Marsden Park Residential Precinct

Post Exhibition Water Cycle & Flood Management Strategy Report

Winten Property Group

July, 2013

SUSTAINABLE CERTIFICATION
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Endorsed
OHS
Management
System

SUSTAINABLE CERTIFICATION
ISO 14001 : 2004
Endorsed
Environmental
Management
System

SUSTAINABLE CERTIFICATION
ISO 9001 : 2008
Endorsed
Quality
Management
System

Local Government PROCUREMENT
APPROVED CONTRACTOR

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& PROJECT MANAGERS

Post Exhibition Water Cycle & Flood Management Strategy Report

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- TABLE OF CONTENTS -

- LIST OF PLATES-

- LIST OF TABLES -

- LIST OF APPENDICIES -

1 EXECUTIVE SUMMARY

The Marsden Park Residential Precinct planning package was placed on Public Exhibition in November 2012. The Precinct proposes to create approximately 10,000 new housing lots together with approximately 20 ha of commercial development and will provide much needed housing in the Marsden Park area. A number of submissions were received as a result of the Public Exhibition process. The submissions made a series of suggested amendments that included changes to development extents; adjustments to playing field and basin arrangements; removal of detention basins and adjustments to drainage corridors. To address these issues, the Water Cycle Management Strategy has been updated together with the Indicative Layout Plan for the Precinct. Details of the updated ILP are presented in Plate 1.1.

The hydrology modelling has been updated in accordance with the submissions to better reflect the likely flows throughout the Precinct. An investigation into the basin strategy (including the removal of some basins, whilst enlarging others) has also been undertaken. As suggested in the submissions, these investigations have concluded that Basins B1, B2, B3 and 1 could be removed completely, whilst Basin 2 could be increased in size to compensate for the removal of these other basins without adversely influencing flows throughout the Precinct, in particular the discharge points of the Precinct at South Creek.

The hydrological modelling changes also include the adjustment of Basin 8 and the removal of Basin 9, as well as changing the arrangement of Basin 6 into two independent devices (Basin 6A upstream of Richmond Road and Basin 6B downstream of Richmond Road).

Detailed 2D Flood modelling has been completed to assess the effectiveness of the Precinct's Water Quantity Management Strategy. The flood assessment has shown that post development 100 year flows are controlled within the proposed detention basins as well as the riparian corridors within the Precinct.

As part of the original Water Cycle Management strategy for the Precinct, the strategy identified that detention facilities for a number of catchments that discharge directly to South Creek and Bells Creek where not required. However, this "Reduced Basin Strategy" is not supported by Blacktown City Council and has not been pursued, during the Post Exhibition investigation. However, the Reduced Basin Strategy is still a valid and technically sound approach for stormwater management within the Precinct.

The updated strategy will ensure that stormwater flows leaving the Precinct at the boundary (at South and Bells Creeks) are less than existing conditions and that flooding levels are not increased over existing conditions at any point outside the Precinct.

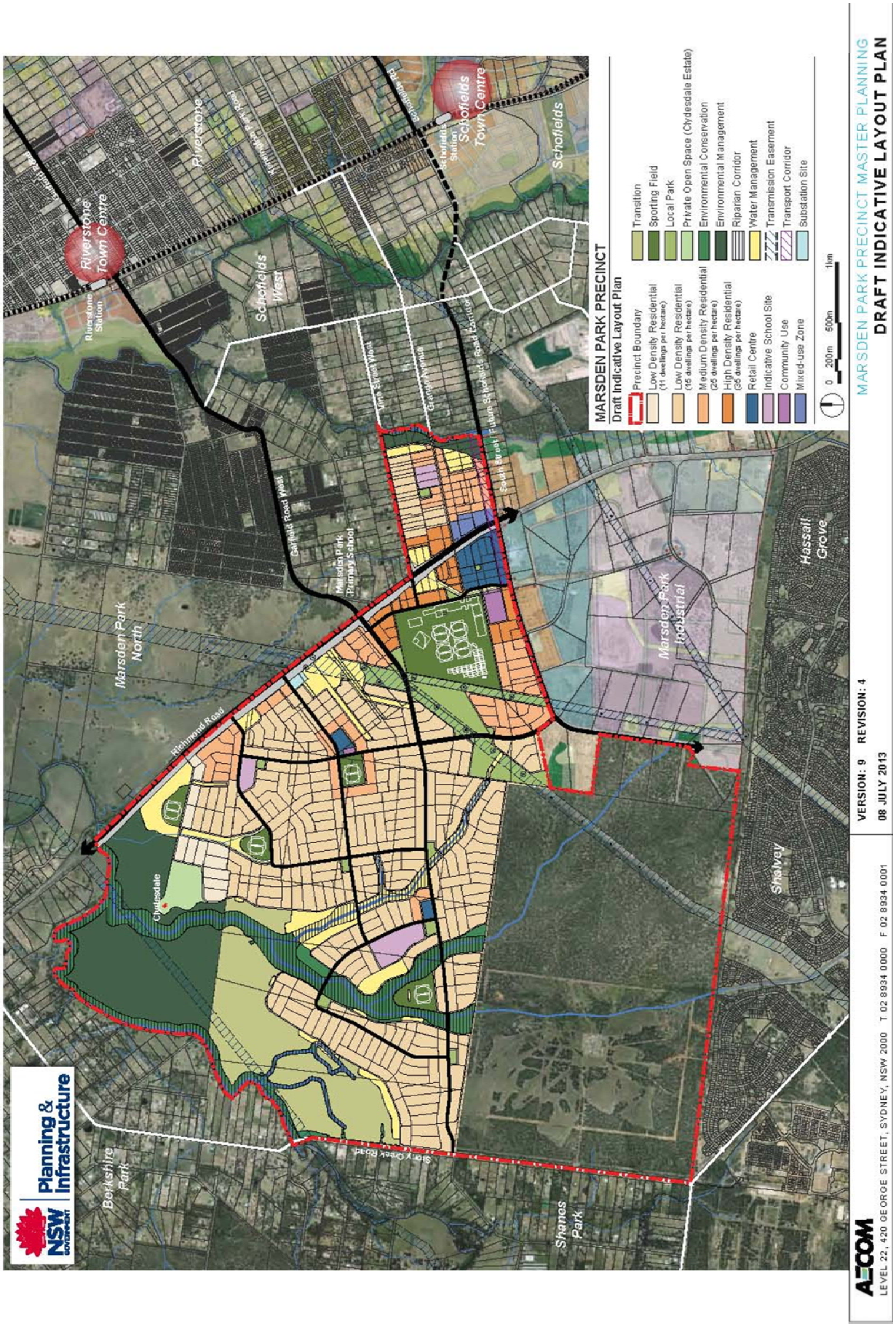

PLATE 1.1 – UPDATED PRECINCT ILP

2 INTRODUCTION

In November 2012, an Exhibition Precinct Planning Package was exhibited for the Marsden Park Residential Precinct (MPP). Subsequent to this exhibition process, a number of submissions were received from various landowners and government agencies. The documents submitted that relate to the Water Cycle Management Strategy include:

- Blacktown City Council, Submission on the Draft Precinct Plan for the Marsden Park Precinct, including addendum letter of Drainage Comments, dated 10th January 2013.
- Submission on behalf of Stockland Developments by GLN Planning dated 21st December 2012.
- Submission of behalf of Diverse Property Solutions by RPS Australia East Pty Ltd dated 30th January 2013.
- NSW State Emergency Service - Exhibition of Marsden Park Draft Precinct Plan dated 21st December 2012
- Winten Property Group dated 21st December 2012
- Submission on behalf of Burton Property (NSW) Pty Ltd by Brown Consulting Pty Ltd received by the DPI 20th December 2012.
- NSW Office of Environment and Heritage dated 17th January 2013.
- Submission on behalf of B.Y. & S. Chung (proprietors of Golf Driving Range) by David Geddes dated 30th January 2013
- Various submissions by, and on behalf of, various individual land holders within the Precinct surrounding the Richmond Road and Vine Street intersection.

As a result of these submissions a further investigation into the Water Cycle Management strategy for the Precinct has been undertaken by J. Wyndham Prince. These investigations, together with the various submissions, will inform a revised Indicative Layout Plan (ILP) for the Precinct.

In response to further issues raised in the submissions, the following items have been included in the revised Water Cycle Management Strategy.

An update to the hydrology modelling and the development of our amended basin strategy, which considered:

- Adjustment of the storage capacity (Bx) factor in the XP-RAFTS modelling to better define local flows throughout the site.
- Reducing the number of basins discharging directly into the Little Creek riparian corridor, with the majority of the detention in the watercourse being managed by two (2) devices.
- Reviewing options to reduce the amount of imported fill required throughout the Precinct to minimise earthworks costs.
- Reviewing the arrangement of Basin 6 (adjacent Richmond Road / Vine Street intersection), by providing two independent detention systems to manage discharges at the Richmond Road / Vine Street intersection. Changes to this device were as a result of additional discussions held between J Wyndham Prince and the NSW Roads and Maritime Service (RMS) to inform the detailed design of the future Richmond Road upgrade.
- The combination of Basins 8 and 9 into a single device to treat discharges from the northern part of the Precinct at Richmond Road, along with removal of drainage channel TC05; and

- Adjustment of the planning within the central portion of the site to better align with the proposed first DA being prepared by Stockland Holdings, which involved the adjustment of drainage channel TC06 and detention Basin 5.
- Developing a further option of stormwater management within Basin 7B to allow for additional development along Vine Street in this locality.
- Reviewing the arrangement of Basin 7B discharging into Bells Creek, by relocating device further south, and providing site filling to ensure development has adequate freeboard to flooding in Bells Creek.

Updated hydraulic flood (TUFLOW) modelling for the Precinct as a result of the amendments to the Water Cycle Management strategy, which considered:

- The potential increase in developable land in the western portion of the Precinct adjacent Little Creek by removal of Basins B1, B2 and 1.
- The provision of additional developable land in the northern part of the Precinct along Richmond Road due to the adjustment of Basins 8 and 9 being consolidated into a single Basin 8, which has been relocated closer to the crossing of Richmond Road, and the removal of TC05 by adjusting sub-catchments draining into the adjusted Basin 8.
- Adjustment of the planning around Basins 5A, 5B and 5C, including the proposal by Stockland's, adjustment of the electrical substation arrangement and the relocation of transmission towers adjacent the proposed Richmond Road upgrade.
- Adjustment of channel TC08 and Basin 6 arrangements to allow more effective utilisation of potential storages in these areas, resulting in smaller footprints required for stormwater management in this area.

Development of a Post Exhibition Report that summarises the investigation and presents the results of this additional work.

This report should be read in conjunction of J. Wyndham Prince's Marsden Park Residential Precinct Water Cycle and Flood Management Strategy Report completed in 2012 (JWP WCFM 2012). Details of how each of the items raised in the submission have been addressed is provided within the following sections of this report

3 PREVIOUS WATER CYCLE AND FLOOD MANAGEMENT STRATEGY REPORT

J. Wyndham Prince completed the development of a Water Cycle and Flood Management Strategy Report (JWP WCFM 2012) to support the ILP for the Precinct, which was publicly exhibited in November 2012.

The key outcomes of this assessment were as follows:

- Inclusion of fifteen (15) detention basins to ensure post development flows from the Precinct are attenuated to less than the pre-development or existing conditions.
- Comprehensive flood modelling to assess the impacts of development within the Precinct and adjacent landowners.
- Development of detention basin concept plans.
- Development of a Preliminary Cost Estimate for all water management elements within the Precinct, to facilitate development of a Contribution Plan for the Precinct.
- Confirmation that works in the floodplain is possible with minimum impact on flood levels.
- Flood evacuation needs of the Precinct can be catered for within the future road design.
- Proposal for a Reduced Basin Strategy, which had the potential to provide significant Section 94 savings by removing basins which discharged directly into the South and Bells Creek corridors, without impacting on peak flow rates downstream of the Precinct.
- All assessments incorporated future expected increase in rainfall intensity as a result of a changed climate, of which all flood levels throughout the Precinct are calculated.

Full details of the previous assessment can be found in the Water Cycle & Flood Management Strategy Report (JWP WCFM 2012).

4 PUBLIC EXHIBITION OF DRAFT PRECINCT PLAN

A number of submissions were received as a result of the exhibition process that directly related to the Water Cycle Management Strategy for the Precinct. Details of the major items of concern and our responses are below.

4.1 Reduced Basin Strategy

Winten Property Group presented a submission outlining the proposal to remove basins within the Precinct which discharge directly into the South Creek and Bells Creek corridors, citing that detention systems are not required to ensure peak discharges within the creeks are managed to pre-development levels. Blacktown City Council (BCC) have raised concerns for the Reduced Basin Strategy (RBS), claiming that undetained discharges will "severely" impact local watercourses.

It should be noted that peak discharges under an RBS are similar to existing flows, hence the reference by Council that the RBS "severely changes" to hydrology appears to be referring to flow regime or volume of runoff, which significantly changes whenever any development takes place (with or without an RBS.) Most of the runoff changes will occur within internal watercourses of the Precinct. As part of any development adjacent to these watercourses an appropriate design to modified/rehabilitate riparian corridor would be required. Furthermore, trunk drainage channel throughout the Precinct would be designed to cater for these localised changes in flows and can easily be accommodated. The NSW Office of Environment and Heritage (OEH) also expressed concern regarding the RBS and suggested further investigations are required to confirm whether this strategy is acceptable.

BCC has suggested that under a traditional basin strategy, a number of basins along the western peninsula of the Precinct could be removed (Basin B1, B2, B3 and 1) by over compensating flows within Basin 2, which has been incorporated into the Post Exhibition investigation.

Even though the Reduced Basin Strategy in a valid Stormwater Management Strategy, it was decided that the Reduced Basin Strategy would not be pursued as part of the Post Exhibition investigation.

4.2 Hydraulic Modelling – Existing Catchment Conditions

BCC has suggested that for the existing condition modelling for MPP, that Marsden Park Industrial Precinct (MPIP) immediately to the south-east of the Precinct, should be considered as "undeveloped." The modelling undertaken to date assumes that as MPIP is an already gazetted Precinct, it is assumed to be developed.

The strategy that was developed for MPIP was such that peak flows exiting the Precinct are at or below pre-development conditions. Therefore, from a peak flow management point of view, the flows entering MPP are likely to be unchanged if we were to modify the hydrology modelling to include undeveloped flows from MPIP. However, the volume of runoff from the ultimate development of MPIP is critical in sizing of the water management devices downstream of MPIP within MPP.

Furthermore, the refinement of the actual climate conditions that will need to be managed by the MPP's Water Management devices would be subject to a separate DA process at the time of development of that stage. It is at that time the current level of development within the upstream catchment area should be assessed and not part of Precinct planning process.

Therefore the inclusion of MPIP as a developed catchment is appropriate and will ensure that sufficient land has been set aside for Water Management devices within MPP once the entire MPIP and MPP are developed.

BCC also requested that the flood modelling extents be increased upstream to include the entire Air Services Land to the south – there is no proposal to undertake any alterations to the site upstream of the proposed development extents, therefore there is expected to be no change to flooding profiles in this area, thus the model extent has not been amended.

However, an appropriate discussion will be included in the Precinct planning report regarding the planning within the Air Services Land. Furthermore, all flood maps will be modified to only illustrate flood extents within the development portion of the Precinct.

4.3 Pre Climate Change Assessment

BCC has suggested that there is a need to undertake an assessment of the Precinct without including the likely rainfall increase anticipated with a change in climate. This position was discussed with Council on the 28th October 2011 with the minutes of this meeting circulated to all that attended and confirming that *"BCC agreed with JWP approach for post Climate Change flow derived from a 15% increase in rainfall intensities"*

E-mail correspondence dated 19th January, 2012 to John Molteno of Blacktown City Council again clearly stated this approach and no dissenting reply was received, hence the Precinct modelling has progressed with a 15 % increase in rainfall for both the existing and developed conditions.

Council's desire to assess current climate conditions also extended to the need to undertake a current climate flood assessment. Our work in MPIP has proven that basin storage under both current and post climate conditions (which is critical for assigning land for these devices) are the same, with only a modification to the outlet arrangements being required, to manage the expected changes in climate.

We consider that the post climate assessment is an appropriate assessment to inform the ILP for MPP, hence no Current Climate assessment has been undertaken as part of the Post Exhibition Report.

As mentioned above, details of the any basin construction will be subject to a Development Application process and we consider that this is the most appropriate time for BCC to make an assessment of the current climate conditions and not required to inform the Master planning of the Precinct. Further to this, OEH consider that the adoption of post climate change rainfall conditions as a reasonable and pragmatic approach in terms of the proposed development for Flood Planning Level purposes as well as infrastructure design.

4.4 Water Quality Modelling

Blacktown City Council have noted that a bio-filtration filter media TN value of 500 mg/kg was adopted in the JWP modelling in lieu of the 800 mg/kg as provided in MUSIC as a default value. – The value of 500 mg/kg was adopted in accordance with the recommendation made by e-Water when in attendance to an advanced MUSIC modelling seminar in late 2011 by J Wyndham Prince staff. It was noted that a conservative value of 800 mg/kg is provided as a default. We are not aware of any requirements or standard modelling parameters regarding the adoption of this value within any Blacktown Council's DCP, thus the 500 mg/kg has been adopted.

The final water quality arrangements are more appropriate dealt with at the DA stage, and the current approach is considered appropriate for Precinct planning.

BCC has also stated that the design of Basin 3 and 4, from a water quality perceptive is unacceptable, as it will result in:

a) Storages that will regularly fill up to 3 m deep and then drain over a period of several days resulting in a public safety risk.

b) Problematic vegetation selection as the area will be subject to extended periods of wet and dry conditions.

c) Increased level of maintenance of the raingarden located downstream of the base flow management devices.

It is agreed that storage will be upwards of 3 m however, this level of inundation is temporary (Hydraulic Residence Time within these devices has been adjusted as part of Post Exhibition work to be a maximum of 24 hours – refer to Section 6 of this report for details). Vegetation selections are available where inundation of upward of 1 metre can be tolerated (i.e. Baumea). An appropriate surface treatment and plant selection for these areas of frequent inundation will form part of the detailed design of these basins. Sediment accumulation zones could form part of the detailed design, however, as detailed in Section 6 of this report, less than 3 mm per year sediment deposit is unlikely to result in a significant maintenance requirement. The advantage of providing these devices is that it also allows for the storage of a large volume, which is necessary for detention management for a significant catchment within the Precinct. The safety concerns of the increased storage depth can be easily be addressed with fencing off the devices, which has now been included in the estimated Section 94 costs. However, depths greater than 1 metre are only likely to occur about five (5) times per year.

The alternative treatment arrangement will result in a number of more traditional water quality devices (raingardens) being used in their place and located throughout the Precinct. This will significantly increase land take requirements, Section 94 costs implications and will result in a substantial increase in the level and cost of maintenance that BCC will be ultimately responsible for (potential maintenance saving of over $250,000 per year). The current arrangement is therefore considered to be the most cost effective water quality treatment for the Precinct.

The proposed raingarden downstream of the Basin 3 baseflow management device has been located such that it is clear of the proposed riparian corridor extents.

Council have also expressed concern that catchment areas adopted in the water quality modelling do not compare with the areas used in the hydrological modelling. In general, hydrological catchments are a combination of sub-catchment areas likely to drain to a certain point, whereas water quality catchments as adopted in MUSIC are equivalent to the overall total catchment draining to a particular treatment device broken down into landuse components. Furthermore, the sub-catchments adopted in the water quality assessment (MUSIC) are considerably larger than those used in hydrology (XP-RAFTS) as the MUSIC software model is required to undertake more complex calculations, so fewer, larger catchments are more easily handled by the software, rather than many, smaller catchments.

Council have noted that the devices used to treat stormwater from the medium and high density residential and other special uses (i.e. commercial, education facilities etc.) are not directed to the regional raingarden devices. Whilst the modelling undertaken has assumed that the road systems in these areas are directed to the regional raingarden devices, it has been assumed that the treated discharges from these areas are directed to the trunk drainage systems without further treatment by the regional raingarden devices. J Wyndham Prince are of the opinion that there is generally limited distance to the Precinct trunk drainage channels and that these flows can be conveyed in a “clean water system” to the trunk drainage channels. If required the inclusion of medium and high density residential to drain to the Precinct raingardens can be refined at this time.

The assessments undertaken as part of the rezoning process are a broad indication of what is expected over the Precinct as a whole. The detailed design process is likely to result in changes to the internal catchments, which in turn will modify the water quality treatment devices servicing the overall Precinct strategy.

BCC have requested that Richmond Road catchments not be considered in the water quality modelling and that the water quality treatment within the Precinct shall not need to be designed to overcompensate for Richmond Road catchments. As a result of this request, those devices that were specifically included in the Strategy to treat Richmond Road catchments have been removed from the Precinct strategy.

As part of the original Water Cycle Management Strategy of the Precinct, the Water quality treatment devices within other parts of the Little Creek catchment provide sufficient compensatory treatment (No additional increase in water quality device sizing) to allow the heritage Clydesdale Site to not require any water quality treatment, other than a GPT. However, if Council still require a device to service this part of the Precinct, then a device sized to 1% of the contributing catchment should be sufficient to ensure water quality targets are met. Details of this device would form part of the detailed design for the Clydesdale Site.

The Strategy does not include stormwater harvesting for the Precinct playing fields but could be provided at DA stage of the development.

4.5 Hydrological Modelling Parameters

BCC has suggested that the use of the South Creek XP-RAFTS calibration factor (storage coefficient multiplier) i.e. BX of 1.3, is inappropriate for the assessment of development impacts for MPP as it is likely to underestimate flows across the Precinct. A BX of 1.3 formed part of the original calibrated 1990 South Creek model and from an overall catchment modelling perspective, the calibrated model is considered to be the most appropriate model to be used in the MPP. Without additional calibration information to support a change to this parameter, it was considered inappropriate to amend a calibrated model as part of the original strategy.

A change to the calibration factor in the modelling i.e. BX of 1.0, is likely to lead to a change to the basin volume/outlet configurations together with flows through the Precinct.

As a result of Council's submission, the updated hydrological modelling that forms part of the Post Exhibition strategy has adopted the XP-RAFTS calibration factor of Bx = 1.0.

A copy of the draft South Creek study that is currently underway for OEH, Penrith and Blacktown Councils has been requested to inform the Post Exhibition investigation. However, as directed by DoPI, the model developed to support the exhibition investigation was to be used and updated for Post Exhibition amendment as the draft South Creek study data was not available at the time of writing this report.

Overall, the results of the hydrological modelling (see Section 5) as a result of adopting Bx = 1 have indicated that discharges to local catchments throughout the Precinct have increased, without significant change to the peak discharge levels within the main South Creek system.

4.6 Preliminary Concept Designs of Major Drainage Structures

BCC have commented on a number of general issues about the modelling parameters used in the basin designs and trunk drainage channel configurations and have suggested a number of invert level changes, the issues investigated as part of the Post Exhibition assessment include:

a) **Basin spillways designed for local PMF flows where practical** – current designs of spillways cater for local 0.6x PMF (100,000 year ARI). In a practical sense, it is unlikely that all PMF flows will ever reach the majority of the basins as the drainage systems and roads will have reached their collective capacities when discharges exceed 100 year ARI levels. For the cases where all of the PMF runoff is likely to

drain to the basins, the spillways have been made as wide as practicable given the basin embankment extents, and 0.6 PMF overflow depths have been reported.

b) **Maintaining minimum 5:1 batter slopes within all basins** – Batter slopes within the basins vary between 4:1 and 5:1, all embankment batter slopes downstream of the storages have been maintained at 5:1 throughout the Precinct.

c) **Maintaining 1% grade in the floors of all detention storages** – Active detention storages have been kept to a maximum of 1.5 m deep for the peak 100 year ARI storm event. In all cases where large storages are required, the depth restriction does not allow for an efficient storages arrangements if the floor grades are maintained at 1%, therefore, some of the basin floor grade have remain the same as the original concept design (i.e. 0.5%);

d) **Ensuring that grades within raingarden storages are at least 2% towards the media bed area within the extended detention zone** – details of the specific requirement is more suited to be considered at DA stage for all devices within the Precinct;

e) **Maintaining maximum 1.0 m depth for peak 100 year ARI discharges within drainage channels** – this criteria has been generally maintained throughout the Precinct, with the exception of a few locations. The downstream portions of TC01 are designed for 100 year ARI discharges of up to 70 m^3/s, and TC02 (which leads into TC01). In addition to this, TC08 which passes through the proposed Town Centre (where the channel width is restricted to 30 m), is expected to accommodate flows of over 30 m^3/s. Portions of these watercourses have been designed to cater for peak 100 year ARI flows with depths of up to 1.5 m;

f) **Ensuring that cross fall grades within the drainage channels are minimum 1% when longitudinal grades are minimum 1%, and increased to 2% cross fall when longitudinal grades are less than 1%.** - this criteria has been generally maintained throughout the Precinct with the exception of the downstream portions of TC01 and TC04 (due to channel widths greater than 50 m), where cross fall grades of 1% are used when longitudinal grades are less than 1%;(see 9351SK324 for details)

g) **Flow Spreaders to be used for raingarden inflows, and main inflows to be offset from discharging directly into the raingardens** – this will be applied where practical, though it is expected that these details can be determined at detailed design stages of individual development stages.

h) **Manning's n values adopted in the flood modelling appears low, to be checked** – the Manning's n values adopted in the proposed channels was 0.07, which is generally in accordance with the expected riparian planting expected within the proposed channels. The Natural Channel Design Guidelines (Brisbane, 2000) indicate that a channel planted such that the bed has a roughness coefficient of 0.06 and banks at 0.12, result in a bankfull roughness of 0.07, which was adopted in the proposed channels within the flood model. Refer to Plate 4.1 below for the indicative riparian channel arrangement with nominated Manning's value for bankfull condition.

The values adopted in the MPP assessment are generally within the acceptable range as recommended in Australian Rainfall and Runoff Project 15 document. One exception is the paved roads value (0.013) being less than the recommended range (0.02 – 0.03), however, the area where this is adopted is over Richmond Road, where flooding is generally clear for all events up to 500 year ARI.

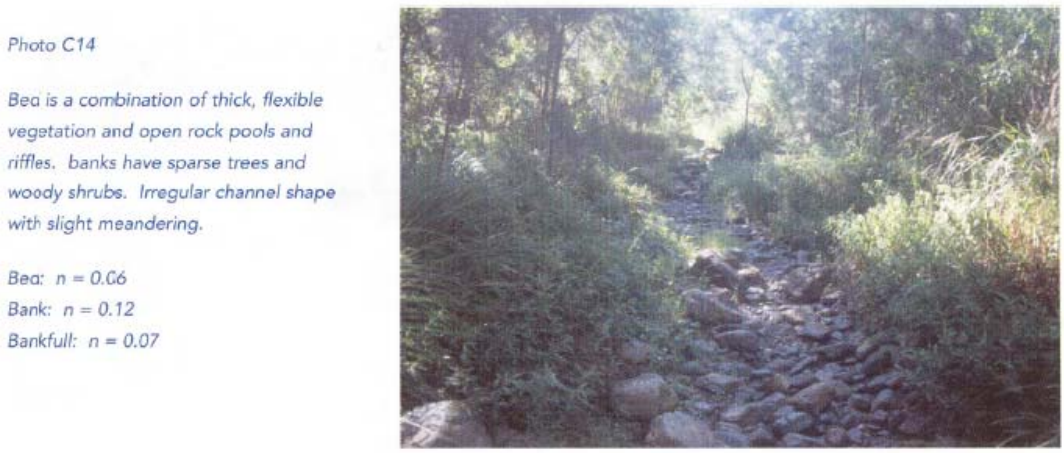

PLATE 4.1 – INDICATIVE ASSUMED CHANNEL ARRANGEMENT
(Source: Natural Channel Design Guidelines, Brisbane City Council, 2000)

TABLE 4.1 – ADOPTED MANNINGS VALUES

Land Use Type	Manning's 'n' as Adopted by JWP	Acceptable Range of Manning's 'n' as Recommended in AR&R Project 15
Residential areas – low density	0.10	0.1 – 0.2
Open pervious areas, minimal vegetation (grassed)	0.03	0.03 – 0.05
Open pervious areas, thick vegetation (trees)	0.08	0.07 – 0.12
Waterways/channels – existing creek lines	0.045	0.04 – 0.1
Waterways/channels – vegetated	0.07	0.04 – 0.1
Paved roads/car park/driveways	0.013	0.02 – 0.03

Acceptable Range derived from *"Table 10-1 Valid Manning's 'n' Ranges for Different Land Use Types"* presented in *Project 15: Two Dimensional Modelling in Urban and Rural Floodplains* (AR&R - 2012)

Other suggestions that refer to specific devices include:

a) **Raising Basin flood levels of Basin 5** – this will impact on the clearance to transmission lines, furthermore, raising Basin 5 will incur further fill requirements to the surrounding development, as Basins 5A and 5B will also need to be raised accordingly. Previously designed levels have generally been adopted in the Post Exhibition assessment. The integration with the future Richmond Road upgrade will be an important design constraint in this locality together with the existing discharge level downstream of Richmond Road;

b) **Raise Basin 6B to reduce cut batter to the south** – Basin 6 arrangement has been redesigned to be a cascading system, with the storage level of Basin 6A above the 100 year top water level of Basin 6B. Raising Basin 6B will also raise Basin 6A, which in turn will limit the grading of drainage channel TC08 (already at 0.5% and 0.7% longitudinal grade from the Marsden Park Industrial Precinct design level at South Street to Basin 6A). The NSW Roads and Maritime Service (RMS) had concerns that the proposed culvert crossing under Richmond Road (which formed the hydraulic link between the two portions of the Basin) would silt-up at such a shallow grade with standing water. RMS suggested that the culvert grade be lifted to reduce the possibility of siltation, and further suggested that the storages be separated and form a cascading system. These amendments have been incorporated into the Post Exhibition investigation;

c) **Removing Basin 7A and direct all 100 year ARI flows to reconfigured Basin 7B** – Basin 7B is about 2 m higher than Basin 7A, so there will be a substantial catchment which will not be able to drain to Basin 7B, so Basin 7B will need to be increased in size to overcompensate for the area bypassing detention.

Furthermore, considerable design requirements will be imposed on the local infrastructure to ensure that the majority of the 100 year ARI local flows are directed to Basin 7B, across Grange Avenue. Therefore Basins 7A and 7B have been retained for these investigations. Furthermore, an alternate Basin 7B concept design has been developed which is located further south and is now situated between residential blocks fronting Grange Avenue and South Street, the hydrological and hydraulic modelling assessments have been updated accordingly. Two options for the configuration of this device are provided in this report. One including a playing field (9351SK322-D) and one without (9351SK330-A). The playing field option was used in the flood modelling, with the other arrangement provided if a playing field is ultimately not provided for the Precinct.

d) **The proprietors of a local Golf Driving Range submitted an objection to the rezoning of the land, with particular reference to the location of Basin 8, as it was proposed over their existing facilities.** –By removing the constraint formed by the existing avenue of trees and consolidating the devices into one basin – Basin 9 has been removed and Basin 8 has now been relocated and reconfigured to accept all discharges from the catchment to Richmond Road. Further to this, rearranging the road alignments also allows the removal of drainage channel TC05 by providing basin sub-catchments which do not exceed 15 ha (a trigger Council requires for open trunk drainage systems). These updates have reduced the impact the basin has on the property such that only the northern portion of the lot adjacent Richmond Road contains a part of the basin;

e) **Consideration of lifting drainage channels to reduce cut** – the current trunk drainage arrangement provides an ultimate outcome from both a drainage function and does not increase the level of fill across the site. Refinement of final levels are more suited to be assessed at detailed design.

f) **Issues regarding alignment and arrangement of Channel TC08 from the Marsden Park Industrial Precinct** – the design has adopted the preliminary alignment and levels from the MPIP, and is considered appropriate for this planning assessment. Refinement can occur to adjust road patterns at the DA stage.

4.7 Redesign of Basin 5 Arrangement

Within the Stocklands submission, a number of proposed amendments to Basin 5 have been suggested to better align with Stockland planned first Stage DA. These include:

a) **Reducing the longitudinal grade of drainage channels TC03, TC04 and TC09, to minimise fill requirements. The intention was to provide 0.2% longitudinal grades within the drainage channels, in conjunction with a "sawtooth" road grading system along the channels, to allow a steady rise to dry land under extreme flooding conditions.** – the change to 0.2 % longitudinal grade would result in non-compliant Trunk Drainage Channels from BCC perspective The move to 0.2 % longitudinal grade also has a two-fold impact:

1) The Trunk Drainage Channel will require an increase in channel width (TC04 by up to 40 – 50 m) over the original design; and

2) This would reduce the developable land surrounding these devices.

The impact that 0.2 % longitudinal grade will have on the overall Precinct master plan would be considerable, therefore we have adopted the same design philosophy for these channels (0.5 % longitudinal grade with 1 % base crossfall to invert) as in the original strategy development.

b) **The relocation of the Transgrid transmission pylon, the shifting of the trunk drainage channel to better align with Stockland first stage release, and the refinement of the electricity substation have all impacted on the design and operation of Basin 5.** – Stocklands have proposed an alternative arrangement to the northern portion of the Basin 5 detention system, including:

- relocation of the transmission tower pylon (in accordance with relevant Transgrid advice);
- rearrangement of the electrical substation proposed to the north of basin adjacent Richmond Road;
- adjustment of the proposed culvert crossing alignment under Richmond Road;
- Provision of an overland flow path to direct basin discharges towards the abovementioned culvert system;
- Layout rearrangements of Basin 5A and downstream Basin 5C; and
- Realignment of channel TC06 to allow development to be facilitated

The majority of the suggestions to amend Basin 5 do not result in an unacceptable Basin arrangement and have subsequently been integrated into the updated design.

4.8 Evacuation Strategy

The NSW State Emergency Service (SES), NSW Office of Environment and Heritage (OEH) and Blacktown City Council have expressed concern regarding the evacuation plan for the MPP, in particular the capacity of the evacuation route when in conjunction with evacuation of other suburbs when using Richmond Road during an extreme flooding event.

As the Molino Stewart original report clearly states, convergence with regional evacuation traffic will have a significant impact on the evacuation of Marsden Park if current developments are given improved access to Richmond Road or future developments require evacuation onto Richmond Road and/or the M7. The only way that this can be dealt with effectively is if new development east of South Creek (including Marsden Park and Schofields) are evacuated to local evacuation centres above the PMF, which keeps the traffic from these new developments off Richmond Road and the M7. The convergence issue with other suburbs and development areas were outside the scope of this study and did not form a part of this assessment.

The move to “a :shelter in place” approach for the management of flood effected evacuees is a significant departure for the current evacuation strategy employed by NSW SES. This change is outside of the consideration of Precinct planning and is seen as a NSW SES role to amend/update the evacuation strategy for both MPP and the other area of the Hawkesbury/Nepean basin.

Therefore, the original strategy presented in the exhibition version of our Water Cycle and Flood Management strategy report is still valid and remain suitable to support the rezoning of the Precinct

4.9 General Submissions From Local Land Owners and Stakeholders.

The majority of the remaining submissions are from local landowners and stakeholders who have raised issues and concerns regarding the misuse of their “prime real estate” to what they believe to be “lesser” landuse than for which they believe it is worth (i.e. stormwater management in lieu of residential or commercial development).

Major concerns were received regarding the perceived impact that the location of the water management devices on their land may have on the value of their land. In addition, a number of submissions have suggested that the water management devices proposed to be located on their land should be relocated elsewhere.

Some Landowners appeared reluctant to relocate, or could not see how they could release a portion of their land for them to remain on a part of their property.

Six (6) of these submissions by local residents were focussed on objections to the provision of Basins 7A and 7B. It should be noted that as part of the Reduced Basin Strategy investigation, these basins are not required. However as support of the Reduced Basin Strategy has not been received, the need to manage post development flows prior to discharge to Bells Creek is required.

To address a number of submissions in this area, a row of residential development has been included adjacent to Grange Avenue with Basin 7B moved further south. As mentioned above, two concept plans for Basin 7B are presented in this report.

The work undertaken within original Water Cycle and Flood Management strategy for MPP (JWP WCFM 2012) is still considered to be a valid approach for stormwater management in this portion of the catchment. If further investigations are undertaken as part of a Development Application process for the redevelopment of this area, there may be opportunity to gain support from BCC to a reduced basin strategy in this locality.

5 UPDATED BASIN STRATEGY & HYDROLOGY MODELLING

As mentioned in Section 4.5, there has been a further detailed hydrological assessment undertaken as part of the refinement to the Basin Strategy to the Precinct.

5.1 Updated Discharges and Flow Targets

As stated in Section 4.5, and following instruction from DoPI, the parameters adopted in the original Water Cycle and Flood Management Study which were consistent with the original model calibrated for the South Creek assessment (WRC, 1992) have been used in this Post Exhibition investigation. The expectation was that the latest South Creek flood study being undertaken for both BCC and Penrith City Council would be provided to inform the Post Exhibition assessment, however the timing is such that it has not been provided to J. Wyndham Prince for review and/or use in this assessment.

However, in accordance with BCC's submission, the adopted storage coefficient multiplication (Bx) factor in the XP-RAFTS modelling was altered from the adopted calibrated South Creek Model of 1.3 to 1.0. As a result of this change, discharges from various locations throughout the site under both pre-development and post-development conditions have altered from that previously reported in the pre-exhibition report (JWP WCFM, 2012).

The 100 year ARI discharges along the main South Creek watercourse are similar to the results previously reported, with the most obvious flow changes occurring within the local sub-catchments from the development area contributing to the system.

A summary of the increased discharges under pre-development conditions are indicated below in Table 5.1. The location of the point of comparison as listed in Table 5.1 and is provided in Plate 5.1 below.

PLATE 5.1 - FLOW COMPARISON POINT LOCATIONS

TABLE 5.1 – UPDATED PRECINCT STRATEGY DISCHARGES

Node	Peak Flow (m^3/s) - Existing Conditions - 2 Year ARI		Peak Flow (m^3/s) - Existing Conditions - 100		Flow Increase (%) (Bx=1/Bx=1.3)	
	BX = 1.3	Bx = 1.0	BX = 1.3	Bx = 1.0	2y ARI	100y ARI
West_D	4.84	5.82	16.43	18.25	20.3%	11.1%
SC_137C	539.06	559.34	1334.43	1334.27	3.8%	0.0%
LC_03	105.31	111.28	275.40	285.45	5.7%	3.7%
LC_05	111.16	117.87	300.67	309.21	6.0%	2.8%
LC_09	112.75	119.53	307.06	315.44	6.0%	2.7%
SC_138	546.77	566.86	1353.21	1351.34	3.7%	-0.1%
SC_139	582.10	603.80	1438.94	1436.65	3.7%	-0.2%
North_D	5.79	7.07	18.14	20.74	22.0%	14.3%
SC_140	584.16	605.67	1443.46	1440.76	3.7%	-0.2%
BC_1.21	57.30	61.05	151.83	166.15	6.6%	9.4%
BC_1.22	58.39	62.08	154.10	167.98	6.3%	9.0%
N-1.08	10.08	11.10	31.56	34.41	10.1%	9.0%
N-1.13	19.44	22.55	59.44	66.49	16.0%	11.9%
N-1.15	22.48	26.01	68.51	75.57	15.7%	10.3%

A copy of the updated discharges under both pre-development and post-development conditions are provided in Attachment B.

5.2 Updated Basin Strategy

The updated hydrological modelling and amended basin strategy has concluded that an overall reduction in the basin volumes throughout the Precinct will not have an adverse effect on the detention performance of the entire development. Details of the amendments to the basins are summarised in Table 5.2 below.

TABLE 5.2 – AMENDMENTS TO PRECINCT BASIN STRATEGY

Basins	2013 Basin Storage (Post Exhibition) (m^3)	2012 Basin Storage (Original Exhibition) (m^3)
Basin A1	23400	23400
Basin A3	10200	10200
Basin B1	Removed	14100
Basin B2	Removed	7400
Basin B3	Removed	10700
Basin 1	Removed	14100
Basin 2	35000	28700
Basin 3	121500	121500
Basin 4	59600	87000
Basin 5	60900	57600
Basin 6A	11300	27400
Basin 6B	13800	
Basin 7A	17600	17600
Basin 7B	19200	19200
Basin 8	15300	20800
Basin 9	Removed	1000
Totals	**387800**	**460700**

The strategy includes eleven (11) detention basins, with a total storage volume of approximately 387,800 m^3. This arrangement provides an optimal solution to the flow management needs for the Marsden Park Residential Precinct, for discharges into South Creek, Bells Creek and across Richmond Road.

5.3 Discharge Estimates

As a result of the amendments to the hydrological modelling and basin strategy, the discharges from various locations throughout the development are provided in Table 5.3 below, with a summary of the basin performance provided in Table 5.4 and Table 5.5.

TABLE 5.3 – SUMMARY OF PEAK FLOWS

Existing Node	Peak Flow (m^3/s) - Existing Conditions		Developed Node	Peak Flow (m^3/s) - Developed Conditions		Flow Ratio (Post/Pre)	
	2y ARI	100y ARI		2y ARI	100y ARI	2y ARI	100y ARI
West_D	5.82	18.25	West_D	6.06	16.89	1.04	0.93
SC_137C	559.34	1334.27	SC_137C	559.00	1334.05	1.00	1.00
LC_03	111.28	285.45	LC_03	111.27	282.26	1.00	0.99
LC_05	117.87	309.21	LC_05	117.20	304.50	0.99	0.98
LC_09	119.53	315.44	LC_09	119.30	312.65	1.00	0.99
SC_138	566.86	1351.34	SC_138	566.61	1351.32	1.00	1.00
SC_139	603.80	1436.65	SC_139	601.94	1433.38	1.00	1.00
North_D	7.07	20.74	North_D	6.69	20.03	0.95	0.97
SC_140	605.67	1440.76	SC_140	604.27	1438.89	1.00	1.00
BC_1.21	61.05	166.15	BC_1.21	60.97	165.58	1.00	1.00
BC_1.22	62.08	167.98	BC_1.22	62.00	167.81	1.00	1.00
N-1.08	11.10	34.41	N-1.08	10.41	31.42	0.94	0.91
CSim_231	6.40	19.15	D_226	5.98	19.03	0.93	0.99
N-1.13	22.55	66.49	N-1.13	20.85	63.95	0.92	0.96
Dummy_3	2.30	6.78	D_239	2.03	6.64	0.88	0.98
N-1.15	26.01	75.57	N-1.15	23.83	72.44	0.92	0.96

NOTE: Final Peak Flow values are to be determined upon completion of the detailed designs and preparation of the Development Application for each basin.

5.4 Basin Performance

The performance of the basins for the 2 and 100 year ARI storm events are detailed in Table 5.4 and Table 5.5, respectively.

TABLE 5.4 – DETENTION BASIN PERFORMANCE – 2 YEAR ARI

Basin	Peak Inflow (m^3/s)	Peak Outflow (m^3/s)	Basin Volume Used (m^3)	Stage Used (m)
Basin_A1	10.98	2.41	7855	16.57
Basin_A3	3.84	1.47	1960	16.46
Basin_2	7.69	0.72	19971	16.74
Basin_3	31.72	7.54	73513	16.63
Basin_4	25.80	5.47	31750	16.74
Basin_5A	11.43	3.70	6848	22.22
Basin_5B	6.33	3.31	5130	22.15
Basin_5	11.20	5.81	13494	20.65
Basin_6A	17.14	12.21	4834	28.70
Basin_6B	13.33	10.50	7866	27.39
Basin_7A	6.91	0.58	8242	19.10
Basin_7B	6.02	0.52	6566	22.51
Basin_8	9.08	1.84	7539	18.98

TABLE 5.5 – DETENTION BASIN PERFORMANCE – 100 YEAR ARI

Basin	Peak Inflow (m^3/s)	Peak Outflow (m^3/s)	Basin Volume Used (m^3)	Stage Used (m)
Basin_A1	21.76	5.53	17826	17.15
Basin_A3	7.60	2.04	5154	17.04
Basin_2	15.77	3.44	35173	17.20
Basin_3	70.49	30.05	121611	17.20
Basin_4	51.99	16.54	56995	17.16
Basin_5A	22.37	12.26	13631	22.73
Basin_5B	16.90	12.38	12900	22.63
Basin_5	26.52	18.51	32623	21.10
Basin_6A	37.90	30.43	10784	29.07
Basin_6B	32.88	31.42	13557	27.79
Basin_7A	14.02	3.35	17987	19.73
Basin_7B	13.23	1.58	18586	23.14
Basin_8	18.17	6.25	15065	19.49

Details of the catchment assumptions used in the XP-RAFTS modelling for both the existing and developed conditions is provided in Appendix B.

5.5 Modelling Discussion

The Post Exhibition Basin Strategy amendments have resulted in flows throughout the Precinct to be managed to or below pre-development levels and provide a strategy that will ensure that the development of the MPP can be progressed without impacting stormwater discharges external to the site.

An updated stormwater management plan is provided in Figures 5.1 and 5.2 to indicate the general location of the stormwater management devices throughout the Precinct. The updated catchment layout as adopted in the Post Exhibition assessment is shown in Figure 5.3.

The major road crossings within the Precinct which were sized to be flood-free up to the 500 year ARI storm event are indicated as bridge or culvert crossings on Figure 5.4, with the relevant estimated contribution plan costs shown in Table 8.1.

6 UPDATED WATER QUALITY MODELLING

As discussed in Section 4.4, there has been further adjustments to the Baseflow management devices (i.e. Basins 3 & 4) to address Council's concerns. Therefore, an updated water quality assessment have been undertaken as part of the refinement to the Precinct strategy.

6.1 Updated Design of Baseflow Management Devices

Following discussions with Blacktown City Council at a meeting held on 3rd June 2013, the parameters adopted in the original water quality modelling for the Baseflow management devices (Basins 3 and 4) have been adjusted. The indicative hydraulic residence time for the pond area has been limited to 24 hours. The previous assessments undertaken as part of the exhibition process assumed hydraulic residence times of over 50 hours in Basin 3 and over 40 hours in Basin 4. The expectation from BCC is that the maximum allowable hydraulic residence time within these devices should be limited to 24 hours.

The outlet configurations of the devices were adjusted in the MUSIC models to provide the hydraulic residence time of 24 hours, and the downstream polishing raingarden area was then adjusted to ensure that the water quality targets are met at the various discharge points.

6.2 Updated Device Parameters

The updated water quality modelling has concluded that an overall increase in the raingarden areas downstream of the basins is required to compensate for the reduction in hydraulic residence time within the baseflow management devices.

Details of the adjusted pond parameters are summarised in Table 6.1 and relevant downstream raingarden area requirements and expected sedimentation loads are summarised in Table 6.2.

TABLE 6.1 – AMENDMENTS TO PONDS 3 & 4 AND ASSOCIATED RAINGARDENS

Adopted Pond Storage Properties	**Basin 3 Pond**	**Basin 4 Pond**
Surface Area (m^2)	45000	25000
Extended Detention Depth (m)	2	1.5
Permanent Pool Volume (m^3)	0	0
Seepage Loss (mm/hr)	0	0
Adopted Pond Outlet Properties		
Equivalent Pipe Diameter (mm)	562	390
Overflow Weir Width (m)	5	5
Notional Detention Time (hrs)	24.0*	24.0*
Required Downstream Raingarden Bed Area (m^2)	**3000**	**1800**

Notes: * Equates to duration of storage in basin

TABLE 6.2 – ASSESSED SEDIMENT LOADS FOR PONDS 3 & 4

MUSIC Model Results		Basin 3		Basin 4	
Inflow	(kg/yr)	97800		54800	
Pond Area	(m²)	45000		25000	
Effective Silt Accumulation Area	(m²)	20000		15000	
Design Designation		Previous	Updated	Previous	Updated
Modelled Pond HRT	(hours)	54	24	41	24
Modelled Pond Outlet	(mm)	375	560	300	390
Required Raingarden Area	(m²)	1600	3000	1600	1800
Pond TSS Outflow	(kg/yr)	44400	51500	28200	30500
Resultant Pond TSS Capture	(kg/yr)	53400	46300	26600	24300
Raingarden TSS Outflow	(kg/yr)	27500	26500	14800	15800
Resultant Raingarden TSS Capture	(kg/yr)	16900	25000	13400	14700
Total TSS Capture	(kg/yr)	70300	71300	40000	39000
Pond TSS Load	(m³/yr)	29.7	25.7	14.8	13.5
Additional Coarse Sediment	(m³/yr)	23.0	23.0	13.0	13.0
Raingarden TSS Load	(m³/yr)	9.4	13.9	7.4	8.2
Indicative TSS Depth in Pond	(mm/yr)	2.6	2.4	1.9	1.8
Indicative TSS Depth in Raingarden	(mm/yr)	5.9	4.6	4.7	4.5

The results of the expected sedimentation loads are derived from the results extracted from the MUSIC modelling, with an assumed adopted sediment density of 1,800 kg/m³. It is estimated that an additional 0.1 m³/ha per year of additional coarse sediment will be accumulated along with the TSS load throughout the upstream catchment. The total captured sediment load is a combination of the captured TSS load as determined by the MUSIC assessment, plus the estimated coarse sediment load.

The total estimated sedimentation volume was determined to be up to 2.4 mm/yr in Pond 3, and up to 1.8 mm/yr in Pond 4

7 FLOOD MODELLING

The major element of the Post Exhibition investigation that will influence the flood level through the Precinct are as a result of the changes to the hydrological modelling (see Section 5.4). The flood modelling (TUFLOW) has been re-run as part of the Post Exhibition investigation.

7.1 Post Exhibition Changes

There have been some updates to the flood modelling since the ILP was exhibited in November, 2012. The changes have occurred for a number of reasons including comments received during the public exhibition phase, refinements to the hydrologic models and refinement of the ILP. The changes made to the flood modelling are summarised as follows:

- Adjustment of the Bx factor to 1.0 (from 1.3) which have resulted in higher peak discharge rates within the Precinct.
- Basins B1, B2, B3, 1 and 9 have been completely removed, the detention volumes in Basins 4, 6 and 8 have been reduced and Basins 2 and 5 have been slightly increased and redesigned as part of these investigations. The relevant outlet configurations have also been updated.
- Manning's 'n' roughness coefficient for the internal open channels within the Precinct under developed conditions have been adjusted to be more consistent with the expected vegetation proposed within the corridors.

The TUFLOW flood models (described in the Water Cycle and Flood Management Strategy Report – (JWP WCFM, 2012) were modified to include the above changes.

The results of the revised modelling are described in the following sections.

7.2 Flood Extent Mapping

For the updated flood study, the post development 2, 100, 500 year ARI and PMF was reanalysed to account for the post exhibition updates and submissions.

A series of maps have been developed for this study and are as follows:

1. 2, 100, 500 year ARI and PMF peak maximum Depth Profiles
2. 2, 100, 500 year ARI and PMF peak maximum Hazard Classification
3. 100 year ARI Flood Difference Mapping

All events were assessed for zero tailwater, whilst the 100 year ARI and PMF were also assessed in conjunction with 100 year ARI tailwater conditions from the Hawkesbury River.

The revised flood extents and depth profile mapping for the updated modelling in accordance with the storm events outlined above for the 2, 100 and 500 year ARI are shown on Figures 6.1, 6.2, 6.4 and 6.6 (pre-development conditions) and Figures 6.11, 6.12, 6.15 and 6.18 (post development conditions). The results of the PMF assessments are shown on Figures 6.7, 6.9, 6.19 and 6.21.

7.3 Flood Difference Mapping

Flood Difference Maps have been prepared which indicate the difference in 100 year ARI flood levels (for both no tailwater and 100 year ARI regional tailwater conditions) between the existing case and the proposed development scenarios within the Precinct.

The results of the flood difference mapping for each of the scenarios are shown in Figures 6.14 (no tailwater) and 6.17 (100 year ARI tailwater).

The figures indicate that development of the Precinct with the recommended controls, proposed site regrading, and detention systems will result in minor increases (maximum of 0.10 m) generally within the riparian corridors only (no development currently present), with some minor increases in flood levels within the bounds of the Precinct.

Five (5) specific locations are shown on Figures 6.14 and 6.17 where increases have been identified and detailed below:

- Bells Creek at the upstream extents of the Precinct – due to the expected development extent into the Bells Creek floodplain and resulting change in roughness, there will be a minor increase (0.06 m) in 100 year ARI flood levels.
- Discharge point from Basin 6 outlet across Vine Street into watercourse – whilst discharges are kept below pre-development levels, expected future road works will alter flood levels around the locality, impacting flood levels on the road.
- Culvert outlet discharging flows from Basin 5 – Discharges from Basin 5 are managed to attenuate flows to below pre-development levels from the Precinct, however, local inflows from the future Richmond Road upgrade contribute undetained flows to the same location, causing a localised increase in flooding levels.
- Culvert outlet discharging flows from Basin 8 – Basin 8 effectively detains discharges from the Precinct, however, localised increases (0.10 m) from undetained discharges from upgraded Richmond Road contribute additional flows, locally increasing flood levels.

7.4 Flood Hazard Mapping

Flood Hazard Maps have been prepared which indicate the peak extent of various hazard categorization during the critical flood events for each ARI event modelled.

The revised flood hazard mapping for the updated modelling in accordance with the storm events outlined above for the 100 year ARI are shown on Figures 6.3 and 6.5 (pre-development conditions) and Figures 6.13 and 6.16 (post development conditions). The results of the PMF assessments are shown on Figures 6.8, 6.10, 6.20 and 6.22.

A comparison between the existing conditions and the post-development conditions within the Precinct shows that the proposed fill extents do have a localised impact on flooding hazard within the drainage reserves of the Precinct boundary. There is a visible increase in the high flood hazard categorized area (coloured red in Figure 6.5) within the Little Creek and tributary drainage corridors, adjacent the areas where the fill has been introduced. Some of this area has been reduced where the compensatory cut has been removed within the South Creek floodway (Figure 6.8).

This potential impact that this change in hazard categorisation may result in the requirement for bank stabilization and may need to be further assessed as part of the detailed design of these portions of the creeklines and channels.

7.5 Floodplain Reclamation

As with the original Water Cycle Management Strategy, floodplain reclamation forms an integral part in the delivery of the Marsden Park Residential Precinct.

With the refinement of development extents and modifications to the Basin arrangements, we have again undertaken an assessment of the floodplain storages below RL 17.3 m AHD (i.e. regional 100 year ARI flood level).

The assessment indicates that there will be an overall 208,000 m³ decrease in floodplain storage across the Precinct. Notwithstanding this minor loss, the flood modelling has shown that in general, the development can occur without impacting flood levels downstream of the Precinct.

The issue of a balance of floodplain storage was raised by Blacktown City Council in their submission.

A strategy to deliver a balance floodplain storage is to provide a flood storage device that will be integrated into the floodplain areas within the South Creek Floodplain. The additional volume will be obtained by providing a depressed area within the floodplain equivalent to 208,000 m^3 to re-gain this loss of floodplain storage.

The concept is that this depressed area will be available to floods in excess of the 2 year ARI event and drain after the major event has passed by a series of discharge points into South Creek or Little Creek. A further advantage of the device is that additional fill can be sourced from this device to reduce the required imported fill volumes. This device could be simply a 200 x 1040 m areas excavated to be 1 m below the proposed developed surface level or 300 x 1400 with only a 0.5 m depth of storage. This device will also provide a visual amenity in what otherwise would be a plain, grassed area of the Precinct.

Please note that this device has not formed part of the flood modelling undertaken as part of the Post Exhibition investigation for the Precinct. Details of the final configuration of this device would form part of a future DA for the development within South Creek.

It is also important to consider the staged development of the Precinct. The DCP needs to ensure that floodplain storages below 17.3 m AHD are balanced at all stages of the development to ensure that status quo on floodplain storage is maintained.

8 UPDATED BASIN CONCEPT AND COST ESTIMATE

Part of the process to inform the flood modelling, the basin concepts have been redesigned and updated to align with the Post Exhibition investigation.

Detail of the updated information from Basins 2, 4, 5, 6 and 8 and channels TC06 and TC08 is provided in Appendix D.

Detailed concept designs were prepared for each of the proposed combined detention / water quality basins and the trunk drainage reserves. The areas where detention systems have been removed from the Strategy still require water quality management devices, which will be situated within either the floodplain area outside the designated floodway, or the development footprint of the Precinct.

The detailed concept designs for the detention basins and water quality raingarden devices are included in Appendix D.

8.1 Preliminary Construction Cost Estimates

Estimates of quantities and preliminary cost estimates were also prepared for each of the basins and drainage reserves. This information will assist Blacktown City Council in the preparation of the Section 94 plan for the development.

A summary of the costs associated with the construction of the detention basins, raingardens and the drainage reserves are presented in Table 8.1. The amended strategy has reduced Section 94 cost estimate for stormwater management by over $9 M in comparison the original strategy Section 94 estimates. A more detailed breakdown of the Estimate of Quantities and the associated construction estimate for each basin and drainage reserve is provided in Appendix D.

These Section 94 costs equate to less than $8,400 /lot for stormwater management devices, which is considered to be reasonable for new urban development in Western Sydney and well within the $30,000 Section 94 cap imposed by new development. As a comparison, estimated Section 94 costs of the Box Hill and Box Hill Industrial Precinct are approximately $10,200 per lot, and over $13,500 per lot for the Schofields Precinct, both of which form other parts of the North-Western Sydney Growth Centre.

TABLE 8.1 – SUMMARY OF WATER MANAGEMENT DEVICES CONSTRUCTION COSTS

J. WYNDHAM PRINCE
CONSULTING CIVIL INFRASTRUCTURE ENGINEERS & PROJECT MANAGERS

PRELIMINARY COST ESTIMATE

PROJECT: Marsden Park Residential Precinct

CLIENT: Winten Property Group

JWP Plan Number/Version: 9351SK301-324 BASINS AND CHANNELS COST SUMMARY

NO.	ITEM		AMOUNT Exc GST$
1	BASIN A1		$3,976,000.00
2	BASIN A3		$2,836,000.00
3	BASIN 2		$2,440,000.00
4	BASIN 3		$4,259,000.00
5	BASIN 4		$7,296,000.00
6	BASIN 5		$7,862,000.00
7	BASIN 6		$6,788,000.00
8	BASIN 7A		$1,421,000.00
9	BASIN 7B		$1,604,000.00
10	BASIN 8		$2,104,000.00
		COMBINED BASINS / RAINGARDENS SUB-TOTAL	**$40,586,000.00**
11	RAINGARDEN A4		$273,000.00
12	RAINGARDEN B1		$831,000.00
13	RAINGARDEN B2		$549,000.00
14	RAINGARDEN B3		$507,000.00
15	RAINGARDEN 1		$703,000.00
16	RAINGARDEN 3		$1,201,000.00
17	RAINGARDEN 3F		$787,000.00
18	RAINGARDEN 4		$762,000.00
19	RAINGARDEN 5D		$757,000.00
20	RAINGARDEN 5B-OS		$342,000.00
21	RAINGARDEN 6E		$830,000.00
		INDEPENDENT RAINGARDENS SUB-TOTAL	**$7,542,000.00**
22	CHANNELS TC1 & TC2		$8,899,000.00
23	CHANNEL TC3		$1,477,000.00
24	CHANNEL TC4		$4,724,000.00
25	CHANNEL TC6		$1,312,000.00
26	CHANNEL TC7		$932,000.00
27	CHANNEL TC8		$2,853,000.00
28	CHANNEL TC9		$1,143,000.00
		CHANNELS SUBTOTAL	**$21,340,000.00**
29	BRIDGE CROSSING 1		$5,680,000.00
30	CULVERT CROSSING 2		$2,496,000.00
31	CULVERT CROSSING 3		Incorporated into Channel TC1 Costs
32	CULVERT CROSSING 4		Incorporated into Channel TC1 Costs
33	BRIDGE CROSSING 5		$5,680,000.00
		BRIDGES SUBTOTAL	**$13,856,000.00**
		STORMWATER & DRAINAGE SECTION 94 TOTAL ESTIMATE	**$83,324,000.00**

9 SUMMARY & CONCLUSION

The Marsden Park Residential Precinct planning package was placed on public exhibition in November, 2012. In response to a number of submissions made from both public and private stakeholders, a revised Water Cycle and Flood Management Strategy has been developed. This revised strategy has resulted in the need to amend the Indicative Layout Plan (ILP) for the Precinct.

The hydrological modelling has been updated to better reflect the likely development potential of the Precinct and an investigation into the basin strategy has been completed. These investigations have concluded that Basin 2 could be increased to compensate for the removal of Basins B1, B2, B3 and 1 and that other devices within the Strategy could be reduced without adversely influencing flows throughout the Precinct. In addition to this, Basin 4 has been reduced, Basin 5 has been adjusted, Basin 8 enlarged to compensate for the removal of Basin 9, and Basin 6 has been reconfigured.

Flood modelling has been completed to assess the effectiveness of the Precinct's water quantity management strategies. The flood assessment shows that post development 100 year ARI flows are controlled and contained within the proposed detention basins of the Precinct.

As reported in the original Water Cycle Management Plan (JWP WCFM, 2012), it is proposed that a degree of Floodplain Reclamation will be implemented within the Marsden Park Residential Precinct. The latest ILP and basin reconfigurations has resulted in a minor floodplain storage loss of approximately 208,000 m^3, which is equivalent to 0.04% of the Hawkesbury / Nepean floodplain. This is an improvement on the exhibition strategy (previously 325,000 m^3 storage loss), is still considered minimal and is unlikely to result in any adverse regional flood level impacts. An alternative arrangement has been proposed to provide a flood storage device integrated into the South Creek floodplain to provide a balance floodplain storage.

The strategy provides a balance between the riparian corridor functions, floodplain management, and development outcomes and will ensure that stormwater flows exiting the Precinct into South Creek, Bells Creek and across Richmond Road at the Precinct boundary are less than existing conditions. The water quality strategy developed for the Precinct will also ensure that the quality of stormwater discharging from the Precinct meets the requirements of OEH and will ensure stormwater pollutant impacts of urban development are mitigated.

10 REFERENCES

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11 GLOSSARY OF TERMS

12D Model is a powerful terrain modelling, surveying and civil engineering software package used to develop the underlying surface for the 2D modelling.

Airborne Laser Survey (ALS) is a technique for obtaining a definition of the surface elevation (ground, buildings, power lines, trees, etc.) by pulsing a laser beam at the ground from an airborne vehicle (generally a plane) and measuring the time taken for the laser beam to return to a scanning device fixed to the plane. The time taken is a measure of the distance which, when ground truthed, is generally accurate to + 150mm.

Average Recurrence Interval (ARI) means the average statistical interval (in years) between occurrences of floods, storms and flows of a particular magnitude.

Australian Rainfall and Runoff (AR&R) refers to the current edition of Australian Rainfall and Runoff published by the Institution of Engineers, Australia.

CatchmentSIM is a 3D-GIS application specifically tailored to hydrology based applications. CatchmentSIM is used to delineate a catchment, break it up into sub catchments, determine their areas and spatial topographic attributes and analyse each sub catchment's hydrologic characteristics to provide insight into the rainfall response of various catchments and the resultant assignment of hydrologic modelling parameters.

Council refers to Blacktown City Council

Digital Terrain Model (DTM) is a spatially referenced three-dimensional (3D) representation of the ground surface represented as discrete point elevations where each cell in the grid represents an elevation above an established datum.

Floodplain Development Manual (FDM) and Guidelines (April 2005), the FDM is a document issued by DECCW that provides a strategic approach to floodplain management. The guidelines have been issued by the NSW DoP to clarify issues regarding the setting of FPL's.

Hydrograph is a graph that shows how the stormwater discharge changes with time at any particular location.

Hydrology The term given to the study of the rainfall and runoff process as it relates to the derivation of hydrographs for given floods.

J. Wyndham Prince Pty Ltd (JWP) Consultant Civil Infrastructure Engineers and Project Managers undertaking these investigations

MUSIC is a modelling package designed to help urban stormwater professionals visualise possible strategies to tackle urban stormwater hydrology and pollution impacts. MUSIC stands for Model for Urban Stormwater Improvement Conceptualisation and has been developed by Cooperative Research Centre (CRC),

Peak Discharge is the maximum stormwater runoff that occurs during a flood event3

Probable Maximum Flood (PMF) is the greatest depth of precipitation for a given duration meteorologically possible for a given size storm area at a particular location at a particular time of the year, with no allowance made for long-term climatic trends." largest flood that could be

Triangular Irregular Network (TIN) is a technique used in the created DTM by developing a mass of interconnected triangles. For each triangle, the ground level is defined at each of the three vertices, thereby defining a plane surface over the area of the triangle

TUFLOW is a computer program that provides two-dimensional (2D) and one dimensional (1D) solutions of the free surface flow equations to simulate flood and tidal wave propagation. It is specifically beneficial where the hydrodynamic behaviour, estuaries, rivers, floodplains and urban drainage environments have complex 2D flow patterns that would be awkward to represent using traditional 1D network models.

XP-RAFTS runoff routing model that uses the Laurenson non-linear runoff routing procedure to develop a subcatchment stormwater runoff hydrograph from either an actual event (recorded rainfall time series) or a design storm utilising Intensity-Frequency-Duration data together with dimensionless storm temporal patterns as well as standard AR&R 1987 data.