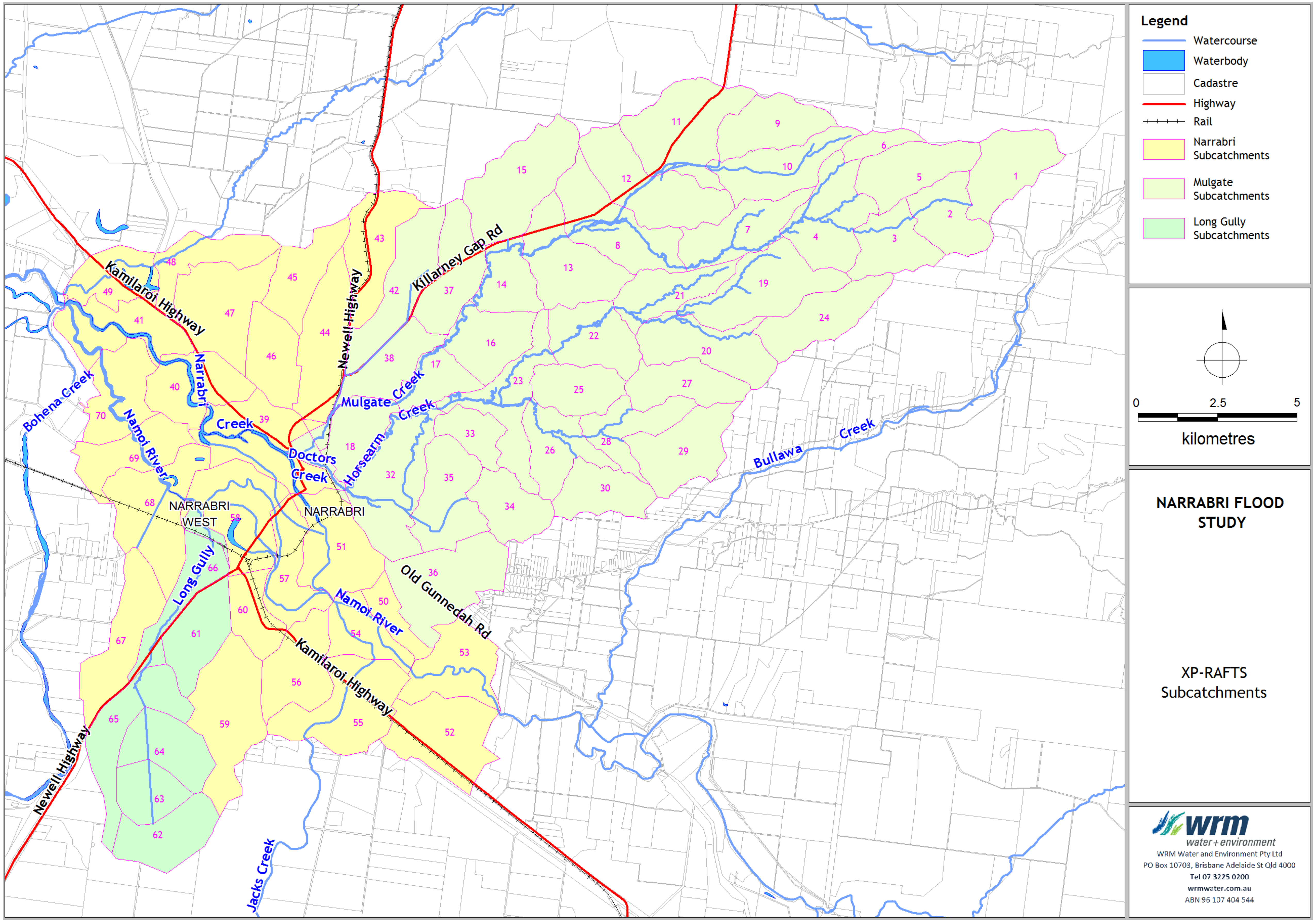

Figure 3.1 - XP RAFTS model configuration and locations of major rainfall stations

Table 3.1 – XP-RAFTS catchment parameters

Sub-catchment	Area (km^2)	Vectored slope (%)
1	5.3	3.98
2	4.43	3.6
3	4.33	4.26
4	6.45	3.14
5	5.14	4.41
6	1.4	5.06
7	5.18	0.78
8	7.1	1.15
9	4.86	2.15
10	5.54	2.18
11	8.24	1.32
12	7.68	1.67
13	6.68	0.32
14	3.61	1.02
15	8.06	1.21
16	4.7	0.48
17	2.91	0.38
18	3.83	0.25
19	7.35	1.83
20	6.14	1.01
21	4.25	0.65
22	5.17	1.12
23	5.81	0.49
24	5.27	2.28
25	3.94	1.13
26	4.5	0.68
27	4.28	1.24
28	4.02	0.94
29	5.9	1.4
30	4.14	1.18
32	8.44	0.15
33	2.57	0.72
34	4.01	1.21
35	5.96	0.3
36	7.84	0.25

Sub-catchment	Area (km^2)	Vectored slope (%)
37	5.24	0.84
38	4.60	0.26
39	8.38	0.10
40	5.42	0.23
41	5.97	0.09
42	6.26	0.52
43	5.77	0.46
44	6.47	0.31
45	4.33	0.83
46	4.29	0.12
47	7.17	0.44
48	4.14	0.43
49	4.09	0.12
50	2.03	0.11
51	6.54	0.25
52	7.17	0.58
53	5.46	0.13
54	3.72	0.59
55	7.93	0.34
56	5.32	0.40
57	4.42	0.07
58	8.00	0.28
59	8.18	0.53
60	3.23	0.41
61	4.69	0.37
62	4.79	0.75
63	3.37	0.47
64	4.66	0.61
65	6.03	0.21
66	3.88	0.19
67	6.14	0.20
68	7.96	0.39
69	4.70	0.45
70	5.26	0.20

Table 3.2 – XP-RAFTS routing link parameters

Link	U/S node	D/S node	Link length (km)	Channel routing, K (hrs)
L1	1	2	2.17	0.6
L2	2	3	2.28	0.63
L3	3	4	3.19	0.89
L4	5	4	3.46	0.96
L5	6	4	3.47	0.96
L6	4	7	3.7	2.05
L7	7	8	5.07	1.41
L8	9	10	0.59	0.17
L9	10	11	1.8	0.5
L10	11	12	1.47	0.41
L11	12	8	2.32	0.64
L12	8	13	1.79	1
L13	13	14	4.64	1.29
L14	15	14	3.65	1.01
L15	14	16	2.25	1.25
L16	16	17	2.77	1.54
L17	17	18	4.1	2.28
L18	19	20	1.14	0.32
L19	20	21	1.44	0.8
L20	21	22	3.1	0.86
L21	22	23	5.36	2.98
L22	24	20	4.18	1.16
L23	25	26	0.32	0.18
L24	26	23	3.63	2.02
L25	27	28	2.06	1.14
L26	28	26	3.15	1.75
L27	29	28	1.39	0.77
L28	30	26	3.02	1.68
L30	23	32	3.45	3.45
L31	33	32	6.15	3.42
L32	34	35	2.6	1.45
L33	35	32	2.34	1.3
L34	36	32	2.96	1.65
L35	37	38	5.23	2.91

Link	U/S node	D/S node	Link length (km)	Channel routing, K (hrs)
L36	38	39	4.92	2.74
L37	39	40	3.02	1.68
L38	40	41	4.42	2.45
L39	42	38	2.5	1.39
L40	43	44	1.73	0.96
L41	44	46	1.99	1.1
L42	45	46	1.03	0.57
L43	46	47	2.79	1.55
L44	47	48	0.87	0.48
L45	48	49	4.07	2.26
L46	18	39	5.42	3.01
L47	32	39	6.19	3.44
L48	50	51	3.98	2.21
L49	51	39	5.19	2.88
L50	52	53	1.07	0.59
L51	53	54	3.69	2.05
L53	55	54	2.56	1.42
L54	56	57	4.76	2.65
L55	57	58	4.03	2.24
L56	59	60	2.28	1.27
L57	60	58	4.42	2.45
L58	61	66	2.56	1.42
L59	66	58	2.14	1.19
L60	62	63	1.73	0.96
L61	63	64	1.17	0.65
L62	64	65	2.28	1.27
L63	65	66	4.79	2.66
L64	67	68	3.38	1.88
L65	58	68	1.55	0.86
L66	68	69	1.65	0.92
L67	69	70	3.82	2.12
L68	70	41	2.79	1.55
L69	54	57	5.42	3.01
Diversion	54	51	4.3	2.39

4 Hydraulic model development

4.1 OVERVIEW

The primary purpose of the Namoi River Flood Study was to convert the existing quasi-two-dimensional MIKE-11 model to a fully two-dimensional model. The existing MIKE-11 model, which has been modified four times since its conception in 1991, has limited ability to develop accurate flood maps for either regional or local flooding. Recent topographical survey of the town (by aerial survey) also provides an opportunity to improve the model calibration and ultimately improve the flood mapping for the town from each flooding source.

A new computer based MIKE-FLOOD FM (flexible mesh) hydrodynamic model in combination with MIKE-11 (DHI, 2014) has been used to simulate the flow behaviour of the Namoi River, Narrabri Creek and local creeks within the study area. MIKE-FLOOD FM incorporates a 2D modelling system (MIKE-21FM) that estimates flood levels and velocities on a flexible mesh. The flexible mesh allows the user to define the topography according to local needs; for example 2 m wide elements can be used to represent a 10 m wide channel and 20 m wide elements can be used to represent a 100 m wide channel. It also incorporates a one-dimensional or quasi two-dimensional modelling system (MIKE-11). The one-dimensional (MIKE-11) and two-dimensional (MIKE-21FM) schemes are solved independently, but are dynamically linked at the boundary to ensure continuity (mass) is conserved.

Figure 4.1 shows the extent of the MIKE-FLOOD hydraulic model. The model includes:

- a digital terrain model (DTM) with all available topographic data;
- cross section data in Narrabri Creek and the upper and lower reaches of the Namoi River;
- inflow and downstream boundaries;
- Manning's 'n' roughness values for surfaces within the study area; and
- road and rail culvert and bridge data.

Descriptions of these are given in the following sections.

4.2 GIS DATA, TOPOGRAPHIC DATA & DRAWINGS

The following GIS data was available for the study:

- LiDAR captured in January 2014 and provided by the NSW Government (Land and Property Information);
- details of various hydraulic structures (bridge and culverts) within the study area;
- detailed survey of various culverts and bridges;
- digital cadastral database (DCDB) of Narrabri;
- digital ortho-photos taken in 2010 and provided by the NSW Government Land and Property Information;
- georeferenced aerial imagery of the 1984 and 1998 Narrabri floods; and
- floor levels of all residential properties within Narrabri.

A ground surface digital terrain model (DTM) of the floodplain around Narrabri was provided by NSW Government Land and Property Information (LPI), and is shown in Figure 4.1. The ground surface DTM was obtained by remote sensing light detection and ranging (LiDAR) techniques and was captured in January 2014. The specified accuracy of the supplied DTM is ± 0.3 m vertically and ± 0.8 m horizontally at the 95% confidence interval.

Within the Mollee Weir pool, the cross-sections embedded within the URS (2014) MIKE-11 model were used to determine the bathymetry of the river bed. That is, the weir pool was modelled within the 1D domain. The LiDAR DTM does not penetrate the water surface within the weir pool and would therefore underestimate the capacity of the channel if it was used. The Mollee weir pool extends upstream to include the entire length of Narrabri Creek and a short section of Namoi River reach upstream of the Narrabri Creek confluence. The Namoi River adjacent to Narrabri Creek generally does not contain water other than in isolated pools and has therefore been modelled wholly within the 2D domain.

4.3 MODEL CONFIGURATION

4.3.1 MIKE-21FM mesh properties

The MIKE-21 module is the two dimensional component of the hydrodynamic model. The flexible mesh version of MIKE-21 (MIKE-21FM) uses triangular and/or trapezoidal elements to create a computational mesh on which the element-centred two-dimensional shallow water equations are solved. An adaptive time step is used by the computational engine to maintain simulation stability.

Any number of regions can be digitised within the model domain. Each distinct region can have a unique set of mesh properties that includes element type, maximum element area, smallest allowable angle and maximum number of nodes. The ability to subdivide the model domain allows greater topographic definition to be implemented in critical study areas, while limiting the computational resources being used in non-critical areas. Mesh orientation can also be controlled by digitising points and lines within the model domain.

For this study, important flow locations, structures, topographical features, watercourses, water bodies, roads, railways and the 1D structure alignments were digitised in a GIS package to define the mesh orientation at these hydraulically significant locations. MIKE-21FM was then used to generate and refine a computational mesh.

Table 4.1 details the six sets of mesh properties that were used to create the flexible mesh. The spatial locations of the six mesh regions are shown in Figure 4.2.

Table 4.1 - Mesh generation inputs

Region	Maximum Element Area (m^2)	Smallest Allowable Angle	Maximum Number of Nodes
Important flow path	75	26°	6,000,000
Developed area	100	26°	6,000,000
Secondary flow path	200	26°	6,000,000
General floodplain / rural land	400	26°	6,000,000
Intensive cropping	600	26°	6,000,000
Non floodplain	1200	26°	6,000,000

The adopted mesh parameters were aimed at optimising run times while providing sufficient model definition in critical areas flow areas. The following is of note:

- The non-floodplain area is not inundated during flooding events (i.e. the hill slope areas on the fringe of the hydraulic model).
- The intensive cropping regions have been applied to land found behind levee banks and earthen bunds and are likely to be laser levelled. The relatively constant topography requires little model definition to fully capture flow behaviour.
- The general floodplain / rural land regions are modelled at an element size sufficient to simulate the flow distribution while not detracting from model performance and run times.

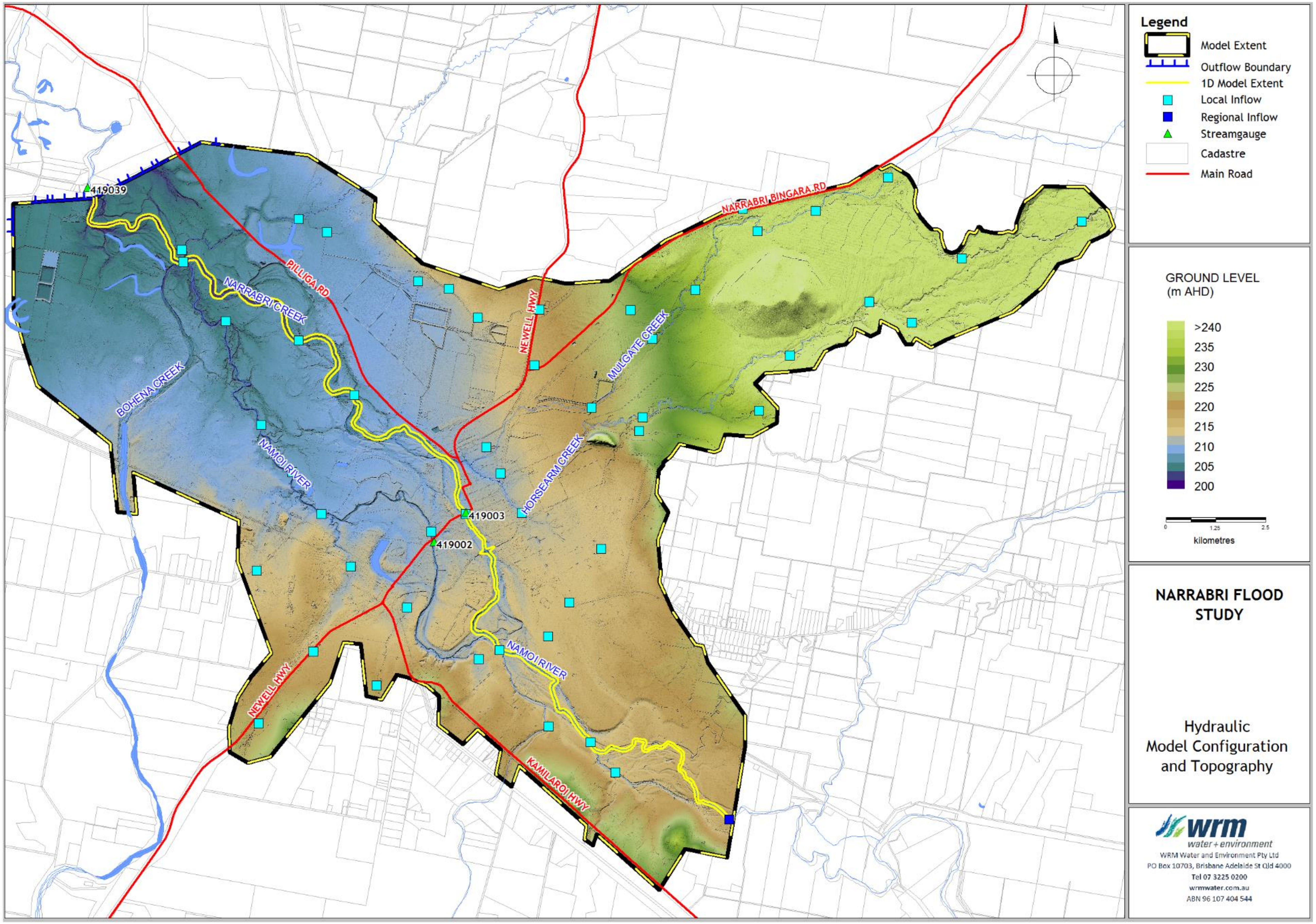

Figure 4.1 – MIKE-FLOOD model configuration and topography