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Melbourne Water Corporation

Report for Murrumbeena Drain Catchment Flood Mapping

Final Report

July 2010

INFRASTRUCTURE | MINING & INDUSTRY | DEFENCE | PROPERTY & BUILDINGS | ENVIRONMENT

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1. Introduction and Background

1.1 Introduction

Melbourne Water is responsible for providing regional drainage and flood protection across Greater Melbourne. This role involves providing a safe and effective system for containing and transferring storm runoff (through a network of underground drains and overland floodways and waterways) and preventing inappropriate development in flood-prone areas. Melbourne Water is working towards protecting flood-prone floors within its area of responsibility, also taking into account the potential future impacts of urban consolidation.

The purpose of this study is to undertake flood plain mapping along Melbourne Water drains in the Murrumbeena Drain catchment, within the municipalities of Stonnington, Monash, Kingston and Glen Eira. The resultant information from this study will be used by Melbourne Water to provide flood advice and assist in identifying capital works. Further progression of the Murrumbeena Drain Redevelopment Services Scheme Functional Design Stage 1 project will also utilise information from this study.

1.2 Background

Flood mapping of Melbourne Water's underground drains within the Murrumbeena Drain catchment was previously undertaken as part of the Drainage Survey Project (CMPS&F 1998) based RORB and EXTRAN modelling. A "diverted" RORB model was used to determine the peak flows for input into the EXTRAN model. The EXTRAN model was run in steady state mode to determine the peak flood levels for mapping. Photogrammetry suitable for the creation of 0.5 m contours was used to create overland cross sections for the EXTRAN model and to create the flood extents. Flood extents were created for the 100, 50 and 20 year ARI[1] flood events.

A Redevelopment Drainage Scheme (RDS) Investigation of the Murrumbeena Drain catchment was completed by SKM in 2005 (SKM 2005). The RDS investigation used RORB modelling to assess the impact of redevelopment on flood flows throughout the catchment. A "diverted" RORB model was used to determine peak flows along the main drains for existing conditions and an ultimate redevelopment scenario. A conceptual drainage design was determined to cater for the expected increases in flow. Only the 100 year ARI event was analysed in the RDS investigation.

A Functional Design of Stage 1 of the Murrumbeena Drain Redevelopment Services Scheme was commenced by GHD in 2007. Part of the Functional Design project included a review of the Concept Design and associated modelling. The Functional Design project is currently on hold pending the outcomes of this flood mapping study.

Melbourne Water engaged GHD to undertake this current flood mapping study of the Murrumbeena Drain catchment to assist with the Functional Design project and to bring the mapping up to date and consistent with other recent flood mapping projects. This study builds on the knowledge of the catchment and experience gained through undertaking the previous projects while utilising more recent terrain and development information. The data obtained will also be used by Melbourne Water to populate their recently developed Flood Risk Assessment Framework Matrix, a tool that assists with prioritising catchments for Flood Mitigation investigation.

[1] Average Recurrence Interval (ARI) – the average or expected value of the period between exceedences of a given discharge.

1.3 Scope of Study

The scope of the investigation and flood mapping for this project can be summarised as follows:

1. Review and revise the RORB model developed for the Murrumbeena Drain Redevelopment Drainage Scheme, with consideration given to future Functional Design requirements, edge matching requirements, and Council pipe diversions into and out of the catchment. Generate flow hydrographs using this revised RORB model for the events and scenarios shown in Table 1-1, for use as inputs to the TUFLOW model.

Table 1-1 Required RORB Model Runs

Design Rainfall Event	PMP	100 yr ARI	50 yr ARI	20 yr ARI	10 yr ARI	5 yr ARI
Base Case	✓	✓	✓	✓	✓	✓
Redevelopment	✓	✓		✓		✓
Climate Change		✓	✓	✓	✓	✓

Where:

- Base Case = Existing drainage system, existing conditions impervious fractions (as defined by Melbourne Water), and normal rainfall intensities (in accordance with Book 2 of AR&R (*IEAust 1997*));
- Redevelopment = Existing drainage system, redevelopment conditions impervious fractions (as defined by Melbourne Water), and normal rainfall intensities (in accordance with Book 2 of AR&R (*IEAust 1997*));
- Climate Change = Existing drainage system, existing conditions impervious fractions (as defined by Melbourne Water), and rainfall intensities increased by 32% (as requested by Melbourne Water).

2. Use an integrated 1D/2D model (TUFLOW) to determine the flood extents for the events and scenarios shown in Table 1-2, including all breakaway flow paths associated with the Melbourne Water drains in the Murrumbeena Drain catchment.

Table 1-2 Required TUFLOW Model Runs and Flood Extents

Estimated Flood Event	PMF	100 yr ARI	50 yr ARI	20 yr ARI	10 yr ARI	5 yr ARI
Base Case	✓	✓	✓	✓	✓	✓
Redevelopment	✓	✓		✓		✓
Climate Change		✓		✓		✓

3. Provide peak discharges at agreed points for Base Case flood events only, as derived from the hydraulic model.
4. Determine the peak flood levels to Australian Height Datum (AHD) for each property in the Base Case flood events only.
5. Determine the peak flood levels to AHD for each principal building "footprint" where the floor is inundated by the Base Case flood events only.
6. Determine property Flood Risk for inundated properties in the Base Case 100 year ARI event.
7. Determine property Safety Risk for inundated properties in the Base Case 100 year ARI event, and create Safety Risk polygons in roads.
8. Prepare a report documenting the findings of the analysis and investigative work undertaken.
9. Provide data within the PMF extent to assist Melbourne Water to determine Average Annual Damages due to flooding.
10. Provide MapInfo tables of the flood extents, flood levels, water surface grids, water depth grids, velocity-depth grids and velocity grids, for the events identified in Table 1-2 above, as well as all RORB model and TUFLOW model files.
11. Provide a separate Quality Assurance report detailing actions undertaken to check the accuracy of the data.

1.4 Available Information

The following information was utilised in undertaking this flood mapping study:

- General MapInfo layers obtained from Melbourne Water in August 2008:
  - Cadastral (properties, easements, road alignments, etc.);
  - Drainage (Melbourne Water underground, channel and natural drains, Boroondara, Glen Eira, Kingston, Monash and Stonnington Council drains);
  - Contours (1 m contours, 0.5 m contours from photogrammetry, 0.5 m contours from LiDAR);
  - Flooding (100, 50 and 20 year ARI flood extents, flood depths, flooded properties);
  - RORB (catchment and subcatchment boundaries, nodes, reach alignments);
  - Planning (Planning Scheme Zones, Heritage Overlay, Public Acquisition Overlay, Land Subject to Inundation);
  - Environmental (flora and fauna);
  - Heritage (indigenous and non-indigenous sites of significance); and
  - Geology.
- Other data obtained from Melbourne Water throughout the course of the project:
  - Design Drawings for Melbourne Water drains;
  - Aerial laser survey data (thinned ground points, contours and metadata);
  - Treyvaud Reserve Wetland Upgrade and Storm Water Diversion drawings dated October 2008, prepared by Melbourne Water and City of Stonnington;
  - Impervious fractions to analyse Base Case and Redevelopment Conditions;

- Tailwater levels for Gardiners Creek; and
  - Properties Flooded and Building Footprints MapInfo layers.
- Relevant information from the following reports:
  - Murrumbeena Main Drain Redevelopment Drainage Scheme Investigation dated June 2005, prepared by SKM;
  - Murrumbeena Main Drain RSS Functional Design Section 1 dated March 2008, prepared by GHD; and
  - Melbourne Water Drainage Survey 1996/97 City of Glen Eira dated April 1998, prepared by CMPS&F.

2. Catchment and Drainage Description

2.1 Murrumbeena Drain Catchment

The Murrumbeena Drain catchment covers an area of approximately 11.2 km^2 within the municipalities of Stonnington, Monash, Kingston and Glen Eira. The catchment comprises predominantly of medium density residential development in the suburbs of Malvern East, Murrumbeena, Carnegie, Hughesdale, Oakleigh, Oakleigh South, Huntingdale, and Bentleigh East. Other key sites within the catchment include the Chadstone Shopping Centre and Metropolitan and Huntingdale Golf Courses.

The catchment is drained by the Murrumbeena Drain (4850), which discharges to Gardiners Creek at the Malvern Valley Public Golf Course. The Chadstone Main Drain (4851), Oakleigh Main Drain (4852), Carlisle Crescent Main Drain (4853) and the Bishop Street Drain (4854) are all tributaries of the Murrumbeena Drain, serving other parts of the catchment. The Pakenham/Cranbourne and Glen Waverley railway lines both traverse the catchment, forming significant obstructions to overland flows at several locations. A small wetland exists above the Chadstone Main Drain in the Treyvaud Memorial Reserve.

Figure 2-1 below shows the location of the Murrumbeena Drain catchment and the Melbourne Water drains.

2.2 Melbourne Water Drainage Systems

2.2.1 Murrumbeena Drain 4850

The Murrumbeena Drain starts at the intersection of Golf Road and Alleford Street in Oakleigh South and discharges to Gardiners Creek at the Malvern Valley Public Golf Course. The Murrumbeena Drain consists entirely of underground pipe. The drain mainly follows roads upstream of the Pakenham/Cranbourne railway line, while downstream of the railway line, the drain runs beneath linear reserves.

2.2.2 Chadstone Main Drain 4851

The Chadstone Main Drain start at the south east corner of the Treyvaud Memorial Park and joins the Murrumbeena Drain just to the south of Waverley Road. The drain consists entirely of underground pipe. A wetland is situated above the drain at the west side of the Treyvaud Memorial Park, although the wetland is not directly connected to the drain. There is a current proposal to modify this wetland with low flows to be extracted from the Chadstone Main Drain.

2.2.3 Oakleigh Main Drain 4852

The Oakleigh Main Drain starts in amongst industrial property opposite Jack Edwards Reserve and joins the Murrumbeena Drain in Springthorpe Gardens on the north side of Neerim Road. The Pakenham/Cranbourne railway line forms an obstruction to overland flow in a couple of locations.

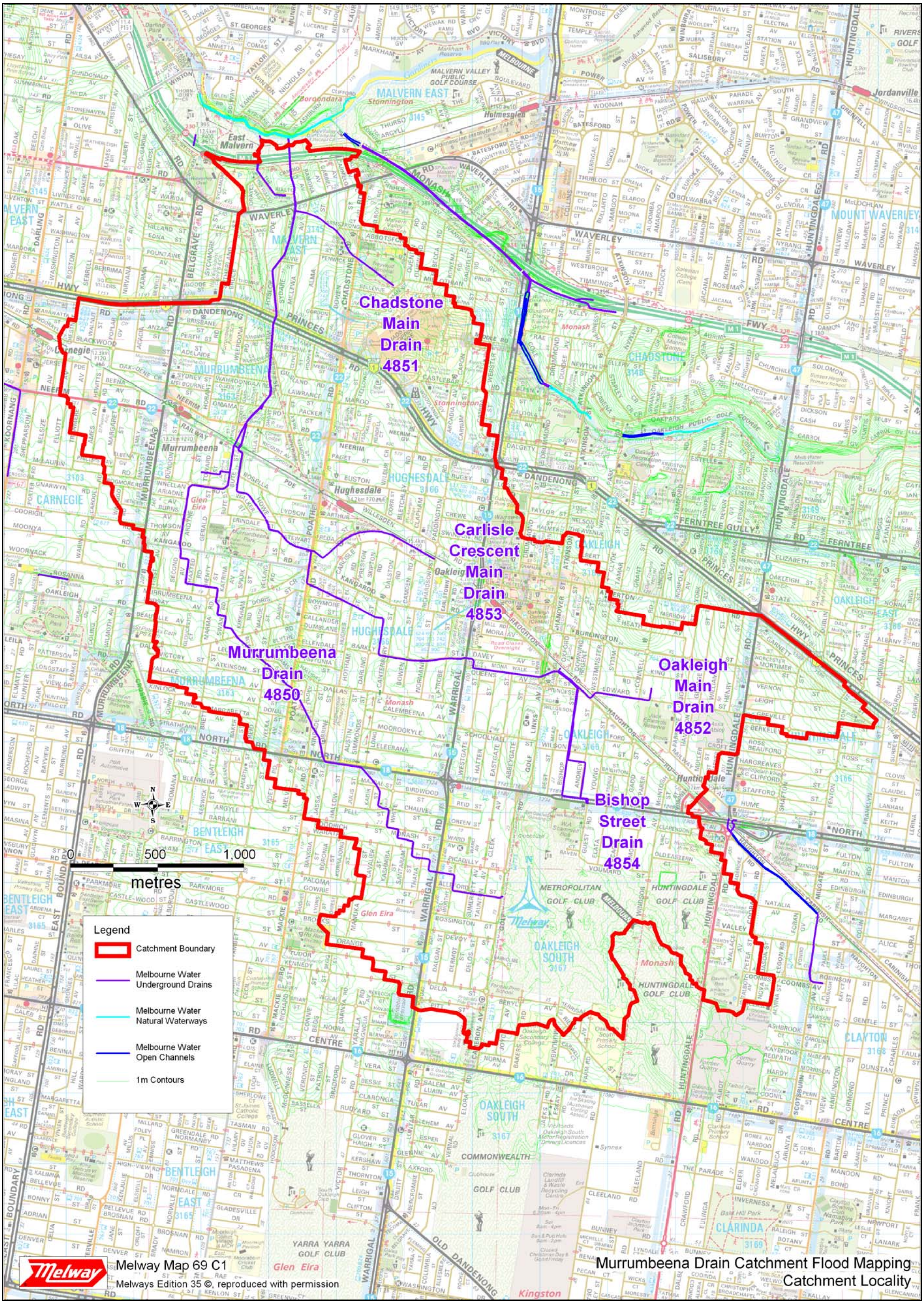

Figure 2-1 Murrumbeena Drain Catchment and Melbourne Water Drains Modelled

2.2.4 Carlisle Crescent Main Drain 4853

The Carlisle Crescent Main Drain starts at the north end of Richardson Street in Oakleigh, adjacent to the railway line, and joins the Oakleigh Main Drain at Poath Road. The drain runs beneath the Galbally Reserve and Freda Street Reserve for most of its length.

2.2.5 Bishop Street Drain 4854

The Bishop Street Drain consists of two parallel drains running from the intersection of North Road and Guest Road to the Oakleigh Main Drain at the intersection of Haughton Road and Cambridge Street.

2.3 Known Flooding Issues

Flood mapping within the Murrumbeena Drain catchment was previously undertaken by CMPS&F in 1998 for the Drainage Survey project (CMPS&F 1998). According to this previous flood mapping, significant inundation occurs along the entire Melbourne Water drainage system. The 100 year ARI flood extent and affected properties derived by CMPS&F are shown in Figure 2-2.

Melbourne Water's flood plain mapping database indicates that 1934 properties in the Murrumbeena Drain catchment are subject to flooding during the 100 year ARI event (based on inspections of the flood risk category). Of these properties, 443 would have floors flooded by the 100 year ARI event. 222 floors would be flooded in the 20 year ARI event.

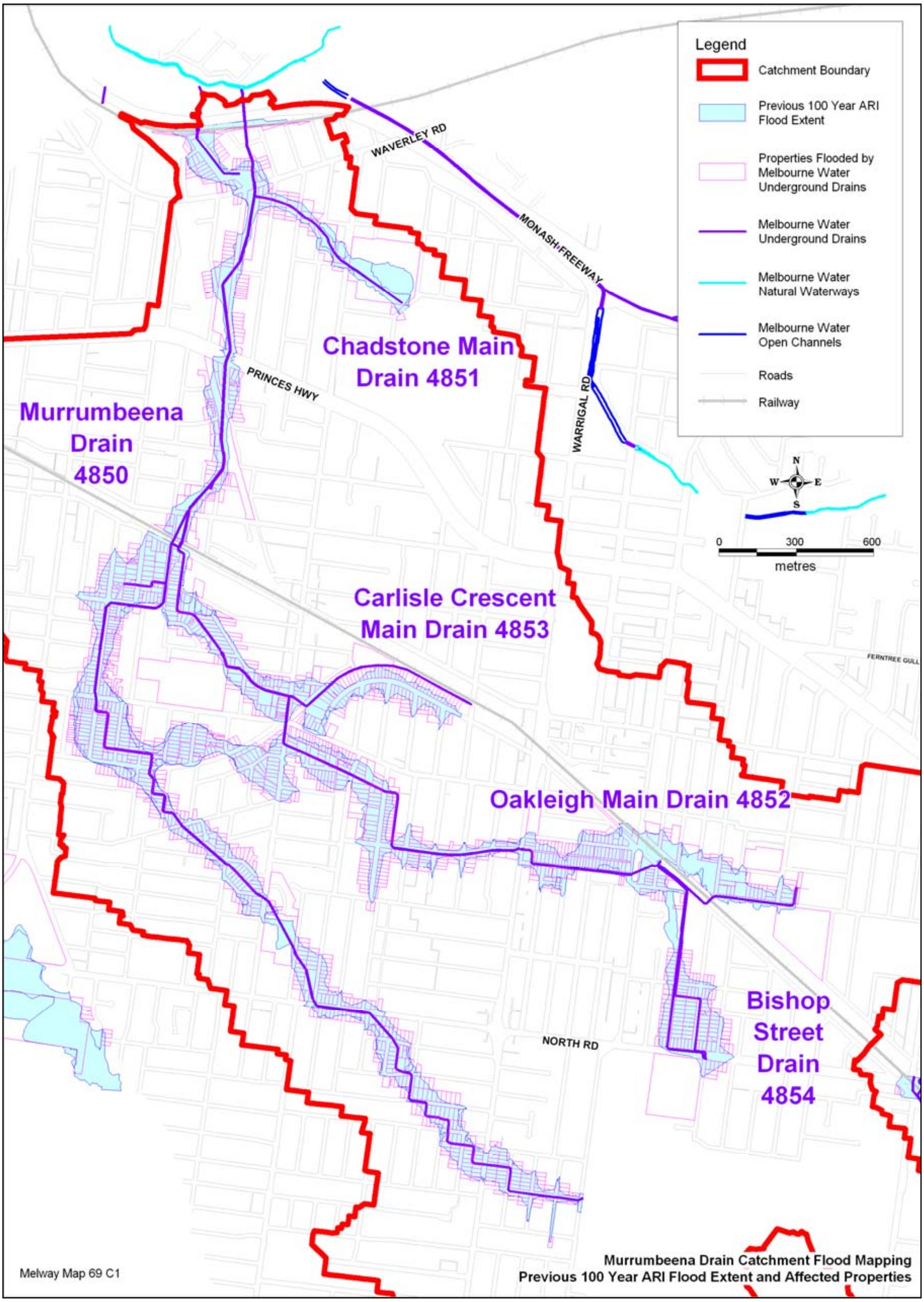

Figure 2-2 Previous 100 Year ARI Flood Extent and Affected Properties

3. Modelling Methodology

3.1 Overview

Hydrologic modelling of the Murrumbeena Drain catchment was undertaken using RORB. An "undiverted" RORB model was initially created for calibrating to a 100 year ARI Rational Method flow estimate. The "final" RORB model has been set up for the purposes of providing hydrographs for input into an unsteady hydraulic model only and as such cannot be relied upon to provide total flow estimates along the Melbourne Water drains. Hydrographs are printed for individual subareas along the Melbourne Water drains, or for groups of subareas above the drains to be mapped. The final RORB model has been run for all standard storm durations (15 minutes to 72 hours – except for PMP) for the events and scenarios listed in Table 1-1.

Hydraulic modelling of the Melbourne Water drains and associated flow paths within the Murrumbeena Drain catchment was undertaken using TUFLOW. The TUFLOW model was created using drainage details and LiDAR based terrain data from Melbourne Water, and using inflow hydrographs from RORB. The TUFLOW model is run to determine flood levels for the events and scenarios listed in Table 1-2. The results of the TUFLOW runs are post-processed to create flood extents.

3.2 Digital Terrain Model

A Digital Terrain Model (DTM) of the Murrumbeena Drain catchment was created by GHD using the LiDAR thinned ground points provided by Melbourne Water. Creation of the DTM was undertaken using 12D and formed the basis of the RORB model layout, and of the two dimensional grid for use in the TUFLOW model. The DTM was also used to create the flood extents and depths.

3.3 Hydrology

3.3.1 RORB Model Overview

RORB (*Laurenson et al 2005*) is a non-linear rainfall runoff and streamflow routing model for calculation of flow hydrographs in drainage and stream networks.

The model requires catchments to be subdivided into subareas, connected by a series of conceptual reach storages. Design storm rainfall is input to the centroid of each subarea. Specified losses are then deducted, and the excess routed to the subarea outlet and subsequently through the reach network.

Each reach is assumed to have storage characteristics as follows:

$$S = 3600kQ^m$$

where S is storage (m^3);
Q is outflow discharge (m^3/s); and
k and m are dimensionless parameters.

The coefficient k is the product of two factors:

$k = k_c.k_r$

where k_c is an empirical coefficient applicable to the entire catchment, and
k_r is the relative delay time applicable to each reach.

The relative delay time for each reach, k_{ri}, is determined as follows:

$k_{ri} = F_i*(L_i/d_{av})$

where L_i is the reach length (km),
d_{av} is the average distance along the reach network from each subarea's centroid to the catchment outlet (km), and
F_i is an empirical factor, and a function of reach type as follows:

for natural reaches, F_i=1.0,
for excavated but unlined reaches, $F_i=1/(3S_c^{0.25})$,
for lined or piped reaches, $F_i=1/(9S_c^{0.5})$, and
for drowned reaches, F_i=0.0,

where S_c is reach slope (%).

The model is also able to simulate:

- Lakes, retarding basins and similar storages; and
- Concentrated and distributed inflows and outflows.

3.3.2 History of RORB Modelling within the Murrumbeena Drain Catchment

A RORB model was created by CMPS&F for the Drainage Survey Project (CMPS&F 1998). This model was established for flood mapping purposes, to generate peak flows for input to a 1D hydraulic model (XP-EXTRAN, run in steady state).

In 2004/2005, the CMPS&F RORB model was adopted by SKM for use in the Murrumbeena Main Drain Redevelopment Drainage Scheme (RDS) Investigation (SKM 2005), for the purpose of assessing the impact of future redevelopment within the catchment on 100 year ARI flows. Only the impervious fractions were updated for the RDS investigation.

GHD commenced the Murrumbeena Main Drain Redevelopment Services Scheme (RSS) Functional Design Section 1 in 2007, where the RORB model used in the RDS investigation was reviewed. That review focussed on the calibration of the model and suggested that the model was satisfactory to use for RSS purposes at the downstream end of the catchment (where the Section 1 works were proposed).

3.3.3 Impervious Fractions

Once the subareas were defined, Melbourne Water provided two sets of impervious fractions for each subarea, representing Base Case conditions and Redevelopment conditions. These are shown in Table 3-1.

Impervious fractions for Base Case and Redevelopment conditions were based on the Planning Model. In summary, the Planning Model is a GIS layer containing polygons of Planning Scheme zone types, but with Residential zones split further into smaller "processing polygons" to better represent density variations within residential areas. Default impervious fraction values were assigned to each zone type, with the split Residential zones assigned a value based on the average property size within each processing polygon. Details of the development of the Planning Model can be found in the report "*Redevelopment Drainage Schemes Planning Assessment Report*" (GHD 2004).

All previous Planning Model overrides made to the impervious fractions in the RDS investigation were adopted for this flood mapping project for both Base Case and Redevelopment conditions. The impervious fractions adopted for the Climate Change Scenario are the same as for Base Case conditions.

Table 3-1 Adopted Impervious Fractions for Base Case and Redevelopment Conditions

Subarea Name	Area (ha)	Impervious Fraction		Subarea Name	Area (ha)	Impervious Fraction	
		Base Case	Redevelopment			Base Case	Redevelopment
A	11.170	0.156	0.156	CK	6.949	0.465	0.758
AA	14.301	0.474	0.710	CL	9.862	0.464	0.648
AB	7.891	0.469	0.702	CM	22.116	0.429	0.687
AC	13.927	0.458	0.687	CN	1.953	0.366	0.406
AD	9.902	0.438	0.634	CO	12.274	0.471	0.701
AE	15.115	0.417	0.614	CP	2.315	0.397	0.746
AF	8.095	0.502	0.740	CQ	3.465	0.419	0.801
AG	12.055	0.507	0.728	CR	12.125	0.481	0.731
AH	3.422	0.510	0.730	CS	11.460	0.579	0.791
AI	4.652	0.345	0.493	CT	19.797	0.467	0.726
AJ	4.116	0.573	0.752	CU	9.174	0.499	0.735
AK	21.227	0.531	0.776	CV	3.936	0.367	0.569
AL	5.767	0.565	0.789	CW	10.862	0.502	0.718
AM	4.162	0.568	0.799	CX	6.545	0.372	0.559
AN	4.954	0.468	0.680	CY	26.851	0.499	0.710
AO	11.406	0.441	0.761	CZ	26.042	0.456	0.754
AP	8.019	0.532	0.797	D	5.466	0.337	0.476
AQ	2.205	0.525	0.798	DA	2.928	0.683	0.737
AR	4.641	0.481	0.742	DB	17.809	0.408	0.585

Subarea Name	Area (ha)	Impervious Fraction		Subarea Name	Area (ha)	Impervious Fraction	
		Base Case	Redevelopment			Base Case	Redevelopment
AS	3.122	0.427	0.701	DC	5.266	0.364	0.523
AT	11.440	0.470	0.710	DD	5.352	0.482	0.787
AU	14.905	0.522	0.762	DE	10.831	0.468	0.727
AV	8.060	0.529	0.799	DF	13.059	0.766	0.870
AW	5.561	0.700	0.836	DG	13.123	0.900	0.900
AX	19.354	0.567	0.772	DH	9.777	0.567	0.780
AY	2.953	0.898	0.898	DI	6.296	0.163	0.216
AZ	10.202	0.663	0.762	DJ	2.947	0.381	0.517
B	10.710	0.100	0.100	DK	4.485	0.721	0.847
BA	13.018	0.895	0.895	DL	9.391	0.489	0.732
BB	4.160	0.236	0.236	DM	9.126	0.450	0.689
BC	5.825	0.678	0.810	DN	2.483	0.485	0.762
BD	4.986	0.608	0.774	DO	3.615	0.379	0.526
BE	11.730	0.400	0.568	DP	3.271	0.524	0.705
BF	4.115	0.235	0.271	DQ	0.837	0.485	0.678
BG	7.631	0.703	0.712	DR	3.036	0.375	0.547
BH	4.553	0.108	0.122	DS	3.226	0.446	0.691
BI	12.322	0.100	0.100	DT	6.214	0.452	0.663
BJ	5.849	0.456	0.650	DU	1.403	0.658	0.670
BK	2.527	0.120	0.133	DV	0.342	0.700	0.700
BL	12.765	0.455	0.684	DW	0.373	0.700	0.700
BM	11.412	0.330	0.472	DX	1.396	0.690	0.690
BN	11.366	0.498	0.764	DY	0.364	0.699	0.699
BO	9.137	0.480	0.743	DZ	3.262	0.401	0.401
BP	4.838	0.485	0.746	E	11.437	0.121	0.133
BQ	4.697	0.441	0.661	F	13.932	0.486	0.645
BR	1.820	0.368	0.649	G	16.739	0.442	0.678
BS	2.128	0.568	0.724	H	9.028	0.475	0.712

Subarea Name	Area (ha)	Impervious Fraction		Subarea Name	Area (ha)	Impervious Fraction	
		Base Case	Redevelopment			Base Case	Redevelopment
BT	20.815	0.696	0.790	I	4.317	0.485	0.748
BU	5.456	0.441	0.659	J	9.230	0.541	0.770
BV	6.491	0.485	0.724	K	13.939	0.472	0.706
BW	7.854	0.566	0.737	L	7.406	0.494	0.722
BX	11.780	0.482	0.690	M	10.441	0.487	0.750
BY	11.054	0.470	0.715	N	8.146	0.491	0.763
BZ	6.493	0.470	0.696	O	6.062	0.221	0.298
C	9.927	0.154	0.187	P	8.529	0.475	0.736
CA	25.917	0.461	0.696	Q	12.158	0.164	0.205
CB	11.610	0.479	0.708	R	24.329	0.493	0.736
CC	4.653	0.504	0.731	S	14.431	0.482	0.769
CD	8.622	0.478	0.717	T	4.360	0.543	0.764
CE	5.814	0.481	0.748	U	12.902	0.486	0.747
CF	4.013	0.683	0.765	V	11.043	0.471	0.683
CG	7.585	0.536	0.752	W	10.294	0.399	0.611
CH	10.648	0.890	0.890	X	15.484	0.481	0.729
CI	10.682	0.542	0.603	Y	7.330	0.457	0.684
CJ	4.712	0.551	0.782	Z	3.884	0.448	0.666

3.3.4 Design Rainfall Intensities

Design rainfall intensities were determined based on the methods prescribed in Book 2 of the 1997 Edition of Australian Rainfall and Runoff (*IEAust 1997*). Two sets of Intensity-Frequency-Duration (IFD) data were required for this project:

1. "normal" rainfall intensities for the Base Case and Redevelopment Scenarios (as per AR&R 1997); and
2. rainfall intensities increased by 32% for the Climate Change Scenario (as specified by Melbourne Water).

Table 3-2 shows the IFD parameters adopted to generate the “normal” and “increased” IFD data for the Murrumbeena Catchment. “Normal” IFD parameters were adopted from the RDS investigation (SKM 2005). The parameters adopted for the Climate Change Scenario result in an IFD table where all intensities are 32% higher than normal intensities. The full IFD tables used for the Murrumbeena Drain Catchment are presented in Appendix A.1.

Table 3-2 IFD Parameters for the Murrumbeena Drain Catchment

Parameter	Base Case & Redevelopment (normal rainfall intensities)	Climate Change (increased rainfall intensities)
${}^{2}i_{1}$ (1 hr duration, 2 yr ARI)	18.70 mm/hr	24.68 mm/hr
${}^{2}i_{12}$ (12 hr duration, 2 yr ARI)	3.80 mm/hr	5.02 mm/hr
${}^{2}i_{72}$ (72 hr duration, 2 yr ARI)	1.10 mm/hr	1.45 mm/hr
${}^{50}i_{1}$ (1 hr duration, 50 yr ARI)	38.00 mm/hr	50.16 mm/hr
${}^{50}i_{12}$ (12 hr duration, 50 yr ARI)	7.15 mm/hr	9.44 mm/hr
${}^{50}i_{72}$ (72 hr duration, 50 yr ARI)	2.25 mm/hr	2.97 mm/hr
G (skewness)	0.36	0.36
F2 (2 yr ARI geographical factor)	4.29	4.41
F50 (50 yr ARI geographical factor)	14.95	16.71

3.3.5 PMP Design Storms

As requested by Melbourne Water, estimations of the Probable Maximum Precipitation (PMP) for the Murrumbeena Drain catchment were determined based on the Bureau of Meteorology’s Generalised Short-Duration Method (GSDM) (*BoM 2003*). This method only applies to storm durations up to six hours. The method prescribed in Chapter 4 of the Bureau’s methodology document (*BoM 2003*) was used to determine PMP rainfall depths (in millimetres) for each duration.

Due to the relatively small size of the catchment in relation to the ellipses used for determining spatial distribution, it was considered that there was no need to vary the PMP rainfall spatially over the Murrumbeena Drain catchment.

Individual PMP design storms were created for the required storm durations up to six hours based on the temporal pattern presented in Chapter 5 of the Bureau’s methodology document (*BoM 2003*).

The GSDM Calculation Sheet used to determine PMP values (mm) for the Murrumbeena Drain catchment is presented in Appendix A.2.

3.3.6 RORB Loss Parameters

RORB's initial loss/runoff coefficient model was used for the 100 year to 5 year ARI design runs. Adopted parameters for *pervious* areas were as follows:

- Initial loss = 10 mm;
- 100 year ARI Runoff coefficient = 0.6;
- 50 year ARI Runoff coefficient = 0.55;
- 20 year ARI Runoff coefficient = 0.45;
- 10 year ARI Runoff coefficient = 0.35; and
- 5 year ARI Runoff coefficient = 0.25.

The model automatically sets these parameters for *impervious* areas as follows:

- Initial loss = 0 mm; and
- Runoff coefficient = 0.9.

The 100 year to 5 year ARI design storms used in the modelling were based on point storms, a fully filtered temporal pattern, and IFD parameters described in Section 3.3.4.

For the PMP events, RORB's initial loss/continuing loss model was used, where an initial loss of 0 mm and continuing loss of 1 mm/hr was adopted (as suggested in Book 6 of AR&R (*IEAust 1997*)).

A value of 0.8 was adopted for the model exponent, m, throughout.

3.3.7 Rational Method

The rational method is the simplest and most widely used method for calculation of peak discharge from a catchment. Rational method flow estimates were used to calibrate the undiverted RORB model.

Since the RORB model was used to generate flow hydrographs at the tops of the Melbourne Water drains and for local flow inputs along the drains, it was considered more appropriate to use routing parameters better suited to generating hydrographs at the tops of the drains rather than at the outlet. Hence, rational method flow estimates were calculated at the tops of five of the main branches, rather than at the catchment outlet.

The basic Rational Method equation is as follows:

$$Q = C.I.A/360$$

where Q is the peak flow in cumecs, corresponding to the average recurrence interval under consideration;

C is a runoff coefficient;

I is the rainfall intensity in mm/hour, corresponding to t_c, the time of concentration of the catchment, and the average recurrence interval under consideration; and

A is the catchment area in hectares.

Runoff coefficients were assessed using the method prescribed in Book 8 of the 1997 Edition of Australian Rainfall and Runoff (*IEAust 1997*). This relates the runoff coefficient to:

- The impervious percentage of the catchment;
- Design recurrence interval; and
- 10 year 1 hour design rainfall intensity.

Times of concentration, t_c, were calculated using:

- Flow velocities upstream of the Melbourne Water drainage system, generally calculated assuming:
  - A Colebrook White roughness coefficient of 1.5 mm;
  - Pipe diameters of Council drains;
  - An estimated effective pipe friction slope in the range of 50 to 100% of the ground slope (to make allowance for losses due to pits, etc.); and
- An allowance of seven minutes for runoff to reach the upstream limit of the piped drainage system.

Time of concentration and rational method calculations are presented in Appendix A.3 and Appendix A.4 respectively.

3.3.8 Undiverted RORB Model Layout

For this flood mapping project, the catchment and subarea boundaries were completely revised based on LiDAR. In particular, the LiDAR indicated that additional area in the vicinity of the Huntingdale Golf Course could be included in the catchment.

For this project, all inflows were routed overland from the centroid of their subcatchment area to the Melbourne Water drainage system. For the purposes of assigning a reach type, the following principles were generally applied:

- Reach types consistent with t_c calculation assumptions;
- Overland flows along roads or other hard surfaces were assigned a reach type 3 (“lined or piped”);
- Overland flows predominantly through properties, or across grassed surfaces, were assigned a reach type 2 (“excavated but unlined”); and
- Overland flow through the Metropolitan and Huntingdale Golf Courses was assigned a reach type 1 (“natural”) due the golf courses having generally undulating terrain and many small depression storages.

In order for the undiverted RORB model to best represent the Rational Method’s assumptions:

- No special storages were included;
- No inter-catchment Council pipe “diversions” were included; and
- Once flow from a subarea reached a Melbourne Water pipe, all flow was assumed to follow the pipe as a reach type 3.

The undiverted RORB model was established for the Base Case Scenario only.

3.3.9 RORB Model Calibration

For the reasons discussed above in Section 3.3.5, several rational method flow estimates were determined, enabling several "mini calibrations" of the RORB model. The Undiverted model was run several times, adjusting k_c each time, until the RORB flows at the tops of five of the main branches matched the corresponding rational method flows for the 100 year ARI event. While each of the five calibrations required a slightly different k_c value, an average k_c value of 5.75 was adopted (refer to Appendix A for calibration results). This was considered to be an appropriate value to obtain representative hydrographs at the tops of each Melbourne Water drain. Calibration was undertaken for the Base Case 100 year ARI event only.

The value for d_{av} for the undiverted model is 4.11 km.

The calibration results and undiverted RORB catchment file are presented in Appendix A.4 and Appendix A.5 respectively.

3.3.10 Final RORB Model Layout

The final RORB model was created by taking the undiverted RORB model and adding:

- Council pipe diversions into and out of the catchment in various locations, for diameters of 450 mm and greater.

As these features are all located upstream of the Melbourne Water drains and not modelled in TUFLOW, their effects on flows reaching the Melbourne Water drainage system have been modelled in RORB.

The introduction of diversions or other flow paths into a model can often result in a change to d_{av}. Any changes in d_{av} should be compensated for by also adjusting k_c, such that the k_c/d_{av} ratio for the final RORB model is the same as for the calibration (undiverted) model. In this instance, the value of d_{av} was the same for both the undiverted and final RORB models, hence no adjustment to k_c was necessary.

The final RORB model was run for the events and scenarios listed in Table 1-1 to obtain hydrographs for use in TUFLOW.

The final RORB catchment file, summary RORB results and the GIS representation of the final RORB model can be found in Appendix A.6, Appendix A.7 and Appendix A.8 respectively.

Council Pipe Diversions

Diversions were added to the RORB model where Council pipes, 450 mm in diameter or greater, crossed the catchment boundary. It was considered, and agreed with Melbourne Water, that the capacities of these sized pipes could have a significant impact on the flow reaching the Melbourne Water drains. In order to estimate the capacities of these pipes, and as only the diameters of the pipes were available from the provided GIS layer of Council drains, it was assumed that the hydraulic grade line of each pipe would be parallel to the ground slope. Ground slopes were estimated from the LiDAR information. Pipe capacities were estimated from a Colebrook-White pipe flow chart for a k_s of 1.5 mm.

Inter-catchment Council pipe diversions were included at the following locations:

- 1125 mm diameter out of the catchment at RORB node BF2;
- 525 mm diameter out of the catchment at RORB node AS2;
- 525 mm diameter into the catchment at RORB node at Z;
- 975 mm diameter out of the catchment at RORB node BA.

Outflows were permanently subtracted from the RORB model at the nodes listed (i.e. they were diverted out and not recalled). Constant inflows were added to the RORB model at the nodes listed and then routed and attenuated along the pipe to the main network.

Some "internal" Council pipe diversions were also included in the final RORB model, at locations where the Council pipes direct flow in a different direction to the overland flow path. An assessment was made of the potential impact on flood extents to decide which diversions were to be included.

3.4 Hydraulic Modelling

3.4.1 Introduction

Hydraulic modelling was undertaken using TUFLOW. TUFLOW is a hydrodynamic model used for simulating one-dimensional (1D) and two-dimensional (2D) flows. The model is based on the solution to the free-surface flow equations. It links 1D network (ESTRY) domains to 2D (TUFLOW) domains to represent the catchment terrain and its drainage system. The TUFLOW model consists of a 2D domain representing the catchment terrain, a 1D network representing the pipe system and a set of boundary conditions comprising the calculated RORB hydrograph inflows and the downstream water levels.

TUFLOW modelling was undertaken to determine the peak water levels along the drainage network for the events and scenarios listed in Table 1-2. The model was initially run for twenty different 100 year ARI storm durations ranging from 10 minutes to 72 hours in order to determine the critical peak flood levels (i.e. 20 runs in total). The longest storm duration run was later revised to 18 hours after a review of an initial set of results showed that running longer storms was unnecessary (i.e. did not result in peak flood levels). The PMF events were run for ten storm durations ranging from 15 minutes to six hours.

Plans showing the layout of the Murrumbeena Drain catchment TUFLOW model, as described below, are included in Appendix B.

3.4.2 2D Domain

The 2D domain represents the surface terrain of all major overland flow paths within the Murrumbeena Drain catchment. A DTM was created from LiDAR thinned ground points to represent the catchment topography. Using this terrain model, a 4 000 m by 5 000 m grid comprising 4 metre square cells was formed. Each cell is made up of nine points, with the elevation for each point based on the LiDAR ground level information. The grid was orientated to align with the major road networks within the catchment. The 2D domain was used to model all overland flow paths.

Some major flow control structures critical in determining overland flow distribution, and/or levels of ponding, were included in the 2D domain by modifying the elevations of cell points where such point elevations directly adjacent to the structures were lower than the actual structure elevation. Such control structures included the Belgrave and Pakenham railway lines, Princes Highway, Waverley Road, a noise wall embankment running parallel to the Belgrave railway line, and the Oakleigh and Hughesdale Station platforms (not represented in the LiDAR thinned ground points).

The bed resistance was allocated to each cell as a Manning's n value based on land use type. Adopted Manning's n values are tabulated in Table 3-3 below.

Table 3-3 Bed Resistance Values for 2D domain

Material Number	Land Use	Manning's n
1	Road Reserve (default material)	0.02
2	Residential and Industrial areas	0.2
3	Railway Reserve	0.05
4	Public Open Space – few trees	0.03
5	Public Open Space – more trees	0.04
6	Public Zones (i.e. PUZ)	0.2
7	Golf Courses	0.03
8	Public Open Space – many trees	0.05
9	En-tout-cas tennis courts	0.03
10	Commercial Areas	0.35

3.4.3 1D Network

The existing one-dimensional network comprises all the underground pipes in the Melbourne Water drainage system that fall within the Murrumbeena Drain catchment. A number of council drains were also included in the 1D network at breakaway overland flow paths between Melbourne Water drains, and to enable flows in land-locked areas to reach the Melbourne Water drains.

The pipe network includes all underground pipes and connections to the surface (pits). Pipes were mostly modelled as circular or irregular culverts. Irregular culverts (predominantly rectangular top and sides with v-shaped bases of varying sizes) were defined using tables of hydraulic properties. Some pipes were modelled as rectangular culverts. A Manning's n value of 0.015 was applied to all concrete pipes.

Appropriate losses were determined throughout the pipe network, based on standard pit loss tables (*MWC 2006*). Each pit loss value was generally assigned to the downstream pipe as a form loss, rather than in the pits themselves. For culverts or ends of pipes, a typical entrance loss of 0.5 and exit loss of 1.0 were applied.

Pits have generally been modelled as 3 m wide weirs, unless real pits were actually larger than this, to allow for additional inlet capacity not otherwise explicitly included in the model.

3.4.4 Boundary Conditions

Boundary conditions in the TUFLOW model include inflow hydrographs and downstream tailwater conditions.

Following consultation with Melbourne Water, the values shown in Table 3-4 were adopted as constant tailwater levels for Gardiners Creek at the drain outlets. These levels were applied in the TUFLOW model as head versus time boundary conditions ("HT" boundary) to the respective pipe outlets in the 1D network (in a 1d_bc layer) and across the 2D domain close to the pipe outlets (in a 2d_bc layer), and remained constant throughout each simulation.

Table 3-4 Adopted Gardiners Creek Water Levels

Event	Water level at East Outlet (Main Drain and Council drain to east)	Water level at West Outlet (Relief Drain)
PMF	28.0 m AHD (100 year ARI creek level)	27.0 m AHD (100 year ARI creek level)
100 Year ARI	27.6 m AHD (10 year ARI creek level)	26.7 m AHD (10 year ARI creek level)
50 Year ARI	25.3 m AHD (pipe obvert)	23.7 m AHD (pipe obvert)
20 Year ARI	25.3 m AHD (pipe obvert)	23.7 m AHD (pipe obvert)
10 Year ARI	25.3 m AHD (pipe obvert)	23.7 m AHD (pipe obvert)
5 Year ARI	25.3 m AHD (pipe obvert)	23.7 m AHD (pipe obvert)

It was agreed to adopt these tailwater levels for the 50 year to 5 year ARI model runs after assessing the effect the tailwater levels for the 100 year ARI event had on the smaller Base Case events. This sensitivity analysis showed that using the 10 year ARI Gardiners Creek flood level for the 50 year to 5 year ARI models caused significant back flooding along the Murrumbeena Drain in residential areas. It was therefore agreed with Melbourne Water that the pipe obvert levels of each outlet be adopted as tailwater levels for the 50 year to 5 year ARI models.

Normally, a downstream tailwater level would also be applied as an initial water level throughout a model to prevent a wall of water rushing back up the network at the start of a simulation. As there are two downstream tailwater levels applied to this model, it was found that applying the lowest tailwater level as an initial water level provided a more stable model at the start of the simulation. Hence, the water levels for the west outlet were applied as initial water levels to the respective models.

The hydrographs generated using the RORB model for the events and scenarios listed in Table 1-2 were adopted as the flow boundary conditions ("QT" – flow versus time). For all events except the PMF, flows were put into the TUFLOW model by distributing hydrographs to nodes in the 1D network (via the 1d_bc layer). This encourages the pipes to flow full before flooding occurs. For PMF event runs, as a result of the extremely large hydrographs being used, flow were put into the model by distributing hydrographs across cells in the 2D domain where pits exist (via the 2d_sa layer). Some flows were input to nodes in the 1D network in the PMF models where those hydrographs represent pipe capacities only.

3.4.5 Model and Run Parameters

Following several test runs trialling various parameters, the following parameters were found to achieve the most stable model runs across a wide range of storm durations, and have been adopted for all runs (unless otherwise specified):

- A time step of 1 second for the 2D domain (except for PMF models where 0.5 seconds was used to minimise the number of 2D negative depth warnings resulting from large overland flows running over areas of steep terrain) and a time step of 0.25 seconds for the 1D network;
- Model run times long enough for peak flood levels to occur through out the drainage system. This can sometimes be considerably longer than the storm duration to allow enough time for flow to reach the outlet and for storage levels to peak;
- An initial water level in the 1D and 2D domains equal to the Gardiners Creek tailwater level at the west pipe outlet (refer to Table 3-4); and
- "Negative Depth Approach == Method B" command. This is an undocumented command that provides greater stability to models when negative depth occurs. This was adopted following discussions with Bill Syme (the principal developer of TUFLOW).

No other special commands were required to stabilise the Murrumbeena Drain model.

3.4.6 Qualifications relating to Flood Mapping Output

All modelling results require appropriate interpretation. It should be noted that the smaller, more frequent events, such as the 5 and 10 year ARI results, are produced using a hydraulic model established primarily for the purpose of modelling the 100 year ARI event. The implication of this is that the modelling results for these smaller events will need to be appropriately interpreted with an understanding of their limitations.

Despite these limitations, the results for the smaller, more frequent events are currently believed to be the best available and hence, it is appropriate that they form the basis of inputs to Melbourne Water's Flood Risk Assessment Framework Matrix. More accurate modelling of the smaller, more frequent events might however be obtained through the use of smaller 2D cell sizes, the more complete inclusion of smaller drainage systems (e.g. Council drains), and a number of other refinements.

The accuracy of the final results is in part a function of the resolution of the TUFLOW model (which uses a 4 m cell size). The higher resolution of results (provided on a 1m grid) is provided as a partially interpreted data source for the convenience of Melbourne Water. This higher resolution grid of results does not infer a higher accuracy.

4. Results

Water level, velocity and velocity-depth results were obtained at each wet 2D cell for every TUFLOW run (*h.dat, *v.dat and *z0.dat respectively). For each of the events and scenarios listed in Table 1-2, envelopes of maximum water levels, maximum velocities and maximum velocity-depths were created using the DAT_to_DAT utility. The maximum envelopes were then converted to 1 m ascii grids using the TUFLOW_to_GIS utility. The 1 m ascii grids were processed further to create the required MapInfo layers, as described further in Chapter 5.

Flow results were also obtained at a selection of locations throughout the catchment (as defined in a 2d_po layer) for every TUFLOW run. For the Base Case Scenario, these results were collated and provided in the MapInfo layer “Flow_Values.tab”. The asset flows reported in that layer are taken at the time at which the maximum overland flows occur, or are the maximum asset flows if there are no corresponding overland flows. These flows are summarised in Table 4-1 for the Base Case Scenario 100 year ARI event.

Table 4-1 Summary of Peak 100 Year ARI Flood Levels and Flows for Base Case Scenario

Flow Point Number	Location	Total Flow (m^3/s)	Pipe Flow (m^3/s)	Overland Flow (m^3/s)	Critical Storm Duration
Murrumbeena Drain 4850					
27	Overland flow through Golf Course	74.08	0	74.08	18h
28	Monash Fwy outbound lanes	34.53	34.53	0	2h
77	Noise wall embankment	13.8	13.8	0	4.5h
76	Camino Tce	13.29	11.71	1.58	2h
26	The Rialto upstream railway	20.4	0.08	20.32	2h
25	The Rialto West	22.18	0.03	22.15	1h
75	The Rialto	37.61	13.83	23.78	1h
74	Waverley Rd	37.37	20.51	16.86	1h
24	Upstream of Waverley Rd	37.08	17.47	19.61	1h
72	4850 upstream 4851	28.09	20.59	7.5	4.5h
41	Syndare Av at Alvie St	28.09	19.15	8.94	6h
71	Syndare Av at Princes Hwy	27.95	24.27	3.68	6h
21	Princes Hwy	27.86	27.75	0.11	4.5h
20	Wilson St at Princes Hwy	27.81	16.64	11.17	4.5h
70	Wahroongaa Rd	27.44	18.37	9.07	4.5h

Flow Point Number	Location	Total Flow (m^3/s)	Pipe Flow (m^3/s)	Overland Flow (m^3/s)	Critical Storm Duration
19	Omama Rd	27.48	18.2	9.28	4.5h
18	North of Neerim Rd	27.02	19.29	7.74	4.5h
17	Riley Reserve	26.09	18.73	7.36	4.5h
69	4850 at Railway	26.17	26.17	0	4.5h
13	Railway Pde	23.63	8.39	15.24	3h
14	Between Ardyne & Toward	14.37	3.67	10.7	3h
12	Ardyne St at Ariadne Av	14.42	7.18	7.24	3h
8	Kangaroo Rd at Ardyne	14.46	6.23	8.23	3h
67	Between Henty & Thaxted	14.56	7.27	7.29	3h
7	Marma Rd at Murrumbeena Cr	9.48	8.03	1.45	2h
39	Dalny Rd	9.46	7.11	2.35	2h
66	Leura St at Reid St	9.53	6.91	2.62	2h
6	Poath Rd at Vera St	9.7	8.6	1.1	2h
65	Kinrade St	9.49	8.98	0.51	2h
5	Brine St at North Rd	10.56	5.21	5.35	2h
64	North Rd at Simmons St	9.99	6	3.99	1h
63	Julis St at North Rd	9.9	6.58	3.32	1h
62	White St at Monash St	7.85	3.68	4.16	2h
4	Waratah St	7.08	3.12	3.97	2h
3	Warrigal Rd 4850	6.08	2.48	3.6	2h
61	Sumersett Av	6.13	2.45	3.69	1h
2	Golf Rd at Alleford St	2.87	1.15	1.72	2h
31	Katrina Av	4.95	1.25	3.69	2h
54	Pelling Rd	4.99	1	3.99	2h
Chadstone Main Drain 4851					
23	Millewa Av	12.1	1.89	10.21	1h
73	Bowen St	13	3.11	9.89	25m
22	Chadstone Rd	13.12	4.39	8.73	25m
29	Downstream of Chapman St	11.17	3.78	7.39	15m

Flow Point Number	Location	Total Flow (m^3/s)	Pipe Flow (m^3/s)	Overland Flow (m^3/s)	Critical Storm Duration
Oakleigh Main Drain 4852					
15	Erindale St to Rosella St	13.68	12.72	0.96	2h
40	Erindale St	14.27	12.54	1.73	1.5h
84	Howe St	14.31	14.31	0	25m
9	Poath Rd bw Kangaroo & Stewart	12.4	12.35	0.05	25m
30	Poath Rd at Doris St	5.71	0	5.71	2h
53	Kelvinside St	13.35	8.08	5.28	2h
38	Downstream of Darling St	13.89	9.38	4.5	1h
52	Barkly St between Canterbury &	12.92	6.7	6.22	2h
51	Barkly St at Normanby St	12.54	8.7	3.84	2h
10	Warrigal Rd at Barkly St	12.34	9.19	3.15	2h
48	Queens Av to Davey Av	11.86	6.97	4.88	1h
47	Beneath Hanover St bridge	15.38	5.67	9.71	1h
46	Oxford St	5.25	0	5.25	1h
45	Haughton Rd at Bishop St	9.08	6.99	2.1	1h
44	4852 at railway	5.09	2.9	2.19	1h
43	Westminster St	11.38	3.4	7.97	1h
11	Edward St near Connell	9.48	3.11	6.36	25m
78	railway at Jack Edwards Res	0.03	0	0.03	20m
Carlisle Crescent Main Drain 4853					
59	Poath Rd at Freda St	4.47	3.85	0.62	1h
58	Carlisle Cr at Kangaroo Rd	1.82	0.06	1.76	1.5h
56	Arthur St	6.08	3.51	2.57	1.5h
57	Carlisle Cr at Dalston Rd	3.92	2.55	1.37	25m
33	Carlisle Cr at Richardson St	4.3	2.69	1.61	15m
34	Paddington Rd	8.03	2.01	6.02	15m

Flow Point Number	Location	Total Flow (m^3/s)	Pipe Flow (m^3/s)	Overland Flow (m^3/s)	Critical Storm Duration
Bishop Street Drain 4854					
42	Bishop St at Princess St	2.8	2.17	0.63	1h
37	Bishop St at Wilson St	2.95	1.71	1.25	2h
1	North Rd at Guest Rd	4.51	3.48	1.03	1h

Flood level hydrographs at a few key locations throughout the catchment for the Base Case Scenario 100 year ARI event are presented in the following figures. These figures also give an indication of the time to peak flood levels around the catchment.

It should be noted that the small steps evident in some of these flood level hydrographs are the result of height averaging along the PO lines as cells in the 2D domain are wet or dried. In general, these steps do not indicate model instability.

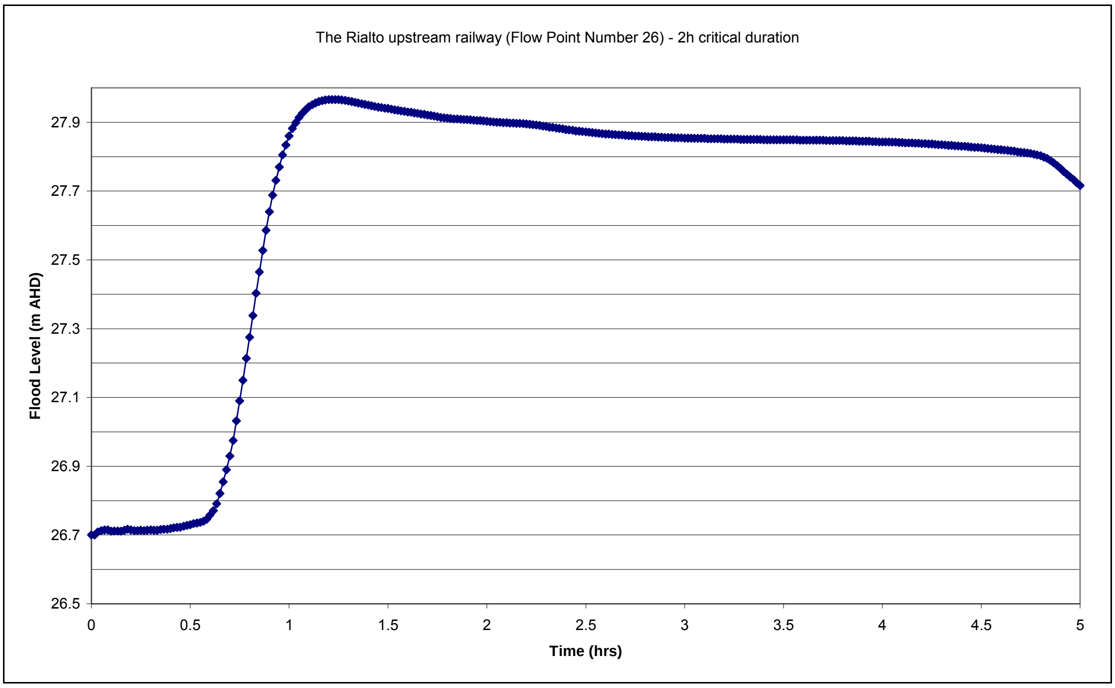

Figure 4-1 Flood Level Hydrograph – Murrumbeena Drain, The Rialto upstream of railway line

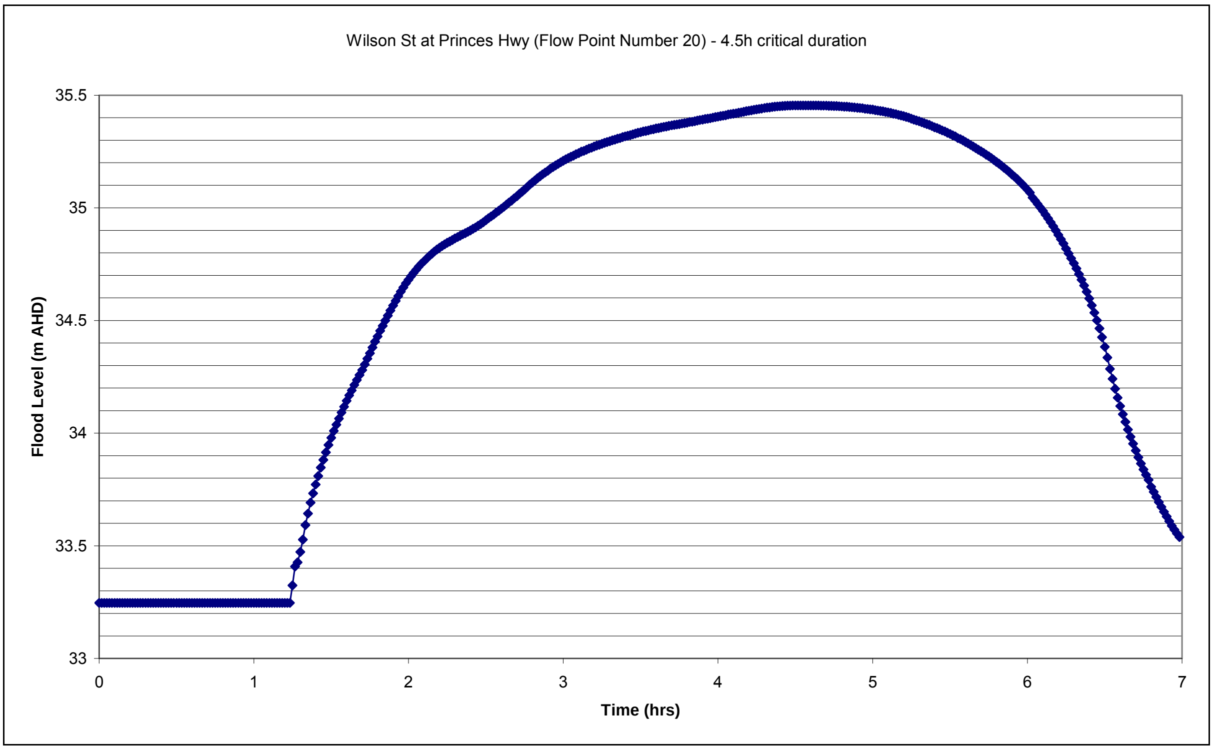

Figure 4-2 Flood Level Hydrograph – Murrumbeena Drain upstream Princes Highway

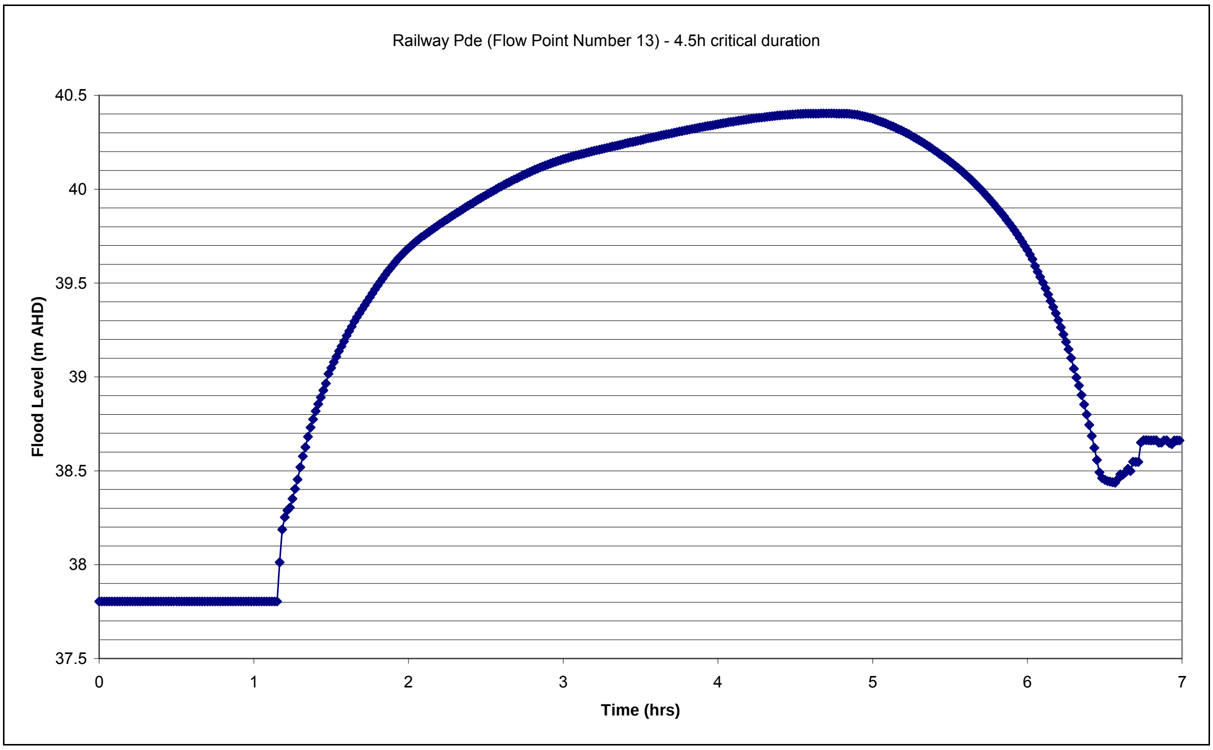

Figure 4-3 Flood Level Hydrograph – Murrumbeena Drain upstream Pakenham Railway Line

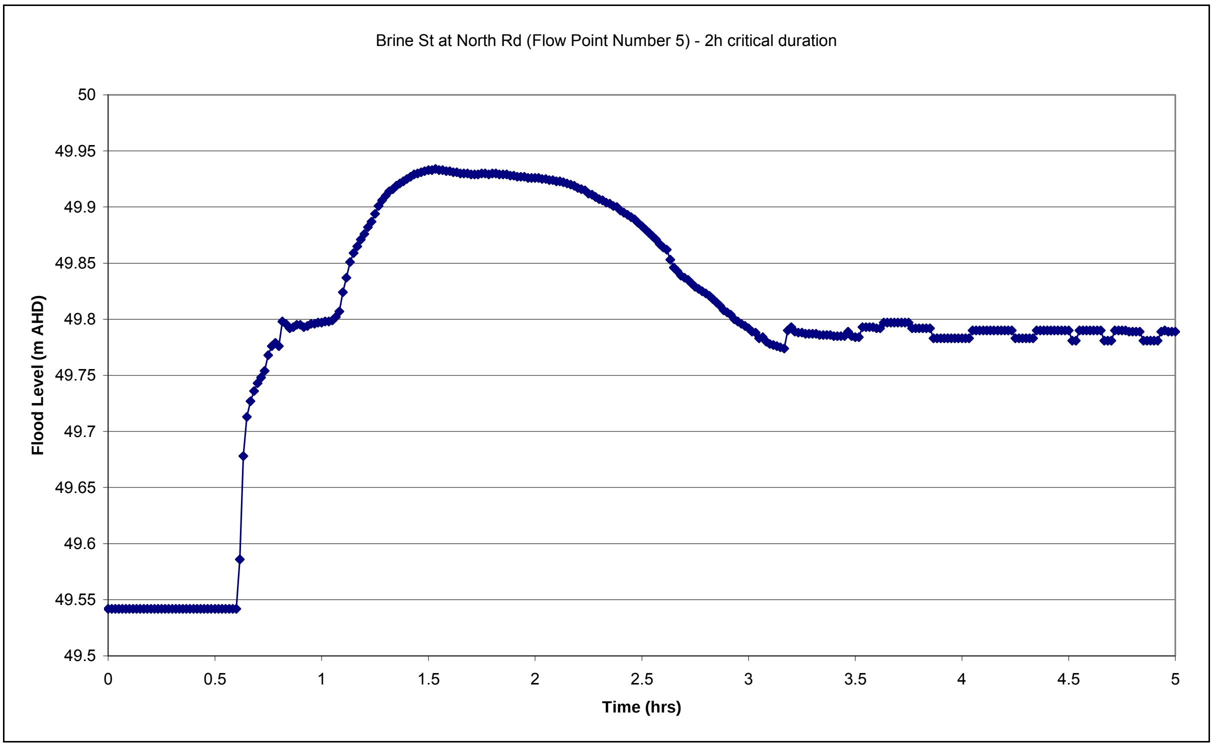

Figure 4-4 Flood Level Hydrograph – Murrumbeena Drain at North Road

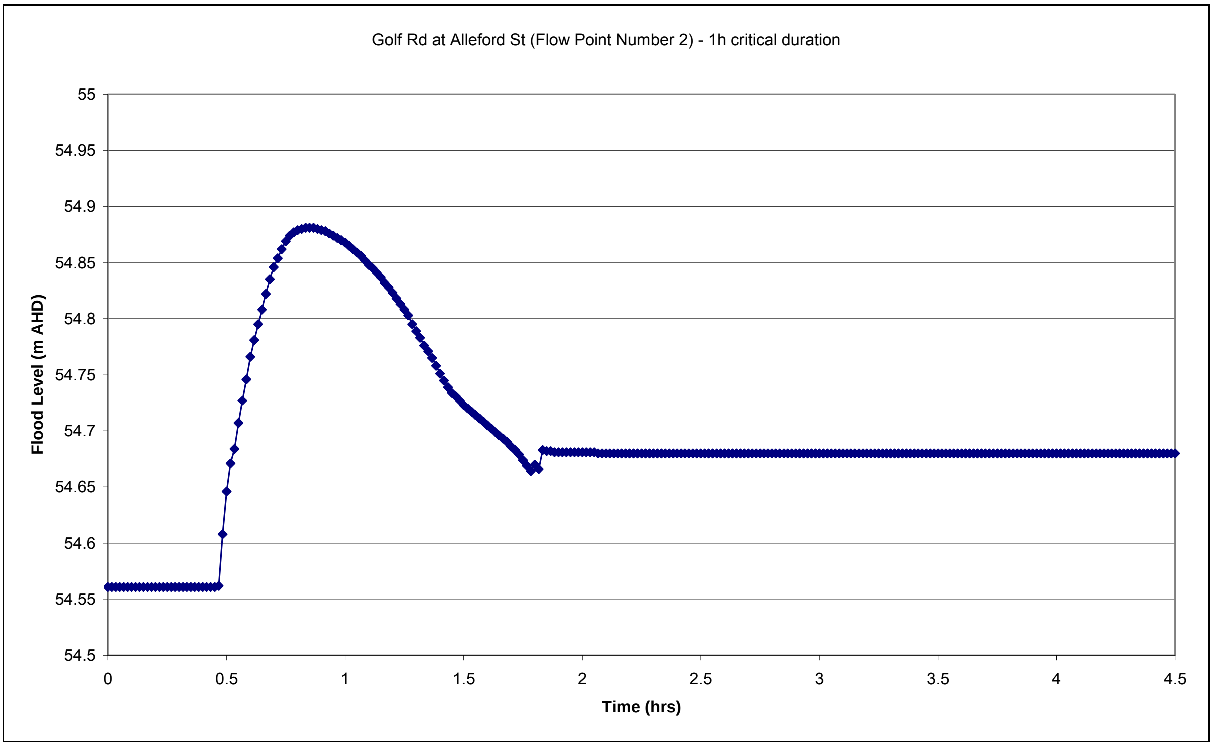

Figure 4-5 Flood Level Hydrograph – Murrumbeena Drain at Golf Road

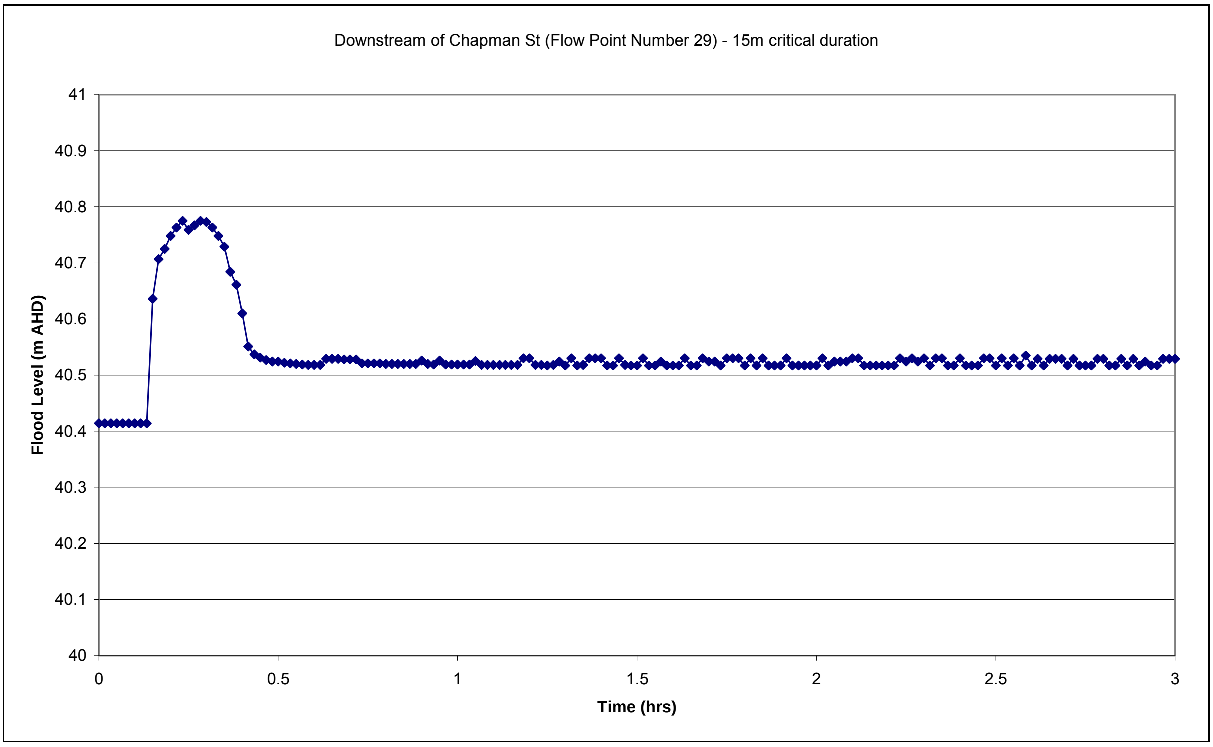

Figure 4-6 Flood Level Hydrograph – Start of Chadstone Main Drain

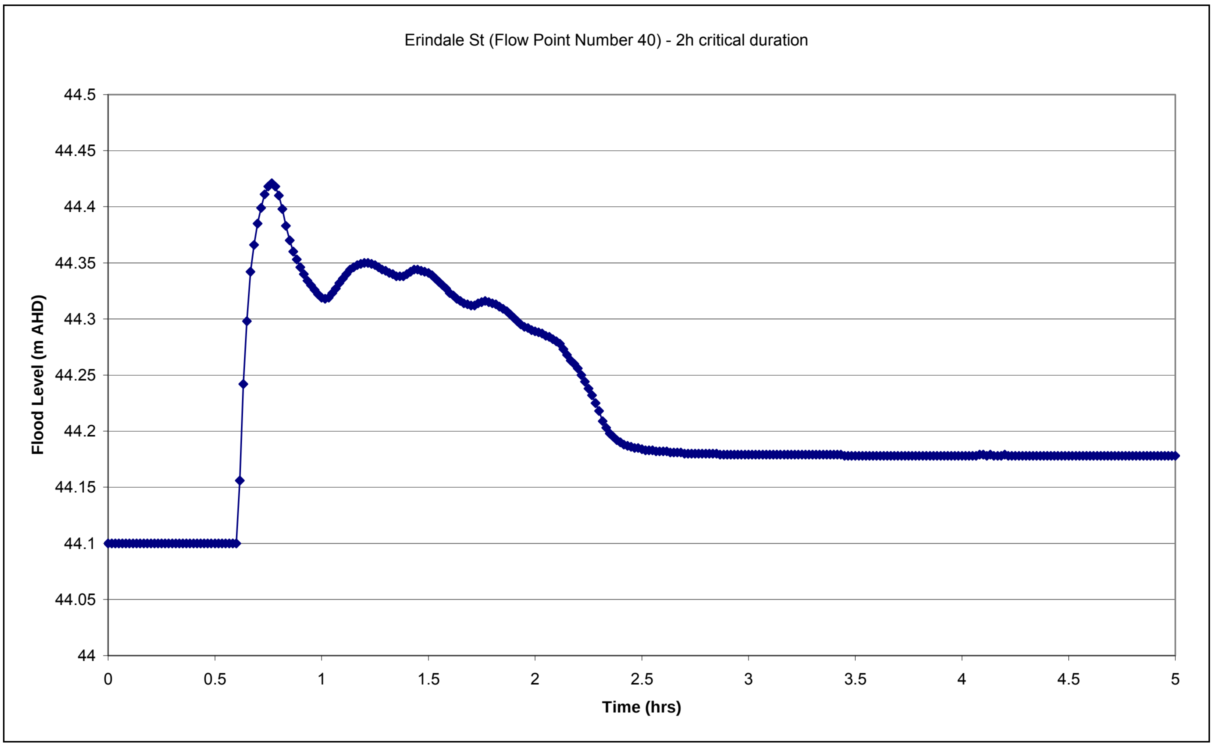

Figure 4-7 Flood Level Hydrograph – Oakleigh Main Drain at Erindale Street

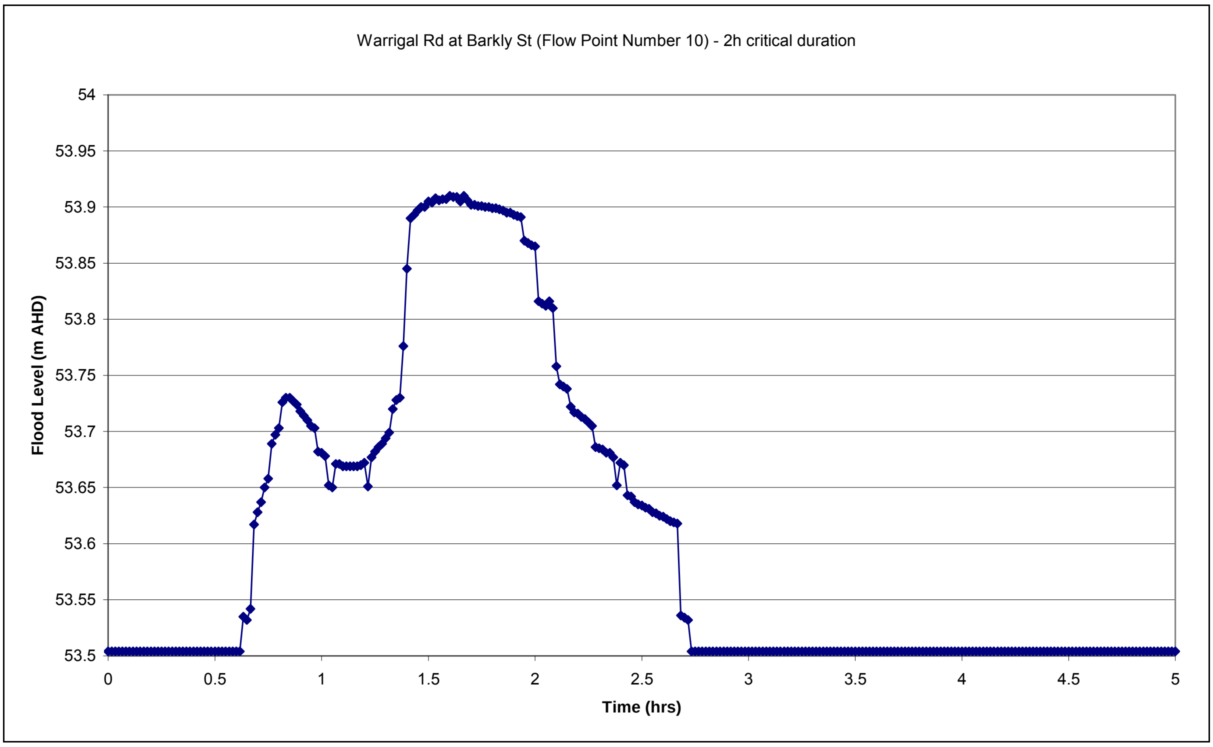

Figure 4-8 Flood Level Hydrograph – Oakleigh Main Drain at Warrigal Road

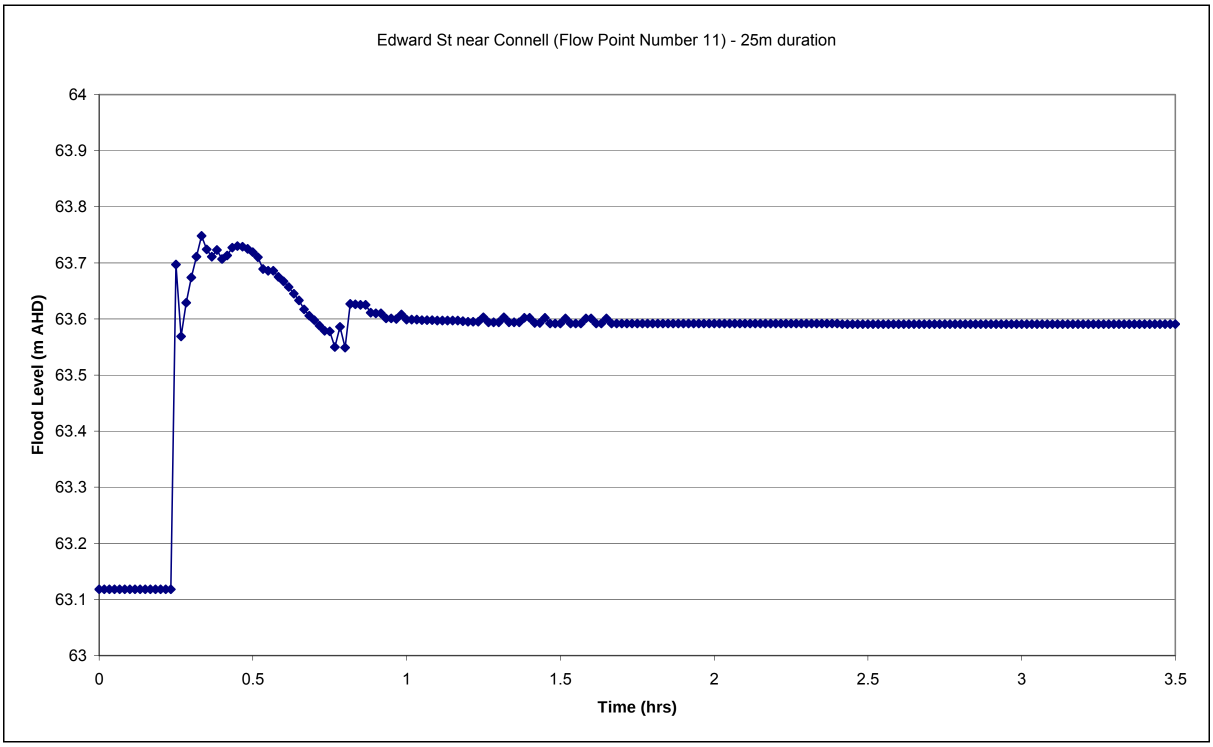

Figure 4-9 Flood Level Hydrograph – Start of Oakleigh Main Drain

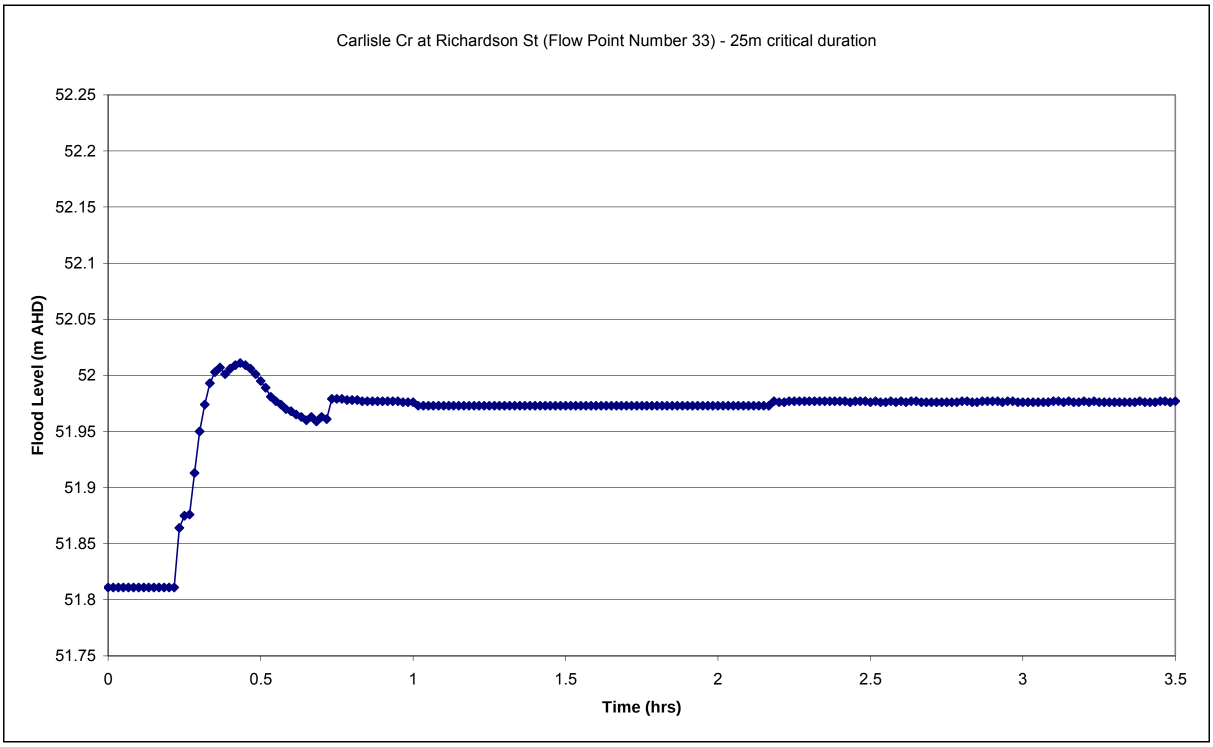

Figure 4-10 Flood Level Hydrograph – Start of Carlisle Crescent Main Drain

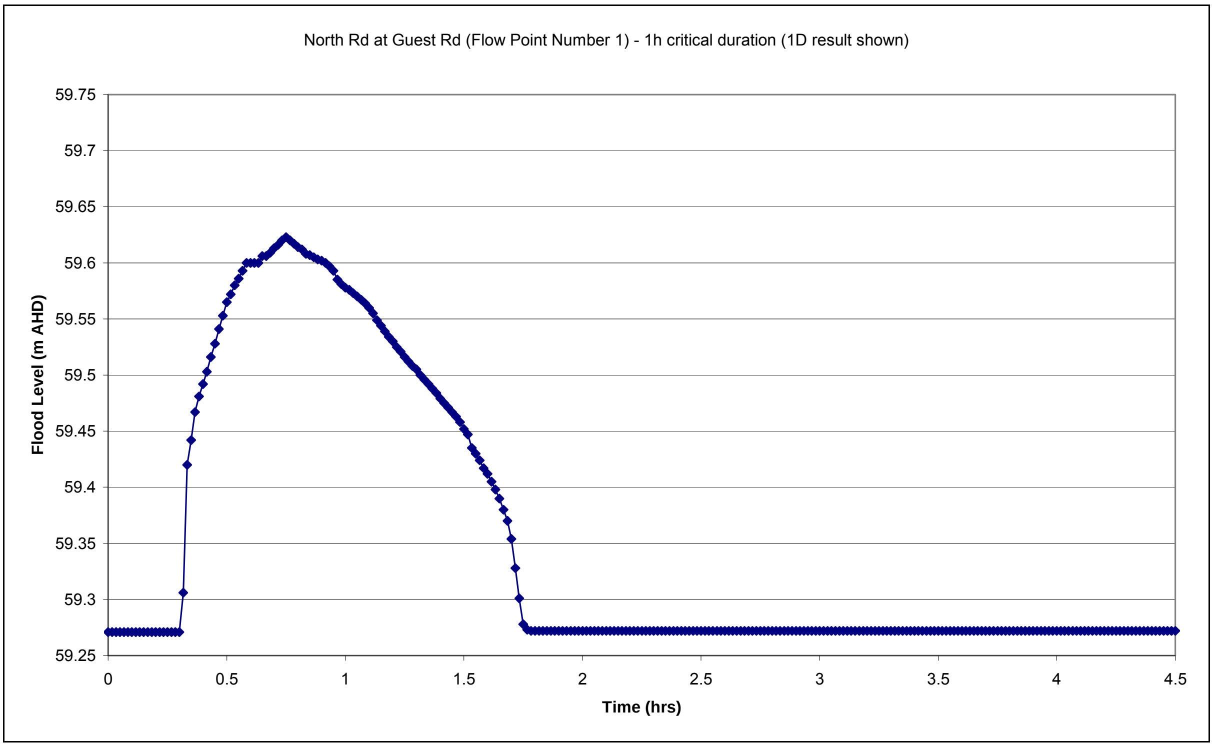

Figure 4-11 Flood Level Hydrograph – Start of Bishop Street Drain

5. Mapping and Risk Assessment

5.1 Flood Extents

The 1 m grids of water levels were used to create flood extents for the events and scenarios listed in Table 1-2. Natural surface levels were subtracted from the water level results to create 1 m grids of depth results. The zero depth contours for these depth grids was produced to form the flood extents. The flood extents were reviewed and tidied up in MapInfo. Flood extent maps are included in Appendix C.

5.2 1 m Results Grids

For each of the events and scenarios listed in Table 1-2, a MapInfo layer was created containing points on a 1 m orthogonal grid within the corresponding flood extent. Each point contains the following information for each event:

- Maximum water level (based on TUFLOW "h.dat" results);
- Maximum depth (calculated by subtracting the ground level at that point from the maximum water level);
- Maximum velocity (based on TUFLOW "v.dat" results);
- Maximum velocity-depth product (based on TUFLOW "z0.dat" results); and
- Critical storm duration (based on TUFLOW "h.dat" results).

5.3 Properties and Floors Flooded

Melbourne Water provided MapInfo layers of property polygons "touched" by the Base Case 100 year ARI flood extent, and building footprint polygons of buildings within those properties.

For each property polygon, the following information was attached for the Base Case Scenario only, based on the 1 m results grids:

- Maximum PMF, 100, 50, 20, 10 and 5 year ARI flood levels on the property;
- Minimum 100 year ARI flood level on the property;
- Maximum 100 year ARI velocity on the property;
- Maximum PMF, 100, 50, 20, 10 and 5 year ARI depths on the property; and
- Maximum PMF, 100, 50, 20, 10 and 5 year ARI velocity-depths on the property.

For each building footprint polygon, maximum PMF, 100, 50, 20, 10 and 5 year ARI flood levels on the building footprint was attached for the Base Case Scenario only, also based on the 1 m results grids.

The total numbers of properties and floors inundated within the Murrumbeena Drain Catchment for each design event, based entirely on the “Properties Flooded” and “Building Footprints” layers, is shown in Table 5-1.

Table 5-1 Properties and Floors Affected by Flooding within the Murrumbeena Drain Catchment

	Total Number of Properties Affected			Total Number of Floors Flooded (where floor levels are available)		
ARI Event	Residential	Industrial / Commercial	Other	Residential	Industrial / Commercial	Other
PMP	4751*	215*	167*	1470	59	14
100 Year	1604	67	167	310	41	6
50 Year	1401	64	153	217	33	4
20 Year	1166	55	137	117	27	3
10 Year	835	45	110	78	19	3
5 Year	413	34	69	25	13	-

* These values are estimated based on Planning Scheme Zones and adjusted to be consistent with the “Properties Flooded” layer.

For the Base Case 100 year ARI event only, 25th percentile, median, 75th percentile and average values of depths and velocity-depth products on flooded properties across the Murrumbeena Drain catchment are presented in Table 5-2.

Table 5-2 Base Case 100 year ARI Property Depth and Velocity-depth Statistics

		Residential	Industrial / Commercial	Other
Depth (m)	25th Percentile	0.19	0.15	0.22
	Median	0.36	0.35	0.46
	75th Percentile	0.54	0.54	0.83
	Average (mean)	0.43	0.35	0.62
Velocity-depth (m^2/s)	25th Percentile	0.0190	0.0295	0.0430
	Median	0.0542	0.0880	0.1454
	75th Percentile	0.1093	0.2910	0.3569
	Average (mean)	0.0809	0.1521	0.2439

5.4 Flood Risk Rating

A Flood Risk rating was assigned to each building within the "Building Footprints" MapInfo layer based on the following criteria:

Flood risk rating = 0 Outside the currently generated PMF flood extent

Flood risk rating = 1 100 year ARI flood level < floor level <= PMF flood level

Flood risk rating = 2 50 year ARI flood level < floor level <= 100 year ARI flood level

Flood risk rating = 3 20 year ARI flood level < floor level <= 50 year ARI flood level

Flood risk rating = 4 10 year ARI flood level < floor level <= 20 year ARI flood level

Flood risk rating = 5 5 year ARI flood level < floor level <= 10 year ARI flood level

Flood risk rating = 6 Floor level <= 5 year ARI flood level

Based on the information in the "Building Footprints" layer, two additional Flood Risk ratings were required:

Flood risk rating = 7 Floor level > PMF flood level

Flood risk rating = 8 No floor level provided (provided attribute of -99.99)

Flood Risk was assessed for the Base Case Scenario only. The total number of buildings for each Flood Risk rating is shown in Table 5-3.

Table 5-3 Flood Risk Ratings within the Murrumbeena Drain Catchment

Flood Risk Rating	Number of Buildings Affected		
	Residential	Industrial / Commercial	Other
0	5	1	11
1	1160	18	8
2	93	8	2
3	100	6	1
4	39	8	-
5	53	6	3
6	25	13	-
7	72	1	2
8	5	1	-

5.5 Safety Risks in Roads

Safety Risk was determined in road reserves (i.e. all areas other than cadastral polygons) for the Base Case 100 year ARI event. Safety Risk Categories were assigned based on the following criteria defined by Melbourne Water in terms of the velocity and depth of the 100 year ARI flood waters.

Low Risk (Value = 1)	Velocity × Depth < 0.2 m^2/s, or Depth < 0.2 m
Low to Moderate Risk (Value = 2)	0.2 m^2/s ≤ Velocity × Depth < 0.4 m^2/s, or 0.2 m ≤ Depth < 0.4 m
Moderate Risk (Value = 3)	0.4 m^2/s ≤ Velocity × Depth < 0.6 m^2/s, or 0.4 m ≤ Depth < 0.6 m
Moderate to High Risk (Value = 4)	0.6 m^2/s ≤ Velocity × Depth < 0.84 m^2/s, or 0.6 m ≤ Depth < 0.84 m
High Risk (Value= 5)	Velocity × Depth ≥ 0.84 m^2/s, or Depth ≥ 0.84 m

The higher of the "velocity x depth" and "depth" criteria governs the Safety Risk value.

TUFLOW is able to calculate velocity-depth products throughout the model simulation (Z0 output). The maximum velocity-depth envelope for the Base Case 100 year ARI event was converted into a 1 m grid of velocity-depth values. The maximums of the velocity-depth values and the depth values (determined previously for creating flood extents) were then used to form a 1 m grid of "Safety Risk" values.

5.6 GIS Output

The MapInfo layers listed below were provided to Melbourne Water as the major outcome of this flood mapping project. This report describes the methodology and steps taken to arrive at these layers. The layers listed in Table 5-4 conform to Melbourne Water's supplied metadata standards and naming conventions, as outlined in the August 2009 Technical Specifications (*MWC 2009*). The projection of all layers is Map Grid of Australia Zone 55 (GDA94) with the Bounds (0, 5500000) (1000000, 6500000).

Table 5-4 MapInfo Deliverables

Layer Name	Description
_4850_RORB_Catchment_boundary.TAB	RORB catchment boundary
_4850_RORB_subcatchment_boundaries.TAB	Sub area boundaries for RORB model
_4850_RORB_Undiverted_Nodes.TAB	RORB nodes for Undiverted model
_4850_RORB_Undiverted_Reach_Alignments.TAB	RORB reaches for Undiverted model
_4850_RORB_Diverted_Nodes.TAB	RORB nodes for Diverted model
_4850_RORB_Diverted_Reach_Alignments.TAB	RORB reaches for Diverted model
Points_PMP.TAB	Base Case PMF 1 m results grid
Points_100YR.TAB	Base Case 100 year ARI 1 m results grid
Points_50YR.TAB	Base Case 50 year ARI 1 m results grid
Points_20YR.TAB	Base Case 20 year ARI 1 m results grid
Points_10YR.TAB	Base Case 10 year ARI 1 m results grid
Points_5YR.TAB	Base Case 5 year ARI 1 m results grid
RE_Points_PMP.TAB	Redevelopment PMF 1 m results grid
RE_Points_100YR.TAB	Redevelopment 100 year ARI 1 m results grid

Layer Name	Description
RE_Points_20YR.TAB	Redevelopment 20 year ARI 1 m results grid
RE_Points_5YR.TAB	Redevelopment 5 year ARI 1 m results grid
CC_Points_100YR.TAB	Climate Change 100 year ARI 1 m results grid
CC_Points_20YR.TAB	Climate Change 20 year ARI 1 m results grid
CC_Points_5YR.TAB	Climate Change 5 year ARI 1 m results grid
Flow_Values.TAB	Locations of flow results extracted from TUFLOW model – when maximum overland flow occurs
FE_UGround_DR_PMP.TAB	Base Case PMP flood extents
FE_UGround_DR_100YR.TAB	Base Case 100 year ARI flood extents
FE_UGround_DR_50YR.TAB	Base Case 50 year ARI flood extents
FE_UGround_DR_20YR.TAB	Base Case 20 year ARI flood extents
FE_UGround_DR_10YR.TAB	Base Case 10 year ARI flood extents
FE_UGround_DR_5YR.TAB	Base Case 5 year ARI flood extents
RE_FE_UGround_DR_PMP.TAB	Redevelopment PMP flood extents
RE_FE_UGround_DR_100YR.TAB	Redevelopment 100 year ARI flood extents
RE_FE_UGround_DR_20YR.TAB	Redevelopment 20 year ARI flood extents
RE_FE_UGround_DR_5YR.TAB	Redevelopment 5 year ARI flood extents
CC_FE_UGround_DR_100YR.TAB	Climate Change 100 year ARI flood extents
CC_FE_UGround_DR_20YR.TAB	Climate Change 20 year ARI flood extents
CC_FE_UGround_DR_5YR.TAB	Climate Change 5 year ARI flood extents
Properties_Flooded.TAB	Flood database of properties “touched” by the Base Case 100 year ARI flood extent
Building_Footprints.TAB	Flood database of buildings within the properties “touched” by the Base Case 100 year ARI flood extent
Flood_Contours.TAB	Base Case 100 year ARI flood level contours at 0.5 m intervals
Flood_Mapping_Limits.TAB	Mapping Limits
SRR_LOW.TAB	Low safety risk polygons in roads
SRR_LOW_MOD.TAB	Low to moderate safety risk polygons in roads
SRR_MOD.TAB	Moderate safety risk polygons in roads
SRR_MOD_HIGH.TAB	Moderate to high safety risk polygons in roads
SRR_HIGH.TAB	High safety risk polygons in roads

6. Recommendations

It is recommended that:

- Melbourne Water adopts the outcomes of this investigation in determining the classification of the catchment in terms of severity of flooding;
- Melbourne Water adopts the outcomes of this investigation for future planning purposes and assessment of mitigation options;
- Further investigation is undertaken to determine and assess the impact of flood mitigation options that may also cater for future development within the catchment;
- Melbourne Water re-assesses the need to continue with the RSS Functional Design project (currently on hold) based on the outcomes of this flood mapping study; and
- The planning assumptions used in this modelling are reviewed periodically and updated as required.

7. References

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Appendix A

Hydrologic Calculations and RORB Results

Appendix A.1

IFD Tables

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Rainfall Intensity-Frequency-Duration Table - Normal Intensities

Location : Murrumbeena

1 HR DUR 2 ARI	18.70	mm/hr
12 HR DUR 2 ARI	3.80	mm/hr
72 HR DUR 2 ARI	1.10	mm/hr
1 HR DUR 50 ARI	38.00	mm/hr
12 HR DUR 50 ARI	7.15	mm/hr
72 HR DUR 50 ARI	2.25	mm/hr
G (skewness)	0.36	mm/hr
F2 Geo factor 2 ARI	4.29	
F50 Geo factor 50 ARI	14.95	

Duration		**Design Rainfalls for Average Recurrance Intervals (Years)**								
		1	**2**	**5**	**10**	**20**	**50**	**100**	**200**	**500**
(min)	(hr)	(mm/hr)	(mm/hr)	(mm/hr)	(mm/hr)	(mm/hr)	(mm/hr)	(mm/hr)	(mm/hr)	(mm/hr)
5	0.083	46.69	62.34	85.97	102.24	123.84	155.14	181.22	209.88	251.91
6	0.100	43.68	58.28	80.20	95.27	115.27	144.22	168.33	194.80	233.58
7	0.117	41.16	54.87	75.36	89.42	108.10	135.11	157.57	182.22	218.30
8	0.133	39.01	51.97	71.25	84.46	102.02	127.38	148.46	171.57	205.38
9	0.150	37.14	49.45	67.70	80.18	96.77	120.71	140.60	162.39	194.25
10	0.167	35.50	47.24	64.57	76.42	92.17	114.88	133.72	154.37	184.53
11	0.183	34.04	45.27	61.81	73.08	88.09	109.71	127.64	147.27	175.94
12	0.200	32.73	43.51	59.33	70.10	84.45	105.10	122.21	140.94	168.28
13	0.217	31.55	41.92	57.09	67.42	81.16	100.94	117.33	135.25	161.39
14	0.233	30.48	40.48	55.06	64.98	78.18	97.17	112.90	130.09	155.15
15	0.250	29.49	39.15	53.20	62.75	75.46	93.74	108.86	125.39	149.47
16	0.267	28.59	37.94	51.50	60.70	72.97	90.59	105.16	121.08	144.27
17	0.283	27.75	36.81	49.93	58.82	70.67	87.68	101.75	117.11	139.48
18	0.300	26.98	35.77	48.47	57.07	68.54	85.00	98.60	113.45	135.06
19	0.317	26.25	34.80	47.12	55.45	66.57	82.51	95.68	110.05	130.97
20	0.333	25.58	33.90	45.85	53.94	64.73	80.19	92.96	106.89	127.15
25	0.417	22.78	30.14	40.62	47.68	57.11	70.60	81.73	93.84	111.44
30	0.500	20.65	27.29	36.65	42.95	51.37	63.39	73.28	84.05	99.66
35	0.583	18.96	25.03	33.53	39.23	46.85	57.73	66.67	76.38	90.46
40	0.667	17.58	23.19	30.99	36.21	43.19	53.15	61.32	70.19	83.03
45	0.750	16.43	21.65	28.88	33.70	40.16	49.35	56.89	65.07	76.89
50	0.833	15.46	20.35	27.09	31.58	37.59	46.14	53.15	60.75	71.72
55	0.917	14.62	19.23	25.55	29.75	35.39	43.40	49.95	57.05	67.30
60	1	13.88	18.25	24.21	28.16	33.47	41.01	47.17	53.85	63.47
75	1.25	12.10	15.90	21.02	24.42	28.98	35.45	40.73	46.44	54.67
90	1.5	10.80	14.17	18.70	21.69	25.72	31.41	36.06	41.08	48.31
120	2	9.01	11.80	15.51	17.96	21.25	25.90	29.68	33.77	39.64
180	3	6.95	9.09	11.88	13.71	16.19	19.67	22.49	25.54	29.91
240	4	5.78	7.55	9.83	11.32	13.33	16.16	18.46	20.93	24.46
300	5	5.01	6.53	8.48	9.75	11.47	13.88	15.84	17.93	20.93
360	6	4.46	5.81	7.52	8.63	10.15	12.26	13.97	15.81	18.43
420	7	4.04	5.26	6.80	7.79	9.15	11.04	12.57	14.22	16.56
480	8	3.71	4.82	6.22	7.13	8.36	10.09	11.48	12.97	15.09
540	9	3.44	4.47	5.76	6.59	7.73	9.31	10.59	11.96	13.91
600	10	3.22	4.18	5.38	6.15	7.20	8.67	9.85	11.12	12.93
660	11	3.03	3.93	5.05	5.77	6.76	8.13	9.23	10.41	12.10
720	12	2.86	3.72	4.77	5.45	6.37	7.66	8.70	9.81	11.39
780	13	2.72	3.53	4.54	5.18	6.07	7.30	8.30	9.36	10.87
840	14	2.59	3.36	4.33	4.95	5.80	6.98	7.94	8.96	10.42
900	15	2.47	3.22	4.14	4.74	5.56	6.70	7.62	8.61	10.01
960	16	2.37	3.08	3.98	4.56	5.34	6.44	7.33	8.29	9.64
1020	17	2.28	2.96	3.83	4.39	5.15	6.21	7.07	8.00	9.31
1080	18	2.19	2.85	3.69	4.23	4.97	6.00	6.84	7.73	9.01
1140	19	2.12	2.76	3.57	4.09	4.81	5.81	6.62	7.49	8.73
1200	20	2.04	2.66	3.45	3.96	4.66	5.63	6.42	7.26	8.47
1440	24	1.81	2.36	3.07	3.53	4.16	5.04	5.75	6.51	7.61
1800	30	1.56	2.03	2.65	3.06	3.61	4.38	5.01	5.69	6.66
2160	36	1.37	1.79	2.35	2.72	3.21	3.90	4.47	5.08	5.96
2880	48	1.11	1.46	1.93	2.23	2.65	3.23	3.71	4.22	4.97
3600	60	0.94	1.24	1.64	1.91	2.26	2.77	3.19	3.64	4.28
4320	72	0.82	1.07	1.43	1.66	1.98	2.43	2.80	3.20	3.77

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Rainfall Intensity-Frequency-Duration Table - 32% Higher Intensities

Location : Murrumbeena

1 HR DUR 2 ARI	24.68	mm/hr
12 HR DUR 2 ARI	5.02	mm/hr
72 HR DUR 2 ARI	1.45	mm/hr
1 HR DUR 50 ARI	50.16	mm/hr
12 HR DUR 50 ARI	9.44	mm/hr
72 HR DUR 50 ARI	2.97	mm/hr
G (skewness)	0.36	mm/hr
F2 Geo factor 2 ARI	4.41	
F50 Geo factor 50 ARI	16.71	

Duration		**32% Higher Design Rainfalls for Average Recurrance Intervals (Years)**								
		1	**2**	**5**	**10**	**20**	**50**	**100**	**200**	**500**
(min)	(hr)	(mm/hr)	(mm/hr)	(mm/hr)	(mm/hr)	(mm/hr)	(mm/hr)	(mm/hr)	(mm/hr)	(mm/hr)
5	0.083	61.63	82.29	113.48	134.96	163.47	204.78	239.21	277.04	332.52
6	0.100	57.66	76.93	105.86	125.75	152.16	190.38	222.20	257.13	308.32
7	0.117	54.33	72.43	99.48	118.04	142.70	178.34	207.99	240.52	288.15
8	0.133	51.49	68.60	94.05	111.49	134.67	168.14	195.96	226.47	271.10
9	0.150	49.03	65.27	89.36	105.83	127.73	159.34	185.59	214.35	256.41
10	0.167	46.86	62.36	85.24	100.87	121.66	151.64	176.52	203.76	243.58
11	0.183	44.94	59.76	81.58	96.47	116.28	144.82	168.49	194.40	232.24
12	0.200	43.21	57.44	78.31	92.54	111.47	138.73	161.32	186.05	222.13
13	0.217	41.65	55.34	75.36	88.99	107.13	133.24	154.87	178.53	213.03
14	0.233	40.23	53.43	72.68	85.77	103.20	128.27	149.03	171.72	204.80
15	0.250	38.93	51.68	70.23	82.83	99.61	123.73	143.70	165.51	197.30
16	0.267	37.74	50.08	67.98	80.13	96.32	119.57	138.81	159.82	190.43
17	0.283	36.63	48.59	65.90	77.64	93.28	115.74	134.31	154.59	184.12
18	0.300	35.61	47.22	63.98	75.34	90.47	112.20	130.16	149.75	178.28
19	0.317	34.66	45.94	62.19	73.20	87.87	108.91	126.30	145.27	172.87
20	0.333	33.77	44.75	60.53	71.20	85.44	105.85	122.71	141.10	167.84
25	0.417	30.07	39.78	53.61	62.94	75.38	93.20	107.88	123.87	147.10
30	0.500	27.25	36.02	48.38	56.70	67.80	83.67	96.74	110.95	131.56
35	0.583	25.03	33.04	44.26	51.78	61.85	76.20	88.00	100.83	119.40
40	0.667	23.21	30.61	40.91	47.79	57.02	70.15	80.94	92.65	109.60
45	0.750	21.69	28.58	38.12	44.48	53.01	65.14	75.09	85.89	101.50
50	0.833	20.40	26.87	35.76	41.68	49.62	60.91	70.16	80.19	94.68
55	0.917	19.29	25.39	33.72	39.27	46.71	57.28	65.93	75.31	88.84
60	1	18.32	24.09	31.95	37.18	44.19	54.13	62.27	71.08	83.78
75	1.25	15.98	20.98	27.75	32.23	38.26	46.79	53.76	61.30	72.17
90	1.50	14.26	18.71	24.69	28.63	33.95	41.46	47.60	54.23	63.77
120	2	11.89	15.58	20.48	23.70	28.05	34.18	39.18	44.58	52.33
180	3	9.18	12.00	15.69	18.10	21.37	25.96	29.69	33.71	39.48
240	4	7.63	9.96	12.97	14.94	17.60	21.34	24.37	27.63	32.29
300	5	6.61	8.62	11.20	12.87	15.14	18.33	20.90	23.67	27.63
360	6	5.88	7.67	9.93	11.40	13.39	16.19	18.45	20.87	24.33
420	7	5.33	6.94	8.97	10.29	12.07	14.58	16.60	18.76	21.86
480	8	4.90	6.37	8.22	9.41	11.04	13.31	15.15	17.12	19.92
540	9	4.54	5.90	7.61	8.70	10.20	12.29	13.98	15.78	18.36
600	10	4.25	5.52	7.10	8.12	9.51	11.44	13.01	14.68	17.06
660	11	4.00	5.19	6.67	7.62	8.92	10.73	12.19	13.75	15.97
720	12	3.78	4.91	6.30	7.19	8.41	10.11	11.48	12.95	15.03
780	13	3.59	4.66	5.99	6.84	8.01	9.64	10.95	12.36	14.35
840	14	3.42	4.44	5.71	6.54	7.66	9.22	10.48	11.83	13.75
900	15	3.27	4.24	5.47	6.26	7.34	8.84	10.06	11.36	13.21
960	16	3.13	4.07	5.25	6.02	7.05	8.51	9.68	10.94	12.73
1020	17	3.01	3.91	5.05	5.79	6.80	8.20	9.34	10.55	12.29
1080	18	2.89	3.77	4.87	5.59	6.56	7.92	9.02	10.20	11.89
1140	19	2.79	3.64	4.71	5.40	6.35	7.67	8.74	9.88	11.52
1200	20	2.70	3.52	4.56	5.23	6.15	7.43	8.47	9.59	11.18
1440	24	2.39	3.12	4.05	4.66	5.49	6.65	7.59	8.60	10.04
1800	30	2.05	2.68	3.50	4.04	4.77	5.79	6.62	7.51	8.79
2160	36	1.81	2.37	3.10	3.58	4.24	5.15	5.90	6.71	7.86
2880	48	1.47	1.93	2.54	2.95	3.49	4.27	4.90	5.58	6.55
3600	60	1.24	1.63	2.16	2.52	2.99	3.66	4.21	4.80	5.65
4320	72	1.08	1.42	1.88	2.20	2.61	3.21	3.69	4.22	4.98

Appendix A.2

GSDM Calculation Sheet

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Melbourne Water - Murrumbeena Drain Catchment Flood Mapping
GSDM Calculation Sheet

LOCATION INFORMATION

Catchment	Murrumbeena Drain		Area	11.292	km^2
State	Victoria		Duration Limit	6	hrs
Latitude.................°...............'S			Longitude...................°...............'E		
Portion of Area Considered:					
Smooth , S =	1	(0.0 - 1.0)	Rough , R =	0	(0.0 - 1.0)

ELEVATION ADJUSTMENT FACTOR (EAF)

Mean Elevation		m
Adjustment for Elevation (-0.05 per 300m above 1500m)		
EAF =	1	(0.85 - 1.00)

MOISTURE ADJUSTMENT FACTOR (MAF)

MAF =	0.55	(0.40 - 1.00)

PMP VALUES (mm)

Duration (hours)	Initial Depth - Smooth (D_S)	Initial Depth - Rough (D_R)	PMP Estimate = (D_SxS + D_RxR) x MAF x EAF	Rounded PMP Estimate (nearest 10 mm)
0.25	210		115.5	**120**
0.5	310		170.5	**170**
0.75	395		217.25	**220**
1	460		253	**250**
1.5	525		288.75	**290**
2	590		324.5	**320**
2.5	625		343.75	**340**
3	655		360.25	**360**
4	725		398.75	**400**
5	780		429	**430**
6	825		453.75	**450**

Prepared by	*Kate Wilson*	Date	9 February 2009
Checked by	*Greg Eaton*	Date	19 February 2009

Appendix A.3

Time of Concentration Calculations

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Murrumbeena - Tc calculations

Upstream of Murrumbeena Drain 4850

MANNING'S N	UPSTREAM SURFACE LEVEL	DOWNSTREAM SURFACE LEVEL	LENGTH (m)	GROUND SLOPE (%)	MANNING'S N	CHANNEL SIDE SLOPE (1 in ?)	CHANNEL BASE WIDTH (m)	CHANNEL HEIGHT (m)	AREA (sq m)	WETTED PERIMETER (m)	VELOCITY (m/s)	TIME (mins)
Subarea A	60	58.75	420	0.30%	0.05	20	18	0.5	14.00	38.02	0.56	12.489
Subarea B	58.75	58.25	270	0.19%	0.05	20	18	0.5	14.00	38.02	0.44	10.178
Subarea C	58.25	54.5	380	0.99%	0.05	36	12	0.25	5.25	30.01	0.62	10.190
			1070									32.86

gutter time	0.00	minutes
Melbourne Water pipe flow time	0.00	minutes
council pipe flow time	0.00	minutes
Sheet flow time	0.00	minutes
Manning's n flow time	32.86	minutes
TIME OF CONCENTRATION	**32.86**	**minutes**

Upstream of Chadstone Main Drain 4851

COUNCIL DRAINS	UPSTREAM SURFACE LEVEL	DOWNSTREAM SURFACE LEVEL	LENGTH (m)	GROUND SLOPE (%)	Effective Slope Factor (%)	VELOCITY (m/s)	Diameter (mm)	TIME (mins)
Along Carrum St	56.75	56	105	0.71%	80%	1.37	450	1.28
Carrum St to Arcadia Av, along Arcadia Av to Castlebar	56	52.5	431	0.81%	80%	2.02	750	3.56
Through Chadstone south east car park	52.5	48.75	175	2.14%	50%	2.43	675	1.20
Through Chadstone east car park			193	1.52%	50%	2.45	900	1.31
Through Chadstone Main Buildling			334	1.52%	50%	2.93	1200	1.90
			1238					9.25

gutter time	7.00	minutes
Melbourne Water pipe flow time	0.00	minutes
council pipe flow time	9.25	minutes
Sheet flow time	0.00	minutes
Manning's n flow time	0.00	minutes
TIME OF CONCENTRATION	**16.25**	**minutes**

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Upstream of Oakleigh Main Drain 4852

COUNCIL DRAINS	UPSTREAM SURFACE LEVEL	DOWNSTREAM SURFACE LEVEL	LENGTH (m)	GROUND SLOPE (%)	Effective Slope Factor (%)	VELOCITY (m/s)	Diameter (mm)	TIME (mins)
Princes Hwy thorugh to Garnett	80.5	77	130	2.69%	50%	2.32	525	0.93
Garnett to Worchestor and along Worchestor	77	74.75	112	2.01%	50%	2.35	675	0.79
Along Huntingdale from Worchestor to Mortier	74.75	72.5	130	1.73%	50%	2.33	750	0.93
Along Huntingdale from Mortier to Vernon	72.75	71.75	70	1.43%	50%	2.25	825	0.52
Along Huntingdale from Vernon to Leigh	71.75	71.5	95	0.26%	80%	1.42	1050	1.11
From Leigh along Huntingdale then along Edward to William	71.5	69.5	237	0.84%	80%	2.66	1125	1.49
Along Edward from William to John	69.5	66.75	237	1.16%	50%	2.25	975	1.75
Along Eward from John to intersection of 1200 pipe	67.75	63.5	188	2.26%	50%	2.99	900	1.05
			1199					8.58

gutter time	7.00	minutes
Melbourne Water pipe flow time	0.00	minutes
council pipe flow time	8.58	minutes
Sheet flow time	0.00	minutes
Manning's n flow time	0.00	minutes
TIME OF CONCENTRATION	**15.58**	**minutes**

Upstream of Carlisle Crescent Main Drain 4853

COUNCIL DRAINS	UPSTREAM SURFACE LEVEL	DOWNSTREAM SURFACE LEVEL	LENGTH (m)	GROUND SLOPE (%)	Effective Slope Factor (%)	VELOCITY (m/s)	Diameter (mm)	TIME (mins)
Along Atherton from Atkinson to Eaton	63.75	61.25	167	1.50%	50%	1.88	600	1.48
Along Eaton to Chester	61.25	60.25	82	1.22%	50%	1.96	750	0.70
Along Chester from Eaton to Station	60.25	57.25	132	2.27%	50%	2.50	675	0.88
Along Chester from Station to Warrigal	57.25	56.25	120	0.83%	80%	2.30	900	0.87
Across Warrigal Rd	56.25	55.5	37	2.03%	50%	3.12	1050	0.20
Across railway	55.5	54.75	39	1.92%	50%	2.90	975	0.22
Along railway	54.75	51.75	253	1.19%	50%	2.49	1125	1.69
			830					6.04

gutter time	7.00	minutes
Melbourne Water pipe flow time	0.00	minutes
council pipe flow time	6.04	minutes
Sheet flow time	0.00	minutes
Manning's n flow time	0.00	minutes
TIME OF CONCENTRATION	**13.04**	**minutes**

Upstream of Bishop Street Drain 4854

COUNCIL DRAINS	UPSTREAM SURFACE LEVEL	DOWNSTREAM SURFACE LEVEL	LENGTH (m)	GROUND SLOPE (%)	Effective Slope Factor (%)	VELOCITY (m/s)	Diameter (mm)	TIME (mins)
Corner Guest and North then half way along Elata	59.5	59.25	210	0.12%	80%	0.96	1050	3.66
From Elata through to Mimosa	60.5	59.5	192	0.52%	80%	1.82	900	1.76
Along Mimosa	60.25	60.5	66	0.23%	80%	1.08	750	1.02
Along Mimosa then through to Windsor	60.75	60.25	216	0.23%	80%	0.94	600	3.85
			684					10.29

MANNING'S N	UPSTREAM SURFACE LEVEL	DOWNSTREAM SURFACE LEVEL	LENGTH (m)	GROUND SLOPE (%)	MANNING'S N	CHANNEL SIDE SLOPE (1 in ?)	CHANNEL BASE WIDTH (m)	CHANNEL HEIGHT (m)	AREA (sq m)	WETTED PERIMETER (m)	VELOCITY (m/s)	TIME (mins)
Through Huntingdale Golf Club	61.5	60.25	450	0.28%	0.05	50	0	0.5	12.50	50.01	0.42	17.931
Through Huntingdale Golf Club	62.5	61.5	220	0.45%	0.05	50	0	0.5	12.50	50.01	0.54	6.853
			670									24.78

gutter time	0.00	minutes
Melbourne Water pipe flow time	0.00	minutes
council pipe flow time	10.29	minutes
Sheet flow time	0.00	minutes
Manning's n flow time	24.78	minutes
TIME OF CONCENTRATION	**35.07**	**minutes**

Appendix A.4

Rational Method Calculations (and Calibration Summary)

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Scheme: **Murrumbeena Drain Catchment**
Municipality: Stonnington, Glen Eira, Monash, Kingston
RATIONAL METHOD CALCULATIONS G:\31\23394\Tech\RORB\[Rational - Murrumbeena.xls]Rational Estimates

Input Fields				**Calculated Output**				
ARI (years)	Area (ha)	Impervious Fraction (%)	Tc (minutes)	Interpolated Intensity (mm/hr)	C10	Runoff Coefficient	**Estimated Flow (m^3/s)**	Description
100	48.7105	16%	32.86	69.33	0.26	0.31	**2.92**	Upstream of Murrumbeena Drain 4850 (Subareas A to E)
100	52.1423	67%	16.25	104.32	0.65	0.78	**11.80**	Upstream of Chadstone Main Drain 4851 (Subareas DD to DH)
100	39.9665	53%	15.58	106.72	0.55	0.66	**7.77**	Upstream of Oakleigh Main Drain 4852 (Subareas AT to AW)
100	44.589	63%	13.04	117.14	0.62	0.74	**10.73**	Upstream of Carlisle Crescent Main Drain 4853 (Subarea CF to CK)
100	60.7941	33%	35.07	66.58	0.39	0.47	**5.27**	Upstream of Bishop Street Drain 4854 (Subareas BH to BN)

Calibration			
Print Location	**RORB Flow**	kc	Crit Storm
Start of 4850	**2.92**	5.7	2h
Start of 4851	**11.80**	5.69	15m
Start of 4852	**7.77**	6.48	25m
Start of 4853	**10.73**	8*	25m
Start of 4854	**5.27**	5.17	1h

Average Value 5.76

5.75 Adopted kc

* kc value obtained at "Start of 4853" was not included in kc average calculations as the tc path did not correlate well with the RORB network. This is due to the RORB network (based on overland flow) and the tc path (Council pipes) following different paths.

Appendix A.5

Undiverted RORB Catchment File

```
Catchment file created using G:\31\23394\Tech\RORB\RORB_cat.xls written by GCH
C created at 08:51 on 24/02/09 by GHD Pty Ltd
C
C Undiverted catchment file of Existing Conditions (Base Case)
C for the Murrumbeena Drain Catchment Flood Mapping Project
C
C Catchment file   : G:\31\23394\Tech\RORB\Undiverted (Calibration)\4850 Undiverted.cat
C    Created for calibration to Rational Method - 100 year ARI only
C
C Rainfall location: Murrumbeena
C Temporal pattern : AR&R87 Volume 2 for zone 1 (filtered)
C Spatial pattern  : Uniform
C Areal Red. Fact. : Based on Siriwardena and Weinmann formulation
C Loss factors     : Constant with ARI
C
C Parameters:  kc =    5.75    m = 0.80
C
C Loss parameters     Initial loss (mm)     Runoff coeff.
C                           10.00              0.60
C
C Reach type flag
0
C The Control Vector
1, 2, 0.07, 0.357,-99                 ,Gen rain-xs h'graph from sub-area BE route through next stor
5, 2, 0.11, 0.227,-99                 ,Route running h'graph through next storage reach from BE1
5, 3, 0.129, 0.078,-99                ,Route running h'graph through next storage reach from BE2
3                                     ,Store the current running hydrograph.
1, 2, 0.089, 1.011,-99                ,Gen rain-xs h'graph from sub-area BF route through next stor
5, 3, 0.19, 0.053,-99                 ,Route running h'graph through next storage reach from BF1
4                                     ,Add the last stored h'graph to running h'graph.
7
BF2
5, 3, 0.063, 0.079,-99                ,Route running h'graph through next storage reach from BF2
3                                     ,Store the current running hydrograph.
1, 2, 0.097, 0.258,-99                ,Gen rain-xs h'graph from sub-area BG route through next stor
4                                     ,Add the last stored h'graph to running h'graph.
5, 1, 0.345,-99                       ,Route running h'graph through next storage reach from BG1
3                                     ,Store the current running hydrograph.
1, 1, 0.03,-99                        ,Gen rain-xs h'graph from sub-area BH route through next stor
4                                     ,Add the last stored h'graph to running h'graph.
5, 1, 0.056,-99                       ,Route running h'graph through next storage reach from BH1
5, 4, 0.131,-99                       ,Route running h'graph through next storage reach from BH2
3                                     ,Store the current running hydrograph.
1, 1, 0.233,-99                       ,Gen rain-xs h'graph from sub-area BI route through next stor
5, 4, 0.091,-99                       ,Route running h'graph through next storage reach from BI1
4                                     ,Add the last stored h'graph to running h'graph.
5, 1, 0.111,-99                       ,Route running h'graph through next storage reach from BH3
3                                     ,Store the current running hydrograph.
1, 2, 0.076, 1.974,-99                ,Gen rain-xs h'graph from sub-area BJ route through next stor
5, 3, 0.157, 0.318,-99                ,Route running h'graph through next storage reach from BJ1
4                                     ,Add the last stored h'graph to running h'graph.
5, 3, 0.051, 0.196,-99                ,Route running h'graph through next storage reach from BJ2
3                                     ,Store the current running hydrograph.
1, 2, 0.166, 1.416,-99                ,Gen rain-xs h'graph from sub-area BK route through next stor
4                                     ,Add the last stored h'graph to running h'graph.
5, 3, 0.269, 0.372,-99                ,Route running h'graph through next storage reach from BK1
3                                     ,Store the current running hydrograph.
1, 2, 0.049, 1.531,-99                ,Gen rain-xs h'graph from sub-area BL route through next stor
4                                     ,Add the last stored h'graph to running h'graph.
5, 3, 0.215, 0.233,-99                ,Route running h'graph through next storage reach from BL1
5, 2, 0.113, 0.221,-99                ,Route running h'graph through next storage reach from BL2
5, 3, 0.23, 0.109,-99                 ,Route running h'graph through next storage reach from BL3
3                                     ,Store the current running hydrograph.
1, 3, 0.141, 1.064,-99                ,Gen rain-xs h'graph from sub-area BM route through next stor
4                                     ,Add the last stored h'graph to running h'graph.
7
Start of 4854
5, 3, 0.025, 2.0,-99                  ,Route running h'graph through next storage reach from BM1
3                                     ,Store the current running hydrograph.
1, 2, 0.075, 3.333,-99                ,Gen rain-xs h'graph from sub-area BN route through next stor
5, 3, 0.268, 0.746,-99                ,Route running h'graph through next storage reach from BN1
4                                     ,Add the last stored h'graph to running h'graph.
5, 3, 0.398, 0.176,-99                ,Route running h'graph through next storage reach from BM2
3                                     ,Store the current running hydrograph.
1, 2, 0.074, 0.676,-99                ,Gen rain-xs h'graph from sub-area BO route through next stor
5, 3, 0.094, 0.125,-99                ,Route running h'graph through next storage reach from BO1
4                                     ,Add the last stored h'graph to running h'graph.
3                                     ,Store the current running hydrograph.
1, 3, 0.027, 2.778,-99                ,Gen rain-xs h'graph from sub-area BP route through next stor
5, 3, 0.24, 0.938,-99                 ,Route running h'graph through next storage reach from BP1
4                                     ,Add the last stored h'graph to running h'graph.
5, 3, 0.138, 0.104,-99                ,Route running h'graph through next storage reach from BO2
3                                     ,Store the current running hydrograph.
1, 2, 0.112, 0.446,-99                ,Gen rain-xs h'graph from sub-area BQ route through next stor
4                                     ,Add the last stored h'graph to running h'graph.
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5, 3, 0.119, 0.104,-99                ,Route running h'graph through next storage reach from BQ1
3                                     ,Store the current running hydrograph.
1, 2, 0.041, 1.22,-99                 ,Gen rain-xs h'graph from sub-area BR route through next stor
4                                     ,Add the last stored h'graph to running h'graph.
5, 3, 0.121, 0.104,-99                ,Route running h'graph through next storage reach from BR1
3                                     ,Store the current running hydrograph.
1, 3, 0.144, 2.951,-99                ,Gen rain-xs h'graph from sub-area AS route through next stor
5, 3, 0.082, 3.659,-99                ,Route running h'graph through next storage reach from AS1
5, 3, 0.268, 0.933,-99                ,Route running h'graph through next storage reach from AS2
5, 3, 0.073, 0.137,-99                ,Route running h'graph through next storage reach from AS3
3                                     ,Store the current running hydrograph.
1, 3, 0.127, 3.15,-99                 ,Gen rain-xs h'graph from sub-area AT route through next stor
5, 3, 0.083, 1.627,-99                ,Route running h'graph through next storage reach from AT1
4                                     ,Add the last stored h'graph to running h'graph.
5, 3, 0.258, 0.93,-99                 ,Route running h'graph through next storage reach from AT2
5, 3, 0.107, 0.467,-99                ,Route running h'graph through next storage reach from AT3
3                                     ,Store the current running hydrograph.
1, 3, 0.147, 1.701,-99                ,Gen rain-xs h'graph from sub-area AU route through next stor
5, 3, 0.057, 0.877,-99                ,Route running h'graph through next storage reach from AU1
4                                     ,Add the last stored h'graph to running h'graph.
5, 2, 0.085, 2.353,-99                ,Route running h'graph through next storage reach from AU2
3                                     ,Store the current running hydrograph.
1, 3, 0.102, 0.98,-99                 ,Gen rain-xs h'graph from sub-area AV route through next stor
4                                     ,Add the last stored h'graph to running h'graph.
5, 2, 0.091, 1.099,-99                ,Route running h'graph through next storage reach from AV1
5, 3, 0.137, 0.073,-99                ,Route running h'graph through next storage reach from AV2
5, 3, 0.163, 0.859,-99                ,Route running h'graph through next storage reach from AV3
3                                     ,Store the current running hydrograph.
1, 3, 0.061, 0.82,-99                 ,Gen rain-xs h'graph from sub-area AW route through next stor
4                                     ,Add the last stored h'graph to running h'graph.
5, 3, 0.204, 1.716,-99                ,Route running h'graph through next storage reach from AW1
7
Start of 4852
5, 3, 0.061, 1.25,-99                 ,Route running h'graph through next storage reach from AW2
3                                     ,Store the current running hydrograph.
1, 3, 0.13, 1.346,-99                 ,Gen rain-xs h'graph from sub-area AX route through next stor
5, 2, 0.146, 1.199,-99                ,Route running h'graph through next storage reach from AX3
5, 3, 0.192, 0.651,-99                ,Route running h'graph through next storage reach from AX4
4                                     ,Add the last stored h'graph to running h'graph.
5, 3, 0.098, 1.25,-99                 ,Route running h'graph through next storage reach from AX1
3                                     ,Store the current running hydrograph.
1, 3, 0.053, 1.887,-99                ,Gen rain-xs h'graph from sub-area AY route through next stor
4                                     ,Add the last stored h'graph to running h'graph.
5, 3, 0.151, 0.5,-99                  ,Route running h'graph through next storage reach from AX2
3                                     ,Store the current running hydrograph.
1, 3, 0.179, 1.955,-99                ,Gen rain-xs h'graph from sub-area AZ route through next stor
5, 2, 0.148, 0.169,-99                ,Route running h'graph through next storage reach from AZ1
4                                     ,Add the last stored h'graph to running h'graph.
5, 3, 0.021, 0.909,-99                ,Route running h'graph through next storage reach from AY1
3                                     ,Store the current running hydrograph.
1, 2, 0.252, 0.397,-99                ,Gen rain-xs h'graph from sub-area BA route through next stor
5, 3, 0.234, 0.321,-99                ,Route running h'graph through next storage reach from BA1
5, 2, 0.244, 0.082,-99                ,Route running h'graph through next storage reach from BA2
3                                     ,Store the current running hydrograph.
1, 2, 0.096, 1.563,-99                ,Gen rain-xs h'graph from sub-area BB route through next stor
4                                     ,Add the last stored h'graph to running h'graph.
5, 3, 0.074, 1.689,-99                ,Route running h'graph through next storage reach from BB1
3                                     ,Store the current running hydrograph.
1, 2, 0.22, 0.795,-99                 ,Gen rain-xs h'graph from sub-area BC route through next stor
5, 2, 0.146, 0.685,-99                ,Route running h'graph through next storage reach from BC1
4                                     ,Add the last stored h'graph to running h'graph.
5, 2, 0.111, 1.126,-99                ,Route running h'graph through next storage reach from BC2
3                                     ,Store the current running hydrograph.
1, 3, 0.044, 0.568,-99                ,Gen rain-xs h'graph from sub-area BD route through next stor
4                                     ,Add the last stored h'graph to running h'graph.
5, 2, 0.152, 0.329,-99                ,Route running h'graph through next storage reach from BD1
4                                     ,Add the last stored h'graph to running h'graph.
5, 3, 0.119, 0.769,-99                ,Route running h'graph through next storage reach from BD2
4                                     ,Add the last stored h'graph to running h'graph.
3                                     ,Store the current running hydrograph.
1, 2, 0.03, 0.833,-99                 ,Gen rain-xs h'graph from sub-area BS route through next stor
4                                     ,Add the last stored h'graph to running h'graph.
5, 3, 0.14, 0.769,-99                 ,Route running h'graph through next storage reach from BS1
3                                     ,Store the current running hydrograph.
1, 3, 0.314, 1.354,-99                ,Gen rain-xs h'graph from sub-area BT route through next stor
5, 2, 0.04, 0.625,-99                 ,Route running h'graph through next storage reach from BT1
5, 3, 0.057, 0.877,-99                ,Route running h'graph through next storage reach from BT2
4                                     ,Add the last stored h'graph to running h'graph.
5, 3, 0.131, 0.971,-99                ,Route running h'graph through next storage reach from BS2
3                                     ,Store the current running hydrograph.
1, 2, 0.066, 1.515,-99                ,Gen rain-xs h'graph from sub-area BU route through next stor
5, 3, 0.112, 1.116,-99                ,Route running h'graph through next storage reach from BU1
4                                     ,Add the last stored h'graph to running h'graph.
5, 3, 0.143, 0.25,-99                 ,Route running h'graph through next storage reach from BU2
3                                     ,Store the current running hydrograph.
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1, 3, 0.077, 3.247,-99                  ,Gen rain-xs h'graph from sub-area BV route through next stor
5, 3, 0.152, 0.329,-99                  ,Route running h'graph through next storage reach from BV1
4                                       ,Add the last stored h'graph to running h'graph.
5, 3, 0.18, 0.667,-99                   ,Route running h'graph through next storage reach from BV2
3                                       ,Store the current running hydrograph.
1, 3, 0.094, 0.798,-99                  ,Gen rain-xs h'graph from sub-area BX route through next stor
4                                       ,Add the last stored h'graph to running h'graph.
5, 3, 0.095, 0.588,-99                  ,Route running h'graph through next storage reach from BX1
3                                       ,Store the current running hydrograph.
1, 2, 0.108, 0.231,-99                  ,Gen rain-xs h'graph from sub-area BW route through next stor
5, 3, 0.236, 0.572,-99                  ,Route running h'graph through next storage reach from BW1
4                                       ,Add the last stored h'graph to running h'graph.
5, 3, 0.05, 0.588,-99                   ,Route running h'graph through next storage reach from BW2
5, 3, 0.107, 0.699,-99                  ,Route running h'graph through next storage reach from BX2
3                                       ,Store the current running hydrograph.
1, 2, 0.106, 1.179,-99                  ,Gen rain-xs h'graph from sub-area BY route through next stor
4                                       ,Add the last stored h'graph to running h'graph.
5, 3, 0.129, 0.8,-99                    ,Route running h'graph through next storage reach from BY1
5, 3, 0.205, 0.699,-99                  ,Route running h'graph through next storage reach from BY2
3                                       ,Store the current running hydrograph.
1, 3, 0.096, 0.781,-99                  ,Gen rain-xs h'graph from sub-area BZ route through next stor
4                                       ,Add the last stored h'graph to running h'graph.
5, 3, 0.059, 0.2,-99                    ,Route running h'graph through next storage reach from BZ1
5, 3, 0.213, 0.27,-99                   ,Route running h'graph through next storage reach from BZ2
3                                       ,Store the current running hydrograph.
1, 2, 0.129, 1.55,-99                   ,Gen rain-xs h'graph from sub-area CC route through next stor
4                                       ,Add the last stored h'graph to running h'graph.
5, 3, 0.045, 1.606,-99                  ,Route running h'graph through next storage reach from CC1
3                                       ,Store the current running hydrograph.
1, 2, 0.236, 0.318,-99                  ,Gen rain-xs h'graph from sub-area CA route through next stor
5, 3, 0.119, 0.42,-99                   ,Route running h'graph through next storage reach from CA1
5, 3, 0.245, 0.408,-99                  ,Route running h'graph through next storage reach from CA2
3                                       ,Store the current running hydrograph.
1, 2, 0.064, 0.391,-99                  ,Gen rain-xs h'graph from sub-area CB route through next stor
4                                       ,Add the last stored h'graph to running h'graph.
5, 3, 0.207, 0.242,-99                  ,Route running h'graph through next storage reach from CB1
4                                       ,Add the last stored h'graph to running h'graph.
5, 3, 0.14, 0.402,-99                   ,Route running h'graph through next storage reach from CB2
5, 3, 0.071, 0.402,-99                  ,Route running h'graph through next storage reach from CC2
3                                       ,Store the current running hydrograph.
1, 3, 0.178, 0.983,-99                  ,Gen rain-xs h'graph from sub-area CD route through next stor
4                                       ,Add the last stored h'graph to running h'graph.
5, 3, 0.216, 0.402,-99                  ,Route running h'graph through next storage reach from CD1
5, 3, 0.092, 0.311,-99                  ,Route running h'graph through next storage reach from CC3
3                                       ,Store the current running hydrograph.
1, 3, 0.075, 2.0,-99                    ,Gen rain-xs h'graph from sub-area CE route through next stor
5, 3, 0.15, 0.667,-99                   ,Route running h'graph through next storage reach from CE1
5, 3, 0.131, 0.382,-99                  ,Route running h'graph through next storage reach from CE2
4                                       ,Add the last stored h'graph to running h'graph.
5, 3, 0.094, 0.311,-99                  ,Route running h'graph through next storage reach from CQ2
3                                       ,Store the current running hydrograph.
1, 3, 0.318, 1.572,-99                  ,Gen rain-xs h'graph from sub-area CI route through next stor
5, 3, 0.04, 1.25,-99                    ,Route running h'graph through next storage reach from CI1
3                                       ,Store the current running hydrograph.
1, 3, 0.255, 1.373,-99                  ,Gen rain-xs h'graph from sub-area CH route through next stor
5, 3, 0.149, 0.168,-99                  ,Route running h'graph through next storage reach from CH1
4                                       ,Add the last stored h'graph to running h'graph.
5, 3, 0.14, 1.786,-99                   ,Route running h'graph through next storage reach from CI2
3                                       ,Store the current running hydrograph.
1, 2, 0.067, 2.239,-99                  ,Gen rain-xs h'graph from sub-area CJ route through next stor
4                                       ,Add the last stored h'graph to running h'graph.
5, 3, 0.13, 0.769,-99                   ,Route running h'graph through next storage reach from CJ1
3                                       ,Store the current running hydrograph.
1, 3, 0.279, 1.434,-99                  ,Gen rain-xs h'graph from sub-area CK route through next stor
4                                       ,Add the last stored h'graph to running h'graph.
5, 3, 0.09, 0.278,-99                   ,Route running h'graph through next storage reach from CK1
3                                       ,Store the current running hydrograph.
1, 3, 0.052, 0.962,-99                  ,Gen rain-xs h'graph from sub-area CF route through next stor
5, 3, 0.133, 0.075,-99                  ,Route running h'graph through next storage reach from CF1
5, 3, 0.192, 0.99,-99                   ,Route running h'graph through next storage reach from CF2
3                                       ,Store the current running hydrograph.
1, 3, 0.06, 0.167,-99                   ,Gen rain-xs h'graph from sub-area CG route through next stor
4                                       ,Add the last stored h'graph to running h'graph.
5, 3, 0.122, 1.23,-99                   ,Route running h'graph through next storage reach from CG1
5, 3, 0.068, 0.368,-99                  ,Route running h'graph through next storage reach from CG2
4                                       ,Add the last stored h'graph to running h'graph.
7
Start of 4853
5, 3, 0.249, 0.5,-99                    ,Route running h'graph through next storage reach from CK2
3                                       ,Store the current running hydrograph.
1, 3, 0.218, 1.147,-99                  ,Gen rain-xs h'graph from sub-area CL route through next stor
5, 3, 0.102, 1.471,-99                  ,Route running h'graph through next storage reach from CL1
5, 3, 0.212, 0.943,-99                  ,Route running h'graph through next storage reach from CL2
3                                       ,Store the current running hydrograph.
1, 3, 0.076, 1.316,-99                  ,Gen rain-xs h'graph from sub-area CM route through next stor
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4                                        ,Add the last stored h'graph to running h'graph.
5, 3, 0.192, 0.651,-99                   ,Route running h'graph through next storage reach from CM1
5, 3, 0.084, 0.298,-99                   ,Route running h'graph through next storage reach from CM2
4                                        ,Add the last stored h'graph to running h'graph.
5, 3, 0.144, 0.476,-99                   ,Route running h'graph through next storage reach from CM3
3                                        ,Store the current running hydrograph.
1, 2, 0.036, 2.083,-99                   ,Gen rain-xs h'graph from sub-area CN route through next stor
4                                        ,Add the last stored h'graph to running h'graph.
5, 3, 0.104, 0.625,-99                   ,Route running h'graph through next storage reach from CN1
3                                        ,Store the current running hydrograph.
1, 3, 0.09, 0.556,-99                    ,Gen rain-xs h'graph from sub-area CO route through next stor
5, 3, 0.233, 0.322,-99                   ,Route running h'graph through next storage reach from CO1
5, 3, 0.065, 0.154,-99                   ,Route running h'graph through next storage reach from CO2
4                                        ,Add the last stored h'graph to running h'graph.
5, 3, 0.23, 0.741,-99                    ,Route running h'graph through next storage reach from CN2
3                                        ,Store the current running hydrograph.
1, 2, 0.058, 0.862,-99                   ,Gen rain-xs h'graph from sub-area CP route through next stor
4                                        ,Add the last stored h'graph to running h'graph.
5, 3, 0.071, 0.714,-99                   ,Route running h'graph through next storage reach from CP1
4                                        ,Add the last stored h'graph to running h'graph.
3                                        ,Store the current running hydrograph.
1, 3, 0.143, 1.399,-99                   ,Gen rain-xs h'graph from sub-area CQ route through next stor
4                                        ,Add the last stored h'graph to running h'graph.
5, 3, 0.209, 0.238,-99                   ,Route running h'graph through next storage reach from CQ1
3                                        ,Store the current running hydrograph.
1, 3, 0.071, 1.408,-99                   ,Gen rain-xs h'graph from sub-area CR route through next stor
4                                        ,Add the last stored h'graph to running h'graph.
5, 3, 0.379, 0.769,-99                   ,Route running h'graph through next storage reach from CR1
5, 3, 0.233, 0.87,-99                    ,Route running h'graph through next storage reach from CR2
3                                        ,Store the current running hydrograph.
1, 3, 0.358, 2.025,-99                   ,Gen rain-xs h'graph from sub-area CS route through next stor
4                                        ,Add the last stored h'graph to running h'graph.
5, 3, 0.062, 1.0,-99                     ,Route running h'graph through next storage reach from CS1
3                                        ,Store the current running hydrograph.
1, 3, 0.111, 0.45,-99                    ,Gen rain-xs h'graph from sub-area F route through next stora
5, 3, 0.257, 1.07,-99                    ,Route running h'graph through next storage reach from F2
5, 2, 0.089, 0.281,-99                   ,Route running h'graph through next storage reach from F1
3                                        ,Store the current running hydrograph.
1, 3, 0.179, 0.559,-99                   ,Gen rain-xs h'graph from sub-area G route through next stora
5, 2, 0.1, 0.25,-99                      ,Route running h'graph through next storage reach from G1
4                                        ,Add the last stored h'graph to running h'graph.
5, 3, 0.08, 0.125,-99                    ,Route running h'graph through next storage reach from G2
5, 2, 0.095, 0.158,-99                   ,Route running h'graph through next storage reach from G3
5, 3, 0.152, 0.164,-99                   ,Route running h'graph through next storage reach from G4
3                                        ,Store the current running hydrograph.
1, 3, 0.048, 1.042,-99                   ,Gen rain-xs h'graph from sub-area D route through next stora
5, 1, 0.425,-99                          ,Route running h'graph through next storage reach from D1
3                                        ,Store the current running hydrograph.
1, 1, 0.095,-99                          ,Gen rain-xs h'graph from sub-area E route through next stora
4                                        ,Add the last stored h'graph to running h'graph.
5, 1, 0.186,-99                          ,Route running h'graph through next storage reach from E1
5, 3, 0.149, 0.503,-99                   ,Route running h'graph through next storage reach from E2
3                                        ,Store the current running hydrograph.
1, 1, 0.096,-99                          ,Gen rain-xs h'graph from sub-area B route through next stora
3                                        ,Store the current running hydrograph.
1, 1, 0.351,-99                          ,Gen rain-xs h'graph from sub-area A route through next stora
4                                        ,Add the last stored h'graph to running h'graph.
5, 1, 0.423,-99                          ,Route running h'graph through next storage reach from B1
3                                        ,Store the current running hydrograph.
1, 1, 0.087,-99                          ,Gen rain-xs h'graph from sub-area C route through next stora
4                                        ,Add the last stored h'graph to running h'graph.
5, 1, 0.111,-99                          ,Route running h'graph through next storage reach from C1
4                                        ,Add the last stored h'graph to running h'graph.
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5, 3, 0.105, 0.189,-99                   ,Route running h'graph through next storage reach from C2
4                                        ,Add the last stored h'graph to running h'graph.
3                                        ,Store the current running hydrograph.
1, 3, 0.066, 0.379,-99                   ,Gen rain-xs h'graph from sub-area H route through next stora
4                                        ,Add the last stored h'graph to running h'graph.
5, 3, 0.117, 0.303,-99                   ,Route running h'graph through next storage reach from H1
5, 3, 0.148, 0.4,-99                     ,Route running h'graph through next storage reach from H2
3                                        ,Store the current running hydrograph.
1, 3, 0.054, 1.389,-99                   ,Gen rain-xs h'graph from sub-area I route through next stora
4                                        ,Add the last stored h'graph to running h'graph.
5, 3, 0.098, 0.26,-99                    ,Route running h'graph through next storage reach from I1
3                                        ,Store the current running hydrograph.
1, 3, 0.369, 0.407,-99                   ,Gen rain-xs h'graph from sub-area J route through next stora
4                                        ,Add the last stored h'graph to running h'graph.
5, 3, 0.156, 0.143,-99                   ,Route running h'graph through next storage reach from J1
3                                        ,Store the current running hydrograph.
1, 2, 0.113, 0.221,-99                   ,Gen rain-xs h'graph from sub-area K route through next stora
5, 2, 0.126, 0.198,-99                   ,Route running h'graph through next storage reach from K2
3                                        ,Store the current running hydrograph.
1, 3, 0.041, 1.22,-99                    ,Gen rain-xs h'graph from sub-area L route through next stora
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4                                         ,Add the last stored h'graph to running h'graph.
5, 2, 0.142, 0.176,-99                    ,Route running h'graph through next storage reach from L1
5, 3, 0.189, 0.397,-99                    ,Route running h'graph through next storage reach from L2
4                                         ,Add the last stored h'graph to running h'graph.
5, 3, 0.095, 0.143,-99                    ,Route running h'graph through next storage reach from L3
3                                         ,Store the current running hydrograph.
1, 3, 0.151, 0.828,-99                    ,Gen rain-xs h'graph from sub-area M route through next stora
4                                         ,Add the last stored h'graph to running h'graph.
5, 3, 0.182, 0.183,-99                    ,Route running h'graph through next storage reach from M1
3                                         ,Store the current running hydrograph.
1, 2, 0.145, 2.069,-99                    ,Gen rain-xs h'graph from sub-area O route through next stora
5, 2, 0.159, 0.314,-99                    ,Route running h'graph through next storage reach from O1
5, 2, 0.104, 0.481,-99                    ,Route running h'graph through next storage reach from O2
3                                         ,Store the current running hydrograph.
1, 2, 0.047, 1.064,-99                    ,Gen rain-xs h'graph from sub-area P route through next stora
4                                         ,Add the last stored h'graph to running h'graph.
5, 3, 0.182, 0.275,-99                    ,Route running h'graph through next storage reach from P1
5, 3, 0.252, 0.794,-99                    ,Route running h'graph through next storage reach from P2
4                                         ,Add the last stored h'graph to running h'graph.
5, 3, 0.069, 0.167,-99                    ,Route running h'graph through next storage reach from M2
3                                         ,Store the current running hydrograph.
1, 2, 0.055, 2.273,-99                    ,Gen rain-xs h'graph from sub-area N route through next stora
4                                         ,Add the last stored h'graph to running h'graph.
5, 3, 0.1, 0.149,-99                      ,Route running h'graph through next storage reach from N1
3                                         ,Store the current running hydrograph.
1, 3, 0.111, 1.577,-99                    ,Gen rain-xs h'graph from sub-area S route through next stora
4                                         ,Add the last stored h'graph to running h'graph.
5, 3, 0.177, 0.286,-99                    ,Route running h'graph through next storage reach from S1
3                                         ,Store the current running hydrograph.
1, 2, 0.331, 0.151,-99                    ,Gen rain-xs h'graph from sub-area Q route through next stora
5, 2, 0.241, 0.726,-99                    ,Route running h'graph through next storage reach from Q1
5, 3, 0.251, 1.394,-99                    ,Route running h'graph through next storage reach from Q2
3                                         ,Store the current running hydrograph.
1, 2, 0.074, 0.338,-99                    ,Gen rain-xs h'graph from sub-area R route through next stora
4                                         ,Add the last stored h'graph to running h'graph.
5, 2, 0.344, 0.436,-99                    ,Route running h'graph through next storage reach from R1
5, 3, 0.403, 0.744,-99                    ,Route running h'graph through next storage reach from R2
4                                         ,Add the last stored h'graph to running h'graph.
5, 3, 0.158, 0.546,-99                    ,Route running h'graph through next storage reach from S2
3                                         ,Store the current running hydrograph.
1, 2, 0.267, 1.03,-99                     ,Gen rain-xs h'graph from sub-area T route through next stora
4                                         ,Add the last stored h'graph to running h'graph.
5, 3, 0.177, 0.427,-99                    ,Route running h'graph through next storage reach from S3
3                                         ,Store the current running hydrograph.
1, 3, 0.133, 1.88,-99                     ,Gen rain-xs h'graph from sub-area U route through next stora
4                                         ,Add the last stored h'graph to running h'graph.
5, 3, 0.165, 0.513,-99                    ,Route running h'graph through next storage reach from U1
3                                         ,Store the current running hydrograph.
1, 2, 0.118, 1.059,-99                    ,Gen rain-xs h'graph from sub-area V route through next stora
4                                         ,Add the last stored h'graph to running h'graph.
5, 3, 0.101, 0.602,-99                    ,Route running h'graph through next storage reach from U2
5, 3, 0.228, 0.602,-99                    ,Route running h'graph through next storage reach from V1
3                                         ,Store the current running hydrograph.
1, 2, 0.095, 1.842,-99                    ,Gen rain-xs h'graph from sub-area W route through next stora
4                                         ,Add the last stored h'graph to running h'graph.
5, 3, 0.207, 0.4,-99                      ,Route running h'graph through next storage reach from W2
3                                         ,Store the current running hydrograph.
1, 3, 0.192, 0.911,-99                    ,Gen rain-xs h'graph from sub-area X route through next stora
4                                         ,Add the last stored h'graph to running h'graph.
5, 3, 0.229, 0.284,-99                    ,Route running h'graph through next storage reach from X1
3                                         ,Store the current running hydrograph.
1, 3, 0.098, 1.02,-99                     ,Gen rain-xs h'graph from sub-area Y route through next stora
4                                         ,Add the last stored h'graph to running h'graph.
5, 3, 0.2, 0.602,-99                      ,Route running h'graph through next storage reach from Y1
3                                         ,Store the current running hydrograph.
1, 2, 0.057, 2.632,-99                    ,Gen rain-xs h'graph from sub-area Z route through next stora
4                                         ,Add the last stored h'graph to running h'graph.
5, 3, 0.155, 0.4,-99                      ,Route running h'graph through next storage reach from Z1
3                                         ,Store the current running hydrograph.
1, 2, 0.253, 0.395,-99                    ,Gen rain-xs h'graph from sub-area AA route through next stor
5, 2, 0.134, 1.119,-99                    ,Route running h'graph through next storage reach from AA1
3                                         ,Store the current running hydrograph.
1, 3, 0.058, 0.862,-99                    ,Gen rain-xs h'graph from sub-area AB route through next stor
4                                         ,Add the last stored h'graph to running h'graph.
5, 2, 0.163, 0.46,-99                     ,Route running h'graph through next storage reach from AB1
4                                         ,Add the last stored h'graph to running h'graph.
5, 3, 0.046, 0.333,-99                    ,Route running h'graph through next storage reach from AB2
3                                         ,Store the current running hydrograph.
1, 3, 0.074, 2.365,-99                    ,Gen rain-xs h'graph from sub-area AC route through next stor
5, 2, 0.116, 0.431,-99                    ,Route running h'graph through next storage reach from AC1
5, 2, 0.227, 0.771,-99                    ,Route running h'graph through next storage reach from AC2
3                                         ,Store the current running hydrograph.
1, 3, 0.161, 1.708,-99                    ,Gen rain-xs h'graph from sub-area AD route through next stor
4                                         ,Add the last stored h'graph to running h'graph.
5, 3, 0.153, 1.144,-99                    ,Route running h'graph through next storage reach from AD1
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4                                     ,Add the last stored h'graph to running h'graph.
5, 3, 0.219, 0.25,-99                 ,Route running h'graph through next storage reach from AD2
3                                     ,Store the current running hydrograph.
1, 3, 0.057, 0.439,-99                ,Gen rain-xs h'graph from sub-area AE route through next stor
5, 2, 0.046, 0.543,-99                ,Route running h'graph through next storage reach from AE1
4                                     ,Add the last stored h'graph to running h'graph.
5, 3, 0.154, 0.25,-99                 ,Route running h'graph through next storage reach from AE2
5, 3, 0.202, 0.333,-99                ,Route running h'graph through next storage reach from AE3
3                                     ,Store the current running hydrograph.
1, 3, 0.056, 3.125,-99                ,Gen rain-xs h'graph from sub-area AF route through next stor
4                                     ,Add the last stored h'graph to running h'graph.
5, 3, 0.185, 0.333,-99                ,Route running h'graph through next storage reach from AF1
3                                     ,Store the current running hydrograph.
1, 2, 0.153, 0.817,-99                ,Gen rain-xs h'graph from sub-area AG route through next stor
5, 3, 0.167, 0.898,-99                ,Route running h'graph through next storage reach from AG1
4                                     ,Add the last stored h'graph to running h'graph.
5, 3, 0.137, 0.38,-99                 ,Route running h'graph through next storage reach from AF2
3                                     ,Store the current running hydrograph.
1, 3, 0.104, 1.923,-99                ,Gen rain-xs h'graph from sub-area AH route through next stor
4                                     ,Add the last stored h'graph to running h'graph.
5, 3, 0.076, 0.38,-99                 ,Route running h'graph through next storage reach from AH1
3                                     ,Store the current running hydrograph.
1, 3, 0.237, 1.477,-99                ,Gen rain-xs h'graph from sub-area AI route through next stor
4                                     ,Add the last stored h'graph to running h'graph.
5, 3, 0.101, 0.38,-99                 ,Route running h'graph through next storage reach from AI1
3                                     ,Store the current running hydrograph.
1, 2, 0.082, 0.915,-99                ,Gen rain-xs h'graph from sub-area AL route through next stor
5, 2, 0.133, 0.564,-99                ,Route running h'graph through next storage reach from AL1
5, 3, 0.153, 0.49,-99                 ,Route running h'graph through next storage reach from AL2
3                                     ,Store the current running hydrograph.
1, 2, 0.032, 1.563,-99                ,Gen rain-xs h'graph from sub-area AM route through next stor
4                                     ,Add the last stored h'graph to running h'graph.
5, 3, 0.108, 0.231,-99                ,Route running h'graph through next storage reach from AM1
5, 2, 0.166, 0.151,-99                ,Route running h'graph through next storage reach from AM2
3                                     ,Store the current running hydrograph.
1, 3, 0.206, 0.121,-99                ,Gen rain-xs h'graph from sub-area AJ route through next stor
3                                     ,Store the current running hydrograph.
1, 3, 0.091, 0.275,-99                ,Gen rain-xs h'graph from sub-area AK route through next stor
4                                     ,Add the last stored h'graph to running h'graph.
5, 3, 0.123, 1.22,-99                 ,Route running h'graph through next storage reach from AJ1
5, 2, 0.352, 0.426,-99                ,Route running h'graph through next storage reach from AJ2
5, 3, 0.061, 0.82,-99                 ,Route running h'graph through next storage reach from AJ3
4                                     ,Add the last stored h'graph to running h'graph.
3                                     ,Store the current running hydrograph.
1, 3, 0.18, 0.833,-99                 ,Gen rain-xs h'graph from sub-area AN route through next stor
5, 3, 0.219, 1.027,-99                ,Route running h'graph through next storage reach from AN1
3                                     ,Store the current running hydrograph.
1, 3, 0.2, 1.0,-99                    ,Gen rain-xs h'graph from sub-area AO route through next stor
4                                     ,Add the last stored h'graph to running h'graph.
5, 3, 0.144, 0.347,-99                ,Route running h'graph through next storage reach from AO1
4                                     ,Add the last stored h'graph to running h'graph.
5, 3, 0.069, 0.725,-99                ,Route running h'graph through next storage reach from AM3
5, 2, 0.295, 0.508,-99                ,Route running h'graph through next storage reach from AO2
3                                     ,Store the current running hydrograph.
1, 2, 0.081, 0.617,-99                ,Gen rain-xs h'graph from sub-area AP route through next stor
4                                     ,Add the last stored h'graph to running h'graph.
5, 3, 0.119, 0.84,-99                 ,Route running h'graph through next storage reach from AP1
5, 3, 0.064, 0.781,-99                ,Route running h'graph through next storage reach from AP2
7
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5, 3, 0.042, 0.313,-99                ,Route running h'graph through next storage reach from AP3
3                                     ,Store the current running hydrograph.
1, 3, 0.075, 1.467,-99                ,Gen rain-xs h'graph from sub-area AQ route through next stor
4                                     ,Add the last stored h'graph to running h'graph.
5, 2, 0.115, 0.313,-99                ,Route running h'graph through next storage reach from AQ1
4                                     ,Add the last stored h'graph to running h'graph.
5, 3, 0.093, 0.476,-99                ,Route running h'graph through next storage reach from AQ2
3                                     ,Store the current running hydrograph.
1, 2, 0.048, 2.083,-99                ,Gen rain-xs h'graph from sub-area AR route through next stor
4                                     ,Add the last stored h'graph to running h'graph.
5, 3, 0.063, 0.476,-99                ,Route running h'graph through next storage reach from AR1
4                                     ,Add the last stored h'graph to running h'graph.
5, 3, 0.14, 0.4,-99                   ,Route running h'graph through next storage reach from AR2
3                                     ,Store the current running hydrograph.
1, 2, 0.094, 3.723,-99                ,Gen rain-xs h'graph from sub-area CT route through next stor
5, 2, 0.18, 1.25,-99                  ,Route running h'graph through next storage reach from CT1
5, 3, 0.236, 2.013,-99                ,Route running h'graph through next storage reach from CT2
4                                     ,Add the last stored h'graph to running h'graph.
3                                     ,Store the current running hydrograph.
1, 3, 0.071, 1.408,-99                ,Gen rain-xs h'graph from sub-area CU route through next stor
5, 3, 0.159, 2.358,-99                ,Route running h'graph through next storage reach from CU1
4                                     ,Add the last stored h'graph to running h'graph.
5, 3, 0.138, 0.435,-99                ,Route running h'graph through next storage reach from CU2
3                                     ,Store the current running hydrograph.
1, 3, 0.084, 3.869,-99                ,Gen rain-xs h'graph from sub-area CV route through next stor
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4                                         ,Add the last stored h'graph to running h'graph.
5, 3, 0.085, 0.333,-99                    ,Route running h'graph through next storage reach from CV1
3                                         ,Store the current running hydrograph.
1, 3, 0.47, 1.011,-99                     ,Gen rain-xs h'graph from sub-area CW route through next stor
5, 3, 0.257, 2.724,-99                    ,Route running h'graph through next storage reach from CW1
3                                         ,Store the current running hydrograph.
1, 3, 0.061, 2.459,-99                    ,Gen rain-xs h'graph from sub-area CX route through next stor
4                                         ,Add the last stored h'graph to running h'graph.
5, 2, 0.157, 3.662,-99                    ,Route running h'graph through next storage reach from CX1
4                                         ,Add the last stored h'graph to running h'graph.
5, 3, 0.18, 0.333,-99                     ,Route running h'graph through next storage reach from CX2
3                                         ,Store the current running hydrograph.
1, 3, 0.396, 2.967,-99                    ,Gen rain-xs h'graph from sub-area CZ route through next stor
4                                         ,Add the last stored h'graph to running h'graph.
5, 3, 0.14, 0.526,-99                     ,Route running h'graph through next storage reach from CZ1
3                                         ,Store the current running hydrograph.
1, 2, 0.149, 1.51,-99                     ,Gen rain-xs h'graph from sub-area CY route through next stor
5, 3, 0.107, 3.738,-99                    ,Route running h'graph through next storage reach from CY1
5, 2, 0.055, 3.182,-99                    ,Route running h'graph through next storage reach from CY2
4                                         ,Add the last stored h'graph to running h'graph.
5, 3, 0.095, 1.0,-99                      ,Route running h'graph through next storage reach from CZ2
5, 3, 0.046, 0.167,-99                    ,Route running h'graph through next storage reach from CY3
3                                         ,Store the current running hydrograph.
1, 3, 0.332, 2.56,-99                     ,Gen rain-xs h'graph from sub-area DA route through next stor
5, 3, 0.304, 3.865,-99                    ,Route running h'graph through next storage reach from DA1
4                                         ,Add the last stored h'graph to running h'graph.
5, 3, 0.198, 0.556,-99                    ,Route running h'graph through next storage reach from CY4
3                                         ,Store the current running hydrograph.
1, 2, 0.063, 4.206,-99                    ,Gen rain-xs h'graph from sub-area DB route through next stor
4                                         ,Add the last stored h'graph to running h'graph.
5, 3, 0.153, 0.556,-99                    ,Route running h'graph through next storage reach from DB1
5, 3, 0.173, 0.556,-99                    ,Route running h'graph through next storage reach from DB2
3                                         ,Store the current running hydrograph.
1, 2, 0.045, 7.222,-99                    ,Gen rain-xs h'graph from sub-area DC route through next stor
4                                         ,Add the last stored h'graph to running h'graph.
5, 3, 0.124, 0.556,-99                    ,Route running h'graph through next storage reach from DC1
3                                         ,Store the current running hydrograph.
1, 2, 0.079, 2.848,-99                    ,Gen rain-xs h'graph from sub-area DD route through next stor
5, 2, 0.149, 0.671,-99                    ,Route running h'graph through next storage reach from DD1
5, 3, 0.141, 1.064,-99                    ,Route running h'graph through next storage reach from DD2
3                                         ,Store the current running hydrograph.
1, 3, 0.081, 2.16,-99                     ,Gen rain-xs h'graph from sub-area DE route through next stor
4                                         ,Add the last stored h'graph to running h'graph.
5, 3, 0.097, 1.031,-99                    ,Route running h'graph through next storage reach from DE1
5, 3, 0.245, 1.633,-99                    ,Route running h'graph through next storage reach from DE2
3                                         ,Store the current running hydrograph.
1, 3, 0.053, 0.943,-99                    ,Gen rain-xs h'graph from sub-area DF route through next stor
4                                         ,Add the last stored h'graph to running h'graph.
5, 3, 0.275, 0.364,-99                    ,Route running h'graph through next storage reach from DF1
5, 3, 0.309, 2.184,-99                    ,Route running h'graph through next storage reach from DF2
3                                         ,Store the current running hydrograph.
1, 2, 0.179, 0.14,-99                     ,Gen rain-xs h'graph from sub-area DG route through next stor
5, 3, 0.165, 1.515,-99                    ,Route running h'graph through next storage reach from DG1
4                                         ,Add the last stored h'graph to running h'graph.
3                                         ,Store the current running hydrograph.
1, 3, 0.126, 2.579,-99                    ,Gen rain-xs h'graph from sub-area DH route through next stor
4                                         ,Add the last stored h'graph to running h'graph.
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5, 3, 0.136, 1.287,-99                    ,Route running h'graph through next storage reach from DH1
3                                         ,Store the current running hydrograph.
1, 2, 0.09, 1.389,-99                     ,Gen rain-xs h'graph from sub-area DI route through next stor
4                                         ,Add the last stored h'graph to running h'graph.
5, 3, 0.126, 2.381,-99                    ,Route running h'graph through next storage reach from DH2
3                                         ,Store the current running hydrograph.
1, 2, 0.087, 5.172,-99                    ,Gen rain-xs h'graph from sub-area DJ route through next stor
5, 3, 0.102, 0.735,-99                    ,Route running h'graph through next storage reach from DJ1
4                                         ,Add the last stored h'graph to running h'graph.
3                                         ,Store the current running hydrograph.
1, 3, 0.392, 2.742,-99                    ,Gen rain-xs h'graph from sub-area DK route through next stor
4                                         ,Add the last stored h'graph to running h'graph.
5, 3, 0.199, 2.01,-99                     ,Route running h'graph through next storage reach from DK1
3                                         ,Store the current running hydrograph.
1, 3, 0.261, 3.448,-99                    ,Gen rain-xs h'graph from sub-area DL route through next stor
4                                         ,Add the last stored h'graph to running h'graph.
5, 3, 0.084, 1.488,-99                    ,Route running h'graph through next storage reach from DL1
3                                         ,Store the current running hydrograph.
1, 3, 0.156, 3.686,-99                    ,Gen rain-xs h'graph from sub-area DM route through next stor
4                                         ,Add the last stored h'graph to running h'graph.
5, 3, 0.187, 1.471,-99                    ,Route running h'graph through next storage reach from DM1
4                                         ,Add the last stored h'graph to running h'graph.
5, 3, 0.04, 0.273,-99                     ,Route running h'graph through next storage reach from DC2
3                                         ,Store the current running hydrograph.
1, 2, 0.066, 2.273,-99                    ,Gen rain-xs h'graph from sub-area DN route through next stor
5, 3, 0.241, 0.104,-99                    ,Route running h'graph through next storage reach from DN1
```

```
5, 3, 0.171, 4.386,-99                ,Route running h'graph through next storage reach from DN2
3                                     ,Store the current running hydrograph.
1, 3, 0.14, 0.893,-99                 ,Gen rain-xs h'graph from sub-area DO route through next stor
4                                     ,Add the last stored h'graph to running h'graph.
5, 3, 0.152, 2.138,-99                ,Route running h'graph through next storage reach from DO1
4                                     ,Add the last stored h'graph to running h'graph.
3                                     ,Store the current running hydrograph.
1, 3, 0.047, 1.596,-99                ,Gen rain-xs h'graph from sub-area DP route through next stor
5, 3, 0.164, 2.439,-99                ,Route running h'graph through next storage reach from DP1
5, 3, 0.083, 2.108,-99                ,Route running h'graph through next storage reach from DP2
4                                     ,Add the last stored h'graph to running h'graph.
5, 3, 0.051, 5.0,-99                  ,Route running h'graph through next storage reach from DC3
3                                     ,Store the current running hydrograph.
1, 2, 0.038, 5.263,-99                ,Gen rain-xs h'graph from sub-area DQ route through next stor
4                                     ,Add the last stored h'graph to running h'graph.
5, 3, 0.18, 0.2,-99                   ,Route running h'graph through next storage reach from DQ1
3                                     ,Store the current running hydrograph.
1, 2, 0.141, 2.482,-99                ,Gen rain-xs h'graph from sub-area DS route through next stor
5, 2, 0.15, 2.0,-99                   ,Route running h'graph through next storage reach from DS1
4                                     ,Add the last stored h'graph to running h'graph.
3                                     ,Store the current running hydrograph.
1, 2, 0.076, 1.316,-99                ,Gen rain-xs h'graph from sub-area DR route through next stor
4                                     ,Add the last stored h'graph to running h'graph.
5, 3, 0.157, 0.2,-99                  ,Route running h'graph through next storage reach from DR1
7
Main Drain Outlet
3                                     ,Store the current running hydrograph.
1, 2, 0.085, 1.765,-99                ,Gen rain-xs h'graph from sub-area DT route through next stor
5, 3, 0.101, 0.345,-99                ,Route running h'graph through next storage reach from DT1
3                                     ,Store the current running hydrograph.
1, 2, 0.17, 3.382,-99                 ,Gen rain-xs h'graph from sub-area DU route through next stor
4                                     ,Add the last stored h'graph to running h'graph.
5, 3, 0.031, 0.222,-99                ,Route running h'graph through next storage reach from DT2
3                                     ,Store the current running hydrograph.
1, 2, 0.066, 1.515,-99                ,Gen rain-xs h'graph from sub-area DV route through next stor
5, 2, 0.121, 0.62,-99                 ,Route running h'graph through next storage reach from DV1
4                                     ,Add the last stored h'graph to running h'graph.
3                                     ,Store the current running hydrograph.
1, 2, 0.038, 3.289,-99                ,Gen rain-xs h'graph from sub-area DW route through next stor
4                                     ,Add the last stored h'graph to running h'graph.
5, 3, 0.052, 0.385,-99                ,Route running h'graph through next storage reach from DW1
3                                     ,Store the current running hydrograph.
1, 2, 0.187, 1.07,-99                 ,Gen rain-xs h'graph from sub-area DX route through next stor
5, 2, 0.124, 0.202,-99                ,Route running h'graph through next storage reach from DX1
3                                     ,Store the current running hydrograph.
1, 3, 0.032, 2.344,-99                ,Gen rain-xs h'graph from sub-area DY route through next stor
4                                     ,Add the last stored h'graph to running h'graph.
5, 3, 0.114, 2.193,-99                ,Route running h'graph through next storage reach from DY1
4                                     ,Add the last stored h'graph to running h'graph.
3                                     ,Store the current running hydrograph.
1, 2, 0.209, 1.794,-99                ,Gen rain-xs h'graph from sub-area DZ route through next stor
4                                     ,Add the last stored h'graph to running h'graph.
5, 3, 0.127, 0.787,-99                ,Route running h'graph through next storage reach from DY2
7
Relief Drain Outlet
4                                     ,Add the last stored h'graph to running h'graph.
0
C Sub Area Data
C Areas, km**2, of subareas A,B....
0.117, 0.041, 0.076, 0.046, 0.123, 0.058, 0.025, 0.128,
0.114, 0.114, 0.091, 0.048, 0.047, 0.018, 0.031, 0.114,
0.149, 0.081, 0.056, 0.194, 0.03, 0.102, 0.13, 0.042,
0.058, 0.05, 0.021, 0.208, 0.055, 0.065, 0.118, 0.079,
0.111, 0.065, 0.047, 0.259, 0.116, 0.086, 0.058, 0.107,
0.106, 0.047, 0.069, 0.04, 0.076, 0.099, 0.221, 0.02,
0.123, 0.023, 0.035, 0.121, 0.115, 0.139, 0.167, 0.055,
0.114, 0.107, 0.112, 0.099, 0.09, 0.043, 0.092, 0.139,
0.074, 0.104, 0.061, 0.085, 0.081, 0.144, 0.122, 0.243,
0.044, 0.129, 0.11, 0.103, 0.155, 0.073, 0.039, 0.143,
0.079, 0.139, 0.099, 0.151, 0.081, 0.121, 0.034, 0.047,
0.058, 0.042, 0.041, 0.212, 0.05, 0.114, 0.08, 0.022,
0.046, 0.198, 0.092, 0.039, 0.109, 0.065, 0.26, 0.269,
0.029, 0.178, 0.053, 0.054, 0.108, 0.131, 0.131, 0.098,
0.063, 0.029, 0.045, 0.094, 0.091, 0.025, 0.036, 0.033,
0.008, 0.032, 0.03, 0.062, 0.014, 0.003, 0.004, 0.014,
0.004, 0.033, -99
C Impervious Area Flag
1
0.4, 0.235, 0.703, 0.108, 0.1, 0.456, 0.12, 0.455,
0.33, 0.498, 0.48, 0.485, 0.441, 0.368, 0.427, 0.47,
0.522, 0.529, 0.7, 0.567, 0.898, 0.663, 0.895, 0.236,
0.678, 0.608, 0.568, 0.696, 0.441, 0.485, 0.482, 0.566,
0.47, 0.47, 0.504, 0.461, 0.479, 0.478, 0.481, 0.542,
0.89, 0.551, 0.465, 0.683, 0.536, 0.464, 0.429, 0.366,
0.471, 0.397, 0.419, 0.481, 0.579, 0.486, 0.442, 0.337,
```

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0.121, 0.1, 0.156, 0.154, 0.475, 0.485, 0.541, 0.472,
0.494, 0.487, 0.221, 0.475, 0.491, 0.482, 0.164, 0.493,
0.543, 0.486, 0.471, 0.399, 0.481, 0.457, 0.448, 0.474,
0.469, 0.458, 0.438, 0.417, 0.502, 0.507, 0.51, 0.345,
0.565, 0.568, 0.573, 0.531, 0.468, 0.441, 0.532, 0.525,
0.481, 0.467, 0.499, 0.367, 0.502, 0.372, 0.456, 0.499,
0.683, 0.408, 0.364, 0.482, 0.468, 0.766, 0.9, 0.567,
0.163, 0.381, 0.721, 0.489, 0.45, 0.485, 0.379, 0.524,
0.485, 0.446, 0.375, 0.452, 0.658, 0.7, 0.7, 0.69,
0.699, 0.401, -99
```

Appendix A.6

Final RORB Catchment File (Base Case Conditions)

```
Catchment file created using G:\31\23394\Tech\RORB\RORB_cat.xls written by GCH
C created at 08:50 on 24/02/09 by GHD Pty Ltd
C
C Diverted catchment file of Existing Conditions (Base Case)
C for the Murrumbeena Drain Catchment Flood Mapping Project
C
C Catchment file   : G:\31\23394\Tech\RORB\Base Case\4850 Base Case.cat
C
C Design runs (100 to 5 year ARIs) are based on the following rainfall parameters
C   Rainfall location: Murrumbeena
C   Temporal pattern : AR&R87 Volume 2 for zone 1 (filtered)
C   Spatial pattern  : Uniform
C   Areal Red. Fact. : Based on Siriwardena and Weinmann formulation
C   Loss factors     : Constant with ARI
C
C Parameters:  kc =    5.75    m = 0.80
C
C Loss parameters     Initial loss (mm)     Runoff coeff.
C     100 yr ARI           10.00               0.60
C      50 yr ARI           10.00               0.55
C      20 yr ARI           10.00               0.45
C      10 yr ARI           10.00               0.35
C       5 yr ARI           10.00               0.25
C
C PMP runs used individually created storm files with 0 mm initial loss and 1 mm/hr continuing loss (as per
Book 6 of ARR)
C
C Reach type flag
0
C The Control Vector
1, 2, 0.07, 0.357,-99                  ,Gen rain-xs h'graph from sub-area BE route through next stor
5, 2, 0.11, 0.227,-99                  ,Route running h'graph through next storage reach from BE1
5, 3, 0.129, 0.078,-99                 ,Route running h'graph through next storage reach from BE2
3                                      ,Store the current running hydrograph.
1, 2, 0.089, 1.011,-99                 ,Gen rain-xs h'graph from sub-area BF route through next stor
5, 3, 0.19, 0.053,-99                  ,Route running h'graph through next storage reach from BF1
4                                      ,Add the last stored h'graph to running h'graph.
7
BF2
C Diversion from Div 25
9, 1, 0, -1,  0 ,-99
Diversion to  0
C I/O formula parameters: a,b,c,d ( ln D=a+c(Q-b)**d)
0.0,  3.2 , 1.0, 1.0, -99
5, 3, 0.063, 0.079,-99                 ,Route running h'graph through next storage reach from BF2
3                                      ,Store the current running hydrograph.
1, 2, 0.097, 0.258,-99                 ,Gen rain-xs h'graph from sub-area BG route through next stor
4                                      ,Add the last stored h'graph to running h'graph.
5, 1, 0.345,-99                        ,Route running h'graph through next storage reach from BG1
3                                      ,Store the current running hydrograph.
1, 1, 0.03,-99                         ,Gen rain-xs h'graph from sub-area BH route through next stor
4                                      ,Add the last stored h'graph to running h'graph.
5, 1, 0.056,-99                        ,Route running h'graph through next storage reach from BH1
5, 4, 0.131,-99                        ,Route running h'graph through next storage reach from BH2
3                                      ,Store the current running hydrograph.
1, 1, 0.233,-99                        ,Gen rain-xs h'graph from sub-area BI route through next stor
5, 4, 0.091,-99                        ,Route running h'graph through next storage reach from BI1
4                                      ,Add the last stored h'graph to running h'graph.
5, 1, 0.111,-99                        ,Route running h'graph through next storage reach from BH3
3                                      ,Store the current running hydrograph.
1, 2, 0.076, 1.974,-99                 ,Gen rain-xs h'graph from sub-area BJ route through next stor
5, 3, 0.157, 0.318,-99                 ,Route running h'graph through next storage reach from BJ1
4                                      ,Add the last stored h'graph to running h'graph.
5, 3, 0.051, 0.196,-99                 ,Route running h'graph through next storage reach from BJ2
3                                      ,Store the current running hydrograph.
1, 2, 0.166, 1.416,-99                 ,Gen rain-xs h'graph from sub-area BK route through next stor
4                                      ,Add the last stored h'graph to running h'graph.
5, 3, 0.269, 0.372,-99                 ,Route running h'graph through next storage reach from BK1
3                                      ,Store the current running hydrograph.
1, 2, 0.049, 1.531,-99                 ,Gen rain-xs h'graph from sub-area BL route through next stor
4                                      ,Add the last stored h'graph to running h'graph.
5, 3, 0.215, 0.233,-99                 ,Route running h'graph through next storage reach from BL1
5, 2, 0.113, 0.221,-99                 ,Route running h'graph through next storage reach from BL2
5, 3, 0.23, 0.109,-99                  ,Route running h'graph through next storage reach from BL3
3                                      ,Store the current running hydrograph.
1, 3, 0.141, 1.064,-99                 ,Gen rain-xs h'graph from sub-area BM route through next stor
4                                      ,Add the last stored h'graph to running h'graph.
7
Start of 4854
5, 3, 0.025, 2.0,-99                   ,Route running h'graph through next storage reach from BM1
3                                      ,Store the current running hydrograph.
1, 2, 0.075, 3.333,-99                 ,Gen rain-xs h'graph from sub-area BN route through next stor
5, 3, 0.268, 0.746,-99                 ,Route running h'graph through next storage reach from BN1
7
BM2
```

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4                                       ,Add the last stored h'graph to running h'graph.
5, 3, 0.398, 0.176,-99                  ,Route running h'graph through next storage reach from BM2
3                                       ,Store the current running hydrograph.
1, 2, 0.074, 0.676,-99                  ,Gen rain-xs h'graph from sub-area BO route through next stor
7
BO
5, 3, 0.094, 0.125,-99                  ,Route running h'graph through next storage reach from BO1
4                                       ,Add the last stored h'graph to running h'graph.
3                                       ,Store the current running hydrograph.
1, 3, 0.027, 2.778,-99                  ,Gen rain-xs h'graph from sub-area BP route through next stor
5, 3, 0.24, 0.938,-99                   ,Route running h'graph through next storage reach from BP1
7
BO2
4                                       ,Add the last stored h'graph to running h'graph.
5, 3, 0.138, 0.104,-99                  ,Route running h'graph through next storage reach from BO2
3                                       ,Store the current running hydrograph.
1, 2, 0.112, 0.446,-99                  ,Gen rain-xs h'graph from sub-area BQ route through next stor
7
BQ
4                                       ,Add the last stored h'graph to running h'graph.
5, 3, 0.119, 0.104,-99                  ,Route running h'graph through next storage reach from BQ1
3                                       ,Store the current running hydrograph.
1, 2, 0.041, 1.22,-99                   ,Gen rain-xs h'graph from sub-area BR route through next stor
7
BR
4                                       ,Add the last stored h'graph to running h'graph.
5, 3, 0.121, 0.104,-99                  ,Route running h'graph through next storage reach from BR1
3                                       ,Store the current running hydrograph.
1, 3, 0.144, 2.951,-99                  ,Gen rain-xs h'graph from sub-area AS route through next stor
5, 3, 0.082, 3.659,-99                  ,Route running h'graph through next storage reach from AS1
C Diversion from Div 50
9, 1, 0, -1,  50 ,-99
Diversion to  50
C I/O formula parameters: a,b,c,d ( ln D=a+c(Q-b)**d)
0.0,  0.35 , 1.0, 1.0, -99
5, 3, 0.268, 0.933,-99                  ,Route running h'graph through next storage reach from AS2
5, 3, 0.073, 0.137,-99                  ,Route running h'graph through next storage reach from AS3
3                                       ,Store the current running hydrograph.
1, 3, 0.127, 3.15,-99                   ,Gen rain-xs h'graph from sub-area AT route through next stor
5, 3, 0.083, 1.627,-99                  ,Route running h'graph through next storage reach from AT1
4                                       ,Add the last stored h'graph to running h'graph.
5, 3, 0.258, 0.93,-99                   ,Route running h'graph through next storage reach from AT2
5, 3, 0.107, 0.467,-99                  ,Route running h'graph through next storage reach from AT3
3                                       ,Store the current running hydrograph.
1, 3, 0.147, 1.701,-99                  ,Gen rain-xs h'graph from sub-area AU route through next stor
3                                       ,Store the current running hydrograph.
C Diversion from Div 100
9, 1, 0, 1,  100 ,-99
Diversion to  100
C I/O formula parameters: a,b,c,d ( ln D=a+c(Q-b)**d)
0.6,  0.0 , 0.0, 1.0, -99
7
Princes Hwy pipe flow
5, 3, 0.422, 1.836,-99                  ,Route running h'graph through next storage reach from Div 10
4                                       ,Add the last stored h'graph to running h'graph.
5, 3, 0.057, 0.877,-99                  ,Route running h'graph through next storage reach from AU1
4                                       ,Add the last stored h'graph to running h'graph.
5, 2, 0.085, 2.353,-99                  ,Route running h'graph through next storage reach from AU2
3                                       ,Store the current running hydrograph.
1, 3, 0.102, 0.98,-99                   ,Gen rain-xs h'graph from sub-area AV route through next stor
4                                       ,Add the last stored h'graph to running h'graph.
5, 2, 0.091, 1.099,-99                  ,Route running h'graph through next storage reach from AV1
5, 3, 0.137, 0.073,-99                  ,Route running h'graph through next storage reach from AV2
5, 3, 0.163, 0.859,-99                  ,Route running h'graph through next storage reach from AV3
3                                       ,Store the current running hydrograph.
1, 3, 0.061, 0.82,-99                   ,Gen rain-xs h'graph from sub-area AW route through next stor
4                                       ,Add the last stored h'graph to running h'graph.
5, 3, 0.204, 1.716,-99                  ,Route running h'graph through next storage reach from AW1
7
Start of 4852
5, 3, 0.061, 1.25,-99                   ,Route running h'graph through next storage reach from AW2
3                                       ,Store the current running hydrograph.
1, 3, 0.13, 1.346,-99                   ,Gen rain-xs h'graph from sub-area AX route through next stor
5, 2, 0.146, 1.199,-99                  ,Route running h'graph through next storage reach from AX3
7
AX4
5, 3, 0.192, 0.651,-99                  ,Route running h'graph through next storage reach from AX4
4                                       ,Add the last stored h'graph to running h'graph.
5, 3, 0.098, 1.25,-99                   ,Route running h'graph through next storage reach from AX1
3                                       ,Store the current running hydrograph.
1, 3, 0.053, 1.887,-99                  ,Gen rain-xs h'graph from sub-area AY route through next stor
7
AY
4                                       ,Add the last stored h'graph to running h'graph.
5, 3, 0.151, 0.5,-99                    ,Route running h'graph through next storage reach from AX2
```

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3                                        ,Store the current running hydrograph.
1, 3, 0.179, 1.955,-99                   ,Gen rain-xs h'graph from sub-area AZ route through next stor
5, 2, 0.148, 0.169,-99                   ,Route running h'graph through next storage reach from AZ1
7
AZ
4                                        ,Add the last stored h'graph to running h'graph.
5, 3, 0.021, 0.909,-99                   ,Route running h'graph through next storage reach from AY1
3                                        ,Store the current running hydrograph.
1, 2, 0.252, 0.397,-99                   ,Gen rain-xs h'graph from sub-area BA route through next stor
C Diversion from Div 200
9, 1, 0, -1,  200 ,-99
Diversion to  200
C I/O formula parameters: a,b,c,d ( ln D=a+c(Q-b)**d)
0.0,  1.2 , 1.0, 1.0, -99
5, 3, 0.234, 0.321,-99                   ,Route running h'graph through next storage reach from BA1
5, 2, 0.244, 0.082,-99                   ,Route running h'graph through next storage reach from BA2
3                                        ,Store the current running hydrograph.
1, 2, 0.096, 1.563,-99                   ,Gen rain-xs h'graph from sub-area BB route through next stor
4                                        ,Add the last stored h'graph to running h'graph.
5, 3, 0.074, 1.689,-99                   ,Route running h'graph through next storage reach from BB1
3                                        ,Store the current running hydrograph.
1, 2, 0.22, 0.795,-99                    ,Gen rain-xs h'graph from sub-area BC route through next stor
5, 2, 0.146, 0.685,-99                   ,Route running h'graph through next storage reach from BC1
4                                        ,Add the last stored h'graph to running h'graph.
5, 2, 0.111, 1.126,-99                   ,Route running h'graph through next storage reach from BC2
3                                        ,Store the current running hydrograph.
1, 3, 0.044, 0.568,-99                   ,Gen rain-xs h'graph from sub-area BD route through next stor
4                                        ,Add the last stored h'graph to running h'graph.
5, 2, 0.152, 0.329,-99                   ,Route running h'graph through next storage reach from BD1
7
BD2
4                                        ,Add the last stored h'graph to running h'graph.
5, 3, 0.119, 0.769,-99                   ,Route running h'graph through next storage reach from BD2
4                                        ,Add the last stored h'graph to running h'graph.
3                                        ,Store the current running hydrograph.
1, 2, 0.03, 0.833,-99                    ,Gen rain-xs h'graph from sub-area BS route through next stor
7
BS
4                                        ,Add the last stored h'graph to running h'graph.
5, 3, 0.14, 0.769,-99                    ,Route running h'graph through next storage reach from BS1
3                                        ,Store the current running hydrograph.
1, 3, 0.314, 1.354,-99                   ,Gen rain-xs h'graph from sub-area BT route through next stor
5, 2, 0.04, 0.625,-99                    ,Route running h'graph through next storage reach from BT1
7
BT2
5, 3, 0.057, 0.877,-99                   ,Route running h'graph through next storage reach from BT2
4                                        ,Add the last stored h'graph to running h'graph.
5, 3, 0.131, 0.971,-99                   ,Route running h'graph through next storage reach from BS2
3                                        ,Store the current running hydrograph.
1, 2, 0.066, 1.515,-99                   ,Gen rain-xs h'graph from sub-area BU route through next stor
5, 3, 0.112, 1.116,-99                   ,Route running h'graph through next storage reach from BU1
7
BU2
4                                        ,Add the last stored h'graph to running h'graph.
5, 3, 0.143, 0.25,-99                    ,Route running h'graph through next storage reach from BU2
3                                        ,Store the current running hydrograph.
1, 3, 0.077, 3.247,-99                   ,Gen rain-xs h'graph from sub-area BV route through next stor
5, 3, 0.152, 0.329,-99                   ,Route running h'graph through next storage reach from BV1
7
BV2
4                                        ,Add the last stored h'graph to running h'graph.
5, 3, 0.18, 0.667,-99                    ,Route running h'graph through next storage reach from BV2
3                                        ,Store the current running hydrograph.
1, 3, 0.094, 0.798,-99                   ,Gen rain-xs h'graph from sub-area BX route through next stor
7
BX
4                                        ,Add the last stored h'graph to running h'graph.
5, 3, 0.095, 0.588,-99                   ,Route running h'graph through next storage reach from BX1
3                                        ,Store the current running hydrograph.
1, 2, 0.108, 0.231,-99                   ,Gen rain-xs h'graph from sub-area BW route through next stor
5, 3, 0.236, 0.572,-99                   ,Route running h'graph through next storage reach from BW1
7
BW2
4                                        ,Add the last stored h'graph to running h'graph.
5, 3, 0.05, 0.588,-99                    ,Route running h'graph through next storage reach from BW2
5, 3, 0.107, 0.699,-99                   ,Route running h'graph through next storage reach from BX2
3                                        ,Store the current running hydrograph.
1, 2, 0.106, 1.179,-99                   ,Gen rain-xs h'graph from sub-area BY route through next stor
7
BY
4                                        ,Add the last stored h'graph to running h'graph.
5, 3, 0.129, 0.8,-99                     ,Route running h'graph through next storage reach from BY1
5, 3, 0.205, 0.699,-99                   ,Route running h'graph through next storage reach from BY2
3                                        ,Store the current running hydrograph.
1, 3, 0.096, 0.781,-99                   ,Gen rain-xs h'graph from sub-area BZ route through next stor
```

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7
BZ
4                                       ,Add the last stored h'graph to running h'graph.
3                                       ,Store the current running hydrograph.
1, 2, 0.236, 0.318,-99                  ,Gen rain-xs h'graph from sub-area CA route through next stor
C Diversion from Div 300
9, 1, 0, 0,  300 ,-99
Diversion to  300
C I/O formula parameters: a,b,c,d ( ln D=a+c(Q-b)**d)
0.0,  0.7 , 1.0, 1.0, -99
5, 3, 0.243, 0.103,-99                  ,Route running h'graph through next storage reach from Div 30
7
BZ1
4                                       ,Add the last stored h'graph to running h'graph.
5, 3, 0.059, 0.2,-99                    ,Route running h'graph through next storage reach from BZ1
5, 3, 0.213, 0.27,-99                   ,Route running h'graph through next storage reach from BZ2
3                                       ,Store the current running hydrograph.
1, 2, 0.129, 1.55,-99                   ,Gen rain-xs h'graph from sub-area CC route through next stor
7
CC1
4                                       ,Add the last stored h'graph to running h'graph.
5, 3, 0.045, 1.606,-99                  ,Route running h'graph through next storage reach from CC1
3                                       ,Store the current running hydrograph.
9, 2, 0, 1,  300 ,-99                   ,Recall flow from diversion  300
5, 3, 0.119, 0.42,-99                   ,Route running h'graph through next storage reach from CA1
5, 3, 0.245, 0.408,-99                  ,Route running h'graph through next storage reach from CA2
3                                       ,Store the current running hydrograph.
1, 2, 0.064, 0.391,-99                  ,Gen rain-xs h'graph from sub-area CB route through next stor
4                                       ,Add the last stored h'graph to running h'graph.
5, 3, 0.207, 0.242,-99                  ,Route running h'graph through next storage reach from CB1
7
CB2
4                                       ,Add the last stored h'graph to running h'graph.
5, 3, 0.14, 0.402,-99                   ,Route running h'graph through next storage reach from CB2
5, 3, 0.071, 0.402,-99                  ,Route running h'graph through next storage reach from CC2
3                                       ,Store the current running hydrograph.
1, 3, 0.178, 0.983,-99                  ,Gen rain-xs h'graph from sub-area CD route through next stor
7
CD
4                                       ,Add the last stored h'graph to running h'graph.
5, 3, 0.216, 0.402,-99                  ,Route running h'graph through next storage reach from CD1
5, 3, 0.092, 0.311,-99                  ,Route running h'graph through next storage reach from CC3
3                                       ,Store the current running hydrograph.
1, 3, 0.075, 2.0,-99                    ,Gen rain-xs h'graph from sub-area CE route through next stor
5, 3, 0.15, 0.667,-99                   ,Route running h'graph through next storage reach from CE1
5, 3, 0.131, 0.382,-99                  ,Route running h'graph through next storage reach from CE2
7
CQ2
4                                       ,Add the last stored h'graph to running h'graph.
5, 3, 0.094, 0.311,-99                  ,Route running h'graph through next storage reach from CQ2
3                                       ,Store the current running hydrograph.
1, 3, 0.318, 1.572,-99                  ,Gen rain-xs h'graph from sub-area CI route through next stor
5, 3, 0.04, 1.25,-99                    ,Route running h'graph through next storage reach from CI1
3                                       ,Store the current running hydrograph.
1, 3, 0.255, 1.373,-99                  ,Gen rain-xs h'graph from sub-area CH route through next stor
5, 3, 0.149, 0.168,-99                  ,Route running h'graph through next storage reach from CH1
4                                       ,Add the last stored h'graph to running h'graph.
5, 3, 0.14, 1.786,-99                   ,Route running h'graph through next storage reach from CI2
3                                       ,Store the current running hydrograph.
1, 2, 0.067, 2.239,-99                  ,Gen rain-xs h'graph from sub-area CJ route through next stor
4                                       ,Add the last stored h'graph to running h'graph.
5, 3, 0.13, 0.769,-99                   ,Route running h'graph through next storage reach from CJ1
3                                       ,Store the current running hydrograph.
1, 3, 0.279, 1.434,-99                  ,Gen rain-xs h'graph from sub-area CK route through next stor
4                                       ,Add the last stored h'graph to running h'graph.
7
CK1
5, 3, 0.09, 0.278,-99                   ,Route running h'graph through next storage reach from CK1
3                                       ,Store the current running hydrograph.
1, 3, 0.052, 0.962,-99                  ,Gen rain-xs h'graph from sub-area CF route through next stor
5, 3, 0.133, 0.075,-99                  ,Route running h'graph through next storage reach from CF1
5, 3, 0.192, 0.99,-99                   ,Route running h'graph through next storage reach from CF2
3                                       ,Store the current running hydrograph.
1, 3, 0.06, 0.167,-99                   ,Gen rain-xs h'graph from sub-area CG route through next stor
4                                       ,Add the last stored h'graph to running h'graph.
5, 3, 0.122, 1.23,-99                   ,Route running h'graph through next storage reach from CG1
7
CG2
5, 3, 0.068, 0.368,-99                  ,Route running h'graph through next storage reach from CG2
4                                       ,Add the last stored h'graph to running h'graph.
7
Start of 4853
5, 3, 0.249, 0.5,-99                    ,Route running h'graph through next storage reach from CK2
3                                       ,Store the current running hydrograph.
1, 3, 0.218, 1.147,-99                  ,Gen rain-xs h'graph from sub-area CL route through next stor
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5, 3, 0.102, 1.471,-99                ,Route running h'graph through next storage reach from CL1
5, 3, 0.212, 0.943,-99                ,Route running h'graph through next storage reach from CL2
3                                     ,Store the current running hydrograph.
1, 3, 0.076, 1.316,-99                ,Gen rain-xs h'graph from sub-area CM route through next stor
4                                     ,Add the last stored h'graph to running h'graph.
5, 3, 0.192, 0.651,-99                ,Route running h'graph through next storage reach from CM1
7
CM2
5, 3, 0.084, 0.298,-99                ,Route running h'graph through next storage reach from CM2
4                                     ,Add the last stored h'graph to running h'graph.
5, 3, 0.144, 0.476,-99                ,Route running h'graph through next storage reach from CM3
3                                     ,Store the current running hydrograph.
1, 2, 0.036, 2.083,-99                ,Gen rain-xs h'graph from sub-area CN route through next stor
7
CN
4                                     ,Add the last stored h'graph to running h'graph.
5, 3, 0.104, 0.625,-99                ,Route running h'graph through next storage reach from CN1
3                                     ,Store the current running hydrograph.
1, 3, 0.09, 0.556,-99                 ,Gen rain-xs h'graph from sub-area CO route through next stor
5, 3, 0.233, 0.322,-99                ,Route running h'graph through next storage reach from CO1
7
CO2
5, 3, 0.065, 0.154,-99                ,Route running h'graph through next storage reach from CO2
4                                     ,Add the last stored h'graph to running h'graph.
5, 3, 0.23, 0.741,-99                 ,Route running h'graph through next storage reach from CN2
3                                     ,Store the current running hydrograph.
1, 2, 0.058, 0.862,-99                ,Gen rain-xs h'graph from sub-area CP route through next stor
7
CP
4                                     ,Add the last stored h'graph to running h'graph.
5, 3, 0.071, 0.714,-99                ,Route running h'graph through next storage reach from CP1
4                                     ,Add the last stored h'graph to running h'graph.
3                                     ,Store the current running hydrograph.
1, 3, 0.143, 1.399,-99                ,Gen rain-xs h'graph from sub-area CQ route through next stor
7
CQ1
4                                     ,Add the last stored h'graph to running h'graph.
5, 3, 0.209, 0.238,-99                ,Route running h'graph through next storage reach from CQ1
3                                     ,Store the current running hydrograph.
1, 3, 0.071, 1.408,-99                ,Gen rain-xs h'graph from sub-area CR route through next stor
7
CR
4                                     ,Add the last stored h'graph to running h'graph.
5, 3, 0.379, 0.769,-99                ,Route running h'graph through next storage reach from CR1
5, 3, 0.233, 0.87,-99                 ,Route running h'graph through next storage reach from CR2
3                                     ,Store the current running hydrograph.
1, 3, 0.358, 2.025,-99                ,Gen rain-xs h'graph from sub-area CS route through next stor
7
CS
4                                     ,Add the last stored h'graph to running h'graph.
5, 3, 0.062, 1.0,-99                  ,Route running h'graph through next storage reach from CS1
3                                     ,Store the current running hydrograph.
1, 3, 0.111, 0.45,-99                 ,Gen rain-xs h'graph from sub-area F route through next stora
5, 3, 0.257, 1.07,-99                 ,Route running h'graph through next storage reach from F2
5, 2, 0.089, 0.281,-99                ,Route running h'graph through next storage reach from F1
3                                     ,Store the current running hydrograph.
1, 3, 0.179, 0.559,-99                ,Gen rain-xs h'graph from sub-area G route through next stora
5, 2, 0.1, 0.25,-99                   ,Route running h'graph through next storage reach from G1
4                                     ,Add the last stored h'graph to running h'graph.
5, 3, 0.08, 0.125,-99                 ,Route running h'graph through next storage reach from G2
5, 2, 0.095, 0.158,-99                ,Route running h'graph through next storage reach from G3
5, 3, 0.152, 0.164,-99                ,Route running h'graph through next storage reach from G4
7
HI
3                                     ,Store the current running hydrograph.
1, 3, 0.048, 1.042,-99                ,Gen rain-xs h'graph from sub-area D route through next stora
5, 1, 0.425,-99                       ,Route running h'graph through next storage reach from D1
3                                     ,Store the current running hydrograph.
1, 1, 0.095,-99                       ,Gen rain-xs h'graph from sub-area E route through next stora
4                                     ,Add the last stored h'graph to running h'graph.
5, 1, 0.186,-99                       ,Route running h'graph through next storage reach from E1
5, 3, 0.149, 0.503,-99                ,Route running h'graph through next storage reach from E2
3                                     ,Store the current running hydrograph.
1, 1, 0.096,-99                       ,Gen rain-xs h'graph from sub-area B route through next stora
3                                     ,Store the current running hydrograph.
1, 1, 0.351,-99                       ,Gen rain-xs h'graph from sub-area A route through next stora
4                                     ,Add the last stored h'graph to running h'graph.
5, 1, 0.423,-99                       ,Route running h'graph through next storage reach from B1
3                                     ,Store the current running hydrograph.
1, 1, 0.087,-99                       ,Gen rain-xs h'graph from sub-area C route through next stora
4                                     ,Add the last stored h'graph to running h'graph.
5, 1, 0.111,-99                       ,Route running h'graph through next storage reach from C1
4                                     ,Add the last stored h'graph to running h'graph.
7
Start of 4850
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5, 3, 0.105, 0.189,-99                  ,Route running h'graph through next storage reach from C2
4                                       ,Add the last stored h'graph to running h'graph.
3                                       ,Store the current running hydrograph.
1, 3, 0.066, 0.379,-99                  ,Gen rain-xs h'graph from sub-area H route through next stora
7
H
4                                       ,Add the last stored h'graph to running h'graph.
5, 3, 0.117, 0.303,-99                  ,Route running h'graph through next storage reach from H1
5, 3, 0.148, 0.4,-99                    ,Route running h'graph through next storage reach from H2
3                                       ,Store the current running hydrograph.
1, 3, 0.054, 1.389,-99                  ,Gen rain-xs h'graph from sub-area I route through next stora
7
I
4                                       ,Add the last stored h'graph to running h'graph.
5, 3, 0.098, 0.26,-99                   ,Route running h'graph through next storage reach from I1
3                                       ,Store the current running hydrograph.
1, 3, 0.369, 0.407,-99                  ,Gen rain-xs h'graph from sub-area J route through next stora
7
J1
4                                       ,Add the last stored h'graph to running h'graph.
5, 3, 0.156, 0.143,-99                  ,Route running h'graph through next storage reach from J1
3                                       ,Store the current running hydrograph.
1, 2, 0.113, 0.221,-99                  ,Gen rain-xs h'graph from sub-area K route through next stora
5, 2, 0.126, 0.198,-99                  ,Route running h'graph through next storage reach from K2
3                                       ,Store the current running hydrograph.
1, 3, 0.041, 1.22,-99                   ,Gen rain-xs h'graph from sub-area L route through next stora
4                                       ,Add the last stored h'graph to running h'graph.
5, 2, 0.142, 0.176,-99                  ,Route running h'graph through next storage reach from L1
5, 3, 0.189, 0.397,-99                  ,Route running h'graph through next storage reach from L2
7
L3
4                                       ,Add the last stored h'graph to running h'graph.
5, 3, 0.095, 0.143,-99                  ,Route running h'graph through next storage reach from L3
3                                       ,Store the current running hydrograph.
1, 3, 0.151, 0.828,-99                  ,Gen rain-xs h'graph from sub-area M route through next stora
7
M1
4                                       ,Add the last stored h'graph to running h'graph.
5, 3, 0.182, 0.183,-99                  ,Route running h'graph through next storage reach from M1
3                                       ,Store the current running hydrograph.
1, 2, 0.145, 2.069,-99                  ,Gen rain-xs h'graph from sub-area O route through next stora
5, 2, 0.159, 0.314,-99                  ,Route running h'graph through next storage reach from O1
5, 2, 0.104, 0.481,-99                  ,Route running h'graph through next storage reach from O2
3                                       ,Store the current running hydrograph.
1, 2, 0.047, 1.064,-99                  ,Gen rain-xs h'graph from sub-area P route through next stora
4                                       ,Add the last stored h'graph to running h'graph.
5, 3, 0.182, 0.275,-99                  ,Route running h'graph through next storage reach from P1
5, 3, 0.252, 0.794,-99                  ,Route running h'graph through next storage reach from P2
7
M2
4                                       ,Add the last stored h'graph to running h'graph.
5, 3, 0.069, 0.167,-99                  ,Route running h'graph through next storage reach from M2
3                                       ,Store the current running hydrograph.
1, 2, 0.055, 2.273,-99                  ,Gen rain-xs h'graph from sub-area N route through next stora
7
N
4                                       ,Add the last stored h'graph to running h'graph.
5, 3, 0.1, 0.149,-99                    ,Route running h'graph through next storage reach from N1
3                                       ,Store the current running hydrograph.
1, 3, 0.111, 1.577,-99                  ,Gen rain-xs h'graph from sub-area S route through next stora
7
S
4                                       ,Add the last stored h'graph to running h'graph.
5, 3, 0.177, 0.286,-99                  ,Route running h'graph through next storage reach from S1
3                                       ,Store the current running hydrograph.
1, 2, 0.331, 0.151,-99                  ,Gen rain-xs h'graph from sub-area Q route through next stora
5, 2, 0.241, 0.726,-99                  ,Route running h'graph through next storage reach from Q1
5, 3, 0.251, 1.394,-99                  ,Route running h'graph through next storage reach from Q2
3                                       ,Store the current running hydrograph.
1, 2, 0.074, 0.338,-99                  ,Gen rain-xs h'graph from sub-area R route through next stora
4                                       ,Add the last stored h'graph to running h'graph.
5, 2, 0.344, 0.436,-99                  ,Route running h'graph through next storage reach from R1
5, 3, 0.403, 0.744,-99                  ,Route running h'graph through next storage reach from R2
7
S2
4                                       ,Add the last stored h'graph to running h'graph.
5, 3, 0.158, 0.546,-99                  ,Route running h'graph through next storage reach from S2
3                                       ,Store the current running hydrograph.
1, 2, 0.267, 1.03,-99                   ,Gen rain-xs h'graph from sub-area T route through next stora
7
S3
4                                       ,Add the last stored h'graph to running h'graph.
5, 3, 0.177, 0.427,-99                  ,Route running h'graph through next storage reach from S3
3                                       ,Store the current running hydrograph.
1, 3, 0.133, 1.88,-99                   ,Gen rain-xs h'graph from sub-area U route through next stora
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7
U
4                                       ,Add the last stored h'graph to running h'graph.
5, 3, 0.165, 0.513,-99                  ,Route running h'graph through next storage reach from U1
3                                       ,Store the current running hydrograph.
1, 2, 0.118, 1.059,-99                  ,Gen rain-xs h'graph from sub-area V route through next stora
7
V
4                                       ,Add the last stored h'graph to running h'graph.
5, 3, 0.101, 0.602,-99                  ,Route running h'graph through next storage reach from U2
5, 3, 0.228, 0.602,-99                  ,Route running h'graph through next storage reach from V1
3                                       ,Store the current running hydrograph.
1, 2, 0.095, 1.842,-99                  ,Gen rain-xs h'graph from sub-area W route through next stora
7
W
4                                       ,Add the last stored h'graph to running h'graph.
5, 3, 0.207, 0.4,-99                    ,Route running h'graph through next storage reach from W2
3                                       ,Store the current running hydrograph.
1, 3, 0.192, 0.911,-99                  ,Gen rain-xs h'graph from sub-area X route through next stora
7
X
4                                       ,Add the last stored h'graph to running h'graph.
5, 3, 0.229, 0.284,-99                  ,Route running h'graph through next storage reach from X1
3                                       ,Store the current running hydrograph.
1, 3, 0.098, 1.02,-99                   ,Gen rain-xs h'graph from sub-area Y route through next stora
7
Y
4                                       ,Add the last stored h'graph to running h'graph.
5, 3, 0.2, 0.602,-99                    ,Route running h'graph through next storage reach from Y1
3                                       ,Store the current running hydrograph.
1, 2, 0.057, 2.632,-99                  ,Gen rain-xs h'graph from sub-area Z route through next stora
7
Z
4                                       ,Add the last stored h'graph to running h'graph.
5, 3, 0.155, 0.4,-99                    ,Route running h'graph through next storage reach from Z1
3                                       ,Store the current running hydrograph.
1, 2, 0.253, 0.395,-99                  ,Gen rain-xs h'graph from sub-area AA route through next stor
5, 2, 0.134, 1.119,-99                  ,Route running h'graph through next storage reach from AA1
3                                       ,Store the current running hydrograph.
1, 3, 0.058, 0.862,-99                  ,Gen rain-xs h'graph from sub-area AB route through next stor
4                                       ,Add the last stored h'graph to running h'graph.
5, 2, 0.163, 0.46,-99                   ,Route running h'graph through next storage reach from AB1
7
AB2
4                                       ,Add the last stored h'graph to running h'graph.
5, 3, 0.046, 0.333,-99                  ,Route running h'graph through next storage reach from AB2
3                                       ,Store the current running hydrograph.
1, 3, 0.074, 2.365,-99                  ,Gen rain-xs h'graph from sub-area AC route through next stor
5, 2, 0.116, 0.431,-99                  ,Route running h'graph through next storage reach from AC1
5, 2, 0.227, 0.771,-99                  ,Route running h'graph through next storage reach from AC2
3                                       ,Store the current running hydrograph.
1, 3, 0.161, 1.708,-99                  ,Gen rain-xs h'graph from sub-area AD route through next stor
4                                       ,Add the last stored h'graph to running h'graph.
5, 3, 0.153, 1.144,-99                  ,Route running h'graph through next storage reach from AD1
7
AD2
4                                       ,Add the last stored h'graph to running h'graph.
5, 3, 0.219, 0.25,-99                   ,Route running h'graph through next storage reach from AD2
3                                       ,Store the current running hydrograph.
1, 3, 0.057, 0.439,-99                  ,Gen rain-xs h'graph from sub-area AE route through next stor
5, 2, 0.046, 0.543,-99                  ,Route running h'graph through next storage reach from AE1
7
AE
4                                       ,Add the last stored h'graph to running h'graph.
5, 3, 0.154, 0.25,-99                   ,Route running h'graph through next storage reach from AE2
5, 3, 0.202, 0.333,-99                  ,Route running h'graph through next storage reach from AE3
3                                       ,Store the current running hydrograph.
1, 3, 0.056, 3.125,-99                  ,Gen rain-xs h'graph from sub-area AF route through next stor
7
AF
4                                       ,Add the last stored h'graph to running h'graph.
5, 3, 0.185, 0.333,-99                  ,Route running h'graph through next storage reach from AF1
3                                       ,Store the current running hydrograph.
1, 2, 0.153, 0.817,-99                  ,Gen rain-xs h'graph from sub-area AG route through next stor
5, 3, 0.167, 0.898,-99                  ,Route running h'graph through next storage reach from AG1
7
AF2
4                                       ,Add the last stored h'graph to running h'graph.
5, 3, 0.137, 0.38,-99                   ,Route running h'graph through next storage reach from AF2
3                                       ,Store the current running hydrograph.
1, 3, 0.104, 1.923,-99                  ,Gen rain-xs h'graph from sub-area AH route through next stor
7
AH
4                                       ,Add the last stored h'graph to running h'graph.
5, 3, 0.076, 0.38,-99                   ,Route running h'graph through next storage reach from AH1
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3                                       ,Store the current running hydrograph.
1, 3, 0.237, 1.477,-99                  ,Gen rain-xs h'graph from sub-area AI route through next stor
7
AI1
4                                       ,Add the last stored h'graph to running h'graph.
5, 3, 0.101, 0.38,-99                   ,Route running h'graph through next storage reach from AI1
3                                       ,Store the current running hydrograph.
1, 2, 0.082, 0.915,-99                  ,Gen rain-xs h'graph from sub-area AL route through next stor
5, 2, 0.133, 0.564,-99                  ,Route running h'graph through next storage reach from AL1
5, 3, 0.153, 0.49,-99                   ,Route running h'graph through next storage reach from AL2
3                                       ,Store the current running hydrograph.
1, 2, 0.032, 1.563,-99                  ,Gen rain-xs h'graph from sub-area AM route through next stor
4                                       ,Add the last stored h'graph to running h'graph.
5, 3, 0.108, 0.231,-99                  ,Route running h'graph through next storage reach from AM1
5, 2, 0.166, 0.151,-99                  ,Route running h'graph through next storage reach from AM2
3                                       ,Store the current running hydrograph.
1, 3, 0.206, 0.121,-99                  ,Gen rain-xs h'graph from sub-area AJ route through next stor
3                                       ,Store the current running hydrograph.
1, 3, 0.091, 0.275,-99                  ,Gen rain-xs h'graph from sub-area AK route through next stor
4                                       ,Add the last stored h'graph to running h'graph.
5, 3, 0.123, 1.22,-99                   ,Route running h'graph through next storage reach from AJ1
5, 2, 0.352, 0.426,-99                  ,Route running h'graph through next storage reach from AJ2
C Diversion from Div 400
9, 1, 0, -1,  400 ,-99
Diversion to  400
C I/O formula parameters: a,b,c,d ( ln D=a+c(Q-b)**d)
0.0,  2.25 , 1.0, 1.0, -99
5, 3, 0.061, 0.82,-99                   ,Route running h'graph through next storage reach from AJ3
4                                       ,Add the last stored h'graph to running h'graph.
3                                       ,Store the current running hydrograph.
1, 3, 0.18, 0.833,-99                   ,Gen rain-xs h'graph from sub-area AN route through next stor
5, 3, 0.219, 1.027,-99                  ,Route running h'graph through next storage reach from AN1
3                                       ,Store the current running hydrograph.
1, 3, 0.2, 1.0,-99                      ,Gen rain-xs h'graph from sub-area AO route through next stor
4                                       ,Add the last stored h'graph to running h'graph.
5, 3, 0.144, 0.347,-99                  ,Route running h'graph through next storage reach from AO1
4                                       ,Add the last stored h'graph to running h'graph.
C Diversion from Div 450
9, 1, 0, -1,  450 ,-99
Diversion to  450
C I/O formula parameters: a,b,c,d ( ln D=a+c(Q-b)**d)
0.0,  2.1 , 1.0, 1.0, -99
5, 3, 0.069, 0.725,-99                  ,Route running h'graph through next storage reach from AM3
5, 2, 0.295, 0.508,-99                  ,Route running h'graph through next storage reach from AO2
3                                       ,Store the current running hydrograph.
1, 2, 0.081, 0.617,-99                  ,Gen rain-xs h'graph from sub-area AP route through next stor
4                                       ,Add the last stored h'graph to running h'graph.
5, 3, 0.119, 0.84,-99                   ,Route running h'graph through next storage reach from AP1
7
AP2
5, 3, 0.064, 0.781,-99                  ,Route running h'graph through next storage reach from AP2
7
4850 Branch (AP3)
5, 3, 0.042, 0.313,-99                  ,Route running h'graph through next storage reach from AP3
3                                       ,Store the current running hydrograph.
1, 3, 0.075, 1.467,-99                  ,Gen rain-xs h'graph from sub-area AQ route through next stor
7
AQ1
4                                       ,Add the last stored h'graph to running h'graph.
5, 2, 0.115, 0.313,-99                  ,Route running h'graph through next storage reach from AQ1
4                                       ,Add the last stored h'graph to running h'graph.
5, 3, 0.093, 0.476,-99                  ,Route running h'graph through next storage reach from AQ2
3                                       ,Store the current running hydrograph.
1, 2, 0.048, 2.083,-99                  ,Gen rain-xs h'graph from sub-area AR route through next stor
7
AR
4                                       ,Add the last stored h'graph to running h'graph.
5, 3, 0.063, 0.476,-99                  ,Route running h'graph through next storage reach from AR1
4                                       ,Add the last stored h'graph to running h'graph.
3                                       ,Store the current running hydrograph.
9, 2, 0, 1,  450 ,-99                   ,Recall flow from diversion  450
5, 3, 0.46, 1.087,-99                   ,Route running h'graph through next storage reach from Div 45
7
AR2
4                                       ,Store the current running hydrograph.
5, 3, 0.14, 0.4,-99                     ,Route running h'graph through next storage reach from AR2
3                                       ,Store the current running hydrograph.
1, 2, 0.094, 3.723,-99                  ,Gen rain-xs h'graph from sub-area CT route through next stor
5, 2, 0.18, 1.25,-99                    ,Route running h'graph through next storage reach from CT1
5, 3, 0.236, 2.013,-99                  ,Route running h'graph through next storage reach from CT2
7
CT
4                                       ,Add the last stored h'graph to running h'graph.
3                                       ,Store the current running hydrograph.
1, 3, 0.071, 1.408,-99                  ,Gen rain-xs h'graph from sub-area CU route through next stor
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3                                      ,Store the current running hydrograph.
9, 2, 0, 1,  400 ,-99                  ,Recall flow from diversion  400
5, 3, 0.357, 0.35,-99                  ,Route running h'graph through next storage reach from Div 40
4                                      ,Add the last stored h'graph to running h'graph.
5, 3, 0.159, 2.358,-99                 ,Route running h'graph through next storage reach from CU1
7
CU2
4                                      ,Add the last stored h'graph to running h'graph.
5, 3, 0.138, 0.435,-99                 ,Route running h'graph through next storage reach from CU2
3                                      ,Store the current running hydrograph.
1, 3, 0.084, 3.869,-99                 ,Gen rain-xs h'graph from sub-area CV route through next stor
7
CV1
4                                      ,Add the last stored h'graph to running h'graph.
5, 3, 0.085, 0.333,-99                 ,Route running h'graph through next storage reach from CV1
3                                      ,Store the current running hydrograph.
1, 3, 0.47, 1.011,-99                  ,Gen rain-xs h'graph from sub-area CW route through next stor
5, 3, 0.257, 2.724,-99                 ,Route running h'graph through next storage reach from CW1
3                                      ,Store the current running hydrograph.
1, 3, 0.061, 2.459,-99                 ,Gen rain-xs h'graph from sub-area CX route through next stor
4                                      ,Add the last stored h'graph to running h'graph.
5, 2, 0.157, 3.662,-99                 ,Route running h'graph through next storage reach from CX1
7
CX2
4                                      ,Add the last stored h'graph to running h'graph.
5, 3, 0.18, 0.333,-99                  ,Route running h'graph through next storage reach from CX2
3                                      ,Store the current running hydrograph.
1, 3, 0.396, 2.967,-99                 ,Gen rain-xs h'graph from sub-area CZ route through next stor
7
CZ
4                                      ,Add the last stored h'graph to running h'graph.
5, 3, 0.14, 0.526,-99                  ,Route running h'graph through next storage reach from CZ1
3                                      ,Store the current running hydrograph.
1, 2, 0.149, 1.51,-99                  ,Gen rain-xs h'graph from sub-area CY route through next stor
5, 3, 0.107, 3.738,-99                 ,Route running h'graph through next storage reach from CY1
5, 2, 0.055, 3.182,-99                 ,Route running h'graph through next storage reach from CY2
7
CY
4                                      ,Add the last stored h'graph to running h'graph.
5, 3, 0.095, 1.0,-99                   ,Route running h'graph through next storage reach from CZ2
5, 3, 0.046, 0.167,-99                 ,Route running h'graph through next storage reach from CY3
3                                      ,Store the current running hydrograph.
1, 3, 0.332, 2.56,-99                  ,Gen rain-xs h'graph from sub-area DA route through next stor
5, 3, 0.304, 3.865,-99                 ,Route running h'graph through next storage reach from DA1
7
CY4
4                                      ,Add the last stored h'graph to running h'graph.
5, 3, 0.198, 0.556,-99                 ,Route running h'graph through next storage reach from CY4
3                                      ,Store the current running hydrograph.
1, 2, 0.063, 4.206,-99                 ,Gen rain-xs h'graph from sub-area DB route through next stor
7
DB
4                                      ,Add the last stored h'graph to running h'graph.
5, 3, 0.153, 0.556,-99                 ,Route running h'graph through next storage reach from DB1
5, 3, 0.173, 0.556,-99                 ,Route running h'graph through next storage reach from DB2
3                                      ,Store the current running hydrograph.
1, 2, 0.045, 7.222,-99                 ,Gen rain-xs h'graph from sub-area DC route through next stor
7
DC
4                                      ,Add the last stored h'graph to running h'graph.
5, 3, 0.124, 0.556,-99                 ,Route running h'graph through next storage reach from DC1
3                                      ,Store the current running hydrograph.
1, 2, 0.079, 2.848,-99                 ,Gen rain-xs h'graph from sub-area DD route through next stor
5, 2, 0.149, 0.671,-99                 ,Route running h'graph through next storage reach from DD1
5, 3, 0.141, 1.064,-99                 ,Route running h'graph through next storage reach from DD2
3                                      ,Store the current running hydrograph.
1, 3, 0.081, 2.16,-99                  ,Gen rain-xs h'graph from sub-area DE route through next stor
4                                      ,Add the last stored h'graph to running h'graph.
5, 3, 0.097, 1.031,-99                 ,Route running h'graph through next storage reach from DE1
5, 3, 0.245, 1.633,-99                 ,Route running h'graph through next storage reach from DE2
3                                      ,Store the current running hydrograph.
1, 3, 0.053, 0.943,-99                 ,Gen rain-xs h'graph from sub-area DF route through next stor
4                                      ,Add the last stored h'graph to running h'graph.
5, 3, 0.275, 0.364,-99                 ,Route running h'graph through next storage reach from DF1
5, 3, 0.309, 2.184,-99                 ,Route running h'graph through next storage reach from DF2
3                                      ,Store the current running hydrograph.
1, 2, 0.179, 0.14,-99                  ,Gen rain-xs h'graph from sub-area DG route through next stor
5, 3, 0.165, 1.515,-99                 ,Route running h'graph through next storage reach from DG1
4                                      ,Add the last stored h'graph to running h'graph.
3                                      ,Store the current running hydrograph.
1, 3, 0.126, 2.579,-99                 ,Gen rain-xs h'graph from sub-area DH route through next stor
4                                      ,Add the last stored h'graph to running h'graph.
7
Start of 4851
5, 3, 0.136, 1.287,-99                 ,Route running h'graph through next storage reach from DH1
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3                                         ,Store the current running hydrograph.
1, 2, 0.09, 1.389,-99                     ,Gen rain-xs h'graph from sub-area DI route through next stor
7
DI
4                                         ,Add the last stored h'graph to running h'graph.
5, 3, 0.126, 2.381,-99                    ,Route running h'graph through next storage reach from DH2
3                                         ,Store the current running hydrograph.
1, 2, 0.087, 5.172,-99                    ,Gen rain-xs h'graph from sub-area DJ route through next stor
5, 3, 0.102, 0.735,-99                    ,Route running h'graph through next storage reach from DJ1
7
DJ
4                                         ,Add the last stored h'graph to running h'graph.
3                                         ,Store the current running hydrograph.
1, 3, 0.392, 2.742,-99                    ,Gen rain-xs h'graph from sub-area DK route through next stor
7
DK
4                                         ,Add the last stored h'graph to running h'graph.
5, 3, 0.199, 2.01,-99                     ,Route running h'graph through next storage reach from DK1
3                                         ,Store the current running hydrograph.
1, 3, 0.261, 3.448,-99                    ,Gen rain-xs h'graph from sub-area DL route through next stor
7
DL1
4                                         ,Add the last stored h'graph to running h'graph.
5, 3, 0.084, 1.488,-99                    ,Route running h'graph through next storage reach from DL1
3                                         ,Store the current running hydrograph.
1, 3, 0.156, 3.686,-99                    ,Gen rain-xs h'graph from sub-area DM route through next stor
7
DM
4                                         ,Add the last stored h'graph to running h'graph.
5, 3, 0.187, 1.471,-99                    ,Route running h'graph through next storage reach from DM1
4                                         ,Add the last stored h'graph to running h'graph.
5, 3, 0.04, 0.273,-99                     ,Route running h'graph through next storage reach from DC2
3                                         ,Store the current running hydrograph.
1, 2, 0.066, 2.273,-99                    ,Gen rain-xs h'graph from sub-area DN route through next stor
5, 3, 0.241, 0.104,-99                    ,Route running h'graph through next storage reach from DN1
5, 3, 0.171, 4.386,-99                    ,Route running h'graph through next storage reach from DN2
3                                         ,Store the current running hydrograph.
1, 3, 0.14, 0.893,-99                     ,Gen rain-xs h'graph from sub-area DO route through next stor
4                                         ,Add the last stored h'graph to running h'graph.
5, 3, 0.152, 2.138,-99                    ,Route running h'graph through next storage reach from DO1
7
DC3
4                                         ,Add the last stored h'graph to running h'graph.
3                                         ,Store the current running hydrograph.
1, 3, 0.047, 1.596,-99                    ,Gen rain-xs h'graph from sub-area DP route through next stor
5, 3, 0.164, 2.439,-99                    ,Route running h'graph through next storage reach from DP1
5, 3, 0.083, 2.108,-99                    ,Route running h'graph through next storage reach from DP2
7
DP
4                                         ,Add the last stored h'graph to running h'graph.
5, 3, 0.051, 5.0,-99                      ,Route running h'graph through next storage reach from DC3
3                                         ,Store the current running hydrograph.
1, 2, 0.038, 5.263,-99                    ,Gen rain-xs h'graph from sub-area DQ route through next stor
7
DQ1
4                                         ,Add the last stored h'graph to running h'graph.
5, 3, 0.18, 0.2,-99                       ,Route running h'graph through next storage reach from DQ1
3                                         ,Store the current running hydrograph.
1, 2, 0.141, 2.482,-99                    ,Gen rain-xs h'graph from sub-area DS route through next stor
5, 2, 0.15, 2.0,-99                       ,Route running h'graph through next storage reach from DS1
7
DR1
4                                         ,Add the last stored h'graph to running h'graph.
3                                         ,Store the current running hydrograph.
1, 2, 0.076, 1.316,-99                    ,Gen rain-xs h'graph from sub-area DR route through next stor
7
DR
4                                         ,Add the last stored h'graph to running h'graph.
5, 3, 0.157, 0.2,-99                      ,Route running h'graph through next storage reach from DR1
7
Main Drain Outlet
3                                         ,Store the current running hydrograph.
1, 2, 0.085, 1.765,-99                    ,Gen rain-xs h'graph from sub-area DT route through next stor
7
DT
5, 3, 0.101, 0.345,-99                    ,Route running h'graph through next storage reach from DT1
3                                         ,Store the current running hydrograph.
1, 2, 0.17, 3.382,-99                     ,Gen rain-xs h'graph from sub-area DU route through next stor
7
DT2
4                                         ,Add the last stored h'graph to running h'graph.
5, 3, 0.031, 0.222,-99                    ,Route running h'graph through next storage reach from DT2
3                                         ,Store the current running hydrograph.
1, 2, 0.066, 1.515,-99                    ,Gen rain-xs h'graph from sub-area DV route through next stor
5, 2, 0.121, 0.62,-99                     ,Route running h'graph through next storage reach from DV1
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3                                       ,Store the current running hydrograph.
1, 2, 0.038, 3.289,-99                  ,Gen rain-xs h'graph from sub-area DW route through next stor
4                                       ,Add the last stored h'graph to running h'graph.
7
DW1
4                                       ,Add the last stored h'graph to running h'graph.
5, 3, 0.052, 0.385,-99                  ,Route running h'graph through next storage reach from DW1
3                                       ,Store the current running hydrograph.
1, 2, 0.187, 1.07,-99                   ,Gen rain-xs h'graph from sub-area DX route through next stor
7
DX1
5, 2, 0.124, 0.202,-99                  ,Route running h'graph through next storage reach from DX1
3                                       ,Store the current running hydrograph.
1, 3, 0.032, 2.344,-99                  ,Gen rain-xs h'graph from sub-area DY route through next stor
7
DY1
4                                       ,Add the last stored h'graph to running h'graph.
5, 3, 0.114, 2.193,-99                  ,Route running h'graph through next storage reach from DY1
4                                       ,Add the last stored h'graph to running h'graph.
3                                       ,Store the current running hydrograph.
1, 2, 0.209, 1.794,-99                  ,Gen rain-xs h'graph from sub-area DZ route through next stor
7
DY2
4                                       ,Add the last stored h'graph to running h'graph.
5, 3, 0.127, 0.787,-99                  ,Route running h'graph through next storage reach from DY2
7
Relief Drain Oulet
4                                       ,Add the last stored h'graph to running h'graph.
0
C Sub Area Data
C Areas, km**2, of subareas A,B....
0.117, 0.041, 0.076, 0.046, 0.123, 0.058, 0.025, 0.128,
0.114, 0.114, 0.091, 0.048, 0.047, 0.018, 0.031, 0.114,
0.149, 0.081, 0.056, 0.194, 0.03, 0.102, 0.13, 0.042,
0.058, 0.05, 0.021, 0.208, 0.055, 0.065, 0.118, 0.079,
0.111, 0.065, 0.259, 0.047, 0.116, 0.086, 0.058, 0.107,
0.106, 0.047, 0.069, 0.04, 0.076, 0.099, 0.221, 0.02,
0.123, 0.023, 0.035, 0.121, 0.115, 0.139, 0.167, 0.055,
0.114, 0.107, 0.112, 0.099, 0.09, 0.043, 0.092, 0.139,
0.074, 0.104, 0.061, 0.085, 0.081, 0.144, 0.122, 0.243,
0.044, 0.129, 0.11, 0.103, 0.155, 0.073, 0.039, 0.143,
0.079, 0.139, 0.099, 0.151, 0.081, 0.121, 0.034, 0.047,
0.058, 0.042, 0.041, 0.212, 0.05, 0.114, 0.08, 0.022,
0.046, 0.198, 0.092, 0.039, 0.109, 0.065, 0.26, 0.269,
0.029, 0.178, 0.053, 0.054, 0.108, 0.131, 0.131, 0.098,
0.063, 0.029, 0.045, 0.094, 0.091, 0.025, 0.036, 0.033,
0.008, 0.032, 0.03, 0.062, 0.014, 0.003, 0.004, 0.014,
0.004, 0.033, -99
C Impervious Area Flag
1
0.4, 0.235, 0.703, 0.108, 0.1, 0.456, 0.12, 0.455,
0.33, 0.498, 0.48, 0.485, 0.441, 0.368, 0.427, 0.47,
0.522, 0.529, 0.7, 0.567, 0.898, 0.663, 0.895, 0.236,
0.678, 0.608, 0.568, 0.696, 0.441, 0.485, 0.482, 0.566,
0.47, 0.47, 0.461, 0.504, 0.479, 0.478, 0.481, 0.542,
0.89, 0.551, 0.465, 0.683, 0.536, 0.464, 0.429, 0.366,
0.471, 0.397, 0.419, 0.481, 0.579, 0.486, 0.442, 0.337,
0.121, 0.1, 0.156, 0.154, 0.475, 0.485, 0.541, 0.472,
0.494, 0.487, 0.221, 0.475, 0.491, 0.482, 0.164, 0.493,
0.543, 0.486, 0.471, 0.399, 0.481, 0.457, 0.448, 0.474,
0.469, 0.458, 0.438, 0.417, 0.502, 0.507, 0.51, 0.345,
0.565, 0.568, 0.573, 0.531, 0.468, 0.441, 0.532, 0.525,
0.481, 0.467, 0.499, 0.367, 0.502, 0.372, 0.456, 0.499,
0.683, 0.408, 0.364, 0.482, 0.468, 0.766, 0.9, 0.567,
0.163, 0.381, 0.721, 0.489, 0.45, 0.485, 0.379, 0.524,
0.485, 0.446, 0.375, 0.452, 0.658, 0.7, 0.7, 0.69,
0.699, 0.401, -99
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Appendix A.7

Summary of Peak RORB Flows for PMP, 100, 50, 20, 10 and 5 year ARI Events

Murrumbeena Drain Catchment 4850
RORB Results Summary for Base Case Scenario

Drain	RORB Node	Flow Location	PMP Peak Flow (m^3/s)	PMP Critical Duration	100yr Peak Flow (m^3/s)	100yr Critical Duration	50yr Peak Flow (m^3/s)	50yr Critical Duration	20yr Peak Flow (m^3/s)	20yr Critical Duration	10yr Peak Flow (m^3/s)	10yr Critical Duration	5yr Peak Flow (m^3/s)	5yr Critical Duration
4854	BF2	BF2	22.77	15m	2.71	20m	2.09	2h	1.57	2h	1.13	2h	0.81	2h
4854	BM1	Start of 4854	51.56	45m	4.73	1h	3.71	1h	2.57	2h	1.75	2h	1.21	2h
4854	BM2	BM2	20.09	15m	3.05	15m	2.50	15m	1.89	15m	1.37	15m	0.95	15m
4854	BO	BO	16.74	15m	2.80	15m	2.28	15m	1.71	15m	1.20	15m	0.80	15m
4854	BO2	BO2	8.70	15m	1.43	15m	1.15	15m	0.84	15m	0.58	15m	0.42	15m
4854	BQ	BQ	7.85	15m	1.13	20m	0.90	20m	0.62	15m	0.47	2h	0.36	15m
4854	BR	BR	3.36	15m	0.56	15m	0.46	15m	0.34	15m	0.21	15m	0.14	15m
4852	AU1	Princes Hwy pipe flow	0.60	15m	0.60	10m	0.60	10m	0.60	10m	0.60	10m	0.60	10m
4852	AW2	Start of 4852	64.92	15m	8.51	20m	6.96	25m	5.22	25m	4.08	2h	3.30	25m
4852	AX4	AX4	33.58	15m	5.40	15m	4.34	20m	3.31	15m	2.49	15m	1.85	15m
4852	AY	AY	6.03	15m	1.15	15m	0.98	15m	0.84	15m	0.68	15m	0.57	15m
4852	AZ	AZ	15.31	15m	2.41	15m	1.96	15m	1.48	25m	1.15	25m	0.89	25m
4852	BD2	BD2	25.29	30m	2.64	1h	2.08	1h	1.50	2h	1.10	2h	0.83	2h
4852	BS	BS	4.08	15m	0.69	15m	0.59	15m	0.49	15m	0.38	15m	0.30	15m
4852	BT2	BT2	38.08	15m	6.96	15m	5.84	15m	4.57	15m	3.41	15m	2.66	15m
4852	BU2	BU2	10.18	15m	1.64	15m	1.29	15m	0.94	15m	0.68	15m	0.47	15m
4852	BV2	BV2	11.70	15m	1.92	15m	1.53	15m	1.09	15m	0.79	15m	0.57	15m
4852	BX	BX	23.44	15m	3.81	15m	3.24	15m	2.68	15m	2.05	15m	1.39	15m
4852	BW2	BW2	12.46	15m	1.81	15m	1.50	25m	1.11	25m	0.81	25m	0.60	25m
4852	BY	BY	20.03	15m	3.25	15m	2.62	15m	1.91	15m	1.29	15m	0.95	15m
4852	BZ	BZ	12.75	15m	2.10	15m	1.78	15m	1.45	15m	1.07	15m	0.71	15m
4852	BZ1	BZ1	0.76	6h	0.76	9h	0.76	6h	0.72	4.5h	0.73	9h	0.75	4.5h
4852	CC1	CC1	8.07	15m	1.27	15m	1.01	20m	0.72	15m	0.51	15m	0.40	15m
4852	CB2	CB2	50.37	15m	5.46	20m	4.23	2h	3.06	2h	2.06	2h	1.34	2h
4852	CD	CD	16.02	15m	2.76	15m	2.28	15m	1.78	15m	1.28	15m	0.83	15m
4852	CQ2	CQ2	10.34	15m	1.61	15m	1.32	15m	0.97	15m	0.67	15m	0.48	15m
4852	CK1	CK1	56.93	15m	9.34	15m	7.81	15m	6.10	15m	4.66	15m	3.51	15m
4852	CG2	CG2	18.75	15m	3.15	15m	2.54	20m	1.86	15m	1.43	15m	1.08	15m
4853	CK2	Start of 4853	75.18	15m	12.62	15m	10.39	15m	7.83	15m	5.71	15m	4.40	15m
4853	CM2	CM2	56.46	15m	8.53	15m	6.75	20m	4.82	15m	3.41	15m	2.59	15m
4853	CN	CN	3.90	15m	0.63	15m	0.53	15m	0.40	15m	0.25	15m	0.16	15m
4853	CO2	CO2	21.05	15m	3.10	15m	2.52	15m	1.86	15m	1.30	15m	0.97	15m
4853	CP	CP	4.24	15m	0.68	15m	0.55	15m	0.40	15m	0.24	15m	0.18	15m
4853	CQ1	CQ1	6.65	15m	1.12	15m	0.93	15m	0.73	15m	0.48	15m	0.30	15m
4853	CR	CR	24.31	15m	3.91	15m	3.26	15m	2.77	15m	2.18	15m	1.53	15m
4853	CS	CS	21.19	15m	3.73	15m	3.09	15m	2.39	15m	1.80	15m	1.35	15m
4853	HI	HI	46.06	15m	6.12	25m	4.85	25m	3.29	2h	2.53	2h	1.94	2h
4850	C2	Start of 4850	34.08	45m	2.90	1h	2.20	2h	1.41	2h	0.90	4.5h	0.59	2h
4850	H	H	17.79	15m	2.91	15m	2.47	15m	2.03	15m	1.52	15m	1.02	15m
4850	I	I	8.64	15m	1.40	15m	1.15	15m	0.98	15m	0.78	15m	0.55	15m
4850	J1	J1	14.60	15m	2.16	20m	1.75	20m	1.25	15m	0.95	2h	0.75	15m
4850	L3	L3	27.95	15m	3.40	25m	2.75	2h	2.09	2h	1.53	2h	1.11	2h
4850	M1	M1	19.40	15m	3.37	15m	2.81	15m	2.23	15m	1.64	15m	1.08	15m
4850	M2	M2	18.67	15m	2.32	25m	1.84	25m	1.31	2h	0.94	2h	0.69	2h
4850	N	N	15.54	15m	2.64	15m	2.22	15m	1.79	15m	1.35	15m	0.90	15m
4850	S	S	28.86	15m	4.60	15m	3.93	15m	3.30	15m	2.56	15m	1.76	15m
4850	S2	S2	34.91	15m	4.12	2h	3.31	2h	2.45	2h	1.79	2h	1.32	2h
4850	S3	S3	6.04	15m	0.82	25m	0.67	25m	0.51	2h	0.39	2h	0.30	2h
4850	U	U	25.76	15m	4.15	15m	3.54	15m	2.95	15m	2.29	15m	1.57	15m
4850	V	V	19.39	15m	3.08	15m	2.46	15m	1.77	15m	1.19	15m	0.93	15m
4850	W	W	18.98	15m	3.05	15m	2.46	15m	1.79	15m	1.10	15m	0.82	15m
4850	X	X	28.88	15m	4.98	15m	4.13	15m	3.22	15m	2.33	15m	1.51	15m
4850	Y	Y	14.49	15m	2.35	15m	1.99	15m	1.64	15m	1.20	15m	0.80	15m
4850	Z	Z	7.28	15m	1.25	15m	1.04	15m	0.82	15m	0.56	15m	0.36	15m
4850	AB2	AB2	27.99	15m	3.38	1.5h	2.75	1.5h	2.08	2h	1.54	2h	1.14	2h
4850	AD2	AD2	33.56	15m	4.41	20m	3.54	2h	2.70	2h	1.99	2h	1.47	2h
4850	AE	AE	28.56	15m	4.83	15m	3.91	15m	2.85	15m	1.82	15m	1.32	15m
4850	AF	AF	16.24	15m	2.71	15m	2.18	15m	1.82	15m	1.48	15m	1.09	15m
4850	AF2	AF2	20.06	15m	2.99	15m	2.40	15m	1.72	15m	1.25	25m	0.93	15m
4850	AH	AH	6.79	15m	1.11	10m	0.94	15m	0.78	15m	0.62	15m	0.44	15m
4850	AI1	AI1	8.70	15m	1.37	15m	1.10	15m	0.75	15m	0.47	2h	0.35	15m
4850	AP2	AP2	59.36	15m	3.69	1h	2.23	25m	1.42	15m	1.05	15m	0.75	15m
4850	AP3	4850 Branch (AP3)	59.25	15m	3.70	1h	2.26	25m	1.44	15m	1.04	15m	0.73	15m
4850	AQ1	AQ1	4.41	15m	0.72	10m	0.60	15m	0.51	15m	0.41	15m	0.30	15m
4850	AR	AR	8.83	15m	1.49	15m	1.26	15m	1.01	15m	0.75	15m	0.50	15m
4850	AR2	AR2	2.42	6h	2.21	3h	2.22	3h	2.10	1h	2.05	2h	1.59	1h
4850	CT	CT	32.61	15m	4.64	25m	3.82	25m	2.67	25m	1.84	25m	1.40	25m
4850	CU2	CU2	18.12	15m	4.24	2h	3.70	2h	2.95	2h	2.14	2h	1.56	2h
4850	CV1	CV1	7.83	15m	1.21	15m	1.03	15m	0.84	15m	0.57	15m	0.37	15m
4850	CX2	CX2	27.73	15m	3.78	15m	3.05	25m	2.19	25m	1.57	2h	1.19	25m
4850	CZ	CZ	48.41	15m	8.24	15m	6.81	15m	5.25	15m	3.63	15m	2.29	15m
4850	CY	CY	47.37	15m	7.27	15m	6.00	15m	4.57	15m	3.32	15m	2.26	15m
4850	CY4	CY4	5.16	15m	0.88	15m	0.72	15m	0.57	15m	0.44	15m	0.35	15m
4850	DB	DB	34.95	15m	5.69	15m	4.79	15m	3.87	15m	2.55	15m	1.60	15m
4850	DC	DC	10.52	15m	1.68	15m	1.42	15m	1.10	15m	0.70	15m	0.43	15m
4851	DH1	Start of 4851	77.84	15m	11.74	15m	9.54	15m	7.07	15m	5.55	2h	4.46	15m
4851	DI	DI	11.49	15m	1.54	15m	1.11	15m	0.71	2h	0.50	2h	0.35	2h
4851	DJ	DJ	5.28	15m	0.77	20m	0.62	15m	0.46	15m	0.30	15m	0.22	15m
4851	DK	DK	8.20	15m	1.52	15m	1.27	15m	1.02	15m	0.80	15m	0.63	15m
4851	DL1	DL1	17.99	15m	3.06	15m	2.57	15m	2.07	15m	1.56	15m	1.04	15m
4851	DM	DM	18.23	15m	2.90	15m	2.47	15m	2.07	15m	1.51	15m	1.02	15m
4851	DC3	DC3	8.74	15m	1.26	20m	0.98	15m	0.71	15m	0.52	2h	0.39	15m
4851	DP	DP	6.34	15m	1.13	15m	0.93	15m	0.69	15m	0.49	15m	0.37	15m
4851	DQ1	DQ1	1.56	15m	0.26	15m	0.22	15m	0.18	15m	0.13	15m	0.09	15m
4851	DR1	DR1	4.92	15m	0.67	25m	0.53	25m	0.36	25m	0.27	2h	0.21	25m
4851	DR	DR	5.48	15m	0.85	15m	0.68	15m	0.47	15m	0.30	2h	0.23	15m
4850	DR2	Main Drain Outlet	934.00	45m	105.29	1h	84.24	1h	61.03	2h	44.87	2h	34.05	2h
4850	DT	DT	11.42	15m	1.89	15m	1.54	15m	1.14	15m	0.77	15m	0.53	15m
4850	DT2	DT2	2.25	15m	0.36	15m	0.30	20m	0.22	20m	0.17	20m	0.13	20m
4850	DW1	DW1	1.02	15m	0.18	15m	0.15	15m	0.12	15m	0.09	15m	0.07	15m
4850	DX1	DX1	2.01	15m	0.31	15m	0.25	15m	0.19	15m	0.15	2h	0.12	15m
4850	DY1	DY1	0.80	15m	0.14	15m	0.12	15m	0.10	15m	0.08	15m	0.06	15m
4850	DY2	DY2	5.04	15m	0.66	20m	0.51	15m	0.38	2h	0.28	2h	0.21	2h
4850	DY3	Relief Drain Outlet	20.76	15m	3.03	25m	2.48	25m	1.76	25m	1.24	25m	0.95	25m

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Murrumbeena Drain Catchment 4850
RORB Results Summary for Redevelopment Scenario

			PMP		100yr		50yr		20yr		10yr		5yr	
Drain	RORB Node	Flow Location	Peak Flow (m^3/s)	Critical Duration	Peak Flow (m^3/s)	Critical Duration	Peak Flow (m^3/s)	Critical Duration	Peak Flow (m^3/s)	Critical Duration	Peak Flow (m^3/s)	Critical Duration	Peak Flow (m^3/s)	Critical Duration
4854	BF2	BF2	22.77	15m	3.03	20m	2.39	20m	1.76	2h	1.33	20m	1.02	2h
4854	BM1	Start of 4854	51.58	45m	5.10	1h	4.14	2h	3.14	2h	2.35	2h	1.77	2h
4854	BM2	BM2	20.10	15m	3.58	15m	2.98	15m	2.34	15m	1.87	15m	1.51	15m
4854	BO	BO	16.75	15m	3.14	15m	2.65	15m	2.15	15m	1.70	15m	1.35	15m
4854	BO2	BO2	8.70	15m	1.62	15m	1.36	15m	1.09	15m	0.86	15m	0.68	15m
4854	BQ	BQ	7.85	15m	1.31	15m	1.07	15m	0.80	15m	0.61	15m	0.46	15m
4854	BR	BR	3.36	15m	0.62	15m	0.52	15m	0.42	15m	0.33	15m	0.27	15m
4852	AU1	Princes Hwy pipe flow	0.60	15m	0.60	10m	0.60	10m	0.60	10m	0.60	10m	0.60	10m
4852	AW2	Start of 4852	64.95	15m	10.07	20m	8.38	20m	6.43	15m	5.10	20m	4.24	25m
4852	AX4	AX4	33.59	15m	6.03	15m	5.03	15m	3.90	15m	3.09	15m	2.50	15m
4852	AY	AY	6.03	15m	1.15	15m	0.98	15m	0.84	15m	0.68	15m	0.57	15m
4852	AZ	AZ	15.31	15m	2.56	15m	2.12	15m	1.64	15m	1.26	15m	1.01	25m
4852	BD2	BD2	25.29	30m	2.76	1h	2.21	1h	1.63	2h	1.23	1h	0.96	2h
4852	BS	BS	4.08	15m	0.74	15m	0.63	15m	0.52	15m	0.42	15m	0.34	15m
4852	BT2	BT2	38.08	15m	7.18	15m	6.07	15m	4.86	15m	3.86	15m	3.11	15m
4852	BU2	BU2	10.18	15m	1.86	15m	1.56	15m	1.20	15m	0.89	15m	0.69	15m
4852	BV2	BV2	11.71	15m	2.16	15m	1.81	15m	1.44	15m	1.11	15m	0.86	15m
4852	BX	BX	23.45	15m	4.09	15m	3.44	15m	2.86	15m	2.32	15m	1.92	15m
4852	BW2	BW2	12.46	15m	2.04	15m	1.68	15m	1.29	25m	1.01	15m	0.80	25m
4852	BY	BY	20.03	15m	3.69	15m	3.09	15m	2.46	15m	1.90	15m	1.49	15m
4852	BZ	BZ	12.76	15m	2.27	15m	1.91	15m	1.58	15m	1.28	15m	1.05	15m
4852	BZ1	BZ1	0.76	6h	0.76	9h	0.75	9h	0.74	6h	0.72	9h	0.73	9h
4852	CC1	CC1	8.07	15m	1.45	15m	1.21	15m	0.95	15m	0.73	15m	0.56	15m
4852	CB2	CB2	50.39	15m	6.59	20m	5.25	20m	3.81	2h	2.86	20m	2.16	2h
4852	CD	CD	16.03	15m	3.01	15m	2.54	15m	2.09	15m	1.66	15m	1.34	15m
4852	CQ2	CQ2	10.35	15m	1.80	15m	1.53	15m	1.24	15m	0.98	15m	0.78	15m
4852	CK1	CK1	56.94	15m	9.81	15m	8.20	15m	6.53	15m	5.14	15m	4.08	15m
4852	CG2	CG2	18.75	15m	3.38	15m	2.83	15m	2.22	15m	1.74	15m	1.35	15m
4853	CK2	Start of 4853	75.20	15m	13.25	15m	11.08	15m	8.66	15m	6.68	15m	5.20	15m
4853	CM2	CM2	56.48	15m	9.88	15m	8.18	15m	6.28	15m	4.68	15m	3.61	20m
4853	CN	CN	3.90	15m	0.64	15m	0.54	15m	0.43	15m	0.28	15m	0.18	15m
4853	CO2	CO2	21.05	15m	3.54	15m	2.92	15m	2.31	15m	1.80	15m	1.41	15m
4853	CP	CP	4.24	15m	0.80	15m	0.67	15m	0.55	15m	0.43	15m	0.35	15m
4853	CQ1	CQ1	6.65	15m	1.27	15m	1.08	15m	0.90	15m	0.73	15m	0.60	15m
4853	CR	CR	24.32	15m	4.24	15m	3.62	15m	2.95	15m	2.37	15m	1.99	15m
4853	CS	CS	21.19	15m	4.05	15m	3.43	15m	2.81	15m	2.25	15m	1.83	15m
4853	HI	HI	46.08	15m	6.85	25m	5.67	25m	4.22	25m	3.12	25m	2.45	2h
4850	C2	Start of 4850	34.08	45m	2.96	1h	2.25	2h	1.47	2h	0.94	2h	0.62	9h
4850	H	H	17.79	15m	3.16	15m	2.66	15m	2.21	15m	1.78	15m	1.48	15m
4850	I	I	8.64	15m	1.52	15m	1.29	15m	1.06	15m	0.86	15m	0.71	15m
4850	J1	J1	14.61	15m	2.49	15m	2.06	15m	1.58	15m	1.24	15m	0.99	15m
4850	L3	L3	27.96	15m	3.92	25m	3.25	25m	2.52	2h	1.99	25m	1.60	2h
4850	M1	M1	19.41	15m	3.70	15m	3.13	15m	2.59	15m	2.07	15m	1.70	15m
4850	M2	M2	18.68	15m	2.58	25m	2.12	25m	1.59	25m	1.21	25m	0.95	25m
4850	N	N	15.55	15m	2.90	15m	2.46	15m	2.05	15m	1.64	15m	1.35	15m
4850	S	S	28.87	15m	5.17	15m	4.36	15m	3.65	15m	2.92	15m	2.42	15m
4850	S2	S2	34.92	15m	4.75	25m	3.88	25m	2.95	2h	2.27	25m	1.80	2h
4850	S3	S3	6.05	15m	0.96	15m	0.79	15m	0.61	15m	0.48	15m	0.39	2h
4850	U	U	25.77	15m	4.58	15m	3.87	15m	3.23	15m	2.58	15m	2.15	15m
4850	V	V	19.40	15m	3.49	15m	2.90	15m	2.26	15m	1.71	15m	1.31	15m
4850	W	W	18.99	15m	3.39	15m	2.82	15m	2.21	15m	1.68	15m	1.28	15m
4850	X	X	28.89	15m	5.45	15m	4.61	15m	3.79	15m	3.02	15m	2.44	15m
4850	Y	Y	14.49	15m	2.52	15m	2.12	15m	1.77	15m	1.43	15m	1.18	15m
4850	Z	Z	7.29	15m	1.35	15m	1.13	15m	0.93	15m	0.74	15m	0.59	15m
4850	AB2	AB2	28.00	15m	4.01	25m	3.28	25m	2.53	1.5h	1.99	25m	1.60	2h
4850	AD2	AD2	33.57	15m	5.11	20m	4.18	20m	3.19	2h	2.52	20m	2.02	2h
4850	AE	AE	28.57	15m	5.23	15m	4.42	15m	3.48	15m	2.64	15m	2.00	15m
4850	AF	AF	16.25	15m	2.84	15m	2.44	15m	1.99	15m	1.62	15m	1.31	15m
4850	AF2	AF2	20.07	15m	3.39	15m	2.83	15m	2.21	15m	1.70	15m	1.32	15m
4850	AH	AH	6.79	15m	1.20	15m	1.01	15m	0.84	15m	0.68	15m	0.56	15m
4850	AI1	AI1	8.70	15m	1.48	15m	1.22	15m	0.93	15m	0.67	15m	0.43	15m
4850	AP2	AP2	59.39	15m	4.98	25m	3.41	25m	1.95	25m	1.41	25m	1.12	15m
4850	AP3	4850 Branch (AP3)	59.29	15m	4.97	25m	3.42	1h	1.96	25m	1.45	1h	1.15	15m
4850	AQ1	AQ1	4.41	15m	0.80	15m	0.68	15m	0.57	15m	0.46	15m	0.38	15m
4850	AR	AR	8.83	15m	1.64	15m	1.38	15m	1.15	15m	0.92	15m	0.76	15m
4850	AR2	AR2	2.42	6h	2.16	4.5h	2.16	3h	2.10	1h	2.10	3h	2.08	2h
4850	CT	CT	32.62	15m	5.52	15m	4.56	15m	3.46	15m	2.69	15m	2.15	25m
4850	CU2	CU2	18.12	15m	4.57	1.5h	4.14	1.5h	3.52	2h	2.91	1.5h	2.34	2h
4850	CV1	CV1	7.84	15m	1.37	15m	1.11	15m	0.90	15m	0.73	15m	0.60	15m
4850	CX2	CX2	27.74	15m	4.39	15m	3.60	15m	2.70	15m	2.07	15m	1.62	25m
4850	CZ	CZ	48.43	15m	9.22	15m	7.80	15m	6.43	15m	5.14	15m	4.17	15m
4850	CY	CY	47.38	15m	8.21	15m	6.79	15m	5.41	15m	4.26	15m	3.38	15m
4850	CY4	CY4	5.16	15m	0.90	15m	0.75	15m	0.59	15m	0.47	15m	0.38	15m
4850	DB	DB	34.96	15m	5.91	15m	5.00	15m	4.17	15m	3.31	15m	2.67	15m
4850	DC	DC	10.53	15m	1.72	15m	1.47	15m	1.22	15m	0.97	15m	0.70	15m
4851	DH1	Start of 4851	77.86	15m	12.89	15m	10.76	15m	8.36	15m	6.53	15m	5.20	2h
4851	DI	DI	11.49	15m	1.60	15m	1.22	15m	0.75	2h	0.54	15m	0.38	2h
4851	DJ	DJ	5.28	15m	0.87	15m	0.68	20m	0.52	15m	0.39	20m	0.28	15m
4851	DK	DK	8.20	15m	1.59	15m	1.35	15m	1.11	15m	0.89	15m	0.73	15m
4851	DL1	DL1	18.00	15m	3.33	15m	2.82	15m	2.33	15m	1.87	15m	1.53	15m
4851	DM	DM	18.24	15m	3.14	15m	2.67	15m	2.19	15m	1.79	15m	1.49	15m
4851	DC3	DC3	8.74	15m	1.44	20m	1.18	20m	0.88	15m	0.67	20m	0.50	2h
4851	DP	DP	6.34	15m	1.18	15m	1.01	15m	0.83	15m	0.64	15m	0.50	15m
4851	DQ1	DQ1	1.56	15m	0.28	15m	0.23	15m	0.19	15m	0.16	15m	0.13	15m
4851	DR1	DR1	4.92	15m	0.76	25m	0.63	25m	0.48	25m	0.37	25m	0.29	25m
4851	DR	DR	5.48	15m	0.94	15m	0.77	15m	0.59	15m	0.43	15m	0.30	15m
4850	DR2	Main Drain Outlet	934.60	45m	120.75	1h	99.81	1h	74.58	1h	58.14	1h	46.39	2h
4850	DT	DT	11.43	15m	2.08	15m	1.74	15m	1.39	15m	1.07	15m	0.83	15m
4850	DT2	DT2	2.25	15m	0.36	15m	0.30	20m	0.22	15m	0.17	20m	0.13	2h
4850	DW1	DW1	1.02	15m	0.18	15m	0.15	15m	0.12	15m	0.09	15m	0.07	15m
4850	DX1	DX1	2.01	15m	0.31	15m	0.25	15m	0.19	15m	0.15	15m	0.12	2h
4850	DY1	DY1	0.80	15m	0.14	15m	0.12	15m	0.10	15m	0.08	15m	0.06	15m
4850	DY2	DY2	5.04	15m	0.66	20m	0.51	15m	0.38	2h	0.28	15m	0.21	2h
4850	DY3	Relief Drain Outlet	20.77	15m	3.29	15m	2.66	15m	1.99	25m	1.51	15m	1.13	25m

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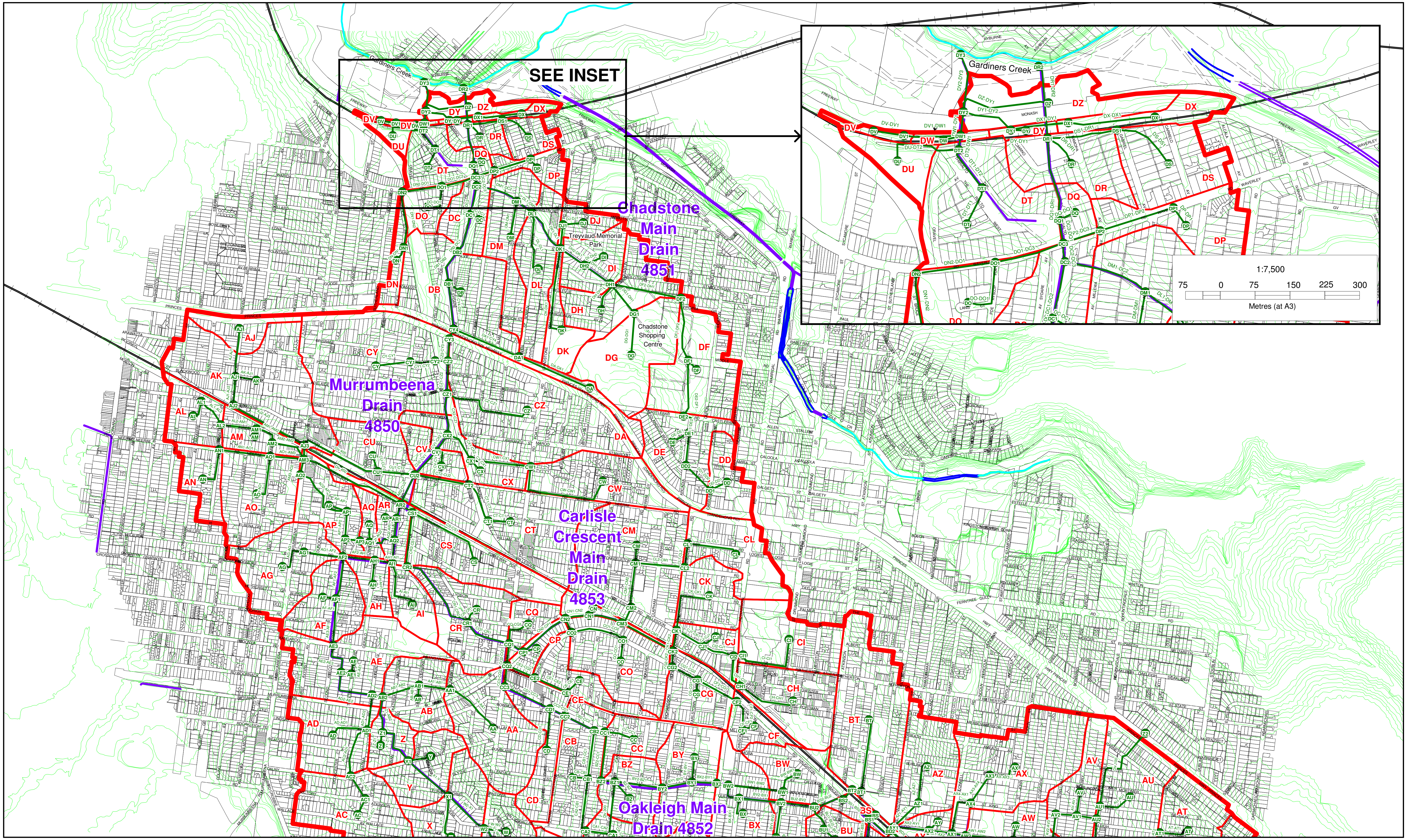
Murrumbeena Drain Catchment 4850
RORB Results Summary for Climate Change Scenario

Drain	RORB Node	Flow Location	100yr		50yr		20yr		10yr		5yr	
			Peak Flow (m^3/s)	Critical Duration	Peak Flow (m^3/s)	Critical Duration	Peak Flow (m^3/s)	Critical Duration	Peak Flow (m^3/s)	Critical Duration	Peak Flow (m^3/s)	Critical Duration
4854	BF2	BF2	3.91	20m	3.07	20m	2.14	2h	1.57	20m	1.16	2h
4854	BM1	Start of 4854	6.73	1h	5.34	1h	3.75	2h	2.64	1h	1.85	2h
4854	BM2	BM2	4.26	15m	3.43	15m	2.59	15m	1.94	15m	1.45	15m
4854	BO	BO	3.76	15m	3.10	15m	2.37	15m	1.75	15m	1.29	15m
4854	BO2	BO2	1.94	15m	1.60	15m	1.20	15m	0.87	15m	0.63	15m
4854	BQ	BQ	1.59	15m	1.26	15m	0.90	20m	0.63	15m	0.48	2h
4854	BR	BR	0.73	15m	0.61	15m	0.47	15m	0.35	15m	0.23	15m
4852	AU1	Princes Hwy pipe flow	0.60	10m	0.60	10m	0.60	10m	0.60	10m	0.60	10m
4852	AW2	Start of 4852	11.92	20m	9.63	20m	7.04	25m	5.43	20m	4.26	2h
4852	AX4	AX4	7.42	15m	6.07	15m	4.49	15m	3.43	15m	2.64	15m
4852	AY	AY	1.54	10m	1.31	15m	1.12	15m	0.91	15m	0.76	15m
4852	AZ	AZ	3.32	15m	2.73	15m	2.08	15m	1.57	15m	1.24	25m
4852	BD2	BD2	3.95	1h	3.12	1h	2.18	1h	1.59	1h	1.19	2h
4852	BS	BS	0.92	15m	0.77	15m	0.63	15m	0.50	15m	0.40	15m
4852	BT2	BT2	9.25	15m	7.79	15m	6.17	15m	4.84	15m	3.77	15m
4852	BU2	BU2	2.29	15m	1.85	15m	1.32	15m	0.94	15m	0.72	15m
4852	BV2	BV2	2.62	15m	2.15	15m	1.58	15m	1.13	15m	0.82	15m
4852	BX	BX	4.99	15m	4.12	15m	3.40	15m	2.67	15m	2.12	15m
4852	BW2	BW2	2.55	15m	2.06	15m	1.54	25m	1.17	15m	0.88	25m
4852	BY	BY	4.43	15m	3.62	15m	2.71	15m	1.96	15m	1.41	15m
4852	BZ	BZ	2.72	15m	2.27	15m	1.86	15m	1.45	15m	1.13	15m
4852	BZ1	BZ1	0.75	9h	0.76	9h	0.75	6h	0.71	9h	0.73	9h
4852	CC1	CC1	1.76	15m	1.43	15m	1.05	15m	0.75	15m	0.54	15m
4852	CB2	CB2	8.09	25m	6.28	20m	4.46	2h	3.17	20m	2.21	2h
4852	CD	CD	3.63	15m	3.02	15m	2.38	15m	1.80	15m	1.36	15m
4852	CQ2	CQ2	2.15	15m	1.78	15m	1.36	15m	1.00	15m	0.73	15m
4852	CK1	CK1	12.81	15m	10.50	15m	8.23	15m	6.40	15m	5.02	15m
4852	CG2	CG2	4.28	15m	3.53	15m	2.64	15m	1.96	15m	1.51	15m
4853	CK2	Start of 4853	16.90	15m	14.10	15m	10.92	15m	8.25	15m	6.25	15m
4853	CM2	CM2	12.03	15m	9.62	15m	6.86	15m	4.87	15m	3.61	15m
4853	CN	CN	0.81	15m	0.68	15m	0.54	15m	0.41	15m	0.28	15m
4853	CO2	CO2	4.28	15m	3.44	15m	2.60	15m	1.91	15m	1.40	15m
4853	CP	CP	0.92	15m	0.75	15m	0.56	15m	0.40	15m	0.27	15m
4853	CQ1	CQ1	1.44	15m	1.21	15m	0.96	15m	0.73	15m	0.53	15m
4853	CR	CR	5.31	15m	4.44	15m	3.44	15m	2.73	15m	2.21	15m
4853	CS	CS	4.96	15m	4.14	15m	3.27	15m	2.49	15m	1.91	15m
4853	HI	HI	8.42	25m	6.86	25m	4.89	25m	3.37	25m	2.61	2h
4850	C2	Start of 4850	4.25	2h	3.25	2h	2.12	2h	1.34	2h	0.85	4.5h
4850	H	H	3.76	15m	3.14	15m	2.58	15m	2.02	15m	1.59	15m
4850	I	I	1.89	15m	1.59	15m	1.22	15m	0.97	15m	0.79	15m
4850	J1	J1	2.98	15m	2.42	20m	1.77	20m	1.31	20m	1.01	2h
4850	L3	L3	4.71	25m	3.82	25m	2.89	2h	2.16	25m	1.62	2h
4850	M1	M1	4.42	15m	3.67	15m	2.94	15m	2.25	15m	1.73	15m
4850	M2	M2	3.24	25m	2.60	25m	1.85	25m	1.34	25m	0.98	2h
4850	N	N	3.44	15m	2.86	15m	2.33	15m	1.80	15m	1.40	15m
4850	S	S	6.21	15m	5.17	15m	4.14	15m	3.27	15m	2.62	15m
4850	S2	S2	5.86	25m	4.70	2h	3.47	2h	2.53	2h	1.88	2h
4850	S3	S3	1.15	15m	0.93	15m	0.69	2h	0.53	15m	0.41	2h
4850	U	U	5.51	15m	4.59	15m	3.72	15m	2.93	15m	2.34	15m
4850	V	V	4.26	15m	3.46	15m	2.55	15m	1.82	15m	1.30	15m
4850	W	W	4.12	15m	3.36	15m	2.52	15m	1.81	15m	1.22	15m
4850	X	X	6.55	15m	5.44	15m	4.31	15m	3.26	15m	2.47	15m
4850	Y	Y	3.07	15m	2.53	15m	2.08	15m	1.63	15m	1.28	15m
4850	Z	Z	1.63	15m	1.36	15m	1.08	15m	0.82	15m	0.62	15m
4850	AB2	AB2	4.82	25m	3.83	25m	2.85	2h	2.15	25m	1.62	2h
4850	AD2	AD2	6.20	20m	4.95	20m	3.70	2h	2.77	20m	2.08	2h
4850	AE	AE	6.46	15m	5.31	15m	4.01	15m	2.89	15m	1.97	15m
4850	AF	AF	3.57	15m	3.05	15m	2.28	15m	1.81	15m	1.47	15m
4850	AF2	AF2	4.11	15m	3.36	15m	2.49	15m	1.79	15m	1.33	25m
4850	AH	AH	1.46	15m	1.23	15m	0.99	15m	0.78	15m	0.63	15m
4850	AI1	AI1	1.85	15m	1.50	15m	1.12	15m	0.79	15m	0.49	15m
4850	AP2	AP2	6.73	1h	4.71	1h	2.46	2h	1.46	1h	1.11	15m
4850	AP3	4850 Branch (AP3)	6.77	1h	4.73	1h	2.47	2h	1.49	1h	1.11	15m
4850	AQ1	AQ1	0.95	15m	0.81	15m	0.64	15m	0.51	15m	0.41	15m
4850	AR	AR	1.95	15m	1.62	15m	1.31	15m	1.01	15m	0.79	15m
4850	AR2	AR2	2.16	6h	2.17	3h	2.24	3h	2.10	3h	2.07	2h
4850	CT	CT	6.57	15m	5.23	15m	3.85	25m	2.77	15m	1.98	25m
4850	CU2	CU2	5.10	1.5h	4.54	1.5h	3.87	2h	3.06	1.5h	2.33	2h
4850	CV1	CV1	1.63	15m	1.29	15m	1.06	15m	0.83	15m	0.60	15m
4850	CX2	CX2	5.34	15m	4.28	15m	3.07	25m	2.25	15m	1.63	25m
4850	CZ	CZ	10.87	15m	9.01	15m	7.06	15m	5.29	15m	3.96	15m
4850	CY	CY	10.10	15m	8.15	15m	6.22	15m	4.67	15m	3.51	15m
4850	CY4	CY4	1.20	15m	0.99	15m	0.76	15m	0.60	15m	0.48	15m
4850	DB	DB	7.26	15m	6.11	15m	4.94	15m	3.79	15m	2.77	15m
4850	DC	DC	2.13	15m	1.79	15m	1.45	15m	1.11	15m	0.76	15m
4851	DH1	Start of 4851	16.26	15m	13.38	15m	10.10	15m	7.63	15m	6.04	2h
4851	DI	DI	2.17	15m	1.69	15m	1.10	15m	0.66	15m	0.46	2h
4851	DJ	DJ	1.11	15m	0.87	15m	0.62	15m	0.46	15m	0.32	15m
4851	DK	DK	2.02	15m	1.70	15m	1.37	15m	1.08	15m	0.87	15m
4851	DL1	DL1	3.99	15m	3.32	15m	2.69	15m	2.08	15m	1.62	15m
4851	DM	DM	3.91	15m	3.19	10m	2.58	15m	2.03	10m	1.62	15m
4851	DC3	DC3	1.74	20m	1.40	20m	0.99	15m	0.72	20m	0.53	2h
4851	DP	DP	1.48	15m	1.25	15m	0.97	15m	0.72	15m	0.53	15m
4851	DQ1	DQ1	0.34	15m	0.28	15m	0.23	15m	0.18	15m	0.14	15m
4851	DR1	DR1	0.91	25m	0.74	25m	0.54	25m	0.38	25m	0.28	2h
4851	DR	DR	1.17	15m	0.94	15m	0.69	15m	0.49	15m	0.31	15m
4850	DR2	Main Drain Outlet	148.04	1h	120.02	1h	85.48	2h	63.84	1h	48.09	2h
4850	DT	DT	2.54	15m	2.09	15m	1.59	15m	1.16	15m	0.85	15m
4850	DT2	DT2	0.50	15m	0.41	15m	0.31	15m	0.23	15m	0.18	15m
4850	DW1	DW1	0.24	15m	0.20	15m	0.16	15m	0.12	15m	0.10	15m
4850	DX1	DX1	0.43	20m	0.35	15m	0.27	15m	0.21	15m	0.16	2h
4850	DY1	DY1	0.18	15m	0.15	15m	0.13	15m	0.10	15m	0.08	15m
4850	DY2	DY2	0.93	20m	0.74	20m	0.52	2h	0.39	20m	0.29	2h
4850	DY3	Relief Drain Outlet	4.30	15m	3.42	15m	2.52	25m	1.83	15m	1.33	25m

Appendix A.8

RORB Model Layout (2 sheets at 1:15,000 scale)



This data should be read in conjunction with the latest revision of the Report entitled "Murrumbeena Drain Catchment Flood Mapping" (Document Number 31/23394/162167) and is subject to the assumptions and qualifications contained therein. If the report is yet to be released, these assumptions and qualifications must be confirmed by reference to GHD Pty Ltd.

1:15,000

150 0 150 300 450 600

Metres (at A3)

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid Of Australia, Zone 55

N W E S

LEGEND

- Catchment Boundary
- Subcatchment Boundaries
- RORB Model Nodes
- RORB Model Reaches
- Melbourne Water Underground Drains
- Melbourne Water Open Channels
- Melbourne Water Natural Waterways
- Ground Contours (1 m interval)
- Property Boundaries
- Easements

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Murrumbeena Drain Catchment
Flood Mapping

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RORB Network Layout
Sheet 1 of 2

Figure A-1

G:\31\23394\CADD\GIS\Mapinfo\Murrumbeena RORB A3 Figure.WOR

Data source: Cadastre, road names, drainage locations, contours supplied by Melbourne Water September 2008. Created by: KEW

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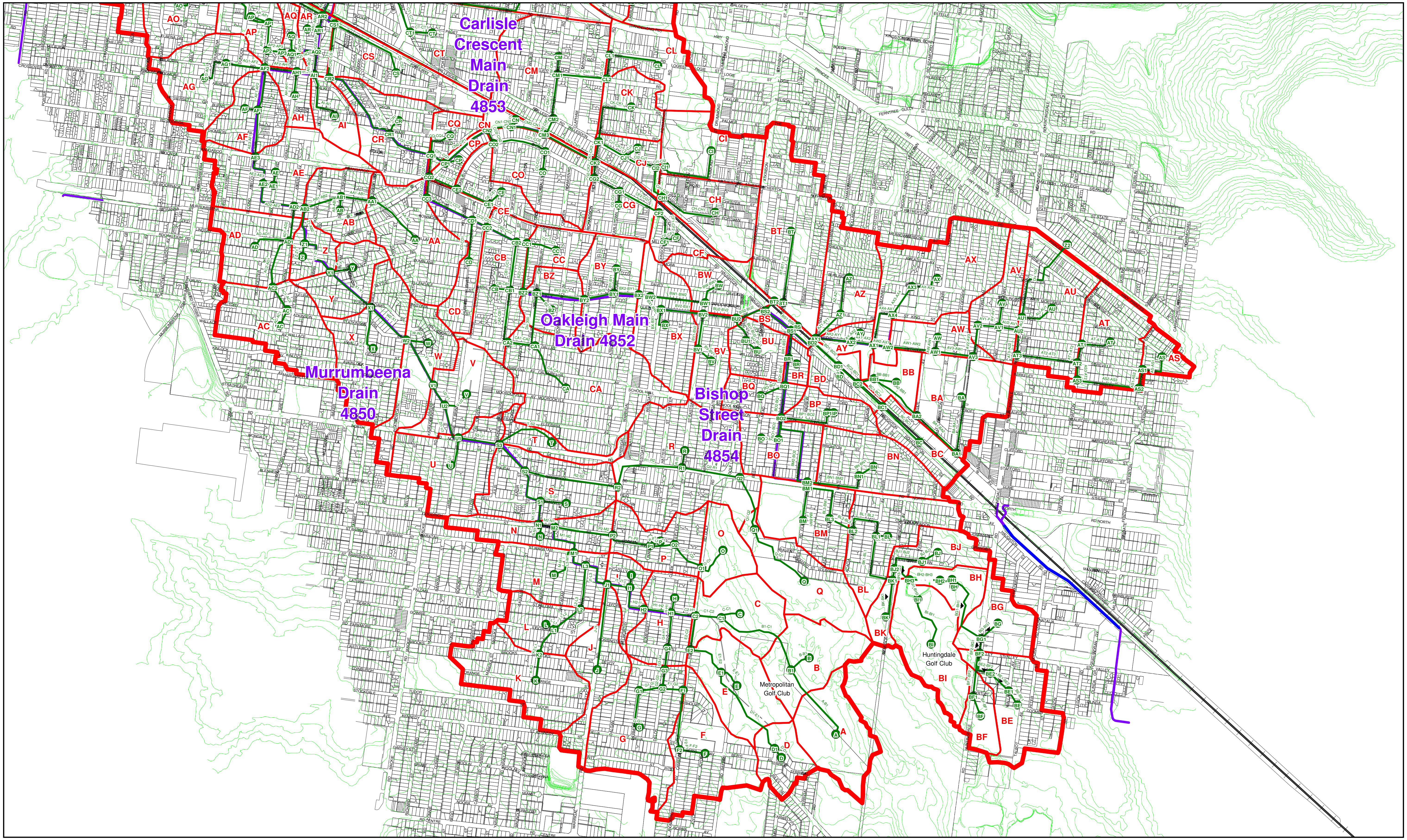

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1:15,000

150 0 150 300 450 600

Metres (at A3)

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid Of Australia, Zone 55

N W E S

LEGEND

- Catchment Boundary
- Subcatchment Boundaries
- RORB Model Nodes
- RORB Model Reaches
- Melbourne Water Underground Drains
- Melbourne Water Open Channels
- Melbourne Water Natural Waterways
- Ground Contours (1 m interval)
- Property Boundaries
- Easements

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RORB Network Layout
Sheet 2 of 2

Figure A-2

G:\31\23394\CADD\GIS\Mapinfo\Murrumbeena RORB A3 Figure.WOR

Data source: Cadastre, road names, drainage locations, contours supplied by Melbourne Water September 2008. Created by: KEW

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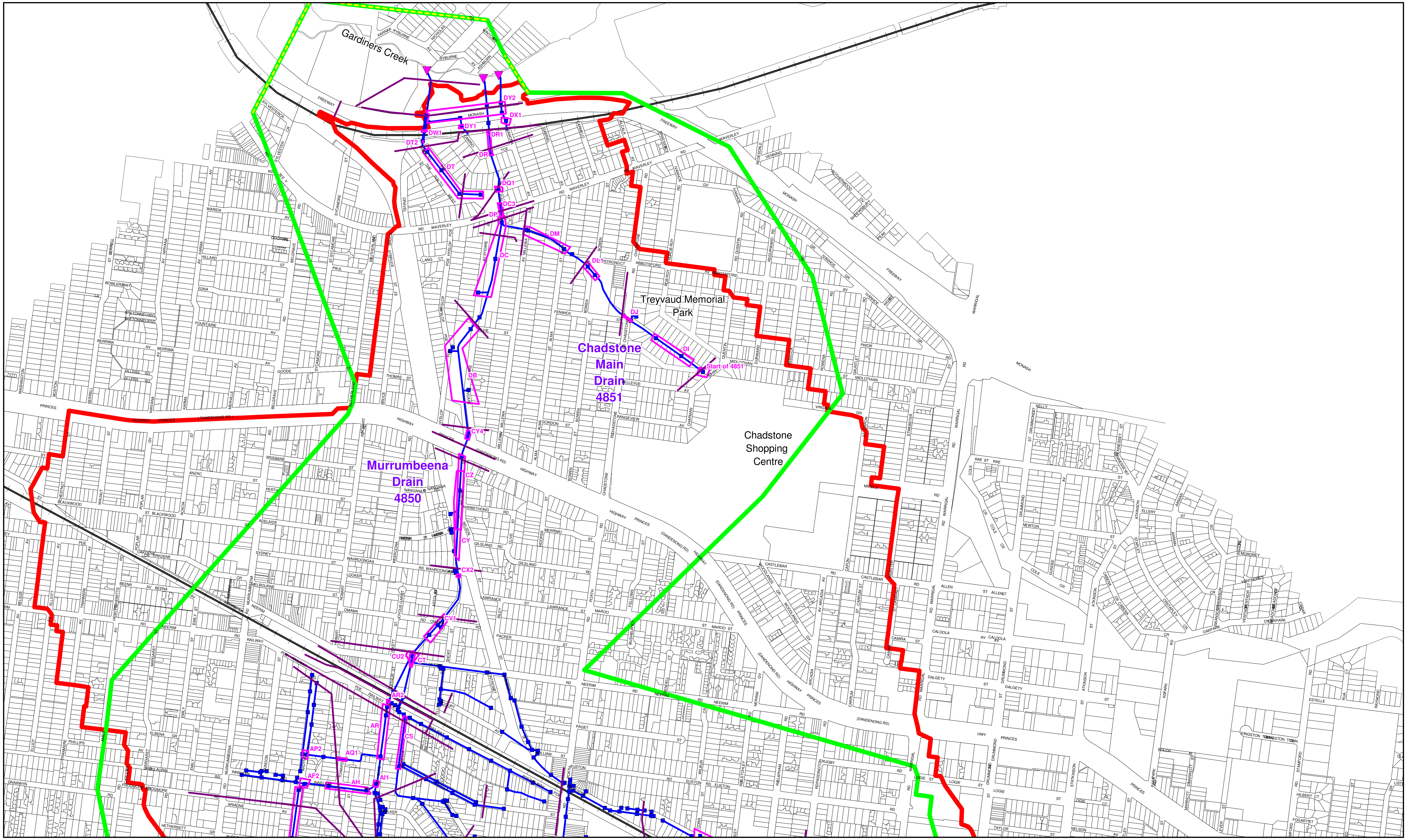
Appendix B

Hydraulic Model Layout

2 sheets at 1:10,000 scale



This data should be read in conjunction with the latest revision of the Report entitled "Murrumbeena Drain Catchment Flood Mapping" (Document Number 31/23394/162167) and is subject to the assumptions and qualifications contained therein. If the report is yet to be released, these assumptions and qualifications must be confirmed by reference to GHD Pty Ltd.

1:10,000

100 0 100 200 300 400

Metres (at A3)

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid Of Australia, Zone 55

N W E S

LEGEND

- RORB Catchment Boundary
- 2D Domain (Code Boundary)
- 1D Pits
- 1D Pipes
- 2D Printout Lines
- Inflow Hydrograph Locations
- 1D Downstream Boundary Conditions
- 2D Downstream Boundary Conditions
- Property Boundaries

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TUFLOW Model Layout
Sheet 1 of 2

Figure B-1

G:\31\23394\CADD\GIS\Mapinfo\Murrumbeena TUFLOW A3 Figure.WOR

Data source: Cadastre, road names, drainage locations, contours supplied by Melbourne Water September 2008. Created by: GJE

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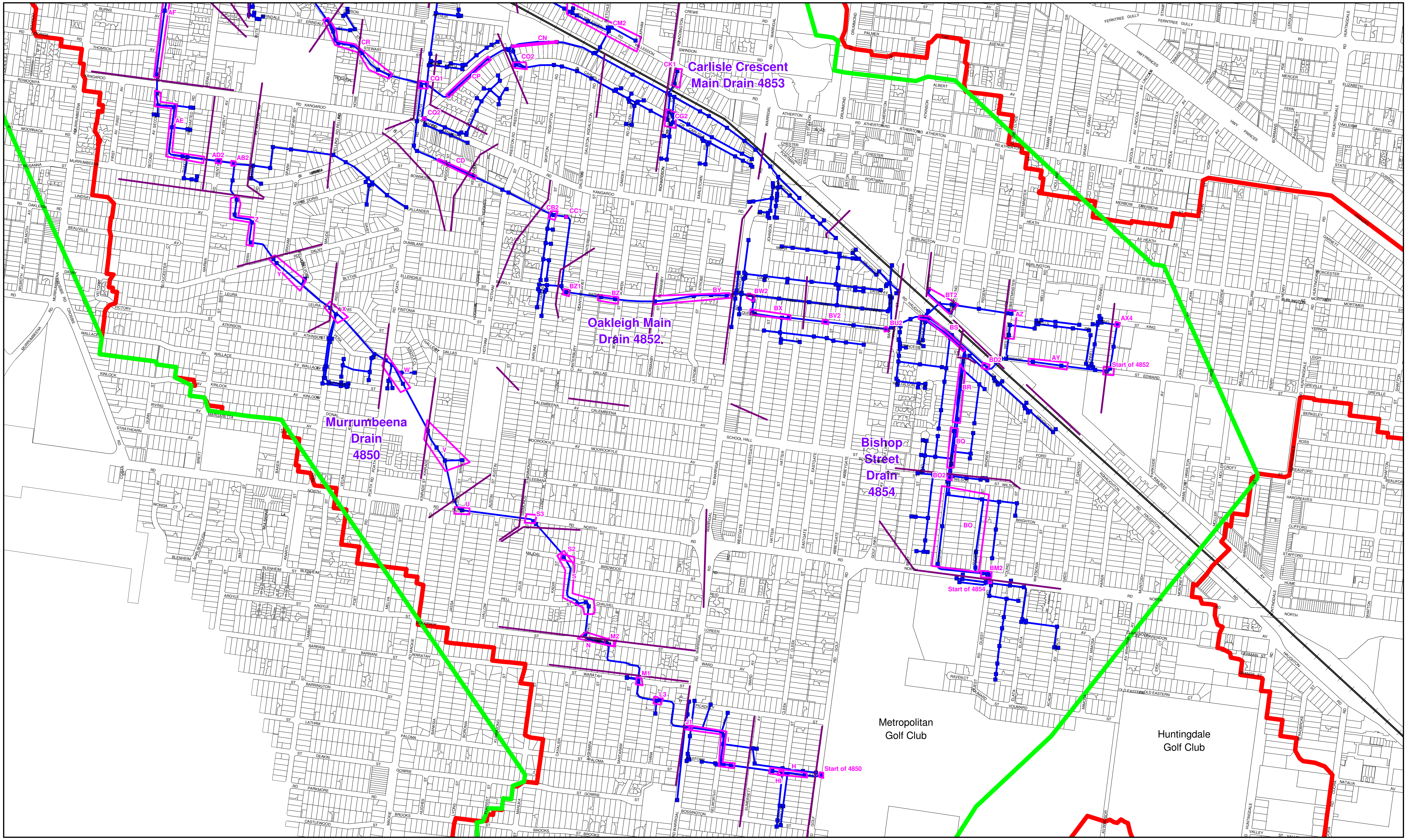

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1:10,000

100 0 100 200 300 400

Metres (at A3)

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid Of Australia, Zone 55

N E S W

LEGEND

- RORB Catchment Boundary
- 2D Domain (Code Boundary)
- 1D Pits
- 1D Pipes
- 2D Printout Lines
- Inflow Hydrograph Locations
- 1D Downstream Boundary Conditions
- 2D Downstream Boundary Conditions
- Property Boundaries

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TUFLOW Model Layout
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Figure B-2

G:\31\23394\CADD\GIS\Mapinfo\Murrumbeena TUFLOW A3 Figure.WOR

Data source: Cadastre, road names, drainage locations, contours supplied by Melbourne Water September 2008. Created by: GJE

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Appendix C

Flood Extent Maps

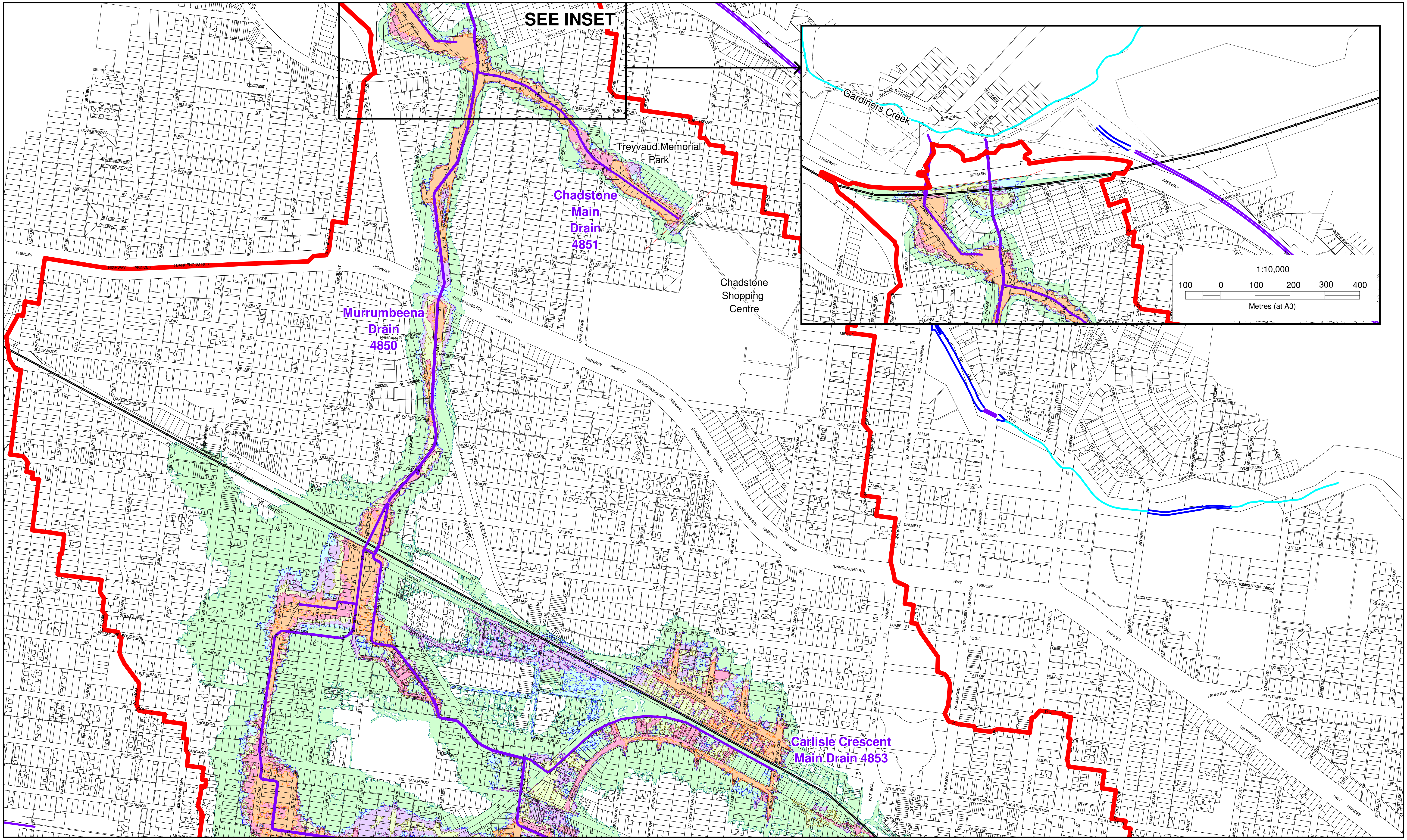
Appendix C.1: Base Case Scenario (2 sheets at 1:10,000 scale showing PMF, 100 year ARI, 50 year ARI, 20 year ARI, 10 year ARI & 5 year ARI flood extents)

Appendix C.2: Redevelopment Scenario (2 sheets at 1:10,000 scale showing PMF, 100 year ARI, 20 year ARI & 5 year ARI flood extents)

Appendix C.3: Climate Change Scenario (2 sheets at 1:10,000 scale showing 100 year ARI, 20 year ARI & 5 year ARI flood extents)

Appendix C.1

Base Case Scenario (2 sheets at 1:10,000 scale showing PMF, 100 year ARI, 50 year ARI, 20 year ARI, 10 year ARI & 5 year ARI flood extents)



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1:10,000

100 0 100 200 300 400

Metres (at A3)

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid Of Australia, Zone 55

N W E S

LEGEND

- RORB Catchment Boundary
- Melbourne Water Underground Drains
- Melbourne Water Open Channels
- Melbourne Water Natural Waterways
- PMP Flood Extent
- 100 year ARI Flood Extent
- 50 year ARI Flood Extent
- 20 year ARI Flood Extent
- 10 year ARI Flood Extent
- 5 year ARI Flood Extent
- Mapping Limits
- Property Boundaries
- Easements

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Base Case Scenario Flood Extents

Sheet 1 of 2

Figure C-1

G:\31\23394\CADD\GIS\Mapinfo\Murrumbeena Base Extents A3 Figure.WOR

Data source: Cadastre, road names, drainage locations, contours supplied by Melbourne Water September 2008. Created by: GJE

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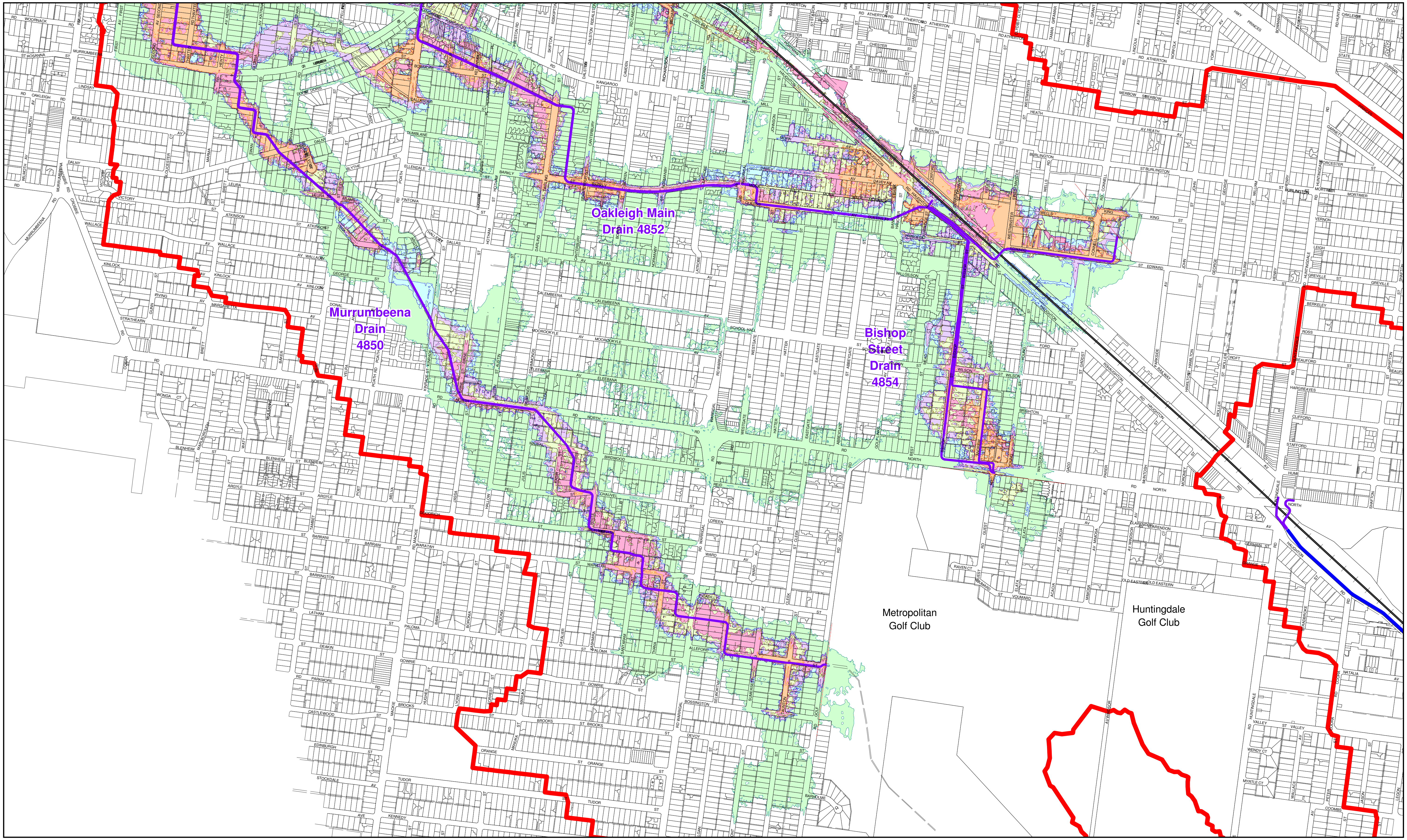

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1:10,000

100 0 100 200 300 400

Metres (at A3)

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid Of Australia, Zone 55

N W E S

LEGEND

- RORB Catchment Boundary
- Melbourne Water Underground Drains
- Melbourne Water Open Channels
- Melbourne Water Natural Waterways
- PMP Flood Extent
- 100 year ARI Flood Extent
- 50 year ARI Flood Extent
- 20 year ARI Flood Extent
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Base Case Scenario Flood Extents
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Figure C-2

G:\31\23394\CADD\GIS\Mapinfo\Murrumbeena Base Extents A3 Figure.WOR

Data source: Cadastre, road names, drainage locations, contours supplied by Melbourne Water September 2008. Created by: GJE

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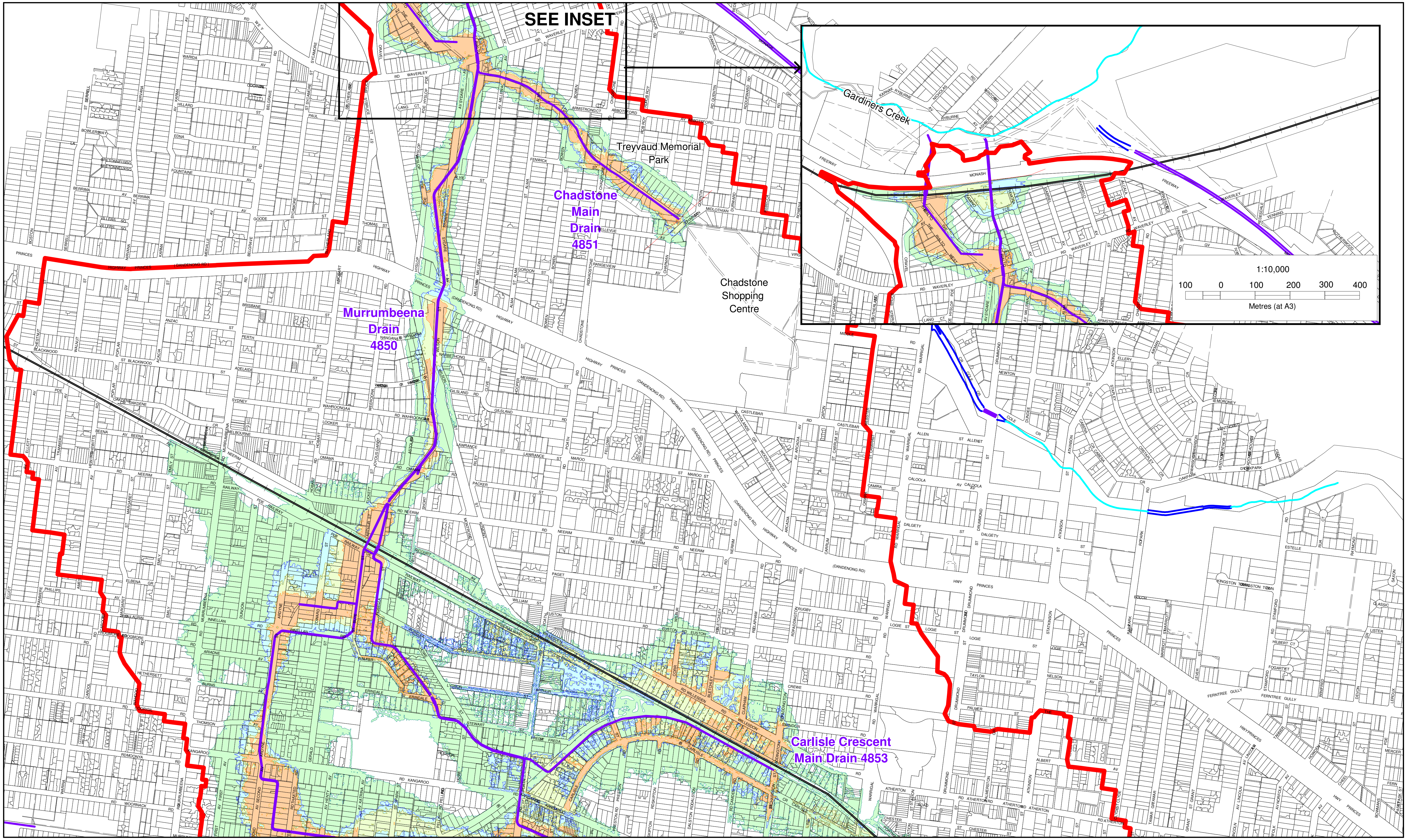
Appendix C.2

Redevelopment Scenario (2 sheets at 1:10,000 scale showing PMF, 100 year ARI, 20 year ARI & 5 year ARI flood extents)



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1:10,000

100 0 100 200 300 400

Metres (at A3)

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid Of Australia, Zone 55

N W E S

LEGEND

- RORB Catchment Boundary
- Melbourne Water Underground Drains
- Melbourne Water Open Channels
- Melbourne Water Natural Waterways
- PMP Flood Extent
- 100 year ARI Flood Extent
- 20 year ARI Flood Extent
- 5 year ARI Flood Extent
- Mapping Limits
- Property Boundaries
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Redevelopment Scenario Flood Extents
Sheet 1 of 2

Figure C-3

G:\31\23394\CADD\GIS\Mapinfo\Murrumbeena Redev Extents A3 Figure.WOR

Data source: Cadastre, road names, drainage locations, contours supplied by Melbourne Water September 2008. Created by: GJE

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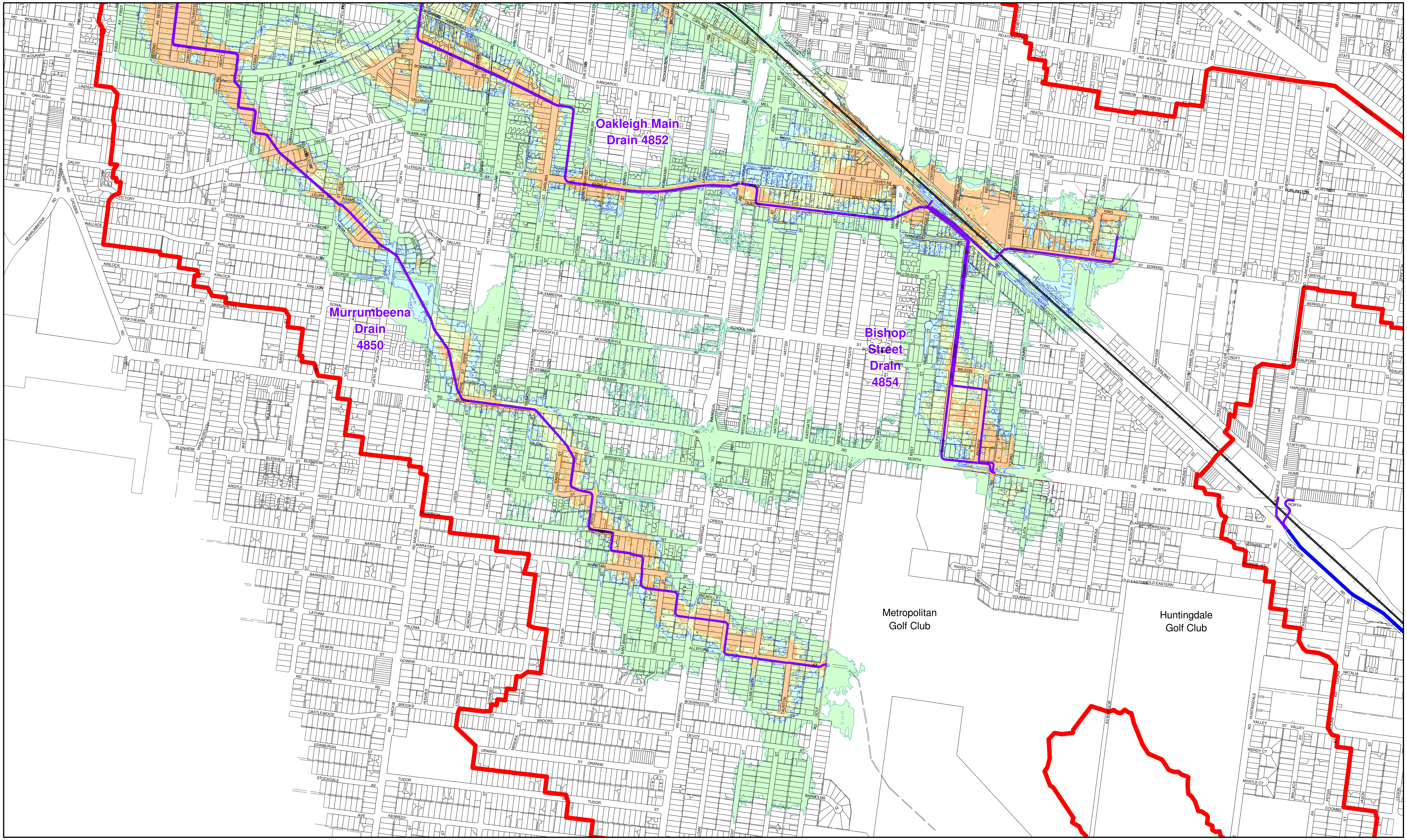

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1:10,000

100 0 100 200 300 400

Metres (at A3)

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid Of Australia, Zone 55

N W E S

LEGEND

- RORB Catchment Boundary
- Melbourne Water Underground Drains
- Melbourne Water Open Channels
- Melbourne Water Natural Waterways
- PMP Flood Extent
- 100 year ARI Flood Extent
- 20 year ARI Flood Extent
- 5 year ARI Flood Extent
- Mapping Limits
- Property Boundaries
- Easements

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Redevelopment Scenario Flood Extents

Sheet 2 of 2

Figure C-4

G:\31\23394\CADD\GIS\Mapinfo\Murrumbeena Redev Extents A3 Figure.WOR

Data source: Cadastre, road names, drainage locations, contours supplied by Melbourne Water September 2008. Created by: GJE

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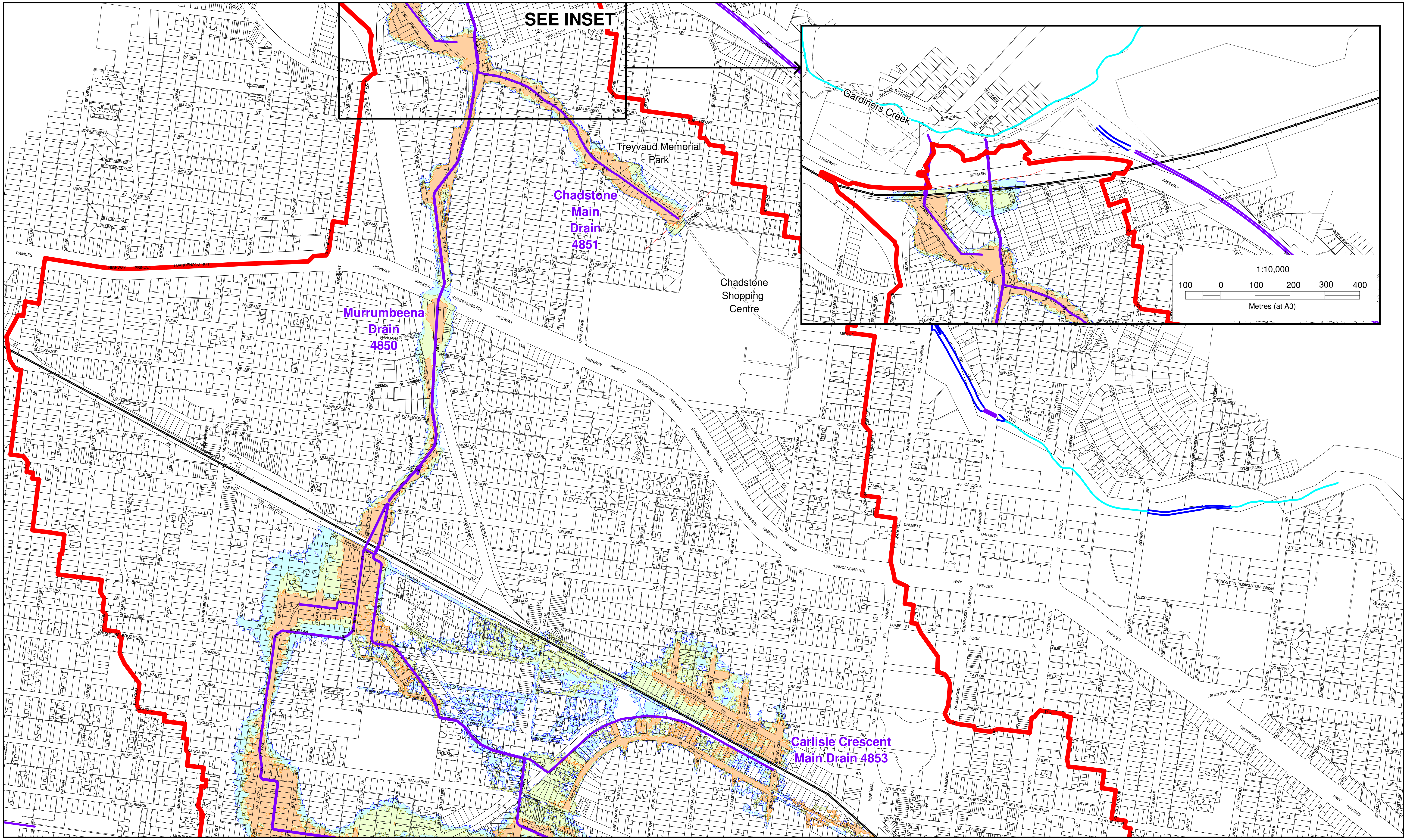
Appendix C.3

Climate Change Scenario (2 sheets at 1:10,000 scale showing 100 year ARI, 20 year ARI & 5 year ARI flood extents)



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1:10,000

100 0 100 200 300 400

Metres (at A3)

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid Of Australia, Zone 55

N W E S

LEGEND

- RORB Catchment Boundary
- Melbourne Water Underground Drains
- Melbourne Water Open Channels
- Melbourne Water Natural Waterways
- 100 year ARI Flood Extent
- 20 year ARI Flood Extent
- 5 year ARI Flood Extent
- Mapping Limits
- Property Boundaries
- Easements

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Climate Change Scenario Flood Extents
Sheet 1 of 2

Figure C-5

G:\31\23394\CADD\GIS\Mapinfo\Murrumbeena Climate Extents A3 Figure.WOR

Data source: Cadastre, road names, drainage locations, contours supplied by Melbourne Water September 2008. Created by: GJE

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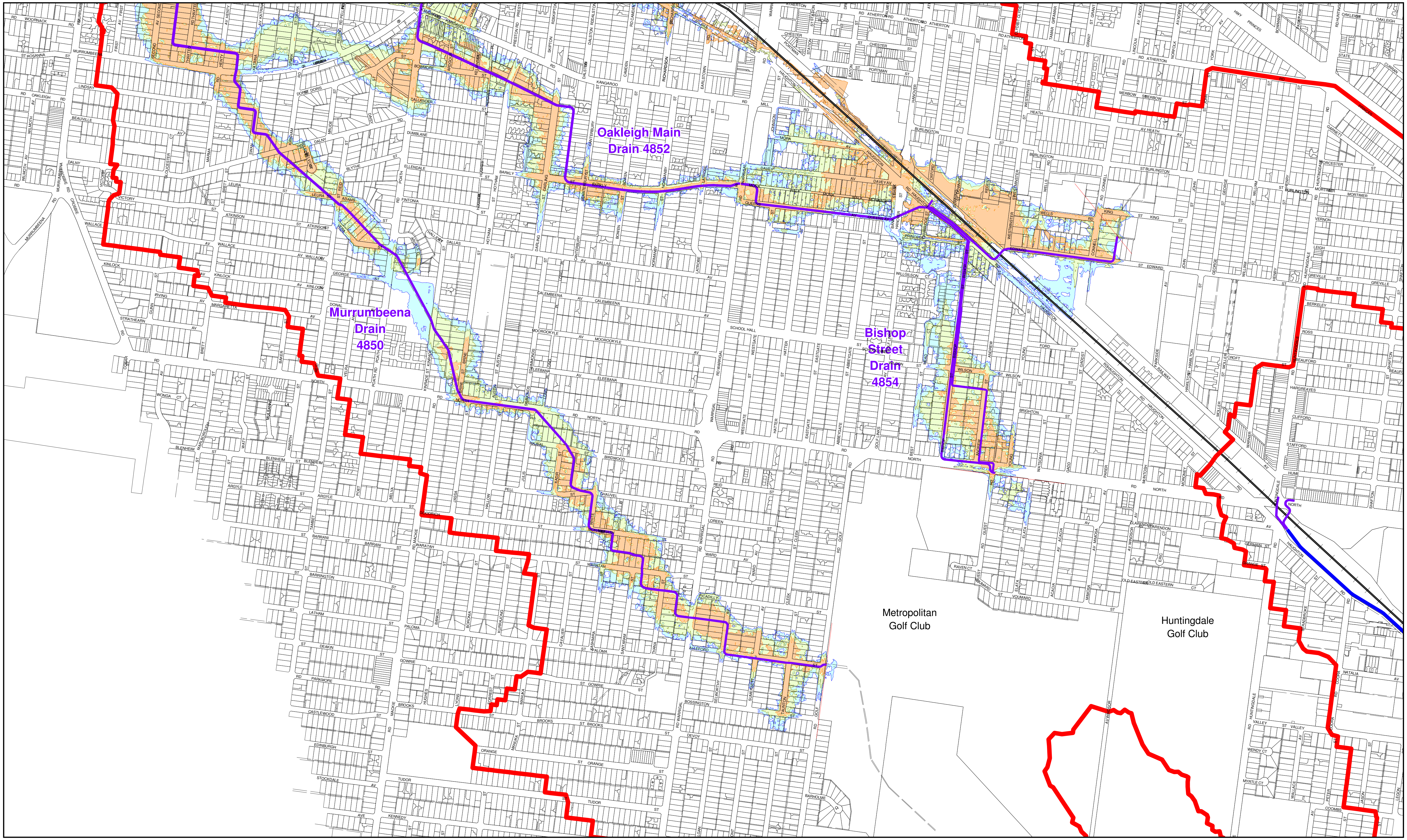

This data should be read in conjunction with the latest revision of the Report entitled "Murrumbeena Drain Catchment Flood Mapping" (Document Number 31/23394/162167) and is subject to the assumptions and qualifications contained therein. If the report is yet to be released, these assumptions and qualifications must be confirmed by reference to GHD Pty Ltd.

1:10,000

100 0 100 200 300 400

Metres (at A3)

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid Of Australia, Zone 55

N W E S

LEGEND

- RORB Catchment Boundary
- Melbourne Water Underground Drains
- Melbourne Water Open Channels
- Melbourne Water Natural Waterways
- 100 year ARI Flood Extent
- 20 year ARI Flood Extent
- 5 year ARI Flood Extent
- Mapping Limits
- Property Boundaries
- Easements

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Melbourne Water

Melbourne Water
Murrumbeena Drain Catchment
Flood Mapping

Job Number	31-23394
Revision	0
Date	14 Jul 2010

Climate Change Scenario Flood Extents
Sheet 2 of 2

Figure C-6

G:\31\23394\CADD\GIS\Mapinfo\Murrumbeena Climate Extents A3 Figure.WOR

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Document Status

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		Name	Signature	Name	Signature	Date
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HP3 Rev						8/10/09
Draft Final						4/6/10
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