3. Design Criteria and Supporting Simulations

3.1 Design Criteria

3.1.1 Supporting Documents

The Growth Centres Development Code (GCC, 2006), Blacktown City Council Engineering Guideline for Development (BCC, 2005), Blacktown Development Control Plan 2006 (BCC, 2006), Blacktown City Council WSUD DCP (BCC, 2008), and the NSW Floodplain Development Manual, 2005 define the requirements for management of stormwater quantity, quality and flooding at the precincts.

3.1.2 Stormwater Quality

The pollutant removal design criteria were adopted from the Western Sydney Growth Centres Stormwater Guidance for Precinct Planning (Prepared by DEC Nov 2006) , supporting the Growth Centres Development Code. These targets are set out in Table 1. The Blacktown Development Control Plan 2006 specifies the same performance targets. In addition, the stream erosion index of 3.5-5 should be achieved.

Table 1 Environmental Stormwater Objectives (after Western Sydney Growth Centres Stormwater Guidance for Precinct Planning)

Pollutant	Pollutant load reduction objective (%)	'Ideal' pollutant load reduction (%)
Gross Pollutants (>5mm)	90	100
Total Suspended Solids	85	95
Total Phosphorus	65	95
Total Nitrogen	45	85

3.1.3 Stormwater Quantity and Flood Risk

The Blacktown City Council Engineering Guideline for Development (BCC, 2005) requires developed flood peaks to match the undeveloped natural peak flow rates for all storm events up to and including the critical duration 100-year ARI event.

Development and land-use in flood prone areas should be in accordance with the Blacktown City Council Engineering Guide for Development and the NSW Floodplain Development Manual. In assessing the flood risk, consideration needs to be given to the full range of risks to people and property, for a full range of flood events up to and including the PMF. Development guidelines specify, amongst others:

- Habitable floor levels of new residences, commercial and industrial developments, together with normally occupied floors of special use developments should either be at or above the Flood Planning Level or be flood proofed to this level. For habitable floor levels, the Flood Planning Level is defined as 500 mm above the 100-year ARI level associated with the creeks across the site and any precinct basins or local flood routes;
- For development in flood storage areas and flood ways development must not lead to a significant increase in flood levels, flood damages, flood behaviour or flood hazard at the site or elsewhere. Provision of adequate and acceptable compensating works to offset must be provided; and
- Effective evacuation procedures must be provided for all flood prone lands (ie up to the PMF)

For flooding associated with discharges on internal roads and other areas of concentrated flow, it is proposed to limit the overland flows and lower flow velocities and depths to reduce the flood hazard. This could be achieved through a detailed design of the subsurface stormwater infrastructure. In addition, areas of high velocity (for example in riparian corridors) may require energy dissipation using environmentally acceptable strategies (for example rock protection).

Most of the precinct site area is generally located above PMF levels. Areas that are inundated by the PMF require a flood evacuation strategy. Elevated areas would provide suitable evacuation muster areas. Windsor Road is considered to be a major flood evacuation route. Council has advised that the Windsor Road culverts have been designed for the 500-year ARI peak flow rate and Windsor Road must remain flood free for all events up to the 500-year ARI flood.

3.2 Supporting Simulations

Numerical modelling was used to assess the flood and stormwater management, which included:

- Existing conditions flood peaks and flood levels for the creeks within the precinct, for a range of design storm events (using RAFTS and Mike 11);
- Determined appropriate volumes of detention throughout the precinct, that responded as best possible to the Indicative Layout Plan (ILP) and which throttled post development flood peaks to existing condition flood peak levels to the requirements of the design criteria (using RAFTS);
- Simulated stormwater runoff quantity and quality for the developed scenario (using MUSIC); and
- Determined appropriate strategies for stormwater quality management throughout the precinct, which responded as best possible to the Indicative Layout Plan (ILP) and which achieved the pollution load export requirements set by the design

criteria (using MUSIC).

All modelling should be updated at later stages with more detailed studies, when better information on landform, development footprints, creek works and road configurations are known.

3.2.1 Simulating Stormwater Quantity Management

Both precincts areas are partially developed and are considered as rural catchments. Flood peaks and detention requirements were simulated using the RAFTS hydrological model. The RAFTS model was simulated for the 5-year and 100 year ARI events and durations ranging from 25 minutes to 12 hours. For each event the critical duration was reported. Percentage of impervious areas, used in the hydrology model, were as follows:

- Low Density Residential 75%
- Medium Density Residential 85%
- Employment/commercial 90%

For existing conditions areas, percent of impervious areas were determined from the topographic maps. The modelling parameters were in accordance with Council's requirements. Key parameters for the RAFTS modelling are provided in Table 2.

Table 2 Key RAFTS modelling parameters

Catchment Conditions	Pern n	Initial loss	Continuous loss
Existing	0.04 to 0.08	25 mm*	2.5 mm/hr
Developed Condition	0.025	ARBM method	ARBM method

*As per BCC Draft DCP and Council advice.

3.2.2 Simulating Stormwater Quality Management

Stormwater quality was assessed using the MUSIC model. The model was configured and simulated for the existing and post-development conditions in response to the ILP. In undertaking the MUSIC modelling, the following approach was used:

- The interim recommended parameters for stormwater modelling – North West and South West Growth Centres were adopted. Event mean concentrations and standard deviations were adopted for both base and storm flows;
- The Western Sydney Growth Centres – Stormwater Guidance for Precinct Planning (prepared by DECC, November 2006) was adopted;
- Treatment efficiencies and guidance as recommended in the MUSIC User Guide (April 2005) and the Fletcher Technical Report 04/8 (December 2004) were adopted;

- Simulations were undertaken using the Richmond (BOM Stn 0607033) 6 mm rainfall data for the period between April 1988 to April 1994 including a wet year; and
- Simulations were undertaken using the MUSIC model default Sydney evaporation data for the same period.

4. Methodology for Rationalisation of Stormwater Management Facilities

4.1 General

The rationalisation of stormwater management facilities was undertaken in an iterative manner, involving the Department of Planning, master planners, stakeholders and Council. This was achieved in a number of meetings throughout the course of the project, and in by means of correspondence.

The following key items were investigated:

- Opportunities to rationalise riparian corridors across the precinct;
- Opportunities to adjust the Indicative Layout Plan;
- Opportunities to consolidate catchments and offset; and
- Opportunities to rationalise Councils design criteria.

4.2 Opportunities to rationalising Riparian Corridors

Meetings were held with DECCW to discuss the riparian corridor network. Opportunities were investigated to rationalise the riparian corridors in order to allow consolidation of facilities, without compromising the ecological outcomes for the two precincts. For example, if a riparian corridor resulted in the need for two offline basins, opportunities were investigated to allow consolidation of the two basins into one online basin.

Furthermore, some of the engineering constraints were discussed with DECCW, which allowed placement of basins in locations which reduced the land take of facilities and earthworks.

The revised riparian corridor network is provided in Appendix B.

4.3 Opportunities to adjust the Indicative Layout Plan

Various discussions were held with the planners on the projects to explore opportunities for:

- Co-location of open space areas;
- Changes to road layouts to better respond to the topography and allow better integration of basins with reduced footprints;
- Changes to road layouts to better respond to the topography and allow better integration of channels within natural drainage corridors; and
- Reducing the numbers of road crossings over drainage channels; reducing the

numbers of culvert crossings.

4.4 Opportunities to Consolidate Catchments

The topography was reviewed in order to find opportunities to consolidate one or more catchments to a single basin or management area. In some instances this would require providing a small amount of fill to facilitate the drainage of overland flow to the basins.

In other instances, an offsetting approach was adopted, where a downstream catchment was over-throttled (ie. A greater than necessary volume of stormwater retained in the proposed basin) in order to permit drainage of a smaller upstream catchment without detention. This was not generally a preferred approach, since if detention could be accommodated in this way, provisions still needs to be made for managing stormwater quality. In some instances rain gardens are proposed to treat water quality in small catchments that are not proposed to drain to bioretention/detention basins.

4.5 Opportunities to rationalise Councils Design Criteria

Although a number of discussions were held in an attempt to rationalise Council's design requirements relating to batters, basin crest widths, depths and other parameters, Councils requirements, as set out in the Engineering Guide to Developments, were adopted for the final strategy.

5. Rationalisation of Drainage Infrastructure

5.1 Facilities Identified for the Exhibition

Council's Draft Section 94 Contributions Plan (November 2008) provides a listing and plans of all the facilities adopted for Section 94 costing during the first exhibition stage of the project.

These are provided in Appendix A. This report reduced the number of facilities across the precincts, as discussed in the ensuing sections.

5.2 Catchment Scale Rationalisation

The following discussion describes the rationalisation of facilities on a catchment by catchment basis. It focuses only on those catchments where amendments have been made.

Plans showing catchments draining to facilities for both stormwater quantity and quality managements are provided in Appendix B. Please refer to these plans for the following discussion.

5.2.1 Catchments E1 to E3

- Basins: E1 and E1a; E2 and E3 consolidated
- Rain gardens: nil
- RAFTS Catchments: E1, E1a, E2, E3
- MUSIC Catchments: E1, E1a, E2, E3M2, E3M1,

Catchments E1, E1a, E2 and E3 are westward draining catchments located adjacent to the western boundary of the Alex Avenue Precinct.

Catchments E2 and E3 will be directed to Basin E3 for detention and treatment. This will require provision of a drainage channel or other stormwater infrastructure to route flows from the low point in E2 along Railway Terrace to the basin. A small area adjacent to Railway Terrace is lower than the basin and treatment is offset in Basin E3 by overcompensation for water quality and detention. The area not treated by the basin would need to be provided with a Gross Pollutant Trap (GPT).

Catchments E1 and E1a will be directed to basins E1 and E1a for detention and treatment respectively.

Positive Outcomes

- Consolidation of two catchments (E2 and E3) into single basin;
- Better definition of basin footprint through concept design; and

- Better definition of issues such as fill, routing of overland flow and consideration of downstream flooding.

5.2.2 Catchments E8 to E11

- Basins: E8
- Rain gardens: nil
- RAFTS Catchments: E8, E10b, E11
- MUSIC Catchments: E8, E10b, E11

Catchments E8, E10b and E11 are located in the Alex Avenue Precinct. The catchments drain to the Eastern Creek tributary that flows through the precinct in a westerly direction.

Through the rationalisation process, the basin located in catchment E8 (Basin E8) was relocated to become an on-line basin, such that all runoff draining from catchments E8, E10b and E11 flows into the basin. The basin detention storage volume and bio-retention area were revised to manage stormwater quantity and quality for catchments E8, E10b and E11. Therefore, the basin located in Catchment E11 in the exhibition draft Indicaitve Layout Plan has been removed from the stormwater management strategy.

Positive Outcomes

- Previous Basin E11 removed, eliminating construction and maintenance costs and increasing developable land area;
- Original Basin E8 location used as developable land;
- Better definition of basin footprint through concept design; and
- Better definition of issues such as fill, routing of overland flow and consideration of downstream flooding.

5.2.3 Catchment F7

- Basins: F4, F6 and F9
- Rain garden: F10b
- RAFTS Catchments: F1 to F7, F7a, F8, F9
- MUSIC Catchments: F1 to F6, F7a, F7S, F7M1, F7M2, F7M3, F8, F9

Catchment F7 is located in the Alex Ave Precinct. Runoff from upstream catchments F0, F1, F2, F3 and F4 enters Catchment F7 from Basin F4 to the south-east, before draining to the north and joining another tributary to form the headwaters of First Ponds Creek.

In the exhibited contributions plan there were detention basins located in Catchments

F4, F6, F7 and F9. Through the rationalisation process the storage volume of basins F4, F6 and F9 was modified to offset runoff from Catchment F7 for stormwater quantity. Stormwater quality for Catchment F7 has been managed through the addition of a raingarden at the boundary of catchments F7 and F10b, and through the redirection of runoff from the eastern region of Catchment F7 to Basin F6 during low flow events. As stormwater quantity and quality for Catchment F7 was managed in Basins F5, F6 and F9, the basin located in Catchment F7 (Basin F7) has been removed from the stormwater management strategy. Basin F6 has been relocated downstream and placed at the southern boundary of Catchment F10a within the area zoned as open space in the exhibited plans.

Positive Outcomes

- Previous Basin F7 removed, eliminating construction and maintenance costs;
- Previous Basin E7 location used as developable land;
- Better definition of basin footprints through concept design; and
- Better definition of issues such as fill, routing of overland flow and consideration of downstream flooding.

5.2.4 Catchments E15a and E18a

- Basins: E16
- Rain gardens: None
- RAFTS Catchments: E15a and E18a
- MUSIC Catchments: E15a and E18a

Catchments E15a and E18a are located at the south-west corner of the Riverstone Precinct. Catchment E18a drains to the north, flowing through the existing Schofields town centre. Catchment E15a drains to the west, joining the existing water course at the south-west corner of the Riverstone Precinct.

After development of the precinct, runoff from Catchment E18a will be redirected to the west towards Catchment E15a, avoiding an increase in flow entering existing developed areas. Through the rationalisation process, the storage volume and bio-retention area of Basin E16 has been modified to offset runoff from catchments E15a and E18a for stormwater quantity and quality. As stormwater quantity and quality for catchment F15a and F18a is to be managed in Basin E16, the basin located in Catchment E15 (Basin E15) has been removed from the stormwater management strategy.

Positive Outcomes

- Previous Basin E15 removed, eliminating construction and maintenance costs and increasing developable land area;

- Runoff from Catchment E18a redirected away from existing developed area, reducing peak flow in existing stormwater network.
- Better definition of basin footprints through concept design; and
- Better definition of issues such as fill, routing of overland flow and consideration of downstream flooding.

5.2.5 Catchments E25 and E26

- Basins: E25
- Rain gardens: None
- RAFTS Catchments: E25, E26
- MUSIC Catchments: E25, E26

Catchments E25 and E26 are located in the Riverstone Precinct, draining in a westerly direction towards Eastern Creek.

Through the rationalisation process, the basin in Catchment E25 (Basin E25) has been relocated such that runoff from both catchments E25 and E26 will be directed to Basin E25 for stormwater quantity and quality treatment. As stormwater quantity and quality for catchment E26 is to be managed in Basin E25, the basin located in Catchment E26 (Basin E26) has been removed from the stormwater management strategy.

Positive Outcomes

- Previous Basin E26 removed, eliminating construction and maintenance costs;
- Better definition of basin footprints through concept design; and
- Better definition of issues such as fill, routing of overland flow and consideration of downstream flooding.

5.2.6 Catchments E24 and E34

- Basins: nil
- Rain gardens: nil
- RAFTS Catchments: E24 and E34
- MUSIC Catchments: E24 and E34

Catchments E24 and E34 are located in the Riverstone Precinct. Runoff from Catchment E34 drains along Riverstone Road in a westerly direction before passing under Railway Terrace. Catchment E24 drains to the proposed riparian corridor to the south, adjacent to the proposed basin E22.

In the exhibited stormwater management plan, basins were located in both Catchments E24 and E34. Through the rationalisation process, the storage volume and bio-retention area of Basins E22, E25 and E27a have been modified to offset

runoff from catchments E24 and E34 for stormwater quantity and quality. As stormwater quantity and quality for these catchments is to be managed in basins E22, E25 and E27a, the basins previously located in Catchment E24 and Catchment E34 have been removed from the stormwater management strategy.

Positive Outcomes

- Previous Basins E24 and E34 removed, eliminating construction and maintenance costs;
- Original locations of Previous Basin E24 and E34 available for use as developable land;
- Better definition of basin footprints through concept design; and
- Better definition of issues such as fill, routing of overland flow and consideration of downstream flooding.

5.2.7 Catchments E24a, E24b, E24c, E27 and E27a

- Basins: E22, E25 and E27a
- Rain gardens: E24b
- RAFTS Catchments: E24a, E24b, E24c, E27 and E27a
- MUSIC Catchments: E24aM2, E24aM1, E24b, E24c, E27 and E27a

Catchments E24a, E24b, E24c, E27 and E27a are located in the Riverstone Precinct and drain to Eastern creek to the West via a proposed riparian corridor.

In the exhibited stormwater management plan, basins had been located in Catchments E22, E24a, E27 and E28. Through the rationalisation process, Previous Basin E28 has been relocated to Catchment E27a and now accepts runoff from Catchments E24c, E27 and E27a. Previous Basin E22 has been relocated and reconfigured to accept runoff from Catchments E22, E23 and part of E24a.

The storage volume and bio-retention areas of basins E22, E25 and E27a have been reconfigured to offset runoff from Catchments E24b and part of E24a for stormwater quantity. Stormwater quality for these areas will be treated in Raingarden E24b.

As a result of this rationalisation of stormwater quantity and quality treatment, previous Basins E24a and E27 have been removed from the stormwater management plan.

Positive Outcomes

- Previous Basins E24a and E27 removed, eliminating construction and maintenance costs;
- Original locations of Previous Basins E24a and E27 available for use as developable land;

- Better definition of basin footprint through concept design; and
- Better definition of issues such as fill, routing of overland flow and consideration of downstream flooding.

5.2.8 Catchments E31, E31a and E32

- Basins: E31
- Rain gardens: nil
- RAFTS Catchments: E31, E31a and E32
- MUSIC Catchments: E31, E31a and E32

Catchments E31, E31a and E32 lie in the north-western section of the Riverstone Precinct forming a wedge between Victoria Street and Riverstone Parade. These catchments drain in a westerly direction, under Riverstone Parade to Eastern Creek.

In the exhibited stormwater management plan, basins had been located in Catchments E31 and E32. Through the rationalisation process, Basin E31 has been enlarged and reconfigured to treat runoff from Catchment E32 for both quantity and quality. Previous Basin E32 has been removed from the stormwater management plan.

Positive Outcomes

- Previous Basin E32 removed, eliminating construction and maintenance costs;
- Original location of Basin E32 available for use as developable land;
- Better definition of basin footprint through concept design; and
- Better definition of issues such as fill, routing of overland flow and consideration of downstream flooding.

5.2.9 Catchments E35 and E35a

- Basin: nil
- Rain gardens: None
- RAFTS Catchments: E35 and E35a
- MUSIC Catchments: E35 and E35a

Catchments E35 and E35a are located in the centre of the Riverstone Precinct immediately to the east of Hamilton Street. The catchment area is relatively small and drains to the west under Hamilton Street to Eastern Creek.

As the catchment area to be treated is small, on-lot treatment will be utilised for stormwater quality and quantity. This on-lot treatment negates the need for a basin in Catchment E35, and Basin E35 has been removed from the stormwater management plan.

Positive Outcomes

- Previous Basin E35 removed, eliminating construction and maintenance costs;
- Original location of Basin E35 available for use as developable land;
- Better definition of issues such as fill, routing of overland flow and consideration of downstream flooding.

5.2.10 Catchments F15, F16a, F16b, F16c and F16d

- Basins: F20, F25 and F28
- Rain gardens: F16b, F16c
- RAFTS Catchments: F15, F16a, F16b, F16c, and F16d
- MUSIC Catchments: F15, F16a, F16b, F16c, and F16d

Catchments F15, F16a, F16b, F16c, and F16d are located in the south-east of the Riverstone Precinct. These catchments drain directly to First Ponds Creek to the east.

In the exhibited stormwater management plan, basins had been located in Catchments F17 and F18 (now split and redefined as F16a, F16b and F16d). Through the rationalisation process, the storage volumes and bio-retention areas for Basins F20, F25 and F28 have been reconfigured to offset stormwater quantity and quality for Catchments F15, F16a, F16b, F16c, and F16d. In addition, stormwater quality for these catchments will be treated by redirecting low-flow runoff to Basin F20 (for Catchment F16a), Raingarden F16c (Catchments F16c and F16d) and Raingarden F16b (Catchment F16b).

Previous Basins F17 and F18 will not be required and have been removed from the stormwater management strategy.

Positive Outcomes

- Previous Basins F17 and F18 removed, eliminating construction and maintenance costs;
- Original location of Previous Basins F17 and F18 available for use as developable land;
- Better definition of basin footprint through concept design; and
- Better definition of issues such as fill, routing of overland flow and consideration of downstream flooding.

5.2.11 Catchments F23 and F25

- Basins: F25
- Rain gardens: F23b and F25a
- RAFTS Catchments: F23, F23a, F23b, F25 and F25a

- MUSIC Catchments: F23, F23a, F23b, F25 and F25a

Catchments F23 and F25 are on the eastern edge of the Riverstone Precinct and receive runoff from F24 and F22. The catchments drain to First Ponds Creek, immediately to the east of the catchments.

In the exhibited stormwater plan, basins had been located in Catchments F23 and F25. Through the rationalisation process, the storage volume and bio-retention area of basin F25 has been resized to offset stormwater quantity treatment for Catchments F23, F23a and F23b. Raingardens F23b and F25a will be provided for stormwater quality treatment where stormwater pipe network cannot be directed to Basin F25.

As a result of this rationalisation of stormwater quantity and quality treatment, Previous Basin F23 has been removed from the stormwater management plan

Positive Outcomes

- Previous Basins F23 removed, eliminating construction and maintenance costs;
- Original location of Basins F23 available for use as developable land;
- Better definition of basin footprint through concept design; and
- Better definition of issues such as fill, routing of overland flow and consideration of downstream flooding.

5.2.12 Catchments F28, F29 and F32

- Basins: F28 and F32
- Rain gardens: F28a, F29b and F29c
- RAFTS Catchments: F28s, F28, F28a, F28b, F29a, F29b, F29c and F32
- MUSIC Catchments: F28s, F28, F28a, F28b, F29a, F29b, F29c and F32

Catchments F28, F29 and F32 lie in the centre of the Riverstone Precinct, adjacent to First Ponds Creek. The catchments drain in an easterly direction to the creek.

In the exhibited stormwater plan, basins were located in Catchments F28, F29 and F32. Through the rationalisation process, the storage volume and bio-retention area of Basins F28 and F32 have been re-sized to offset stormwater quantity treatment for Catchments F28a, F28b, F29b and F29c. Raingardens have been located in Catchments F28a, F29b and F29c to treat stormwater quality from those catchments. Stormwater quality treatment for Catchment F28b has been offset in Basins F28 and F32. On-lot treatment will be utilised for stormwater quality and quantity at the proposed school sites in Catchment F28S.

These catchment rationalisation measures negate the need for a basin in Catchment F29, and Previous Basin F29 has been removed from the stormwater management plan.

Positive Outcomes

- Previous Basin F29 removed, eliminating construction and maintenance costs;
- Original location of Basin F29 available for use as developable land;
- Better definition of basin footprint through concept design; and
- Better definition of issues such as fill, routing of overland flow and consideration of downstream flooding.

5.2.13 Catchments F33 and F34

- Basins: F34
- Rain gardens: F34b
- RAFTS Catchments: F33, F34 and F34b
- MUSIC Catchments: F33, F34 and F34b

Catchments F28, F29 and F32 lie on the eastern boundary of the Riverstone Precinct, adjacent to First Ponds Creek. The catchments drain in an easterly direction to the creek.

In the exhibited stormwater plan, basins were located in Catchments F33 and F34. Through the rationalisation process, the storage volume and bio-retention area of Basin F34 has been redesigned and relocated to treat stormwater quality and quantity for Catchments F33 and F34. Runoff from Catchment F34b now drains directly to First Ponds Creek, with stormwater quality treatment by gross pollutant traps and Raingarden F34b and partially offset in Basin F34. Stormwater quality treatment for Catchment F34b is offset in Basin F34.

These catchment rationalisation measures negate the need for a basin in Catchment F33, and Previous Basin F33 has been removed from the stormwater management plan.

Positive Outcomes

- Previous Basin F33 removed, eliminating construction and maintenance costs;
- Original location of Previous Basin F33 available for use as developable land;
- Better definition of basin footprint through concept design; and
- Better definition of issues such as fill, routing of overland flow and consideration of downstream flooding.

5.2.14 Catchments F40, F40a, F42, F46 and F47

- Basins: F40a and F46
- Rain gardens: F47

- RAFTS Catchments: F40, F40a, F41, F42, F46 and F47
- MUSIC Catchments: F40, F40a, F41, F42, F46 and F47

Catchments F40, F40a, F41, F42, F46 and F47 lie in the centre of the Riverstone Precinct, adjacent to the proposed conservation zone. The catchments drain to a tributary in the proposed conservation zone and thence in an easterly direction to the creek.

In the exhibited stormwater plan, basins were located in Catchments F42, F40a, F46 and F47. Through the rationalisation process, the storage volume and bio-retention area of Basins F40a and F46 have been redesigned to treat stormwater quality and quantity for Catchments F41, F40a, F41, F42 and F46. Filling of some areas will be required to route runoff appropriately from Catchment F42. Runoff from Catchment F47 now drains directly to First Ponds Creek, with stormwater quality treatment provided by Raingarden F47. Stormwater quality treatment for Catchment F47 is offset in Basins F40a and F46.

These catchment rationalisation measures negate the need for basins in Catchments F42 and F47, and Previous Basins F42 and F47 have been removed from the stormwater management plan.

Positive Outcomes

- Previous Basins F42 and F47 removed, eliminating construction and maintenance costs;
- Original location of Basins F42 and F47 available for use as developable land;
- Better definition of basin footprint through concept design; and
- Better definition of issues such as fill, routing of overland flow and consideration of downstream flooding.

5.2.15 Catchments F49, F50 and F51

- Basins: F51
- Rain gardens: None
- RAFTS Catchments: F49, F50 and F51
- MUSIC Catchments: F49, F50 and F51

Catchments F49, F50 and F51 are located in the northeast of the Riverstone Precinct and drain in an easterly direction to First Ponds Creek.

In the exhibited stormwater plan, basins had been located in Catchments F49 and F51. Through the rationalisation process, the storage volume and bio-retention area of Basin F51 have been redesigned to treat stormwater quality and quantity for Catchments F49, F50 and F51. Runoff from Catchment F49 will be redirected to Basin F51 via a proposed drainage channel. Previous Basin F49 is no longer required and

has been removed from the stormwater management plan.

Positive Outcomes

- Previous Basin F49 removed, eliminating construction and maintenance costs;
- Original location of Basin F49 available for use as developable land;
- Better understanding of requirements for diversion of stormwater and provision of stormwater channels.
- Better definition of basin footprint through concept design; and
- Better definition of issues such as fill, routing of overland flow and consideration of downstream flooding.

5.2.16 Catchments F60 and F61

- Basins: nil
- Rain gardens: None
- RAFTS Catchments: F60 and F61
- MUSIC Catchments: F60 and F61

Catchments F60 and F61 lie in the north-eastern corner of the Riverstone Precinct and drain to First Ponds Creek, immediately to the east.

In the exhibited stormwater plan, basins had been located in Catchments F60 and F61. As the catchment area to be treated is relatively small, on-lot treatment will be utilised for stormwater quality and quantity. This on-lot treatment negates the need for basins in Catchments F60 and F61, and Previous Basins F60 and F61 have been removed from the stormwater management plan.

Positive Outcomes

- Previous Basins F60 and F61 removed, eliminating construction and maintenance costs;
- Original location of Previous Basins F60 and F61 available for use as developable land; and
- Better definition of issues such as fill, routing of overland flow and consideration of downstream flooding.

5.3 Culverts and Bridges (See Appendix B)

Preliminary locations and dimensions of proposed culverts and bridges were determined for the purposed of Section 94 contributions costing and agreed with Council. These were identified from the latest Indicative Layout Plan.

Culverts were located where there is a road crossing over the proposed engineered drainage channels or where basin outlets pass underneath roads. Bridges were located where there are road crossings over a riparian corridors and flood affected lands. At locations where a culvert upgrade would result in increases in flood levels downstream the culvert dimensions were determined based upon the capacity of the existing culverts. Key design parameters were adopted as follows:

- An internal height of 1200 mm was adopted for all culverts;
- The width of each set of culverts was determined such that no increase in flood levels occurs upstream of the culverts for the unblocked scenario during the 100-year ARI event; and
- The overall width of each set of culverts was increased by 50% such that the increase in flood levels is less than 300 mm when the culverts are 50% blocked

The 100-year ARI event peak flow rates were extracted from the basin design XP-RAFTS model. Hydraulic calculations were performed using CULVERTW, with consideration of tail water effects.

Bridge spans were determined based upon the width of the riparian corridor and the 100-year ARI event flood extents. The following cases were considered:

- Where the riparian corridor width is greater than the width of the 100-year ARI event extents, the riparian corridor width was adopted as the span of the bridge; and
- Where the 100-year ARI event flood extents were greater than the riparian corridor the width of the bridge was determined such that the resulting increase in flood levels does not exceed 50 mm.

The 100-year ARI event peak flow rates were extracted from the basin design XP-RAFTS model. HECRAS was used to estimate the flood level increase compared to existing conditions, on account of the bridges. A number of openings were iterated to satisfy the design criteria, and allowance was made for piers. Each HECRAS model extended from approximately 1 km downstream of the crossing to 0.5 km upstream of the crossing.

6. Revised WSUD Strategy

The Revised strategy for Riverstone and Alex Avenue is shown in Appendix B. These figures explain in some detail, on a catchment by catchment basis, the proposed strategy for managing stormwater quantity and quality. The figures show:

- Areas where rain gardens are proposed, with an indicative size as shown on the plan;
- Areas where fill will be required, the average fill depth and the maximum fill depth;
- Catchments where stormwater is directed to basins;
- Catchments where onsite-stormwater treatment is proposed;
- Catchments where stormwater is directed to the creeks and management of quantity and quality is either offset of provided in rain gardens; and
- Flooding constraints; and topography as contours.

The figures also provide key basin design parameters and rain garden filter areas with land take estimates. Annotations provide additional details throughout the precincts.