUpperFloodStudy\MapInfo\Drawings\R.M8460.009.01.Final\UW_Final_FigC-17_E01_1%_051_Vel_Catchment_RevA.WOR



Title:
Upper Wimmera Flood Investigation
1% AEP Design Flood Velocity - Navarre

Figure:
C-18

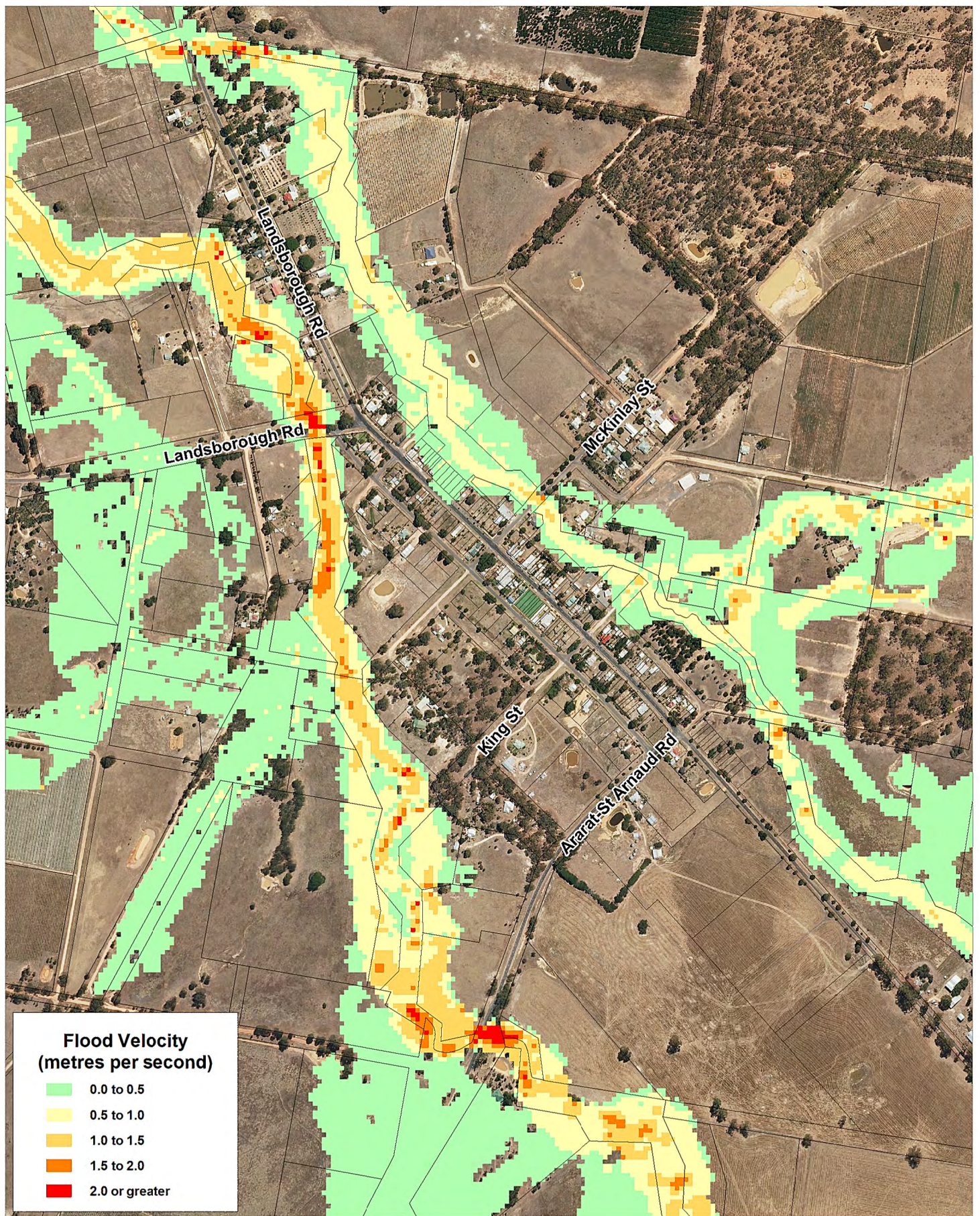
Rev:
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0 250 500m
 Approx. Scale





Title:
Upper Wimmera Flood Investigation
1% AEP Design Flood Velocity - Landsborough

Figure:
C-19

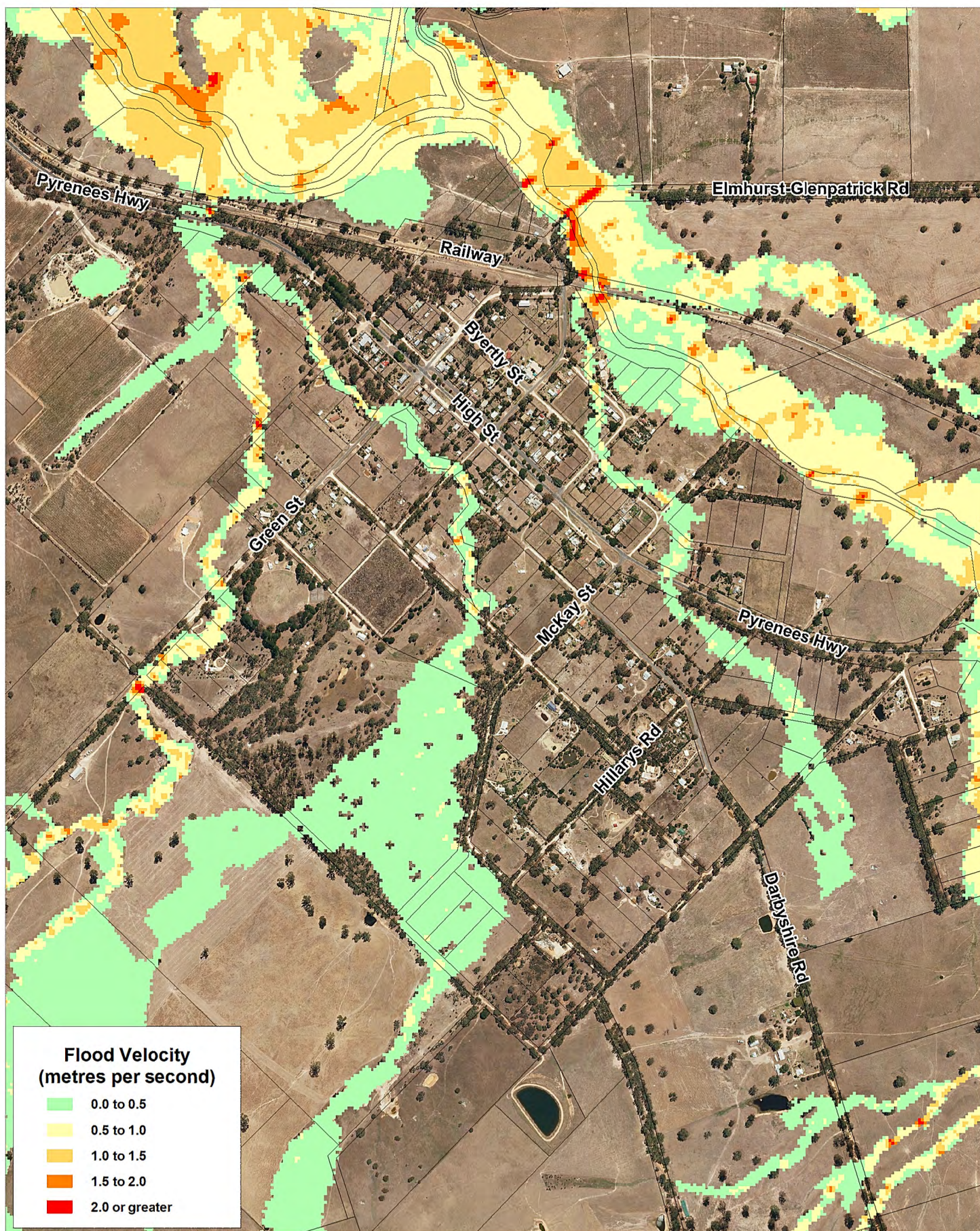
Rev:
A

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0 100 200m
 Approx. Scale





Title:
Upper Wimmera Flood Investigation
1% AEP Design Flood Velocity - Elmhurst

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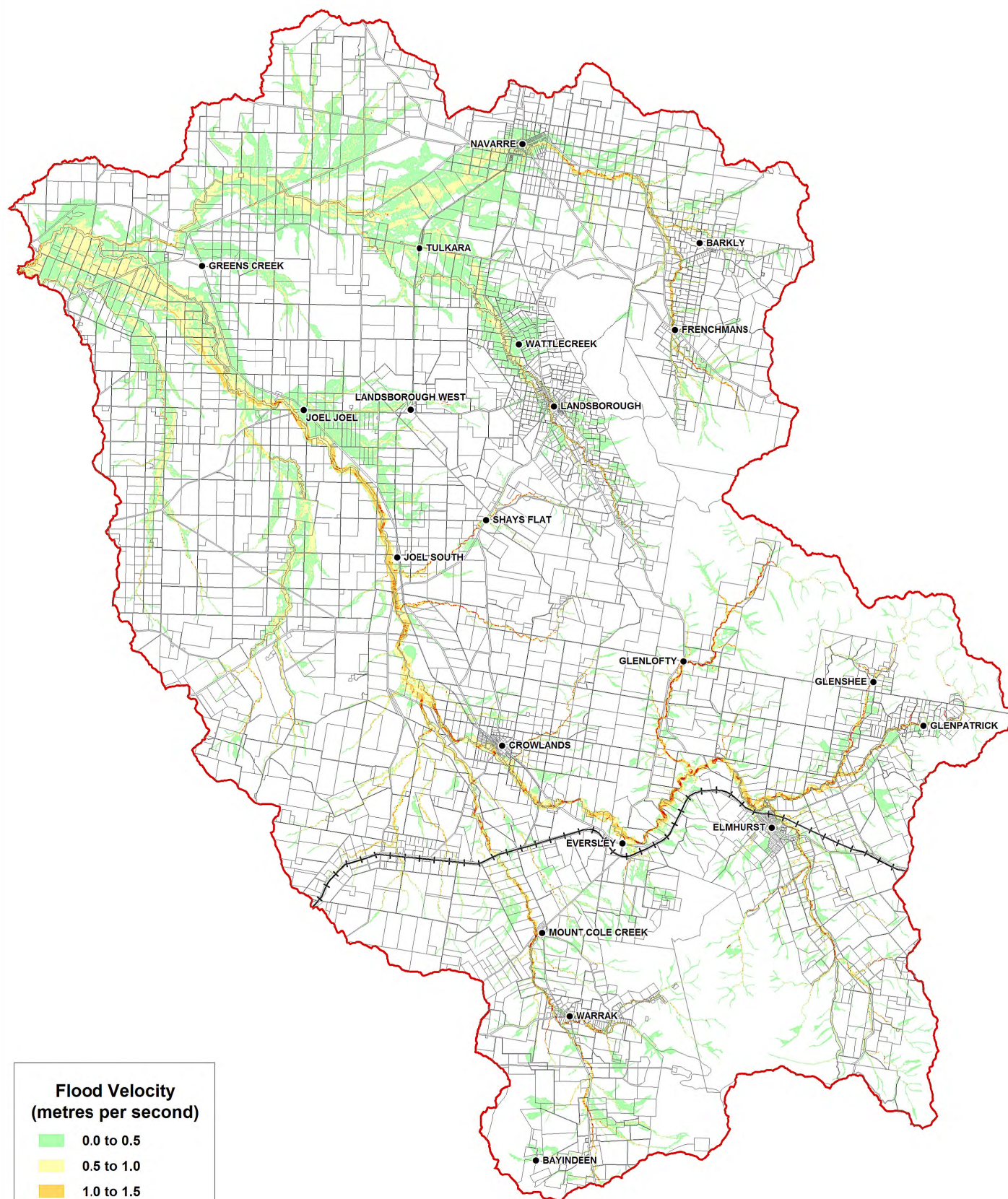
0 200 400m
 Approx. Scale

Figure:
C-20

Rev:
A



Filepath : T:\M8460.MT.WimmeraUpperFloodStudy\MapInfo\Drawings\R.M8460.009.01.Final\UW_Final_FigC-20_E01_1%_051_Vel_Elmhurst_RevA.WOR



**Flood Velocity
(metres per second)**

- 0.0 to 0.5
- 0.5 to 1.0
- 1.0 to 1.5
- 1.5 to 2.0
- 2.0 or greater

Title:
Upper Wimmera Flood Investigation
0.5% AEP Design Flood Velocity - Catchment

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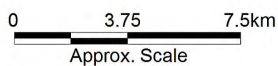
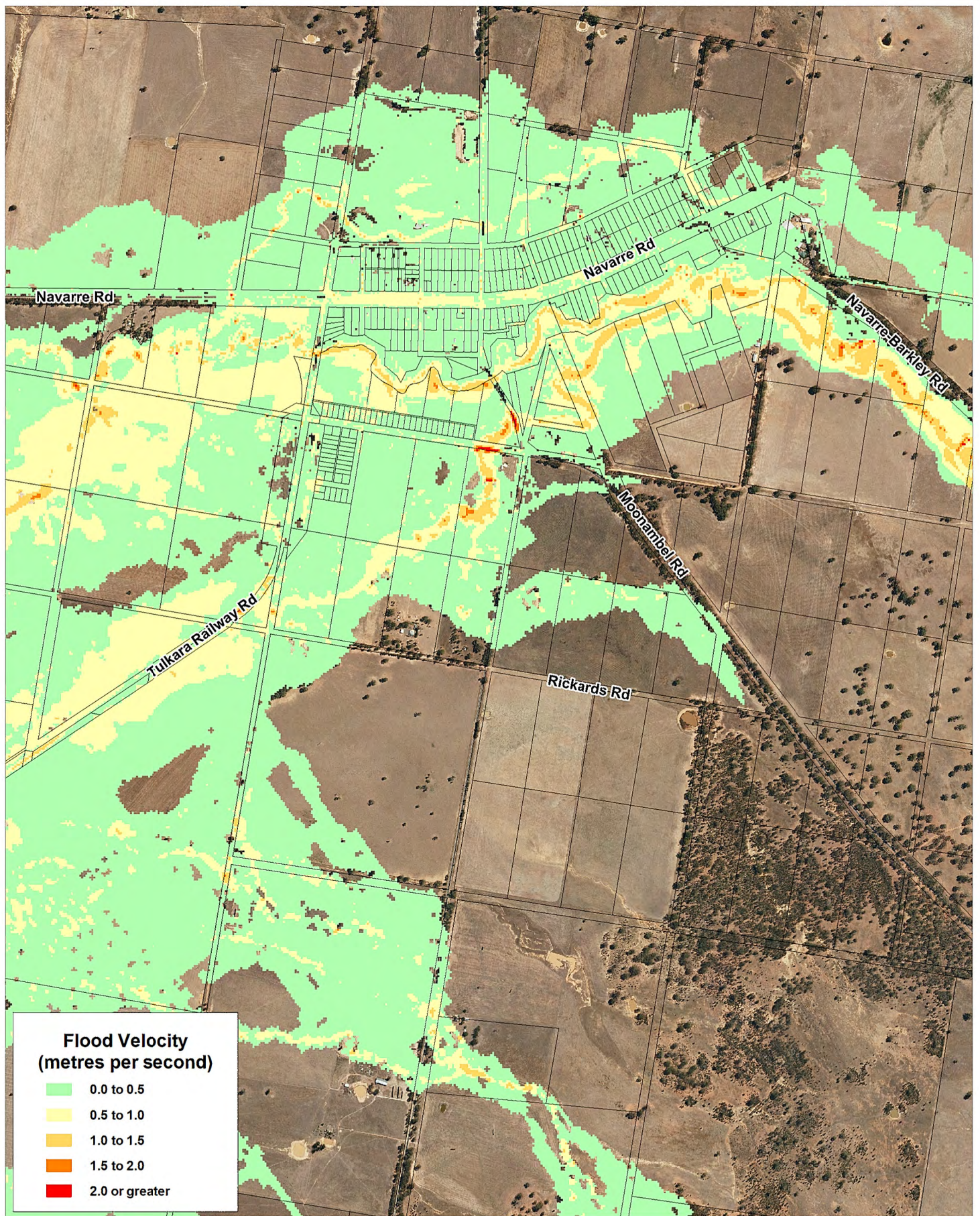


Figure:
C-21

Rev:
A





Title:
Upper Wimmera Flood Investigation
0.5% AEP Design Flood Velocity - Navarre

Figure:
C-22

Rev:
A

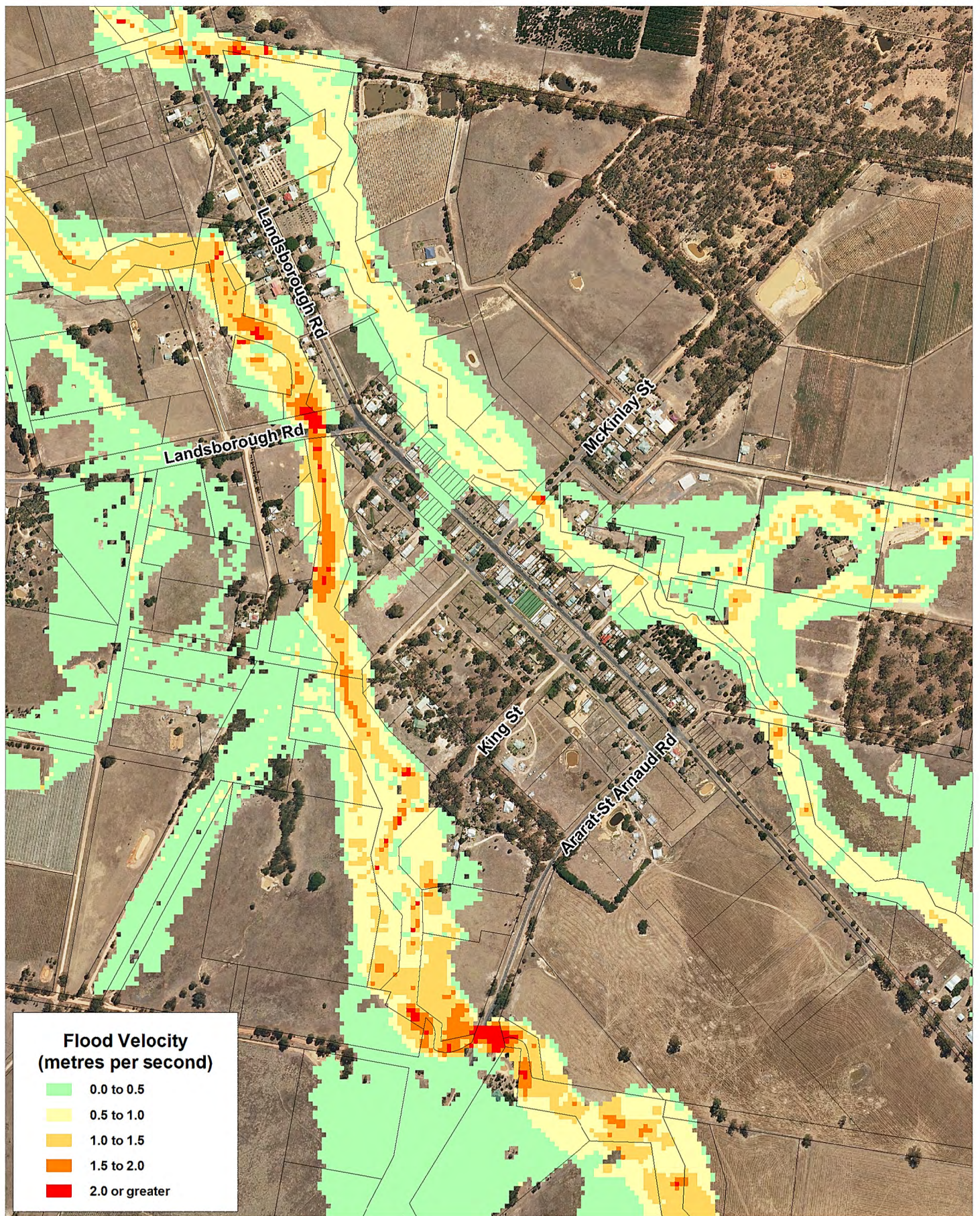
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0 250 500m
 Approx. Scale



Filepath : T:\M8460.MT.WimmeraUpperFloodStudy\MapInfo\Drawings\R.M8460.009.01.FinalUW_Final_FigC-22_E01_0.5%_051_Dep_Navarre_RevA.WOR



Title:
Upper Wimmera Flood Investigation
0.5% AEP Design Flood Velocity - Landsborough

Figure:
C-23

Rev:
A

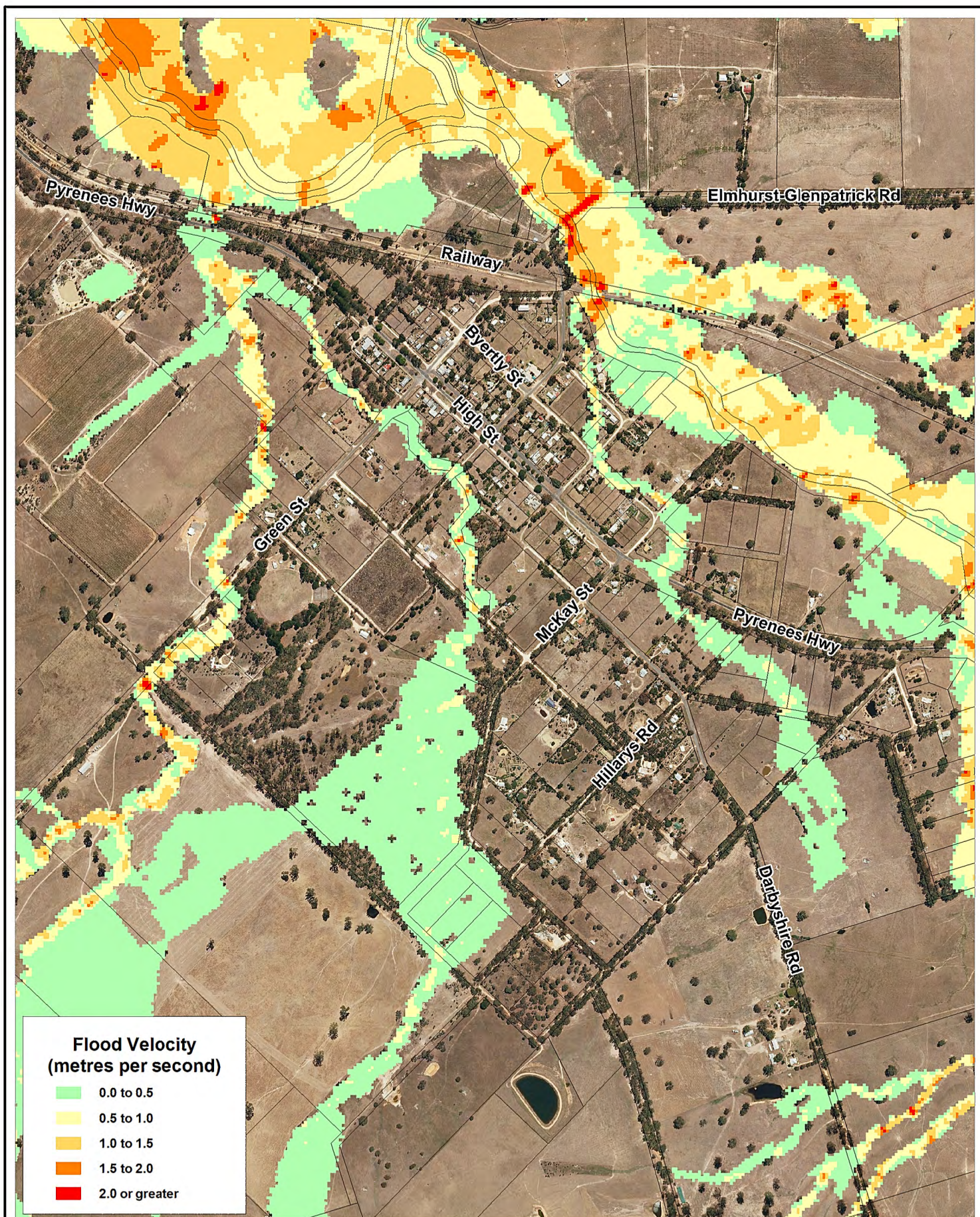
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0 100 200m
 Approx. Scale



Filepath : T:\M8460.MT.WimmeraUpperFloodStudy\MapInfo\Drawings\R.M8460.009.01.Final\UW_Final_FigC-23_E01_0.5%_051_Dep_Landsborough_RevA.WOR



Title:
Upper Wimmera Flood Investigation
0.5% AEP Design Flood Velocity - Elmhurst

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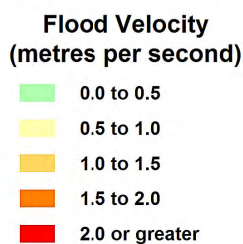
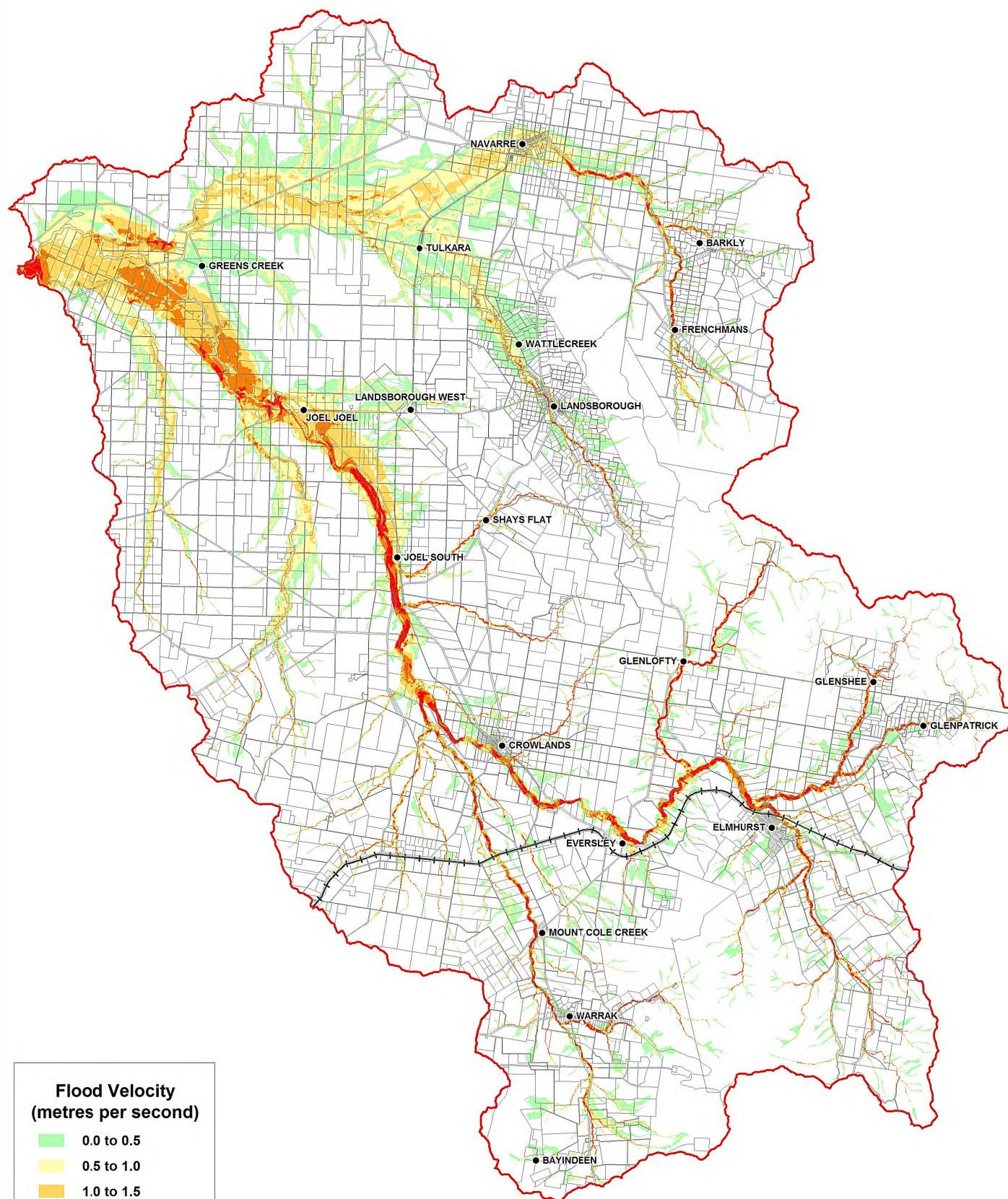
0 200 400m
 Approx. Scale

Figure:
C-24

Rev:
A



Filepath : T:\M8460.MT.WimmeraUpperFloodStudy\MapInfo\Drawings\R.M8460.009.01.Final\UW_Final_FigC-24_E01_0.5%_051_Dep_Elmhurst_RevA.WOR



Title:
**Upper Wimmera Flood Investigation
Probable Maximum Flood Velocity - Catchment**

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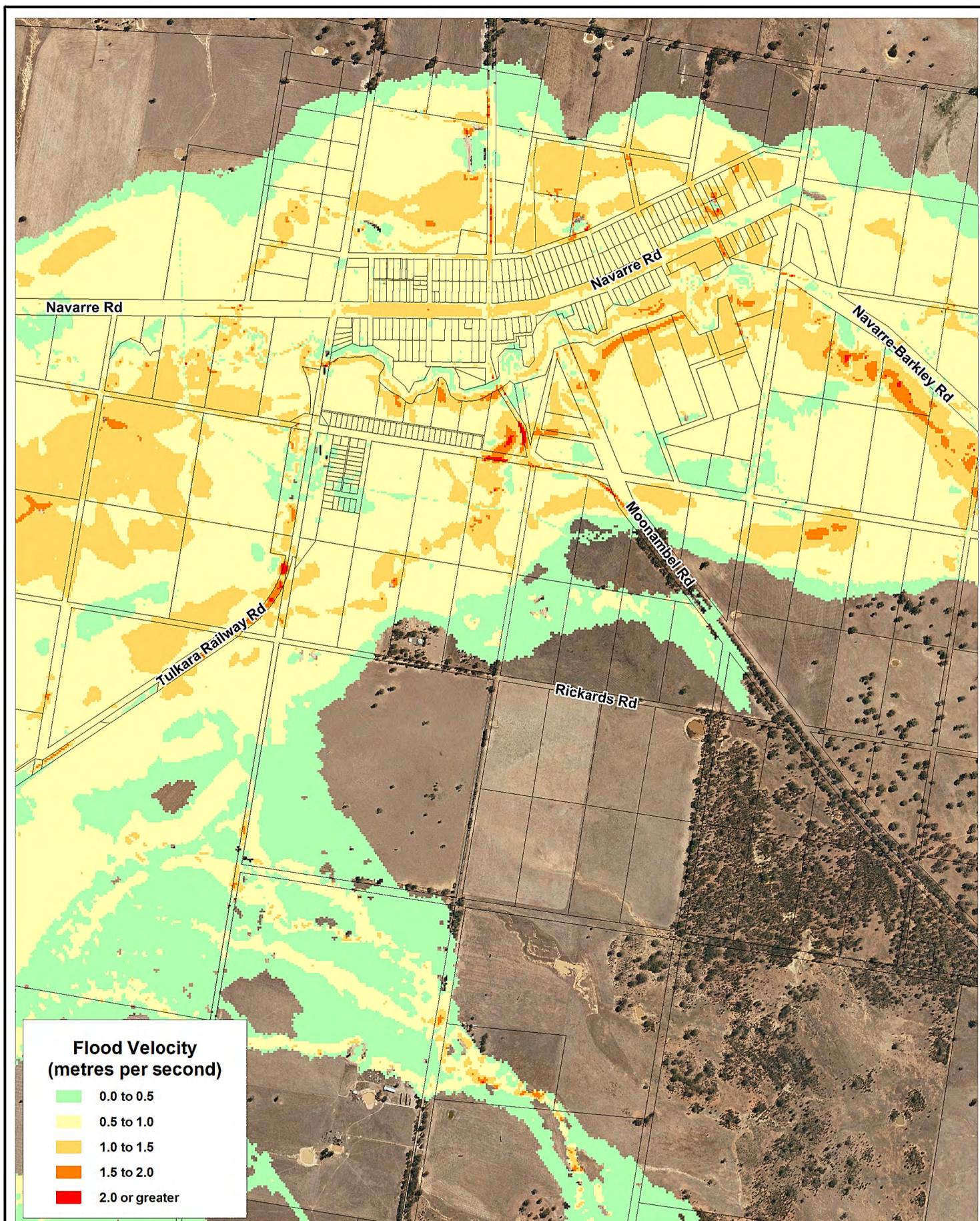
0 3.75 7.5km
Approx. Scale

Figure:
C-25

Rev:
A



Filepath : T:\M8460.MT.WimmeraUpperFloodStudy\MapInfoDrawings\R.M8460.009.01.Final\UW_Final_FigC-25_E01_PMF_051_Dep_Catchment_RevA.WOR



Title:
Upper Wimmera Flood Investigation
Probable Maximum Flood Velocity - Navarre

Figure:
C-26

Rev:
A

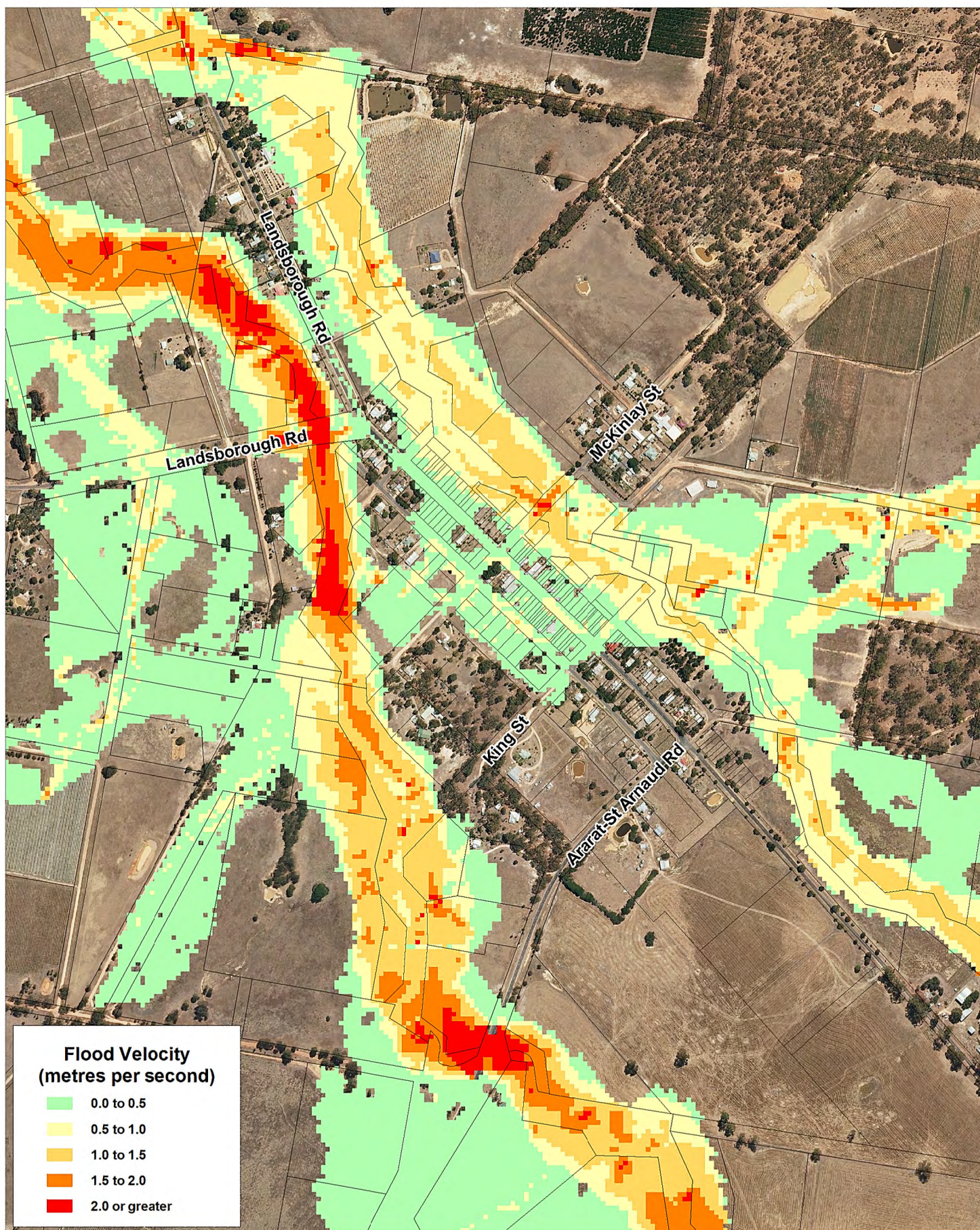
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0 250 500m
 Approx. Scale



Filepath : T:\M8460.MT.WimmeraUpperFloodStudy\MapInfo\Drawings\R.M8460.009.01.Final\UW_Final_FigC-26_E01_PMF_051_Dep_Navarre_RevA.WOR



Title:
Upper Wimmera Flood Investigation
Probable Maximum Flood Velocity - Landsborough

Figure:
C-27

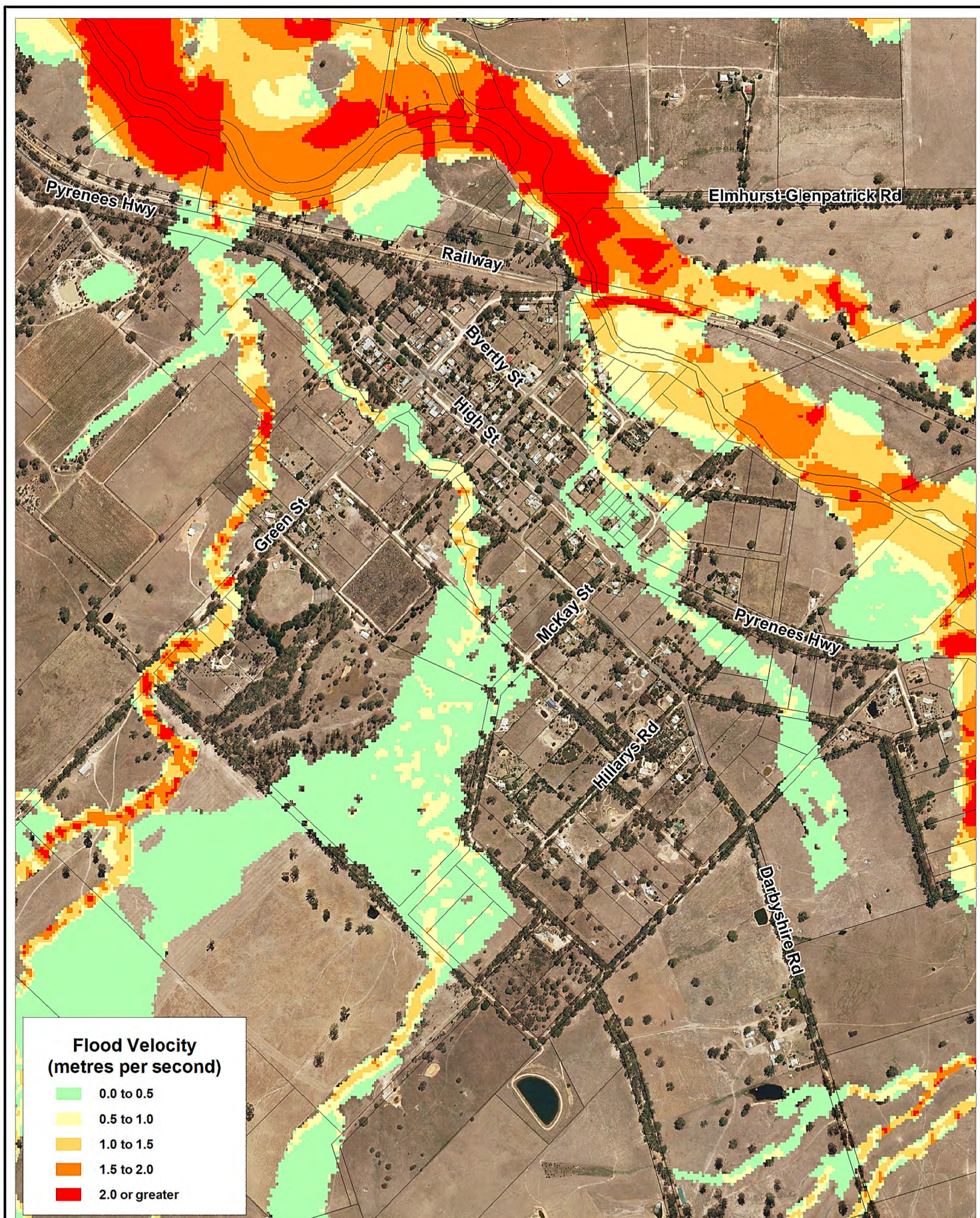
Rev:
A

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0 100 200m
 Approx. Scale





Title:
Upper Wimmera Flood Investigation
Probable Maximum Flood Velocity - Elmhurst

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0 200 400m
 Approx. Scale

Figure:
C-28

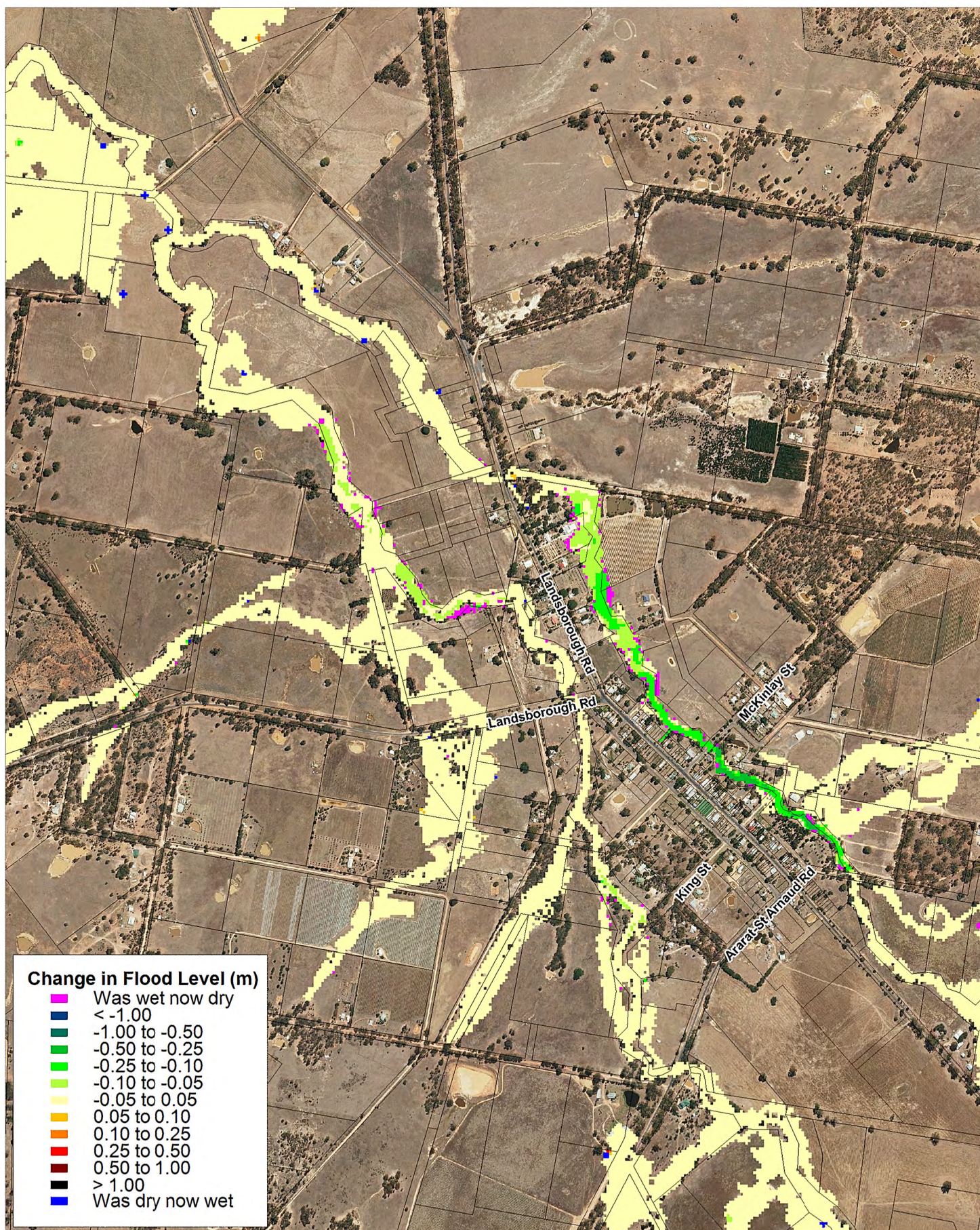
Rev:
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Filepath : T:\M8460.MT.WimmeraUpperFloodStudy\MapInfo\Drawings\R.M8460.009.01.FinalUW_Final_FigC-28_E01_PMF_051_Dep_Elmhurst_RevA.WOR

Appendix D Mitigation Scenarios – Flood Impact Assessment

D.1 Mitigation Assessment Scenario 1 – Vegetation Removal



Title:
**Upper Wimmera Flood Investigation - Mitigation Option 1
 Vegetation Removal - 20% AEP Flood Height Impacts**

Figure:

D1-1

Rev:

A

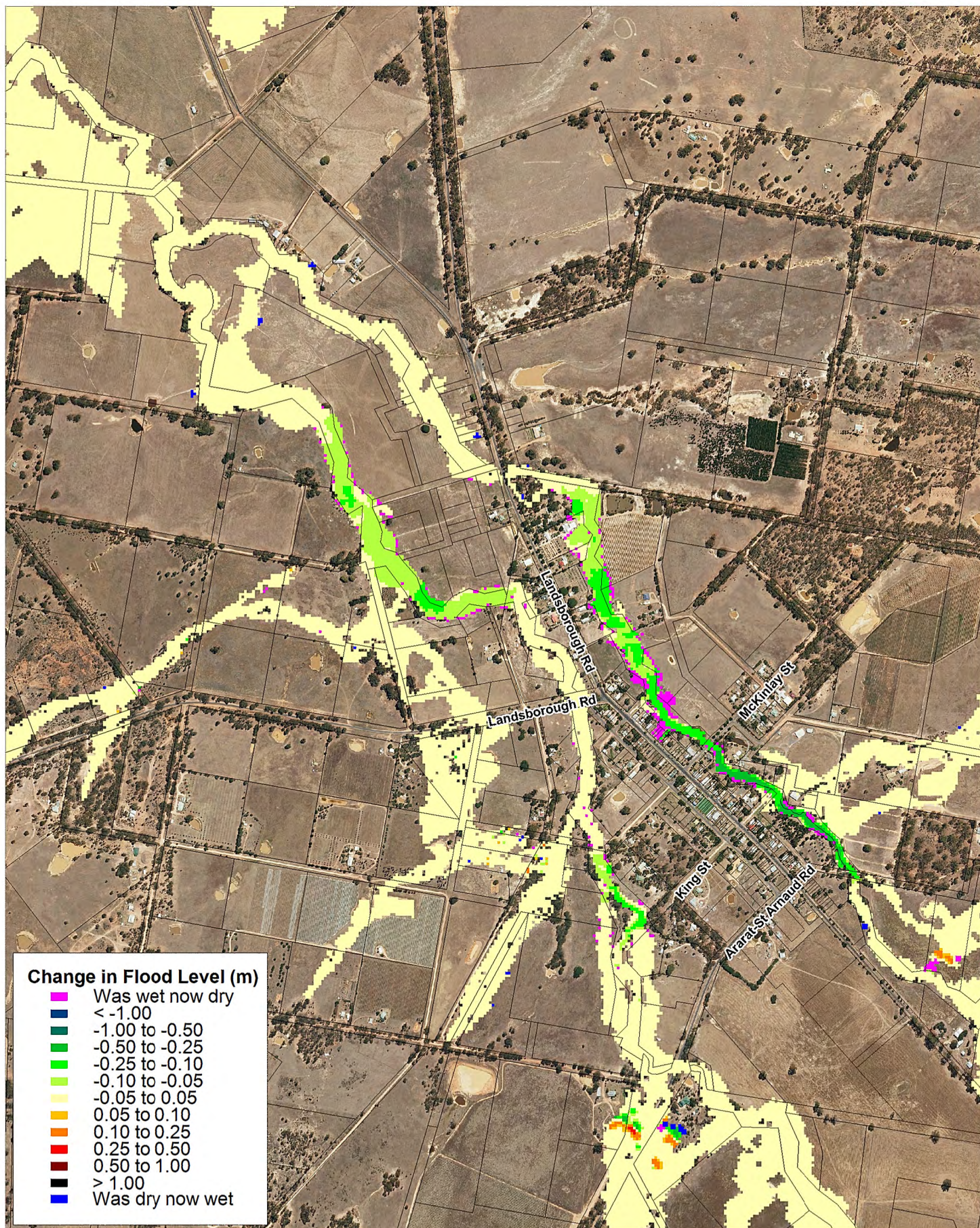
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0 100 200m
 Approx. Scale



Filepath : T:\M8460.MT.WimmeraUpperFloodStudy\MapInfo\Drawings\R.M8460.009.01.FinalUW_Final_FigD1-1_M01_20%_Lands_RevA.WOR



Title:
**Upper Wimmera Flood Investigation - Mitigation Option 1
 Vegetation Removal - 10% AEP Flood Height Impacts**

Figure:

D1-2

Rev:

A

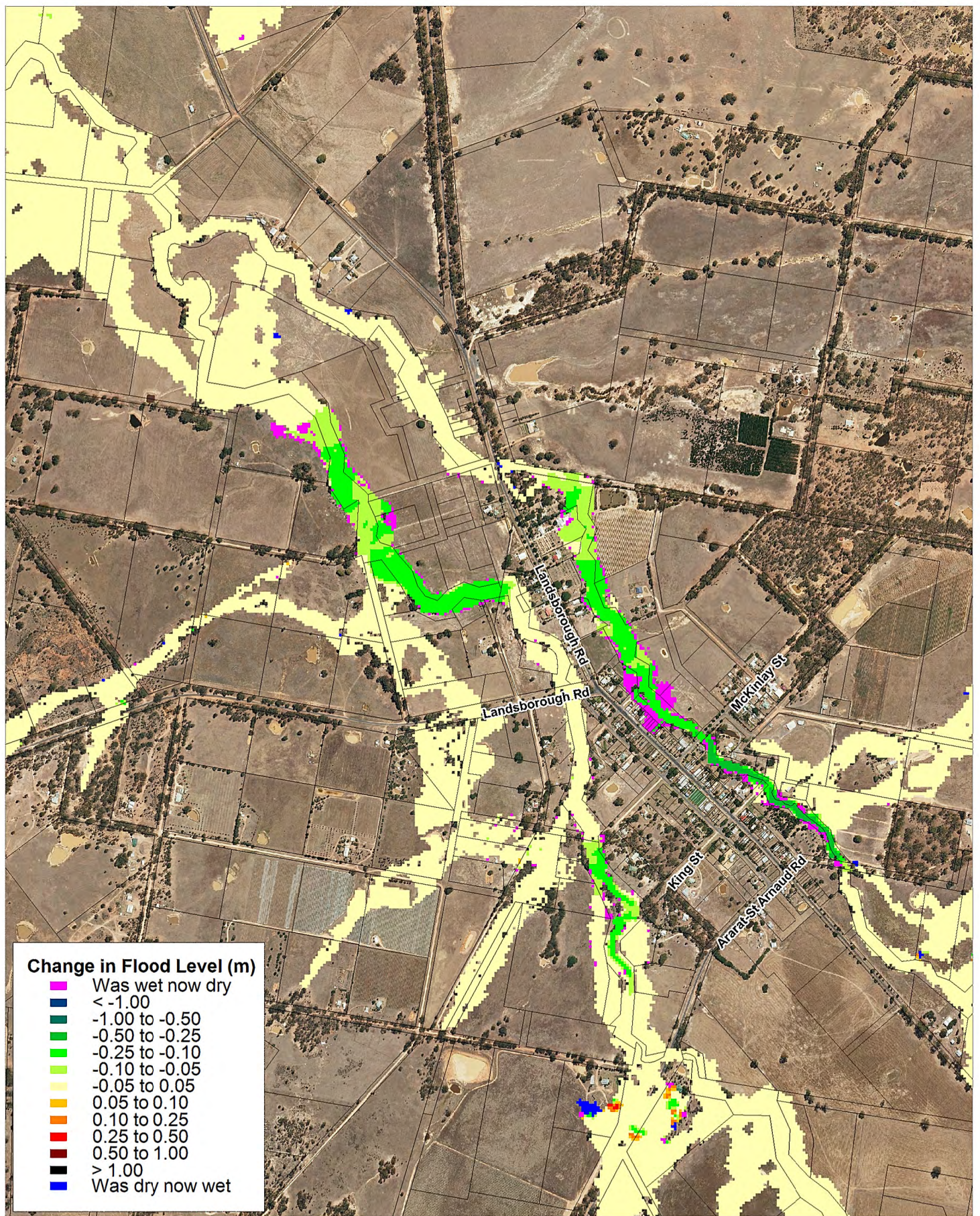
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0 100 200m
 Approx. Scale



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Title:
**Upper Wimmera Flood Investigation - Mitigation Option 1
 Vegetation Removal - 5% AEP Flood Height Impacts**

Figure:
D1-3

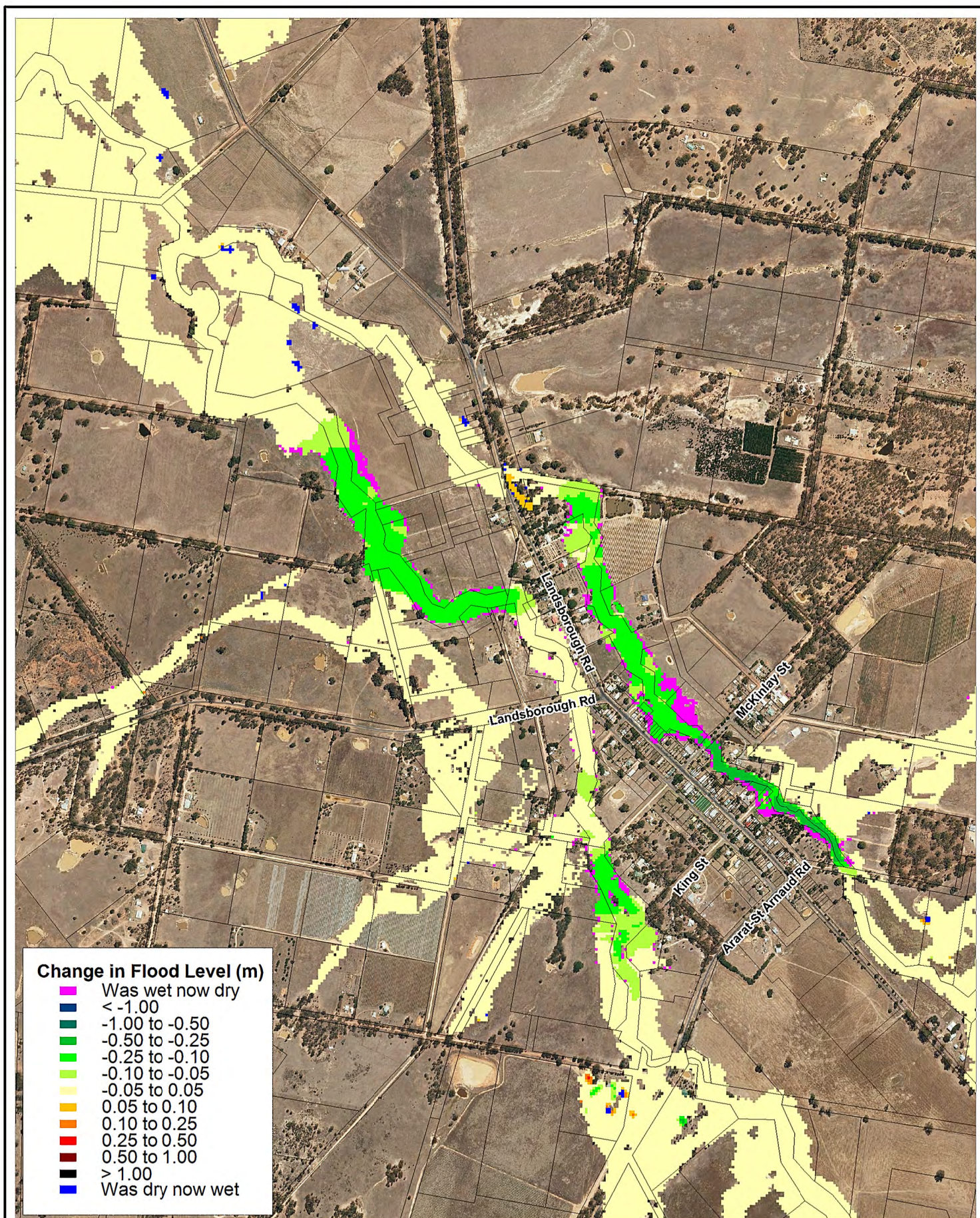
Rev:
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0 100 200m
 Approx. Scale





Title:
**Upper Wimmera Flood Investigation - Mitigation Option 1
 Vegetation Removal - 2% AEP Flood Height Impacts**

Figure:
D1-4

Rev:
A

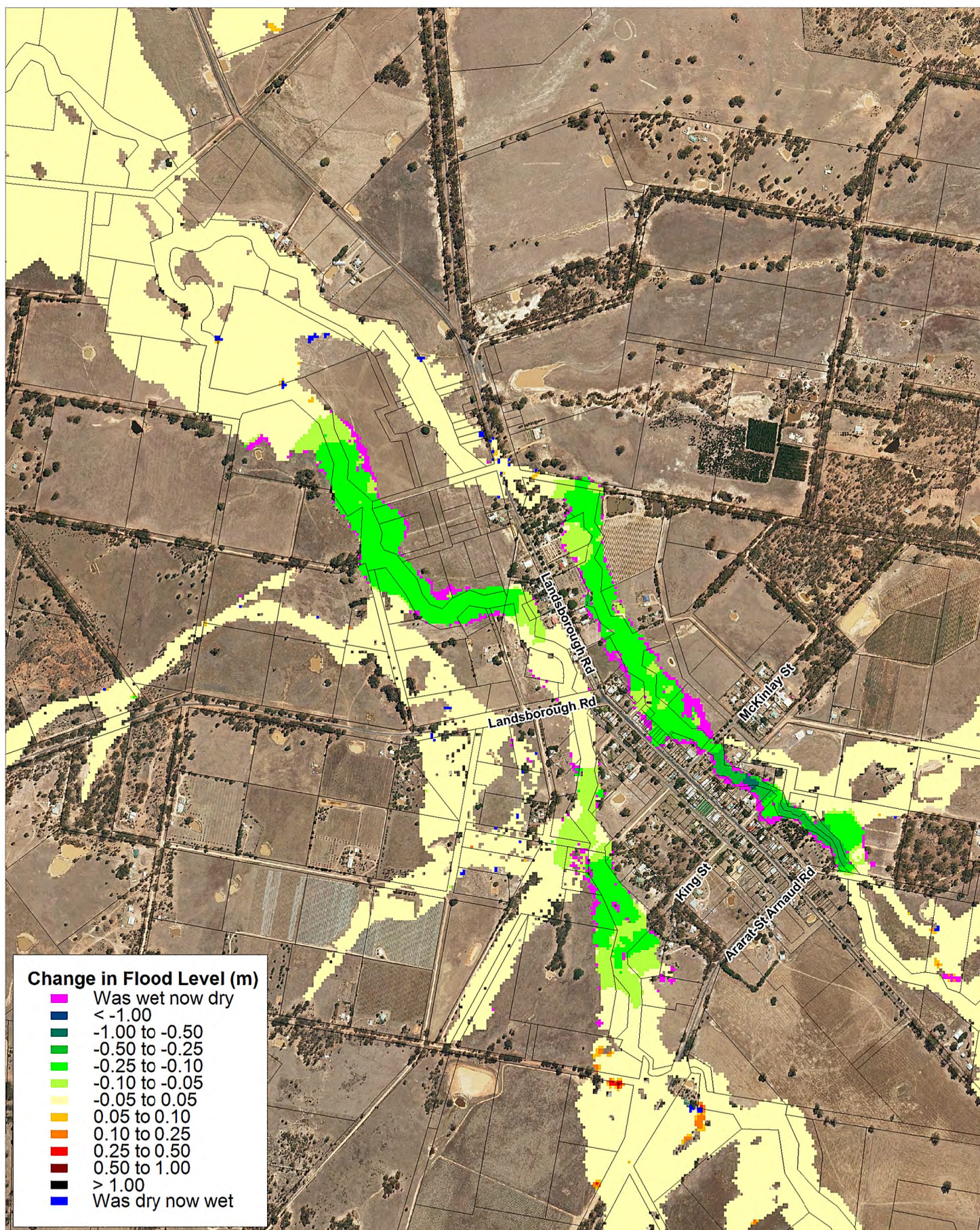
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0 100 200m
 Approx. Scale



Filepath : T:\M8460.MT.WimmeraUpperFloodStudy\MapInfo\Drawings\R.M8460.009.01.FinalUW_Final_FigD1-4_M01_2%_Lands_RevA.WOR



Title:
**Upper Wimmera Flood Investigation - Mitigation Option 1
 Vegetation Removal - 1% AEP Flood Height Impacts**

Figure:
D1-5

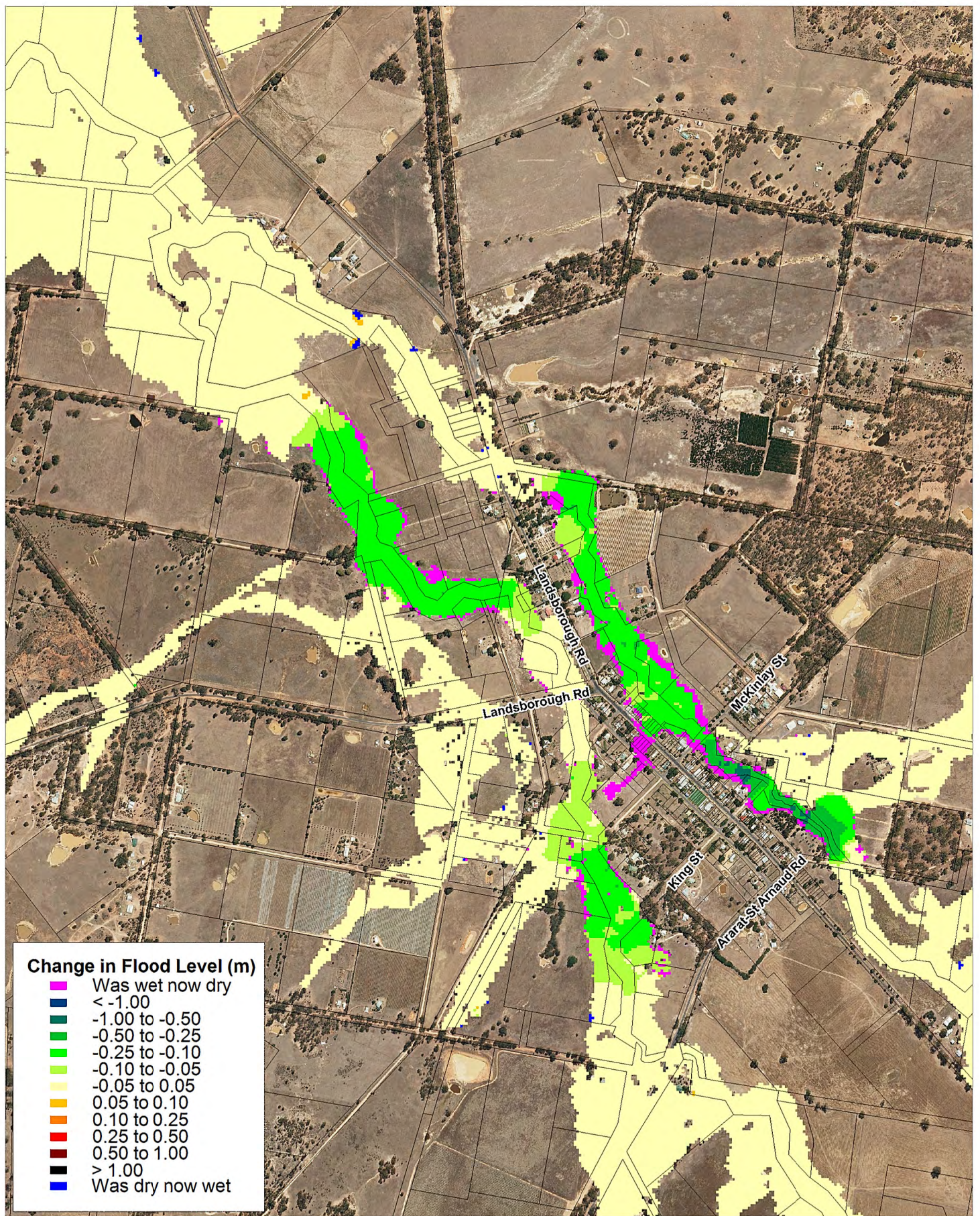
Rev:
A

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0 100 200m
 Approx. Scale





Title:
**Upper Wimmera Flood Investigation - Mitigation Option 1
 Vegetation Removal - 200 Year ARI Flood Height Impacts**

Figure:
D1-6

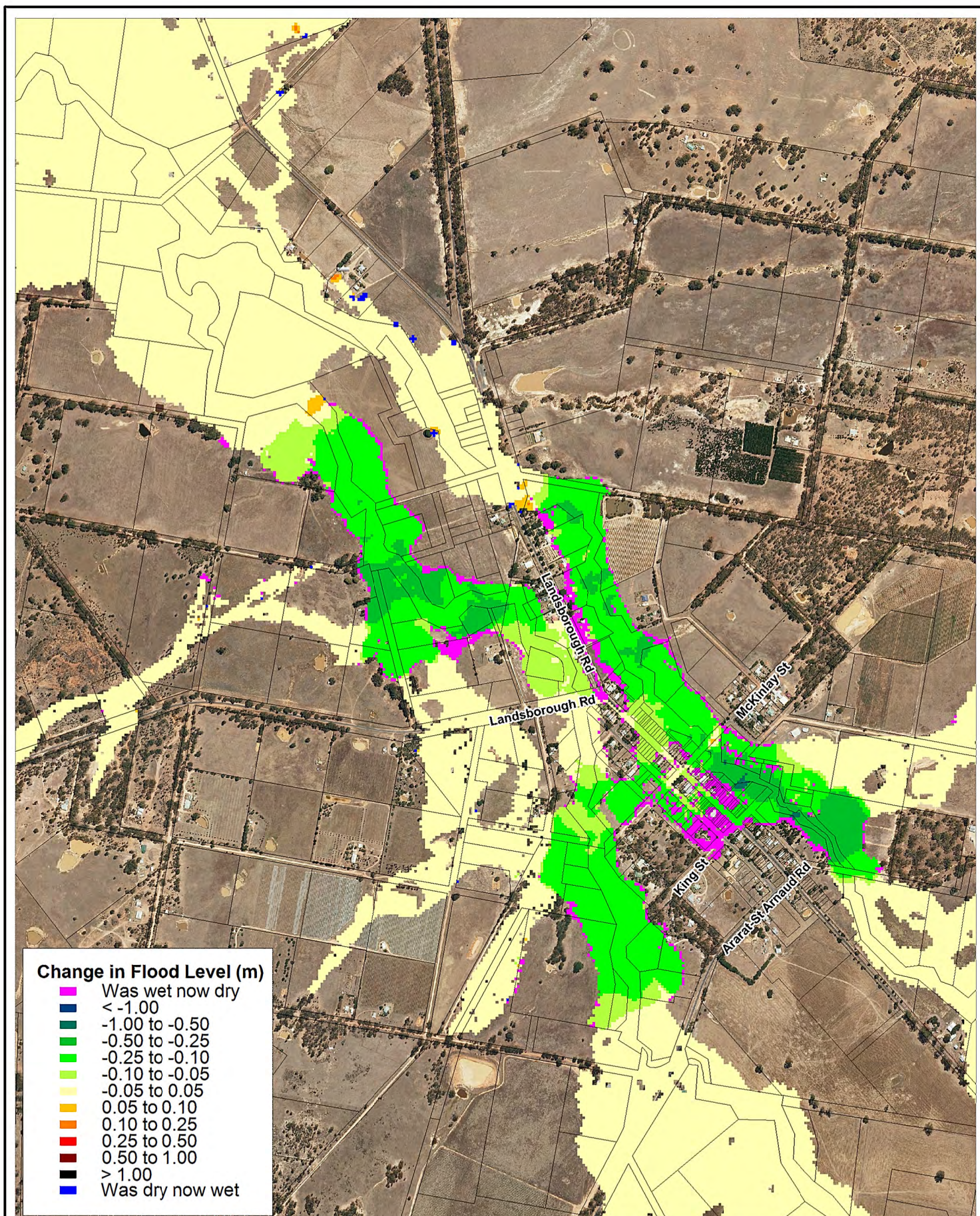
Rev:
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0 100 200m
 Approx. Scale





Title:
**Upper Wimmera Flood Investigation - Mitigation Option 1
 Vegetation Removal - PMF Flood Height Impacts**

Figure:
D1-7

Rev:
A

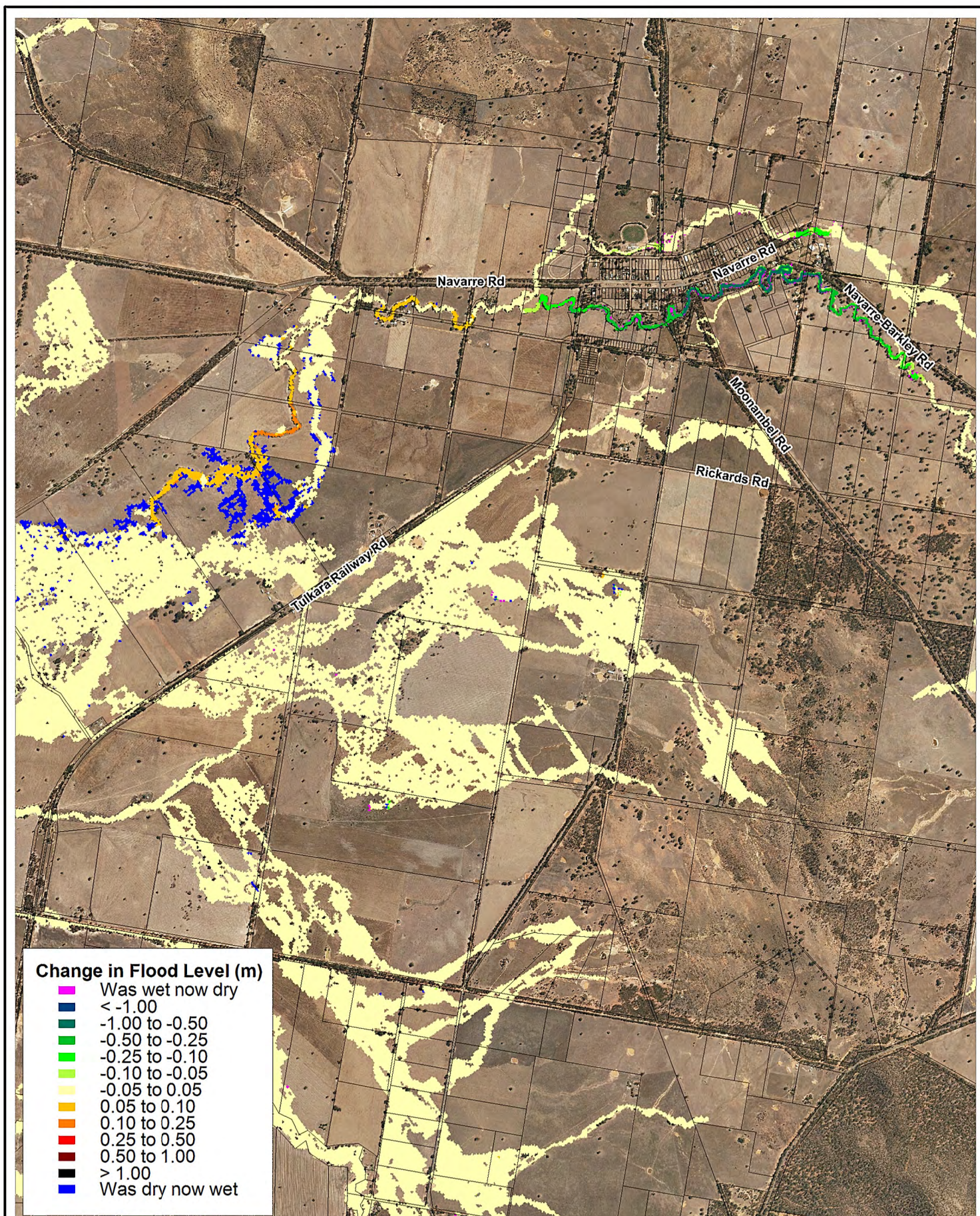
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0 100 200m
 Approx. Scale



Filepath : T:\M8460.MT.WimmeraUpperFloodStudy\MapInfo\Drawings\R.M8460.009.01.FinalUW_Final_FigD1-7_M01_PMF_Lands_RevA.WOR



Title:
**Upper Wimmera Flood Investigation - Mitigation Option 1
 Vegetation Removal - 20% AEP Flood Height Impacts**

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0 0.5 1km
 Approx. Scale

Figure:

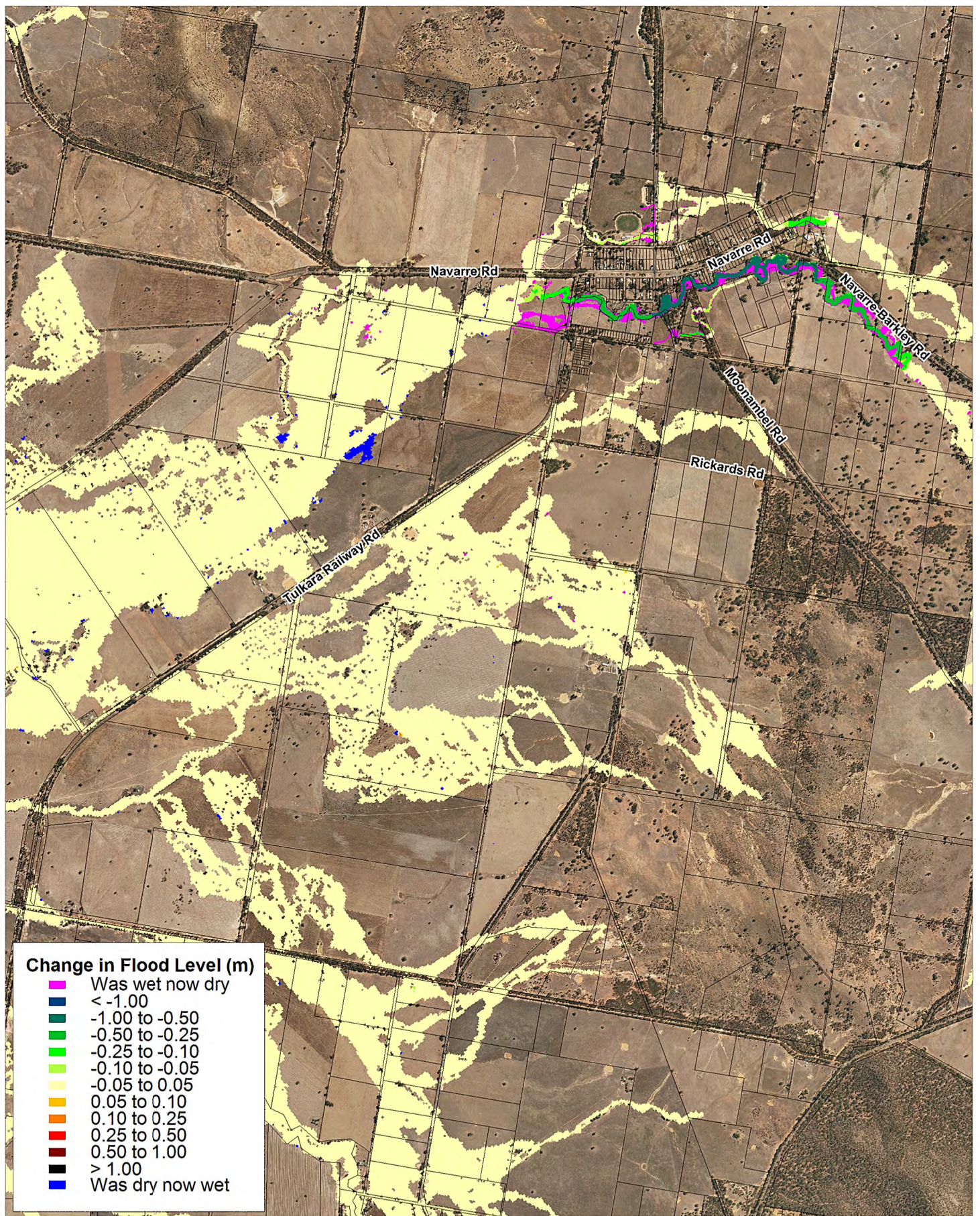
D1-8

Rev:

A



Filepath : T:\M8460.MT.WimmeraUpperFloodStudy\MapInfo\Drawings\R.M8460.009.01.FinalUW_Final_FigD1-8_M01_20%_Nav_RevA.WOR



Title:
Upper Wimmera Flood Investigation - Mitigation Option 1
Vegetation Removal - 10% AEP Flood Height Impacts

Figure:

D1-9

Rev:

A

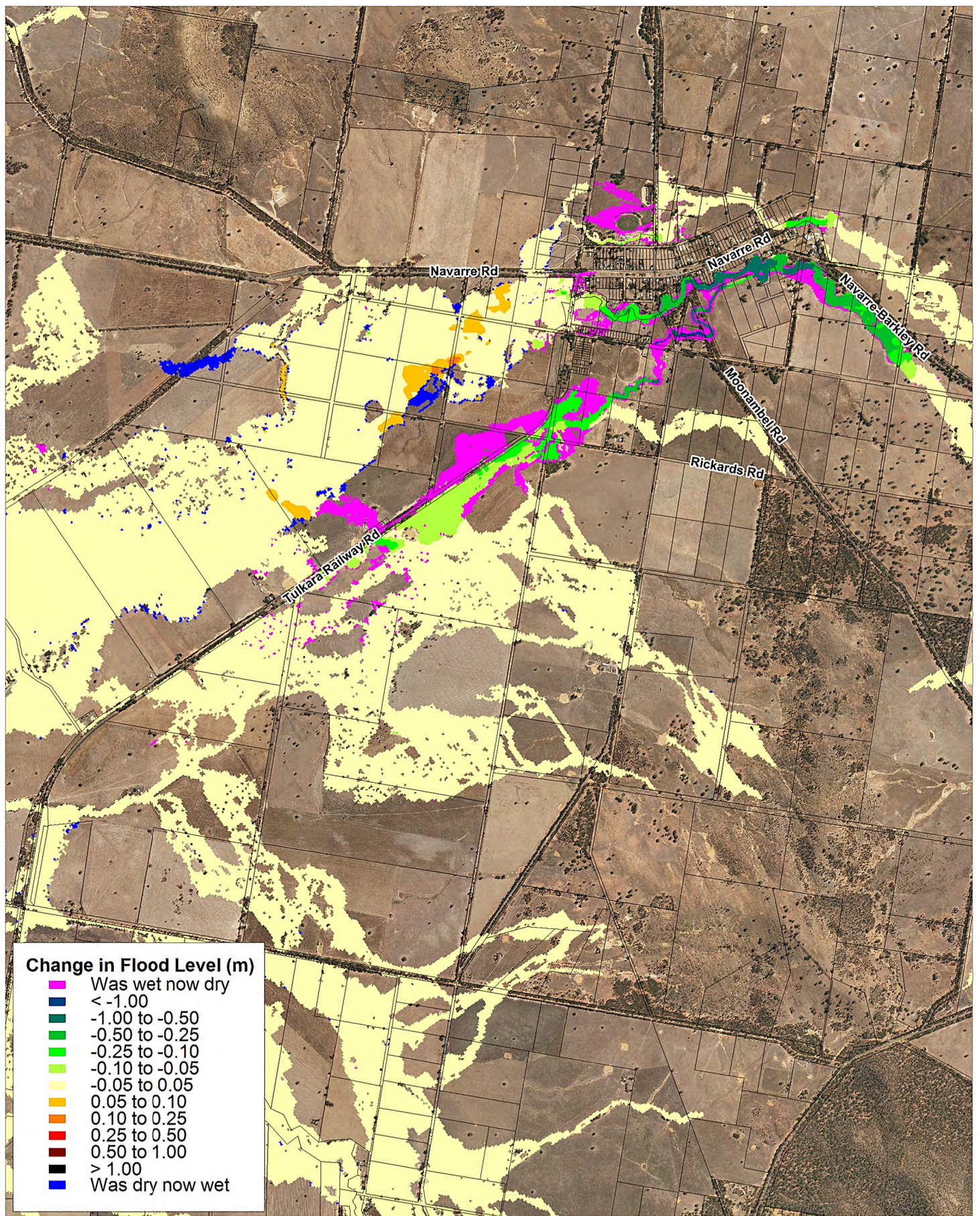
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0 0.5 1km
 Approx. Scale



Filepath : T:\M8460.MT.WimmeraUpperFloodStudy\MapInfo\Drawings\R.M8460.009.01.FinalUW_Final_FigD1-9_M01_10%_Nav_RevA.WOR



Title:
Upper Wimmera Flood Investigation - Mitigation Option 1
Vegetation Removal - 5% AEP Flood Height Impacts

Figure:
D1-10

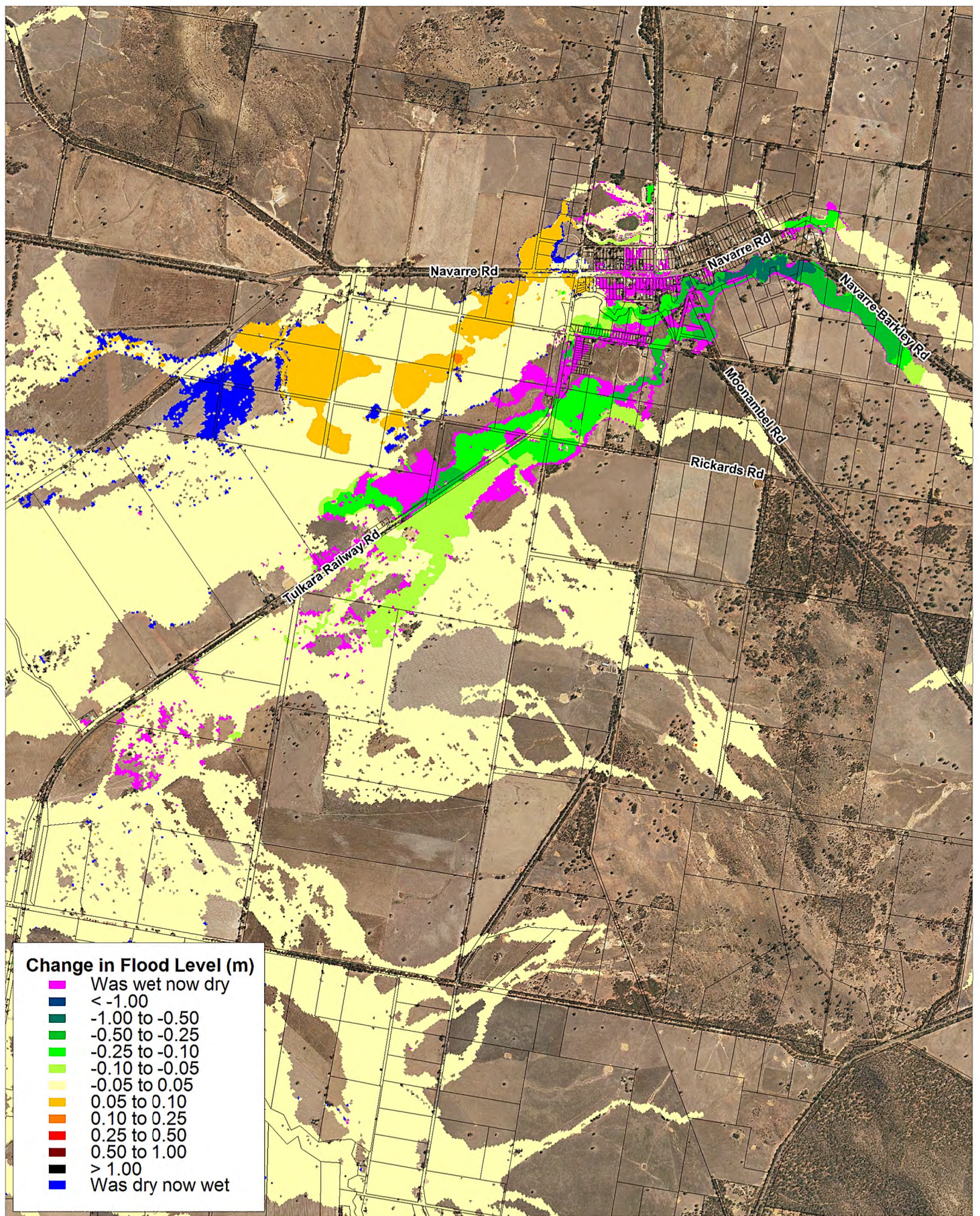
Rev:
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0 0.5 1km
 Approx. Scale





Title:
**Upper Wimmera Flood Investigation - Mitigation Option 1
 Vegetation Removal - 2% AEP Flood Height Impacts**

Figure:
D1-11

Rev:
A

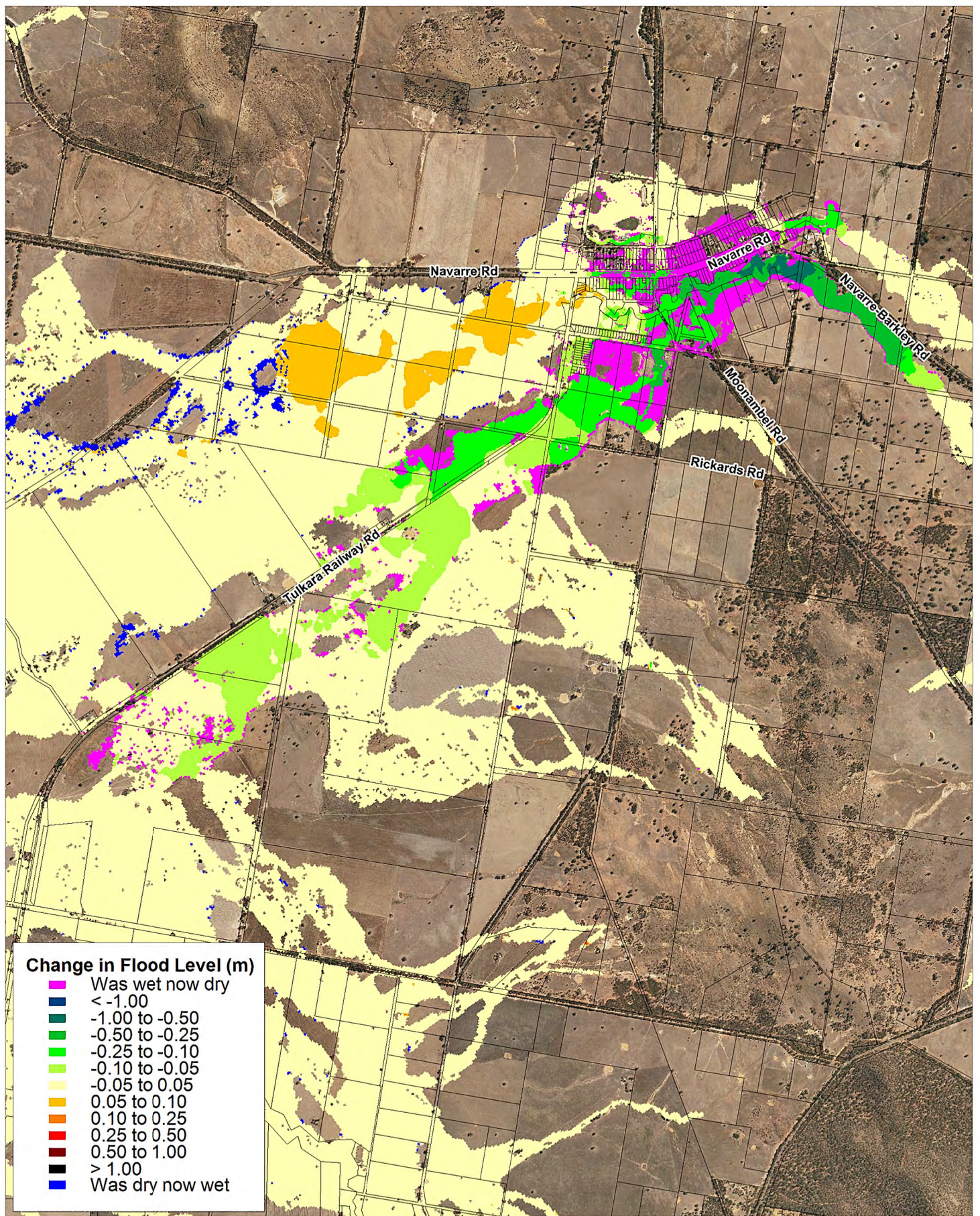
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0 0.5 1km
 Approx. Scale



Filepath : T:\M8460.MT.WimmeraUpperFloodStudy\MapInfo\Drawings\R.M8460.009.01.FinalUW_Final_FigD1-11_M01_2%_Nav_RevA.WOR



Title:
**Upper Wimmera Flood Investigation - Mitigation Option 1
 Vegetation Removal - 1% AEP Flood Height Impacts**

Figure:
D1-12

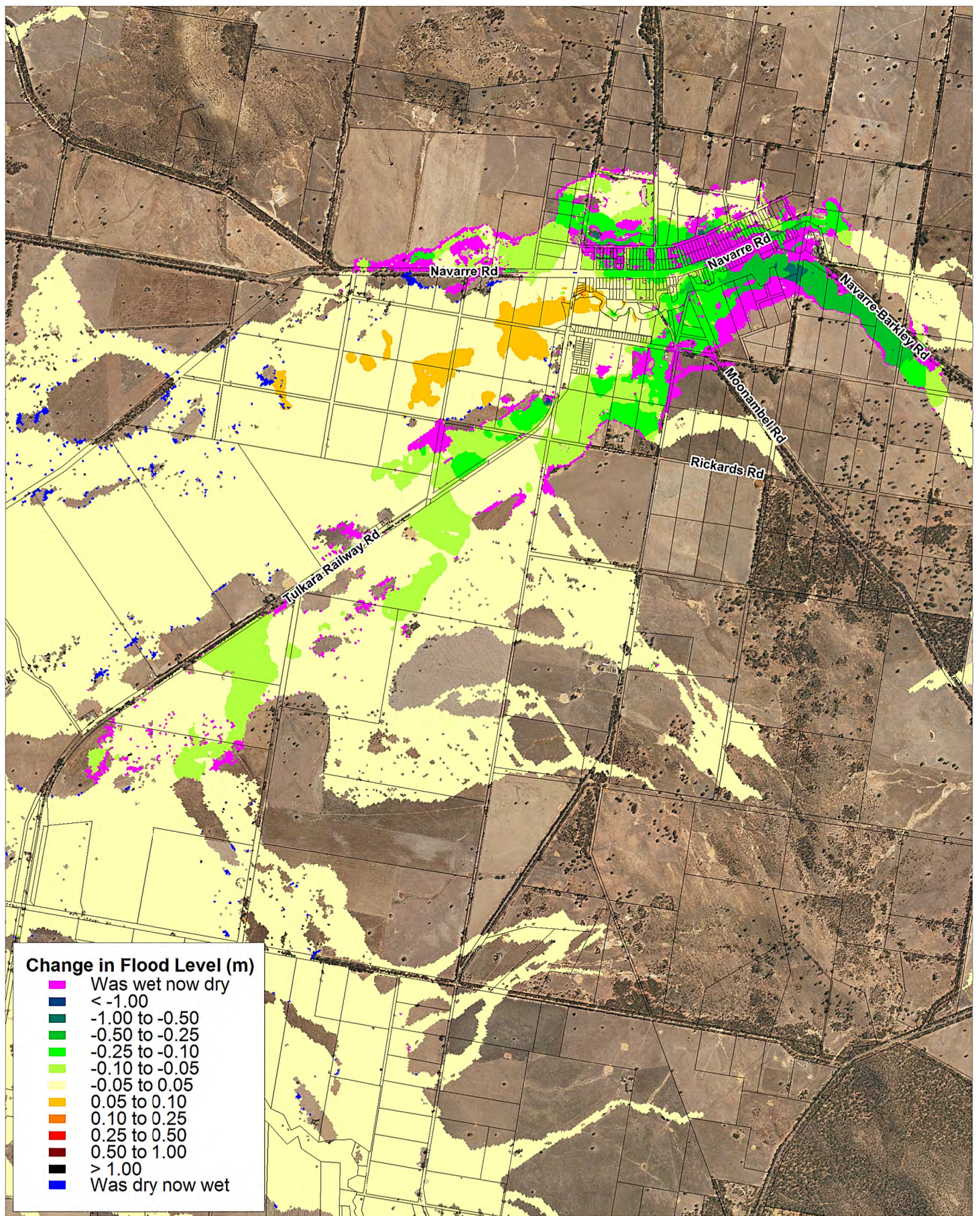
Rev:
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0 0.5 1km
 Approx. Scale





Title:
**Upper Wimmera Flood Investigation - Mitigation Option 1
 Vegetation Removal - 0.5% AEP Flood Height Impacts**

Figure:
D1-13

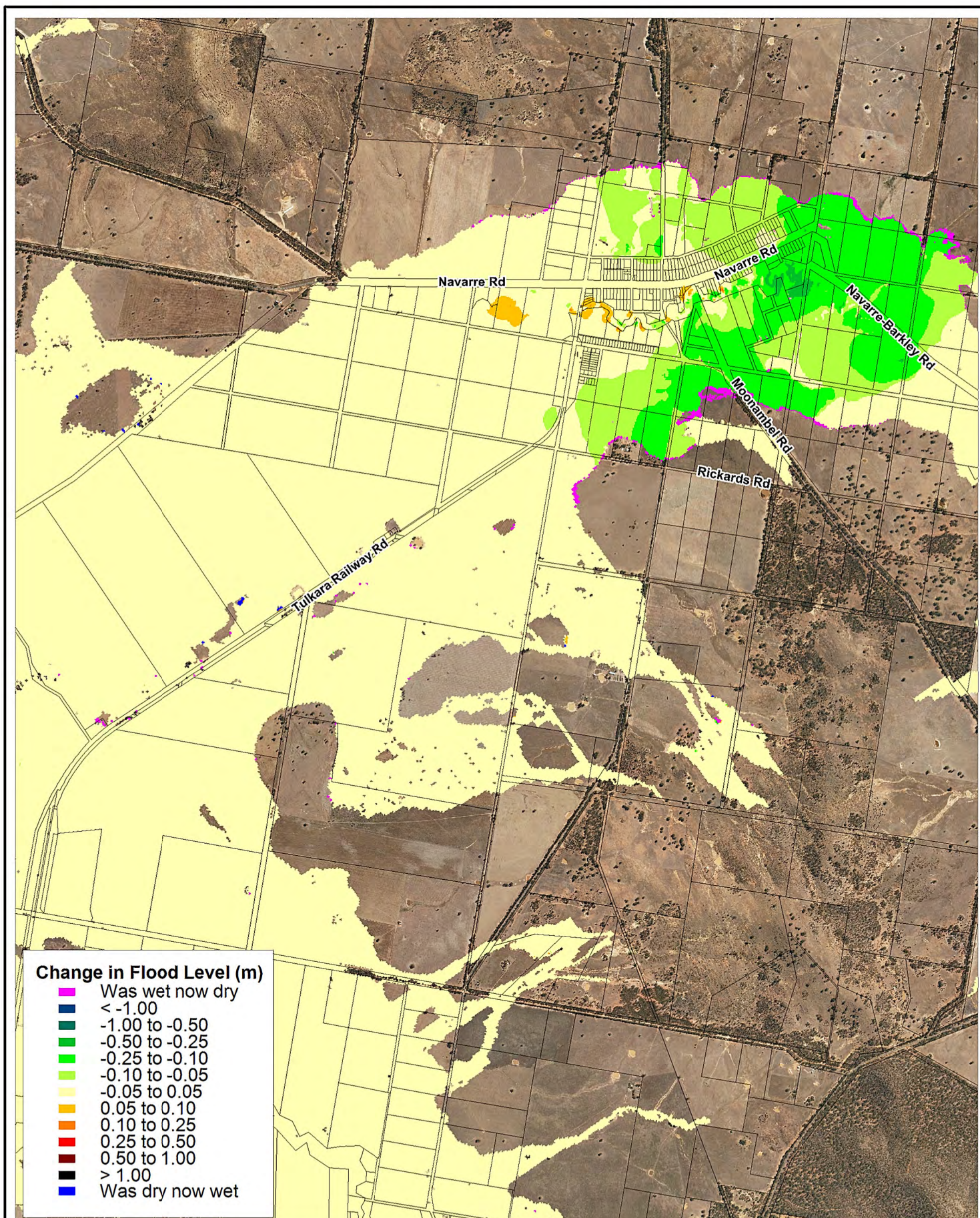
Rev:
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0 0.5 1km
 Approx. Scale





Title:
**Upper Wimmera Flood Investigation - Mitigation Option 1
 Vegetation Removal - PMF Flood Height Impacts**

Figure:
D1-14

Rev:
A

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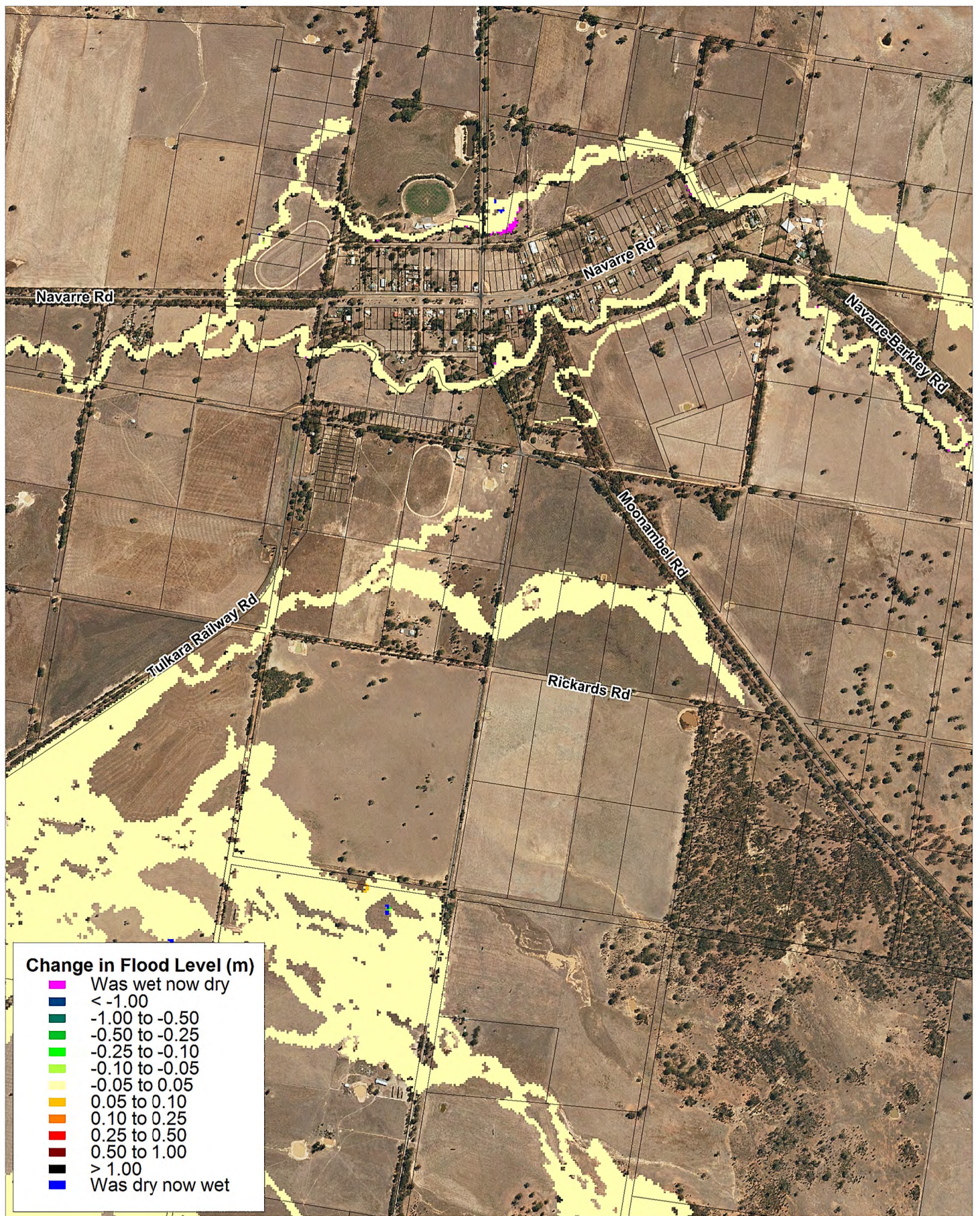



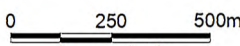

0 0.5 1km
 Approx. Scale

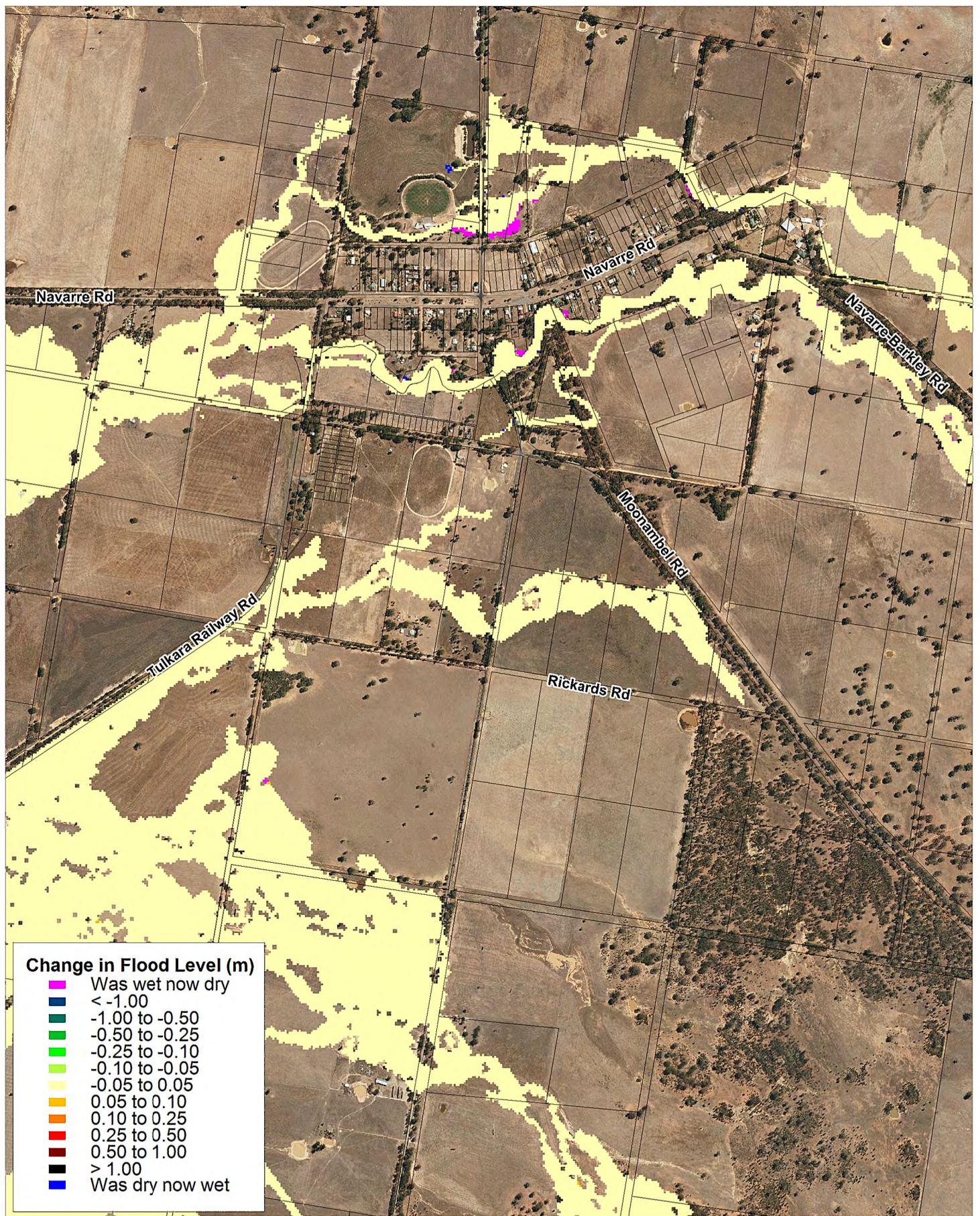


Filepath : T:\M8460.MT.WimmeraUpperFloodStudy\MapInfo\Drawings\R.M8460.009.01.FinalUW_Final_FigD1-14_M01_PMF_Nav_RevA.WOR

D.2 Mitigation Assessment Scenario 2 – Navarre Levees



Title: Upper Wimmera Flood Investigation - Mitigation Option 2 Levees for Navarre - 20% AEP Flood Height Impacts		Figure: D2-1	Rev: A
<p>BMT WBM endeavours to ensure that the information provided in this map is correct at the time of publication. BMT WBM does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.</p>	  Approx. Scale		
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Title:
**Upper Wimmera Flood Investigation - Mitigation Option 2
 Levees for Navarre - 10% AEP Flood Height Impacts**

Figure:
D2-2

Rev:
A

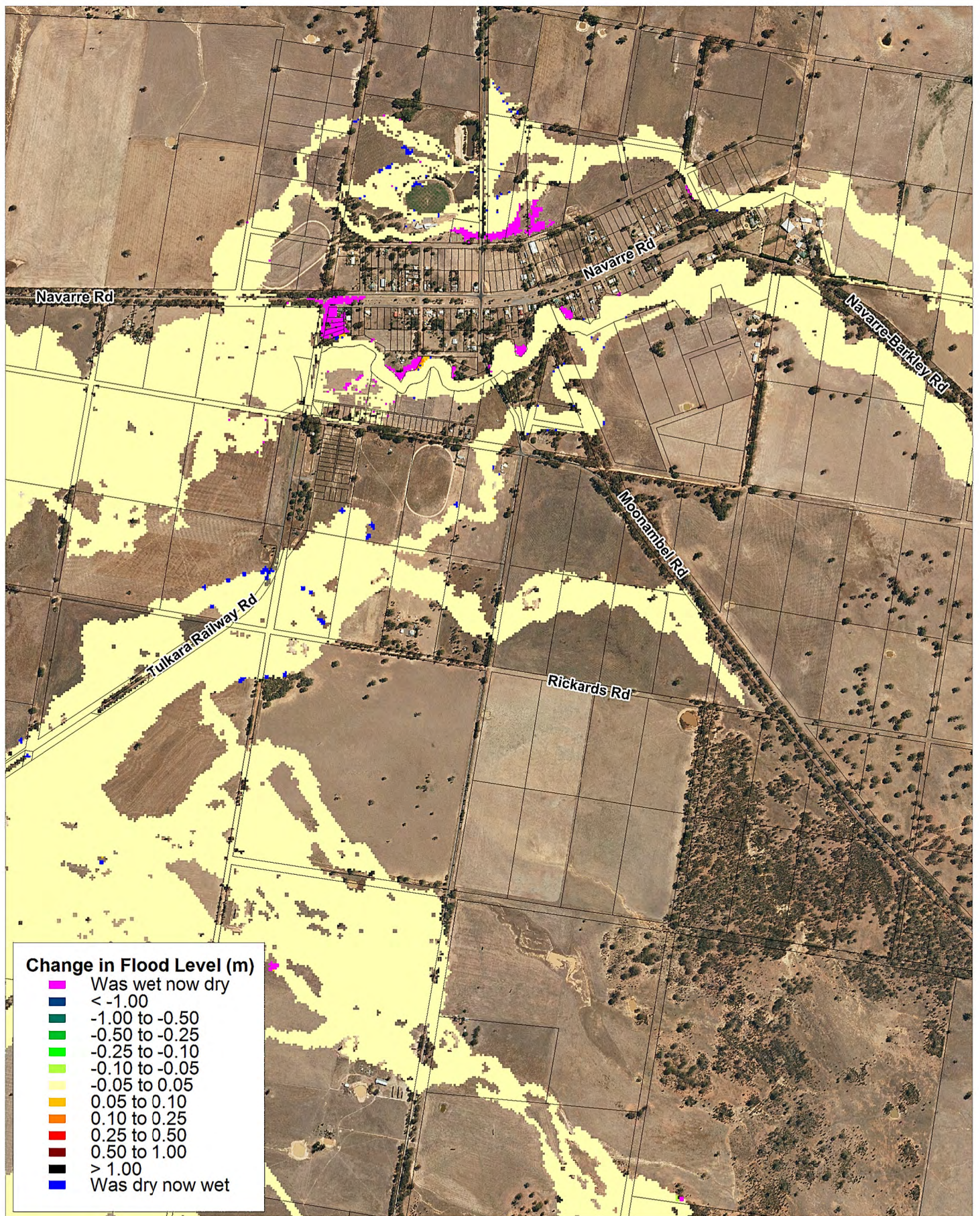
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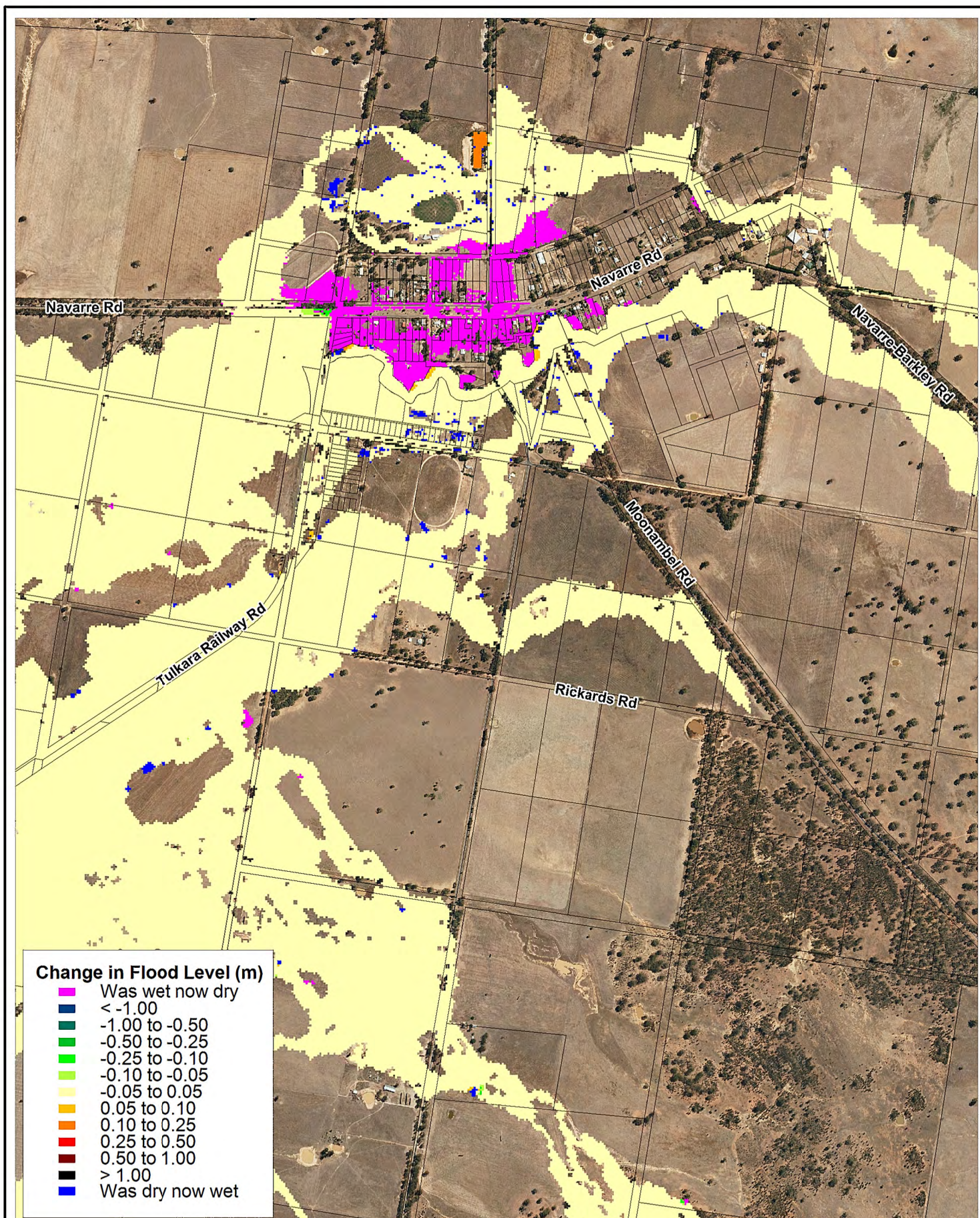
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 Approx. Scale



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<p>Title:</p> <h2>Upper Wimmera Flood Investigation - Mitigation Option 2 Levees for Navarre - 5% AEP Flood Height Impacts</h2>		<p>Figure:</p> <h2>D2-3</h2>	<p>Rev:</p> <h2>A</h2>
<p>BMT WBM endeavours to ensure that the information provided in this map is correct at the time of publication. BMT WBM does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.</p>	 <div style="text-align: center;"> <p>0 250 500m</p> <p>Approx. Scale</p> </div>	<div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;">  Wimmera Catchment Management Authority </div> <div style="text-align: center;">  Ararat Rural City </div> <div style="text-align: center;">  Grampians </div> <div style="text-align: center;">  PYRENEES </div> </div> <div style="display: flex; justify-content: space-around; align-items: center; margin-top: 10px;"> <div style="text-align: center;">  Australian Government </div> <div style="text-align: center;">  Victoria </div> <div style="text-align: center;">  BMT WBM </div> </div>	
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Title:

Upper Wimmera Flood Investigation - Mitigation Option 2 Levees for Navarre - 2% AEP Flood Height Impacts

Figure:

D2-4

Rev:

A

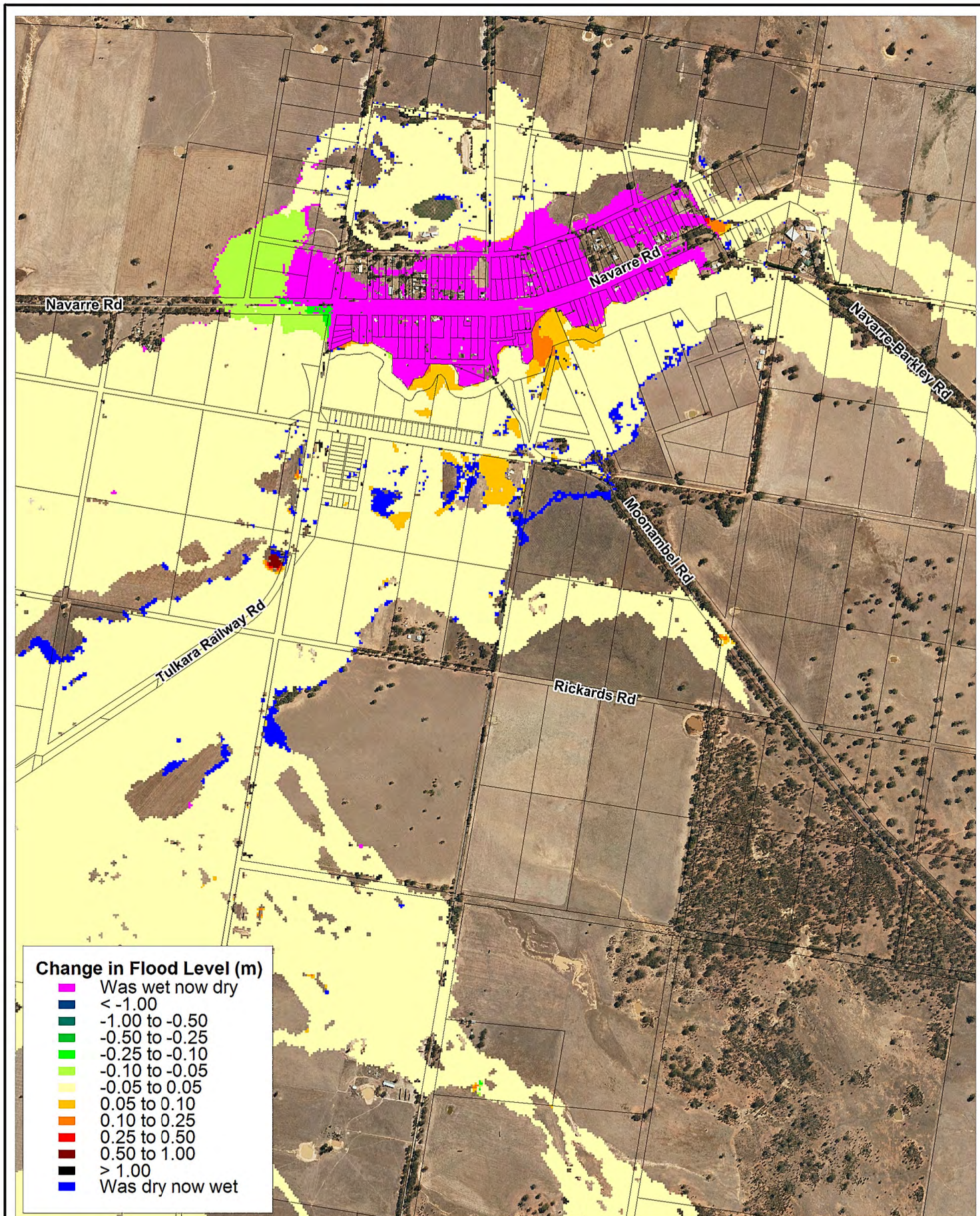
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0 250 500m
Approx. Scale



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Title:
**Upper Wimmera Flood Investigation - Mitigation Option 2
 Levees for Navarre - 1% AEP Flood Height Impacts**

Figure:
D2-5

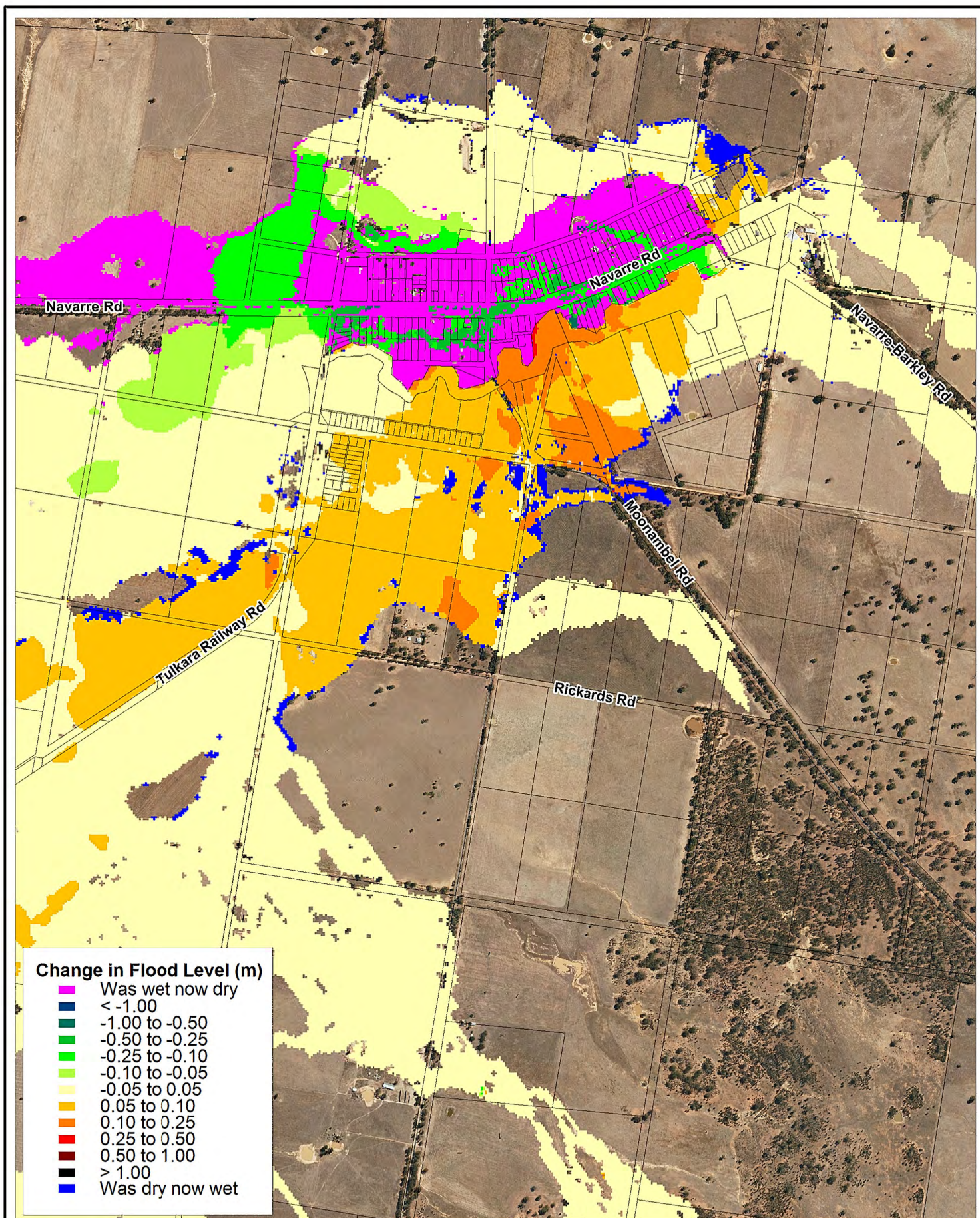
Rev:
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0 250 500m
 Approx. Scale





Title:

Upper Wimmera Flood Investigation - Mitigation Option 2 Levees for Navarre - 0.5% AEP Flood Height Impacts

Figure:

D2-6

Rev:

A

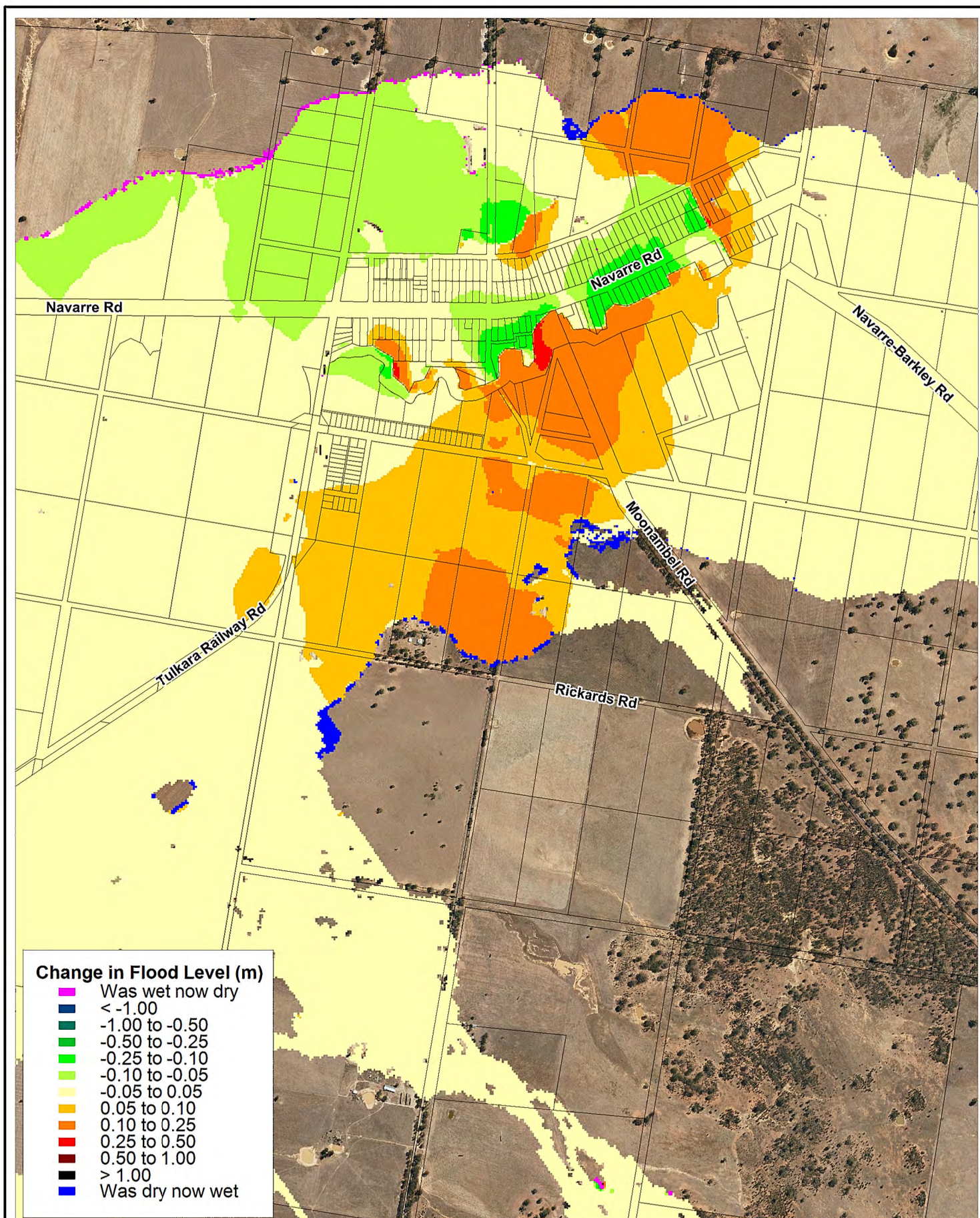
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0 250 500m
Approx. Scale



Filepath : T:\M8460.MT.WimmeraUpperFloodStudy\MapInfo\Drawings\R.M8460.009.01.FinalUW_Final_FigD2-6_M02_0.5%_Nav_RevA.WOR



Title:

Upper Wimmera Flood Investigation - Mitigation Option 2 Levees for Navarre - PMF Flood Height Impacts

Figure:

D2-7

Rev:

A

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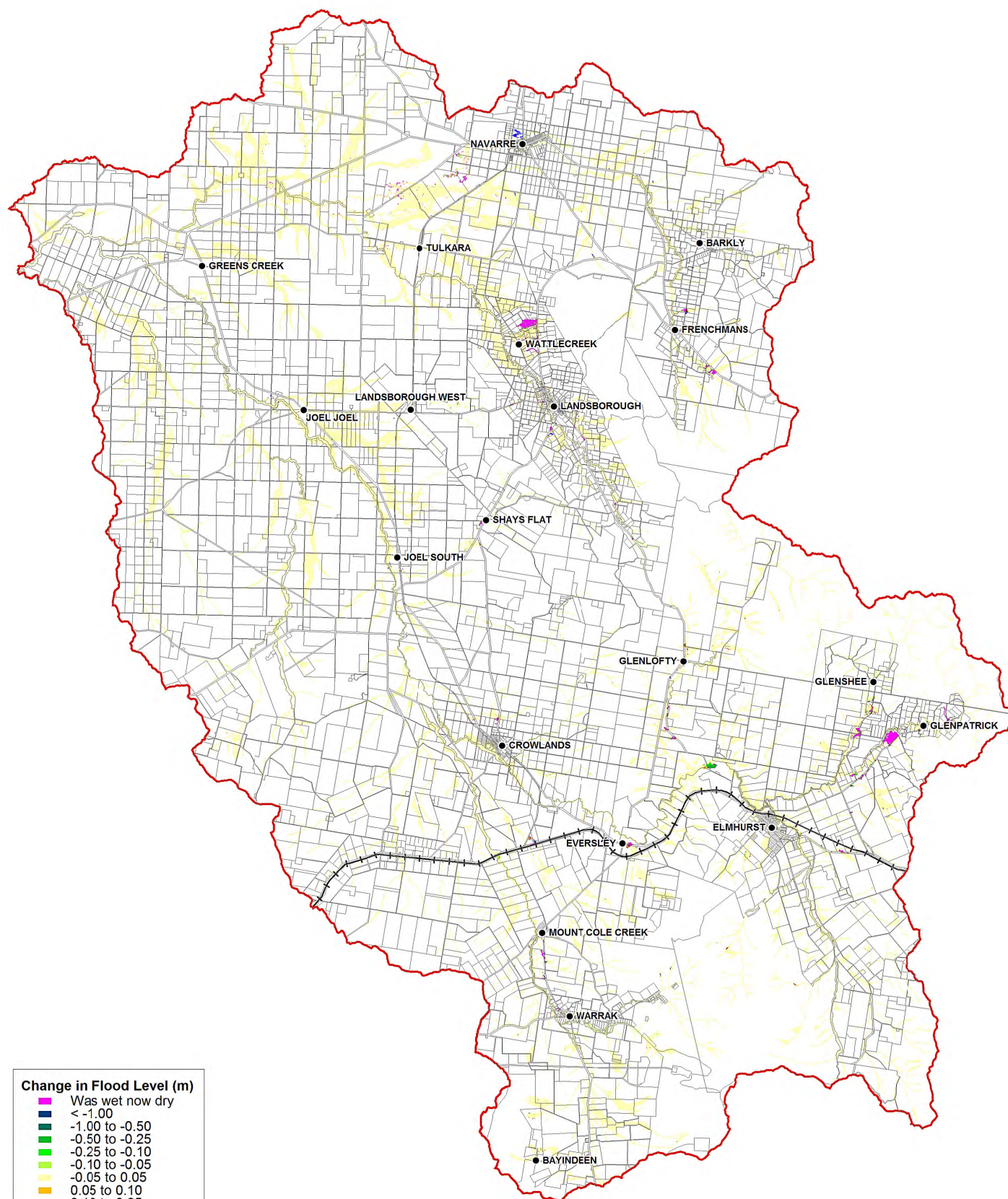


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Approx. Scale



Filepath : T:\M8460.MT.WimmeraUpperFloodStudy\MapInfo\Drawings\R.M8460.009.01.FinalUW_Final_FigD2-7_M02_PMP_Nav_RevA.WOR

D.3 Mitigation Assessment Scenario 3 – Road Raising



Title:
Upper Wimmera Flood Investigation - Mitigation Option 3
Town Access (Road Raising) - 20% AEP Flood Height Impacts

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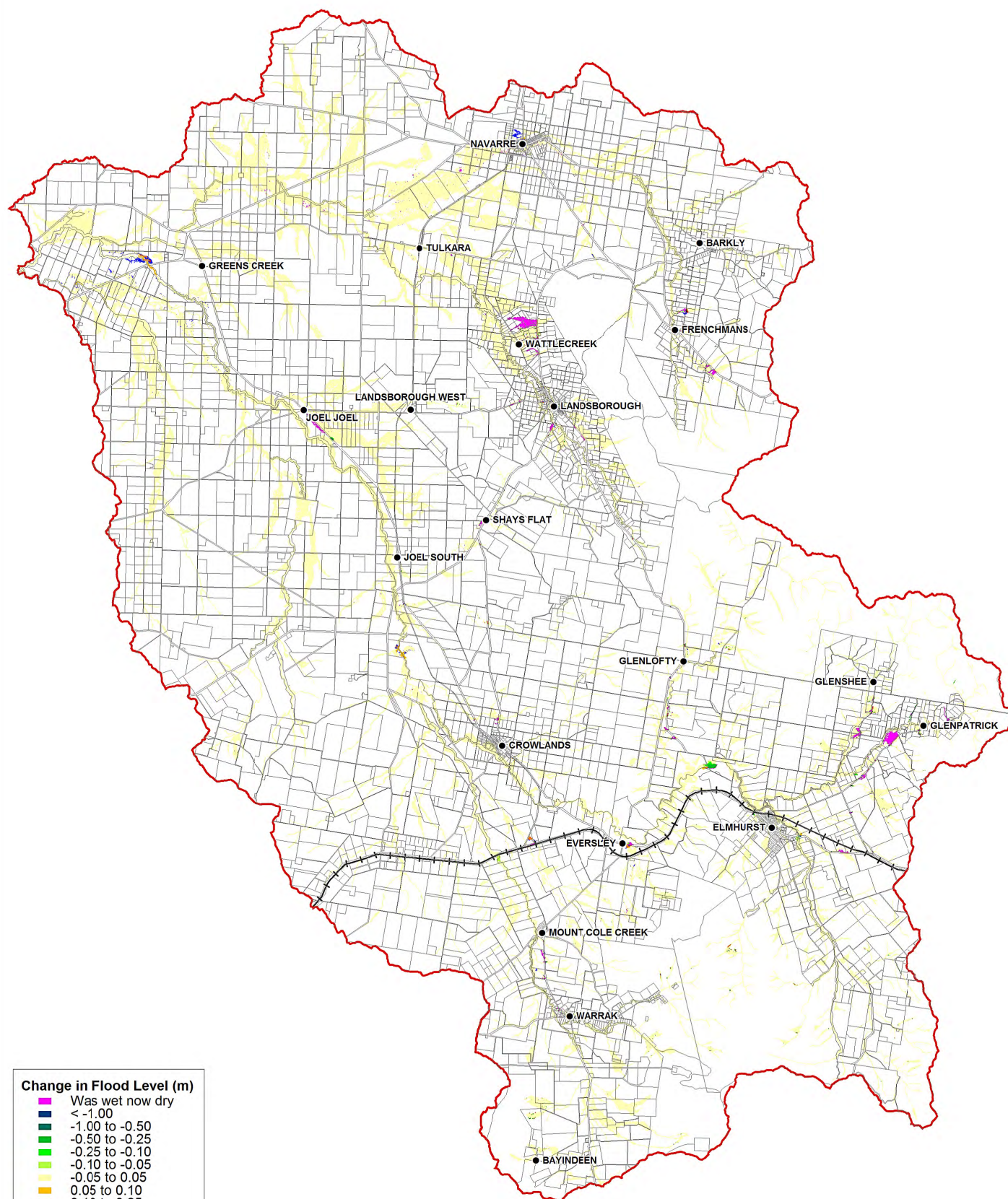
0 3.75 7.5km
 Approx. Scale

Figure:
D3-1

Rev:
A



Filepath : T:\M8460.MT.WimmeraUpperFloodStudy\MapInfo\Drawings\R.M8460.009.01.Final\UW_Final_FigD3-1_M03_20%_Catch_RevA.WOR



Change in Flood Level (m)

- Was wet now dry
- < -1.00
- -1.00 to -0.50
- -0.50 to -0.25
- -0.25 to -0.10
- -0.10 to -0.05
- -0.05 to 0.05
- 0.05 to 0.10
- 0.10 to 0.25
- 0.25 to 0.50
- 0.50 to 1.00
- > 1.00
- Was dry now wet

Title: Upper Wimmera Flood Investigation - Mitigation Option 3 Town Access (Road Raising) - 10% AEP Flood Height Impacts

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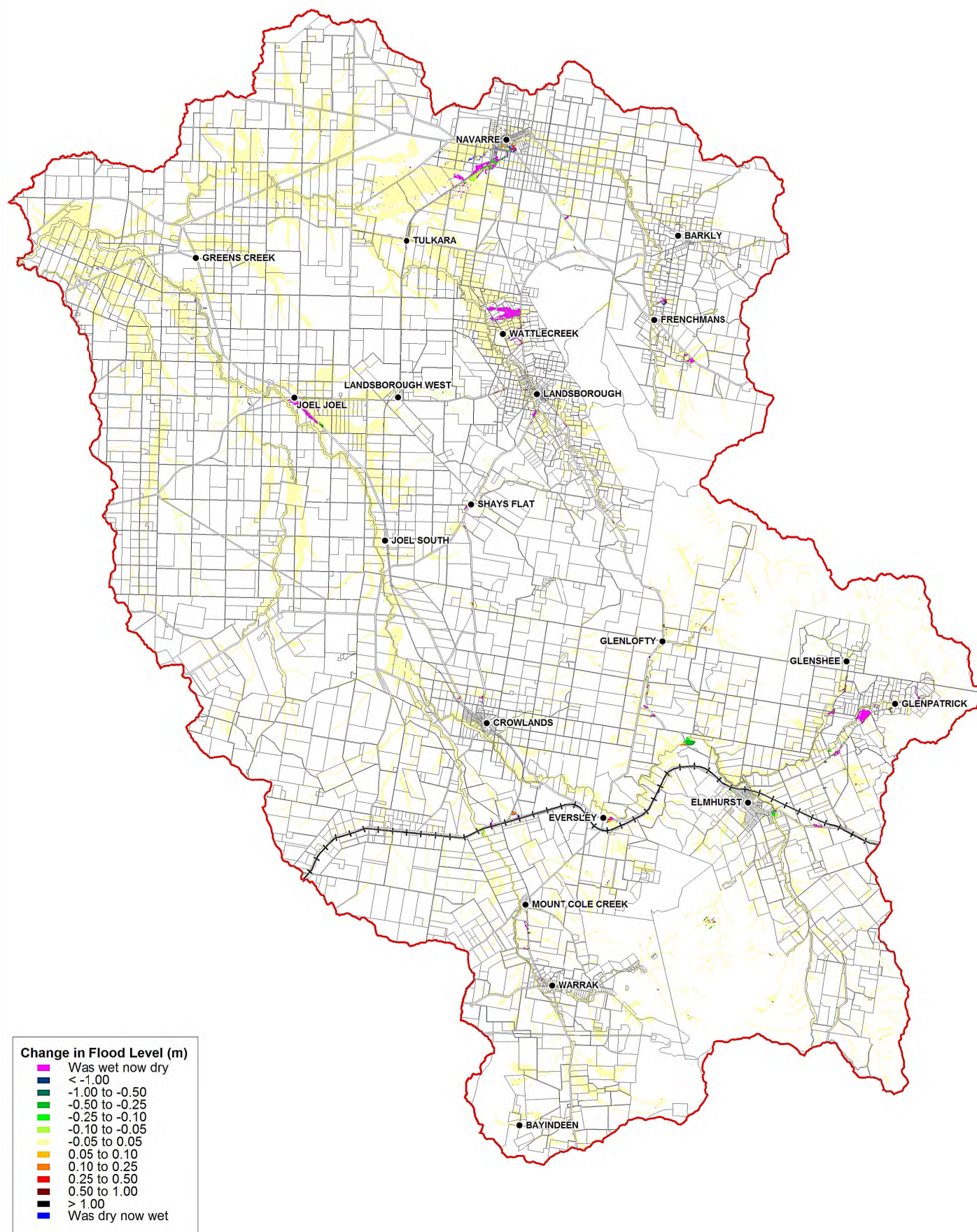
0 3.75 7.5km
Approx. Scale

Figure:
D3-2

Rev:
A



Filepath : T:\M8460.MT.WimmeraUpperFloodStudy\MapInfo\Drawings\R.M8460.009.01.Final\UW_Final_FigD3-2_M03_10%_Catch_RevA.WOR



Title:
Upper Wimmera Flood Investigation - Mitigation Option 3
Town Access (Road Raising) - 5% AEP Flood Height Impacts

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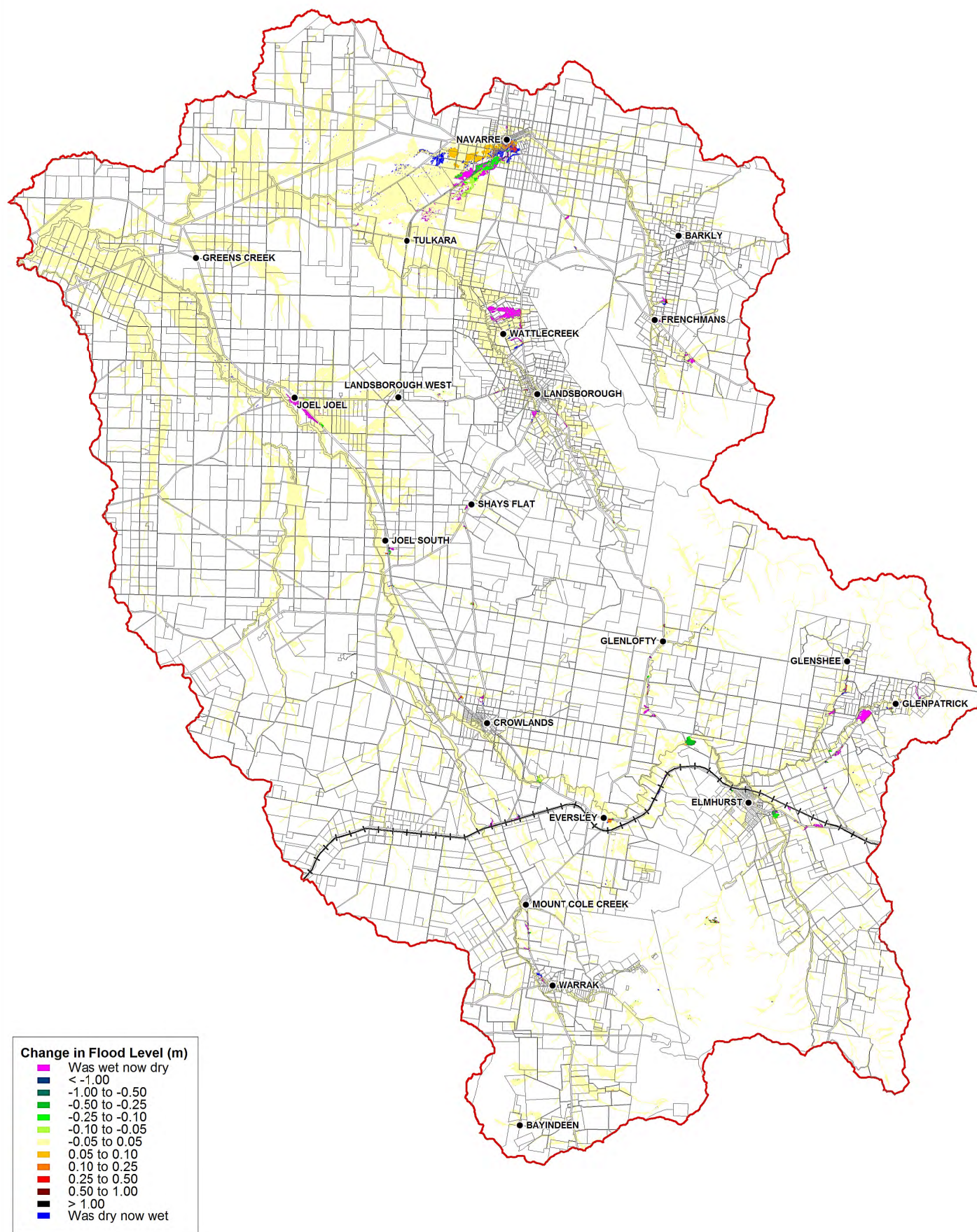
0 3.75 7.5km
 Approx. Scale

Figure:
D3-3

Rev:
A



Filepath : T:\M8460.MT.WimmeraUpperFloodStudy\MapInfo\Drawings\R.M8460.009.01.Final\UW_Final_FigD3-3_M03_5%_Catch_RevA.WOR



Title:
Upper Wimmera Flood Investigation - Mitigation Option 3
Town Access (Road Raising) - 2% AEP Flood Height Impacts

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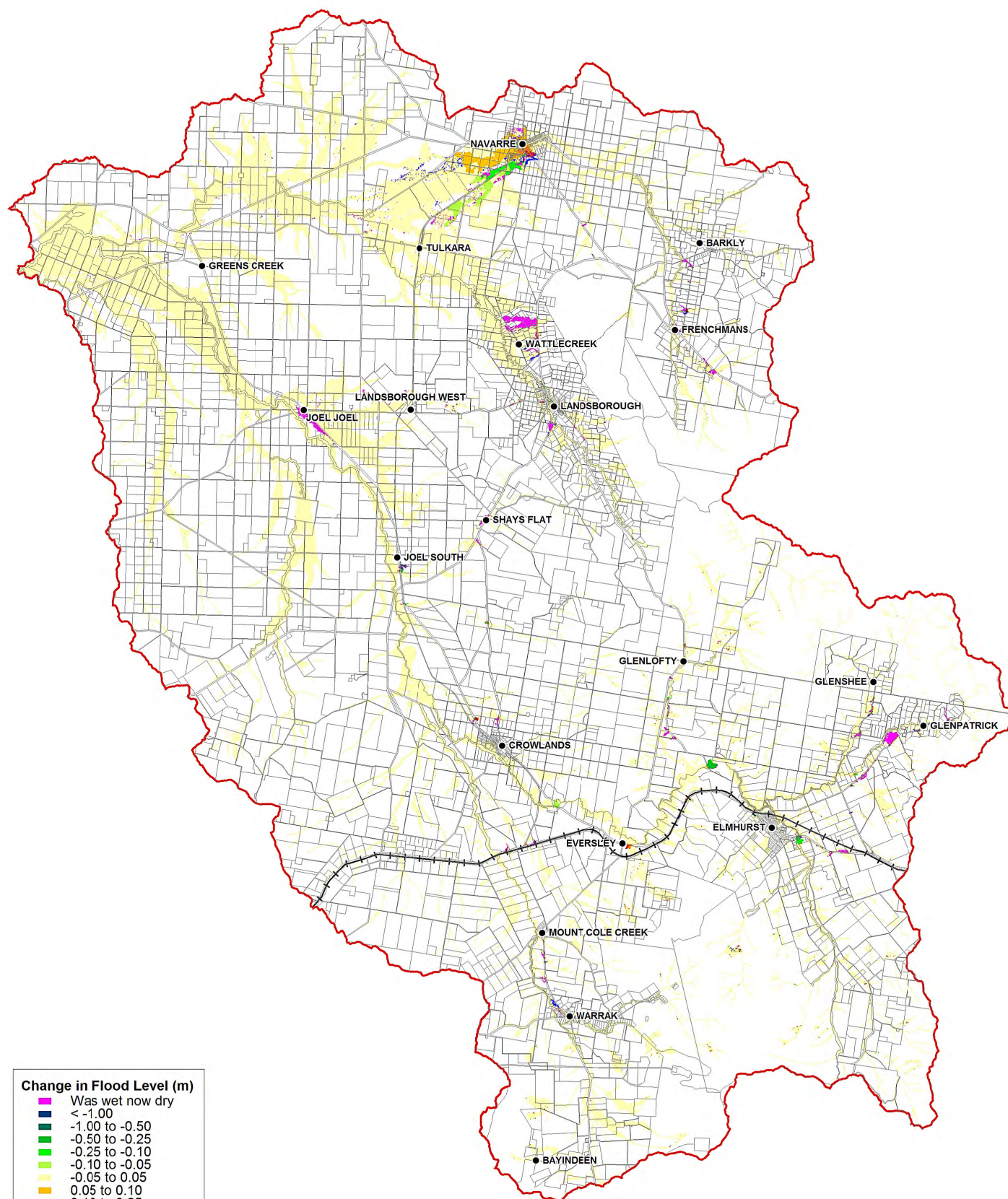
0 3.75 7.5km
 Approx. Scale

Figure:
D3-4

Rev:
A



Filepath : T:\M8460.MT.WimmeraUpperFloodStudy\MapInfo\Drawings\R.M8460.009.01.Final\UW_Final_FigD3-4_M03_2%_Catch_RevA.WOR



Change in Flood Level (m)

- Was wet now dry
- < -1.00
- -1.00 to -0.50
- -0.50 to -0.25
- -0.25 to -0.10
- -0.10 to -0.05
- -0.05 to 0.05
- 0.05 to 0.10
- 0.10 to 0.25
- 0.25 to 0.50
- 0.50 to 1.00
- > 1.00
- Was dry now wet

Title: Upper Wimmera Flood Investigation - Mitigation Option 3 Town Access (Road Raising) - 1% AEP Flood Height Impacts

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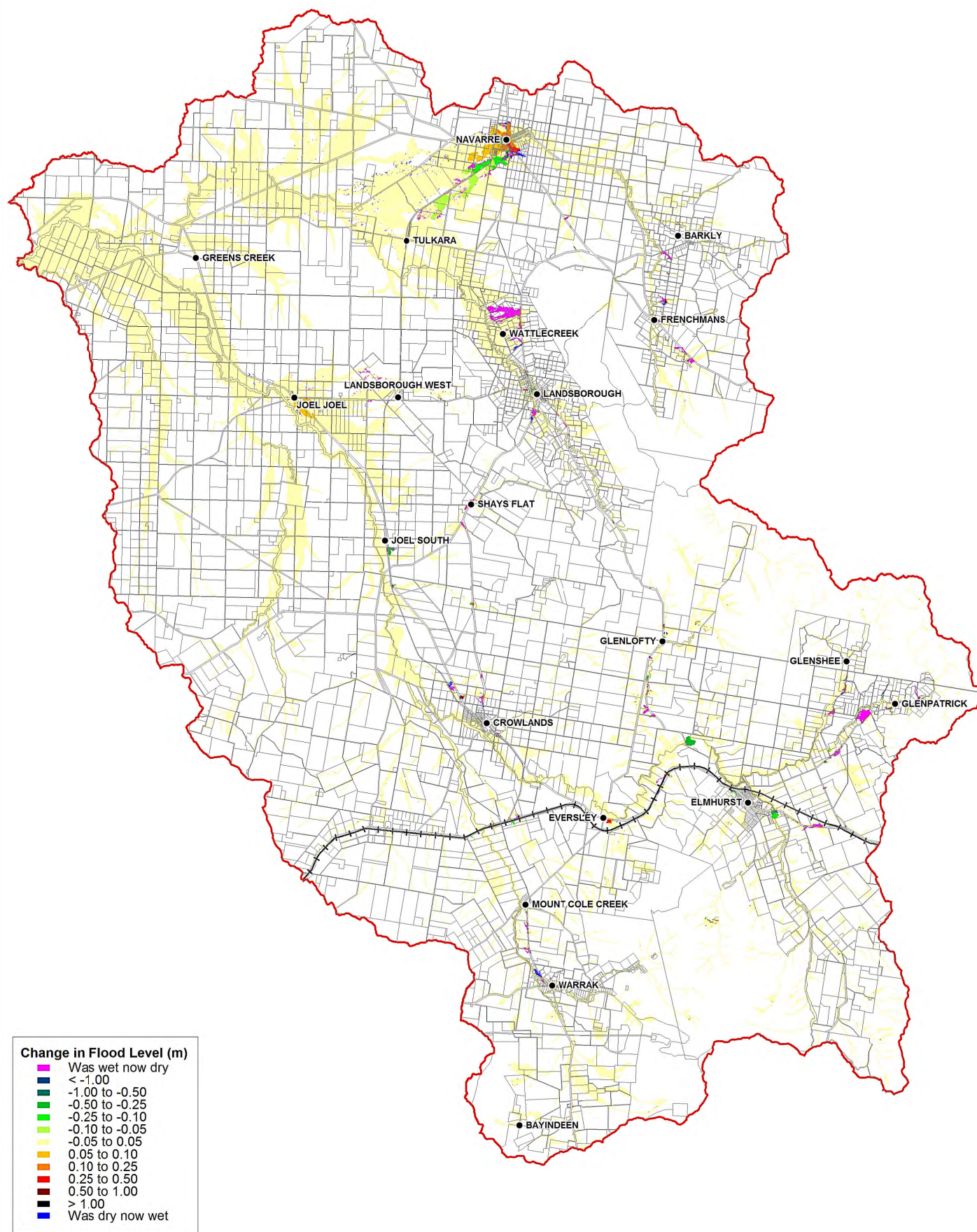
0 3.75 7.5km
Approx. Scale

Figure:
D3-5

Rev:
A



Filepath : T:\M8460.MT.WimmeraUpperFloodStudy\MapInfo\Drawings\R.M8460.009.01.Final\UW_Final_FigD3-5_M03_100y_Catch_RevA.WOR



Title:
Upper Wimmera Flood Investigation - Mitigation Option 3
Town Access (Road Raising) - 0.5% AEP Flood Height Impacts

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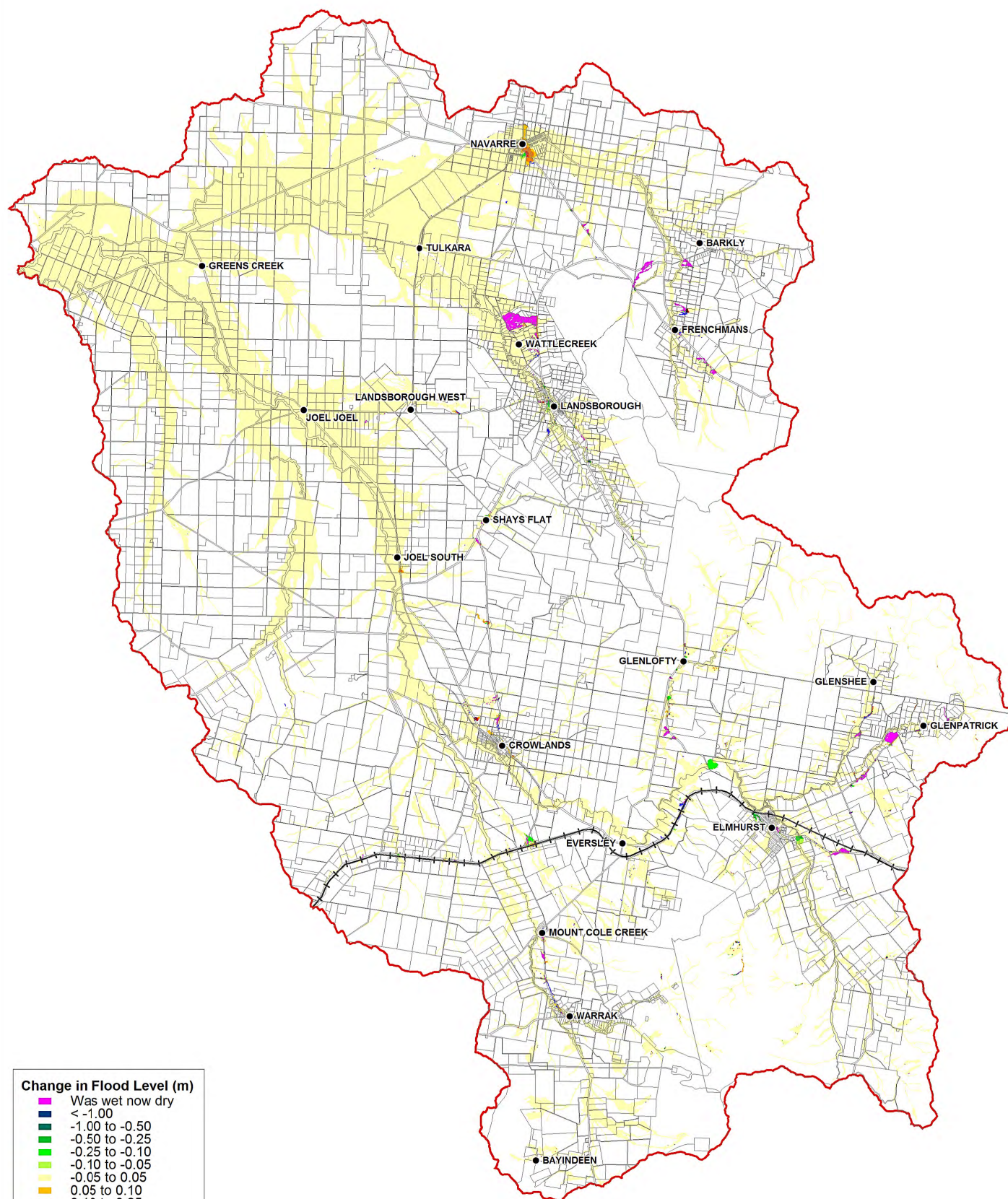
0 3.75 7.5km
 Approx. Scale

Figure:
D3-6

Rev:
A



Filepath : T:\M8460.MT.WimmeraUpperFloodStudy\MapInfo\Drawings\R.M8460.009.01.Final\UW_Final_FigD3-6_M03_0.5%_Catch_RevA.WOR



- Change in Flood Level (m)**
- Was wet now dry
 - < -1.00
 - 1.00 to -0.50
 - 0.50 to -0.25
 - 0.25 to -0.10
 - 0.10 to -0.05
 - 0.05 to 0.05
 - 0.05 to 0.10
 - 0.10 to 0.25
 - 0.25 to 0.50
 - 0.50 to 1.00
 - > 1.00
 - Was dry now wet

Title:
Upper Wimmera Flood Investigation - Mitigation Option 3
Town Access (Road Raising) - PMF Flood Height Impacts

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0 3.75 7.5km
 Approx. Scale

Figure:
D3-7

Rev:
A



Filepath : T:\M8460.MT.WimmeraUpperFloodStudy\MapInfo\Drawings\R.M8460.009.01.Final\UW_Final_FigD3-7_M03_PMF_Catch_RevA.WOR

Appendix E Detailed Mitigation Scheme Costings

Detailed Mitigation Scheme Costings

Scheme 1: Vegetation Removal

Item	Unit	Quantity	Unit Cost	Source	Cost
Site Establishment					
Site Office/Lunch Room/Toilets	month	2	\$1500	Estimate based on Rawlinsons	\$3,000
Site Preparation					
Clear site of vegetation and cart away	m ²	133,000	\$0.48	Rawlinsons factored by 1.02 for rural rates	\$64,000
Channel Works					
Landscaping (Grass)	m ³	133,000	\$4.08	Rawlinsons factored by 1.02 for rural rates	\$543,000
Engineering and Design	%	-	0	Adopted values for study, % of Construction	\$0
Administration	%	-	9	Adopted values for study, % of Construction	\$54,900
Contingency	%	-	30	Adopted values for study, % of Construction	\$182,100
Total Construction Cost					\$850,000
Maintenance					
Mowing of earthen batters	m	6000	\$5.90	Lismore Levee Scheme EIS (factored for CPI)	\$35,000
Total Maintenance Cost per Annum					\$35,000

Detailed Mitigation Scheme Costings

Scheme 2: Town Levees

Item	Unit	Quantity	Unit Cost	Source	Cost
Site Establishment					
Site Office/Lunch Room/Toilets	month	6	\$1500	Estimate based on Rawlinsons	\$3,000
Traffic Management					
Labour	day	30	\$375	Estimate based on Rawlinsons	\$11,000
Signage				Estimate based on Rawlinsons	\$1,000
Site Preparation					
Clear site of vegetation and cart away	m ²	80,000	\$0.35	Rawlinsons factored by 1.02 for rural rates	\$28,000
Levee					
Fill	m ³	36,000	\$16.50	Rawlinsons factored by 1.02 for rural rates	\$594,000
Compaction	m ²	32,000	\$3.15	Rawlinsons factored by 1.02 for rural rates	\$101,000
Landscaping (Ground Cover including planting)	m ²	32,000	\$7.15	Rawlinsons factored by 1.02 for rural rates	\$229,000
Engineering and Design	%	-	15	Adopted values for study, % of Construction	\$145,950
Administration	%	-	9	Adopted values for study, % of Construction	\$87,570
Contingency	%	-	30	Adopted values for study, % of Construction	\$291,900
Total Construction Cost					\$1,500,000
Maintenance					
Mowing of earthen batters	m	6000	\$5.90	Lismore Levee Scheme EIS (factored for CPI)	\$35,000
Monitoring and Survey of Levee	m	6500	\$3.70		\$24,000
Total Maintenance Cost per Annum					\$60,000

Detailed Mitigation Scheme Costings

Scheme 3: Catchment Access

Item	Unit	Quantity	Unit Cost	Source	Cost
Site Establishment					
Site Office/Lunch Room/Toilets	month	18	\$1500	Estimate based on Rawlinsons	\$27,000
Traffic Management					
Labour	day	540	\$375	Estimate based on Rawlinsons	\$61,000
Signage				Estimate based on Rawlinsons	\$3,000
Site Preparation					
Clear site of vegetation and cart away	m ²	278,000	\$0.35	Rawlinsons factored by 1.02 for rural rates	\$97,000
Road Embankment					
Fill	m ³	278,000	\$16.50	Rawlinsons factored by 1.02 for rural rates	\$2,224,000
Compaction	m ²	363,000	\$3.15	Rawlinsons factored by 1.02 for rural rates	\$1,143,000
Landscaping (Ground Cover including planting)	m ²	56,000	\$7.15	Rawlinsons factored by 1.02 for rural rates	\$400,000
Road Surface	m ²	306,960	\$8.42	Rawlinsons factored by 1.02 for rural rates	\$2,585,000
Crash Guard	m ²	2,412	\$88.33	Rawlinsons factored by 1.02 for rural rates	\$213,000
Drainage Infrastructure				Rawlinsons factored by 1.02 for rural rates	\$1,456,000
Bridges				Rawlinsons factored by 1.02 for rural rates	\$24,368,000
Engineering and Design	%	-	15	Adopted values for study, % of Construction	\$1,261,800
Administration	%	-	9	Adopted values for study, % of Construction	\$757,080
Contingency	%	-	30	Adopted values for study, % of Construction	\$2,523,000

Detailed Mitigation Scheme Costings

Total Construction Cost					\$37,320,000
Maintenance					
Mowing of earthen batters	m	31,000	\$5.90	Lismore Levee Scheme EIS (factored for CPI)	\$183,000
Total Maintenance Cost per Annum					\$183,000

Appendix F Flood Warning Services Provided by BOM

OVERVIEW OF FLOOD WARNING SERVICES PROVIDED BY BoM

Flood Warning Products

Flood Warning products and Flood Class Levels can be found on the BoM website. Flood Warning products include Severe Thunderstorm Warnings, Severe Weather Warnings, Flood Watches and Flood Warnings.

Severe Thunderstorm and Severe Weather Warnings

The BoM can forecast the environment in which severe thunderstorms or small scale weather systems that are locally intense and slow moving may occur and provides a generalised service to that effect. However, it is not yet scientifically possible to predict individual flash flooding events except on time scales of tens of minutes at the very best.

The BoM issues warnings of flash flooding when it becomes apparent that an event has commenced which may lead to flash flooding or when flash flooding has commenced.

Flood Watches

Flood watches are issued by the BoM to notify communities and other stakeholders within broad areas (rather than specific catchments) of the potential flood threat from a developing weather situation. They provide a “heads up” of likely flooding.

Flood watches are based on an assessment of the developing weather situation and indicators of current catchment wetness. They provide generalised statements about expected forecast rainfall totals, the current state of the catchments within the target area and the streams at risk from flooding. Instructions for obtaining rain and stream level observations and access to updated Watches and Warnings are also included.

Normally, the BoM would issue a Flood Watch 24 to 36 hours in advance of any likely flooding and issue updates as required. If at any time during that period there was an imminent threat of floods occurring within an area covered by the formal flood forecast and warning service, the Flood Watch would be upgraded to a Flood Warning.

Flood Warnings

Flood Warnings are firm predictions of flooding based on actual rainfall and river height information as well as the results of stream flow based models of catchment behaviour that take account of antecedent conditions (i.e. the “wetness” of the catchment, storage levels within dams, etc) and likely future rainfall. Releases from dams are an essential input to such models.

Flood warnings are categorised as “minor”, “moderate” or “major” (see BoM website for an explanation of these terms and current flood class levels) and indicate the expected severity of the flood for agreed key locations along the watercourse.

Generally flood warnings are issued by the BoM to the media, VICSES, Council and other stakeholder agencies and organisations. VICSES promptly alerts and disseminates such warnings to other agencies and organisations. Stakeholder agencies and organisations, including Council, are responsible for onward dissemination of the warning details.

Flood warnings usually include:

- Rainfall amounts for selected locations within and adjacent to the subject catchment;
- River heights and trends (rising, steady, falling) at key locations within the subject catchment;
- Outflows (in ML/d) from any major storages within the catchment;
- Forecasts of the height and time of flood peaks at key locations;
- A weather outlook and the likely impact of expected rainfall on flooding; and
- A warning re-issue date and time.

Note 1: The term “local flooding” and “flash flooding” may be used for localised flooding resulting from intense rainfall over a small area.

Note 2: The term “significant rises” may be used in the early stages of an event when it is clear that river levels will rise but it is too early to say whether they will reach flood level.

Additional information (e.g. weather radar and satellite images as well as updated rain and river level information) can also be obtained from the BoM website (www.bom.gov.au/hydro/flood/vic) or for the cost of a local call on ☎ 1300 659 217.

Flood Class Levels

The occurrence of a certain class of flooding at one point in a catchment will not necessarily lead to the same class of flooding at other points – for example along the main river and its tributary creeks or along a drainage network’s overland flow paths. This is because the floodplain physiography and use (and thus flood impact) varies along the river or flow path and also because antecedent conditions combined with where and how rainfall occurs (both in time and space) will drive how a flood develops and progresses.

It is emphasised that the flood class levels refer to that part of the watercourse where the flood effects can be related to the gauge reading.

It is important to remember that flood impact is dependent on more than the peak height or flow. The rate of rise, duration, extent and season of flooding are also important. For this reason, flood class levels can only be considered as a guide to flood severity.

Note that in the future it is likely that not all sites for which flood class levels exist will automatically be provided with a quantitative flood forecast by the BoM. It is understood that sites will be classified on the basis of flood risk and consequence. The lower rated sites will receive a quantitative warning service only: BoM will issue warnings that advise only of the exceedance (or likely exceedance) of flood class levels along with the class of flooding expected. A detailed flood forecast will not be provided for these sites.



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