Attachment 18 to Item 3.1.1.

Redbank Stormwater Management Strategy

Date of meeting: 21 November 2024
Location: Audio-visual link
Time: 10am

J. WYNDHAM PRINCE

CONSULTING CIVIL INFRASTRUCTURE ENGINEERS
& PROJECT MANAGERS

ABN 67 002 318 621

Our Ref: 8580_DOP_130510 Lett
AF: dc

10 May, 2013

North Richmond Joint Venture
PO Box 1918
PENRITH NSW 2751

Attn: **Development Director, Mark Regent**

Subject: **North Richmond Release Area - Gateway Planning Package for Exhibition Stormwater Management Strategy and Flooding Report**

Dear Sir,

Please find attached the Stormwater Management Strategy for the LEP Planning Package for exhibition for the Redbank project at North Richmond. The Redbank project is situated west of the existing North Richmond Township, north of Grose Vale Road and south of Redbank Creek. The development area excludes a significant rural property known as "Peel Farm" which fronts Grose Vale Road and is encompassed by the Redbank site.

Redbank consists of an approved Seniors Living Facility (already under construction and under separate approval) in the eastern portion of the site as well as residential allotments with associated service infrastructure, public roads, a commercial centre, open space areas and a conservation area.

The majority of the proposed development consists of low density and medium density residential allotments, with larger rural residential lots proposed within the steeper areas of the site to the south and west. The development also incorporates retained water bodies and areas featuring water quantity (detention) and quality treatment devices within riparian corridor and open space areas.

The current development proposal for this land is:

- Approximately 1,400 homes in addition to the Seniors Living Facility currently under construction,
- Local Council roads including bus route,
- Small scale local centre of approximately 1.0Ha,
- Retention and modification of three (3) – four (4) existing farm dams within the project site to become open water bodies,
- Construction of four (4) primarily trunk drainage corridors (with a secondary riparian and tertiary open space function) separating planned residential areas,
- Retention of an existing farm dam on Redbank Creek and vegetation improvement to the primarily riparian corridor along the south bank of Redbank Creek, which extends along the project site perimeter,
- Capacity improvements to a key component of existing stormwater infrastructure along with water quantity management downstream of the project site, discharging to Redbank Creek,

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- An alternate east-west access to North Richmond providing a significant improvement in vehicle traffic road capacity and the duration of available flood free access for the local area,
- Multiple road connections to existing Grose Vale Road (3), Arthur Phillip Drive (2), Townsend Rd (1) but no connection to Belmont Grove.

Also attached is a copy of the proposed rezoning plan of Redbank to support the Stormwater Management Strategy

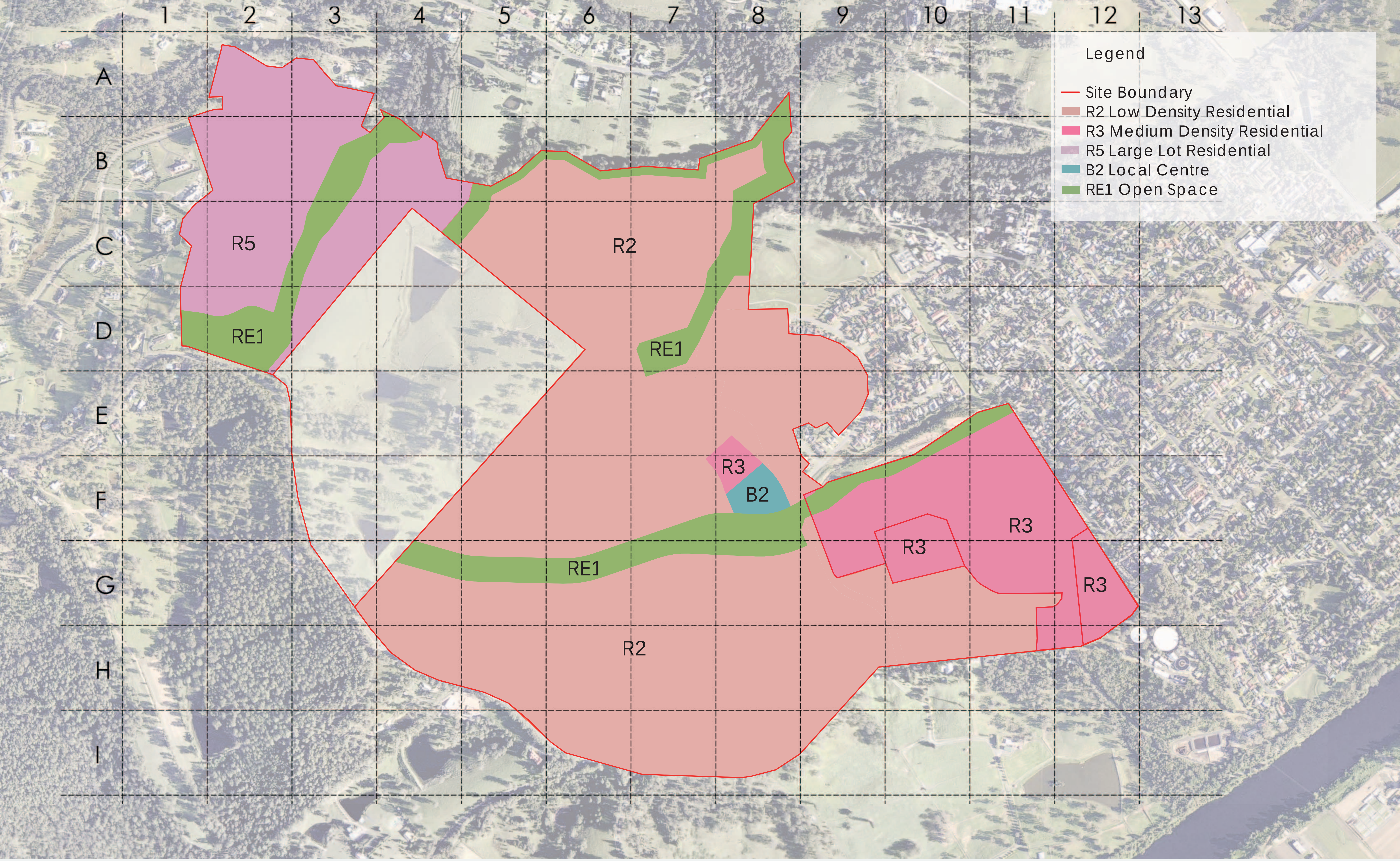
Should you have any queries regarding this matter, please do not hesitate to contact me.

Yours faithfully

J. WYNDHAM PRINCE

[redacted]

DAVID CROMPTON
Manager, Stormwater & Environment



REDBANK
NORTH RICHMOND

Plan 11: Proposed Zoning Plan - Issue as of 10/05/2013

INVESTMENT MANAGEMENT AUSTRALIA LTD

ML Design

Drawn by: AR

File Path: P:\INVE0003_North Richmond Master Plan\B_Documentation\B1_Production\B1_Drawings\Illustrator

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APPROVED FOR ISSUE: 08/05/2013 JOB NO: INVE0003

Redbank Release Area

LEP Planning Proposal
Stormwater Management Strategy

Prepared for:

North Richmond Joint Venture

May, 2013
8505rpt1D

Prepared by:

J. WYNDHAM PRINCE

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REDBANK RELEASE AREA
LEP PLANNING PROPOSAL - STORMWATER MANAGEMENT STRATEGY

- DOCUMENT CONTROL SHEET -

Issue No.	Amendment	Prepared By & Date	Checked By and Date	Approved By and Date
A	DRAFT	JC (13/08/10)	PM(13/08/10)	PM (13/08/10)
B	LEP PROPOSAL	JC (05/12/11)	PM(05/12/11)	PM (05/12/11)
C	MINOR UPDATES	JC (02/03/12)	PM(02/03/12)	PM (02/03/12)
D	MINOR UPDATES	LB (10/05/13)	DC (1/05/13)	DJ (13/05/13)

J. WYNDHAM PRINCE

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REDBANK RELEASE AREA
GATEWAY PLANNING PROPOSAL - STORMWATER MANAGEMENT STRATEGY

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1. EXECUTIVE SUMMARY

The Redbank Release Area is a proposed residential development between Grose Vale Road and Redbank Creek, North Richmond. The proponent, the North Richmond Joint Venture (NRJV) proposes to rezone & develop the 180+ ha site which is currently open pasture land for cattle.

This Stormwater Master Plan Report outlines the intended method of managing stormwater for the site and has been developed to integrate with and support the relevant development planning and approval processes for the proposed residential development at North Richmond. The strategy has been prepared to conform to statutory requirements and industry best practice for stormwater management in this catchment. Sufficient detail is provided to integrate with and support the submission of a Gateway Planning Package for exhibition, for the site to Hawkesbury City Council and the Department of Planning & Infrastructure.

1.1 Statutory Requirements / Guidelines

The recommendations relating to stormwater management from the following statutory authorities / organisations have been addressed in the stormwater management strategy for this site.

- Hawkesbury Council Stormwater Drainage DCP (Ref 1).
- Middle Nepean Hawkesbury Stormwater Management Plan (Ref. 2).

The recommendations relating to stormwater management from the following guidelines have also been addressed for stormwater management for this site.

- Healthy Rivers Commission Investigation into Hawkesbury Nepean (Ref. 3).
- NSW Office of Environment and Heritage (formerly Department of Environment, Climate Change and Water [DECCW]) Guidelines (Ref. 4).

1.2 Methodology

The investigation included the following technical tasks:

Hydrology	Undertake conceptual hydrological assessment of the catchments to determine magnitude of a range of storm flows and evaluate the requirements of any detention storage facilities for the site.
Hydraulics	Undertake conceptual hydraulic assessment of the proposed detention storage outlet configurations to determine capacity requirements. Undertake conceptual hydraulic assessment of the proposed trunk drainage channels.
Water Quality Modelling	Undertake a conceptual assessment of water quality device requirements to match post development pollutant concentrations to pre-development conditions and meet specific load targets.

1.3 Proposed Stormwater Management Strategy

The strategy proposed as being most suitable for this site is as follows;

On Lot Treatments

- Adoption of appropriate waterwise landscaping practices (resident education, on-site management systems, native gardens, mulch, micro-irrigation etc.).
- Implementation of BASIX compliant water efficient fittings and appliances in all dwellings (dual flush toilet, AAA shower heads, water efficient taps and plumbing).
- Provision of BASIX compliant rainwater tanks where appropriate / suitable to supplement demand management measures to achieve overall reduction in potable water demand and to achieve reductions in average annual post-development runoff.

Street Level Treatments

- Utilise a combination of Hawkesbury City Council approved gross pollutant traps (GPT's) on the estate to filter litter, vegetative matter, coarse and fine sediment and oils and greases which derive from roadways and other areas within the estate.

Sub-catchment / Subdivision Scale Treatments

Bio-Retention Raingardens and Bio-Swales

- Bio-Retention Raingardens are proposed to treat the first-flush (3 month ARI) discharges from the catchments.
- The Bio-Retention Raingardens act as a filter for fine particulates & nutrients and will be sized to achieve the required targets. The Raingarden systems also function to assist in detaining first flush flows discharging to the downstream drainage system.

Constructed Ponds

- An on-line Constructed Pond is proposed within the allocated open space area in the same location as the existing water body within the Southern Catchment. Whilst the water body will offer limited benefit for additional water quality treatment for stormwater prior to discharging into the downstream drainage systems, the main purpose of the proposal is to improve visual amenity of the area with additional storage above the static water level of the pond for detention purposes

Detention Basins

- Detention basins are proposed within the allocated open space areas as water quantity control is for stormwater prior to discharging to the downstream drainage infrastructure. It is proposed to provide detention storages above the raingardens and constructed pond as dual purpose devices within the Southern catchment of the site.

- Hydrologic calculations suggest that detention is not required along the northern fringe of the site draining directly into Redbank Creek, as releasing undetained discharges in this area assists in reducing peak discharges along Redbank Creek down to Bells Line of Road.

Pipe Diversion

- Current flooding within the North Richmond Township will be partially alleviated through the duplication of the existing 1500 mm dia. RCP drainage line within the transmission easement, to direct discharges from the Southern Catchment to drain north to Redbank Creek, via the proposed Peel Park Basin.

A general arrangement plan indicating proposed locations for the water quality and water quantity treatments for the site are shown on Figure 3.

1.4 Conclusion

The stormwater management strategy for the developed site provides a basis for the detailed design and development of the site to ensure that the following objectives for stormwater management and site discharge are achieved:

Environmental Existing vegetation within the riparian corridors will be retained and enhanced to promote ecological health and biodiversity within the site, some of the existing water bodies with ecological value will be retained; downstream discharge peaks and velocities limited to avoid scouring, siltation and fauna impacts; water quality elements proposed to reduce gross pollutants and nutrients from the urban catchments in accordance with statutory performance objectives. Ecological health and biodiversity within the riparian corridors maintained and enhanced.

Urban Amenity 100 year ARI (1% AEP) storage requirements and flood levels and extent limits have been defined. Future development can conform to requirements for public safety; quality passive recreational amenity can be provided for the incoming community.

Engineering Considerations Peak discharges, peak velocities and flood levels controlled to conform with Council's technical requirements; detention provided in open space areas to restrict peak discharges to less than pre-development levels; water quality elements provided to conform with performance and maintenance requirements.

Economics	The stormwater management strategy is functional; delivers the required technical performance; avoids environmental degradation and pressure on downstream ecosystems and infrastructure; and provides for a 'soft' sustainable solution for stormwater management within the development area.

Our investigations indicate that there is adequate capacity within the site to achieve the required performance objectives for stormwater management.

2. INTRODUCTION

The client North Richmond Joint Venture (NRJV) proposes to rezone a 181 ha cattle farm located at Lot 27 of DP 1042890 off Grose Vale Road at North Richmond to a 1400 lot residential development designated as the Redbank Release Area. The Release Area incorporates the approved Seniors Living Development (SLD) adjacent the existing North Richmond Township, east of the site. The residential allotments range from medium density (400 m^2) to rural residential (+2,500 m^2).

This report is a preliminary investigation to develop an integrated stormwater management strategy, which incorporates the principles of water sensitive urban design, to integrate with and conform to the relevant statutory requirements for the proposed residential development at North Richmond.

The objective of this investigation is to identify the stormwater issues to be taken into account in the development of the proposed residential development within North Richmond, to identify appropriate options and locations for the management of quantity and quality of stormwater leaving the site, and to identify the land areas required to implement the recommended options.

This report has been prepared in support of a LEP Planning Package for Exhibition to be lodged with Hawkesbury City Council and the Department of Planning & Infrastructure for the residential development on part Lot 27 of DP 1042890 off Arthur Phillip Drive in North Richmond.

The investigation involved the following specific tasks:

- Identify appropriate Water Sensitive Urban Design (WSUD) measures, including water quality treatment devices suitable for the proposed development
- Undertake preliminary hydrologic analysis to determine the peak 1, 2, 5, 10, 20, 50 and 100 year ARI pre development and post development flows;
- Determine the minimum indicative detention storage requirements to restrict post development flows to pre development levels or to the capacity of the existing downstream infrastructure – whichever is less;
- Consideration of the impact of development discharges from the site on the overall Redbank Creek catchment.
- Determine suitable water quality treatment control system configurations required to comply with Council's requirements and the identified performance targets.
- Determine preliminary extents of 100 year ARI flooding on the site under existing site conditions.
- Prepare a Stormwater Management Strategy Report to support the gateway planning proposal for the Redbank development, which conforms to statutory requirements and industry best practice for the management of stormwater from the development.

3. PREVIOUS RELEVANT REPORTS AND STUDIES

There has been a range of reports which relate to the management of stormwater in the North Richmond site that has been prepared and was considered as part of this investigation;

- Gutteridge, Haskins and Davey, (2006) – Report for Proposed North Richmond Development Site – Stormwater and Flooding – DRAFT (Ref. 5) - The objective of this investigation was to provide a preliminary assessment of the site stormwater drainage and flooding issues of the entire Lot 27 of DP 1042890 site at North Richmond.

- Gutteridge, Haskins and Davey, (2006) – Report for Proposed North Richmond Development Site – Riparian Areas Assessment – DRAFT (Ref. 6) – The objectives of this assessment was to:
  - Identify watercourses on the site that fit the definition of protected waters for the purposes of the Rivers and Foreshores Improvement Act 1948 (RFIA),
  - Identify likely maximum riparian buffer widths to provide for bed and bank stability,
  - Identify possibilities for passive uses of riparian areas, and
  - Assess appropriateness of the continued use of existing dams as treatment devices.

- RCA Australia (2006) – Preliminary Geotechnical and Environmental Assessment – North Richmond – DRAFT (Ref. 7) – This report provided a preliminary geotechnical and contamination assessment for the site.

- J. Wyndham Prince Pty Ltd (2008) – Seniors Living Development North Richmond – Stormwater Management Strategy (Ref. 8)

  This report was prepared to support a development application to Hawkesbury Council for the proposed Seniors Living Development portion of the North Richmond site. The investigation included:
  - Water quantity and water quality analysis to demonstrate the proposed stormwater management system achieved the performance targets for the site nominated in Hawkesbury City Council’s 2007 DCP and the targets recommended by the Healthy Rivers Commission,
  - Determine the minimum detention storage requirements to restrict post development flows to pre development levels, and
  - Undertake indicative hydrologic and hydraulic calculations for the two proposed on-site basin outlet control structures.

- J. Wyndham Prince Pty Ltd (2011) – North Richmond Township – Flood Study (Ref. 9)

  This report details the procedures used and presents the results of an assessment of the hydraulic performance of the existing stormwater drainage infrastructure within the township of North Richmond:

  This report is currently under review by Council, however, provides the source of the flood extent mapping within the Precinct that is shown in Figure 2.

4. THE EXISTING ENVIRONMENT

4.1 The Site

The proposed residential development, which totals approximately 180 Hectares, is located off Arthur Phillip Drive, North Richmond. The development area makes up part of Lot 27 of DP 1042890, with that property bordered by Grose Vale Road to the south, Grose Vale Road and existing rural residential properties to the west, Redbank Creek to the north, and existing residential properties to the east. The location of the proposed residential development is shown below and in more detail on Figure 1.

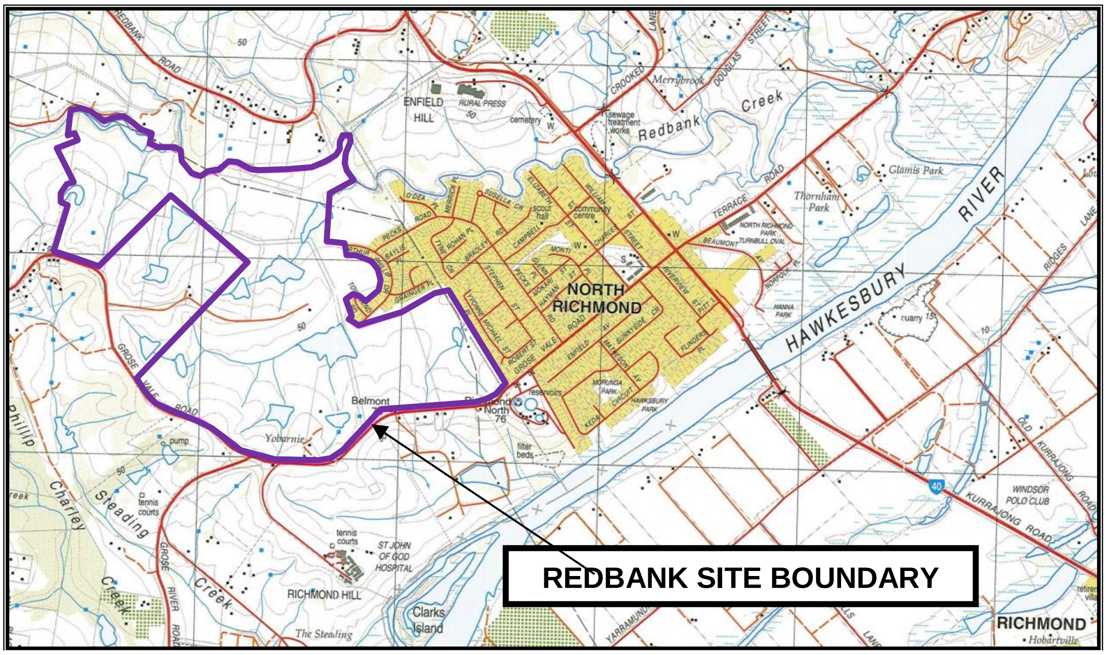


PLATE 1 – LOCATION OF THE PROPOSED RESIDENTIAL DEVELOPMENT AT NORTH RICHMOND

4.2 Landforms

The site consists of undulating land that has generally been cleared, with fenced paddocks for grazing cattle and stands of trees scattered over the site. There are a number of existing farm dams throughout the site with a series of catch drains used to divert runoff to other water storage bodies lower in the site.

The northern portion of the site drains to Redbank Creek.

The land in the southern portion of the site generally falls to the existing formed watercourse which runs in an easterly direction between the proposed Seniors Living Development and the existing residential development towards the existing residential area of North Richmond.

There are a series of existing water bodies (former farm dams) that are currently scattered throughout Redbank which formed part of the “Key Line” system pioneered by Percival Yeoman in the 1940’s and 1950’s. The system formed a technique of maximising water resources on the land and was part of an overall scheme for the site, which was effectively a precursor to what is today referred to as sustainability. It is intended to maintain the footprint of three of these water bodies, with minor reconstruction of two along the northern catchments and to reconstruct another one in the Southern Catchment as a pond and on-line detention basin.

4.3 Rainfall Data

4.3.1 Daily Rainfall Data

Rainfall records for the North Richmond area were obtained from the Bureau of Meteorology. The nearest rainfall station to the Redbank Release Area site was obtained as follows:

Station No.	Location	Type of Data	Years of Record Obtained
67033	Richmond RAAF Base	6 minute	1954 - 1993

4.3.2 Intensity-Frequency-Duration (I.F.D.)

Design rainfall intensity-frequency-duration (I.F.D.) data for the site were obtained using methods set out in Australian Rainfall and Runoff (ARR.) 1987 (Ref. 10). A summary of the rainfall intensities adopted in this study is given in Table 4.1. The critical storm durations were determined using these values for each sub-catchment.

The models used to examine the performance of the catchment utilised temporal patterns for synthetic design storms as detailed in A.R.R. (Ref. 10).

Table 4.1

RICHMOND RAINFALL INTENSITIES

Storm Duration (min.)	Rainfall Intensities (mm/hr) Recurrence Interval (ARI)						
	1	2	5	10	20	50	100
5	76	98	127	145	167	197	220
10	58	75	97	111	128	151	169
15	49	63	81	92	107	126	140
20	42	54	71	80	93	109	122
25	37.7	49	63	72	83	98	109
30	34.2	44	57	65	75	89	99
45	27.4	35.3	46	52	60	71	79
60	23.2	30.0	38.9	44	51	60	68
90	18.4	23.7	30.8	35.0	40.5	48	53
120	15.5	20.0	26.0	29.5	34.2	40.3	45
180	12.3	15.8	20.5	23.2	26.8	31.6	35.2
270	9.7	12.4	16.1	18.2	21.1	24.8	27.6
360	8.16	10.5	13.6	15.4	17.7	20.9	23.3
540	6.39	8.23	10.7	12.1	14.0	16.5	18.4
720	5.34	6.89	8.97	10.2	11.8	14.0	15.6
1080	4.10	5.31	7.01	8.03	9.36	11.1	12.5
1440	3.36	4.38	5.86	6.76	7.93	9.49	10.7
2880	2.01	2.66	3.71	4.38	5.23	6.39	7.31

4.4 Existing Drainage Systems

The North Richmond site is divided into four main catchments. The three northern catchments drain to Redbank Creek via a series of channels and farm dams.

The southern catchment drains in an easterly direction to the existing channel that runs between the proposed Seniors Living Development and the existing residential development of Kemsley Downs. The primary discharge system is a 1500 mm RCP which directs flows north through the transmission easement adjacent the eastern side of the Kemsley Downs residential development area and discharges directly into Redbank Creek. Overflows are directed over a weir into a secondary surcharge discharge system, leading into twin 1200 mm diameter RCP's, conveying flows east through the existing North Richmond residential development, eventually linking up with Redbank Creek east of North Richmond, prior to discharging into the Hawkesbury River.

An indicative layout of the existing drainage system throughout the site is shown on Figure 2. The existing catchments are shown on Plate 2 and in more detail on Figure 3.

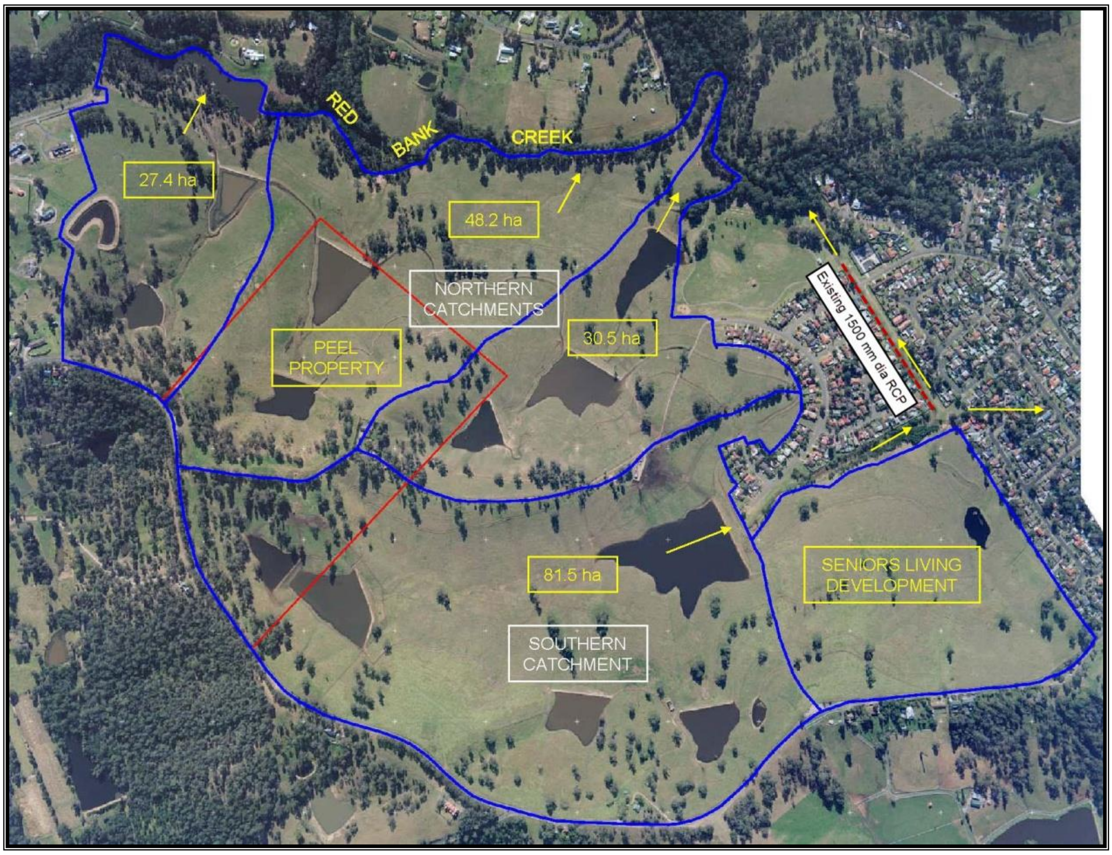


PLATE 2 – EXISTING CATCHMENT BOUNDARIES

5. PROPOSED DEVELOPMENT

Due to the undulating nature of the site, the extent of the catchments have been generally preserved without significant diversions. The majority of the proposed development is made up of low and medium density residential lots, with some larger rural residential lots proposed within the steeper areas of the site to the south and west. A small-scale commercial centre is also proposed, as well as areas set aside for reticulated water and sewer service infrastructure.

The proposed development also incorporates a number of local parks, water quantity and quality treatment devices, riparian corridors, a conservation area and public road infrastructure.

The latest proposed Concept Plan for the site is shown below in Plate 3 and is subject to minor layout alterations.

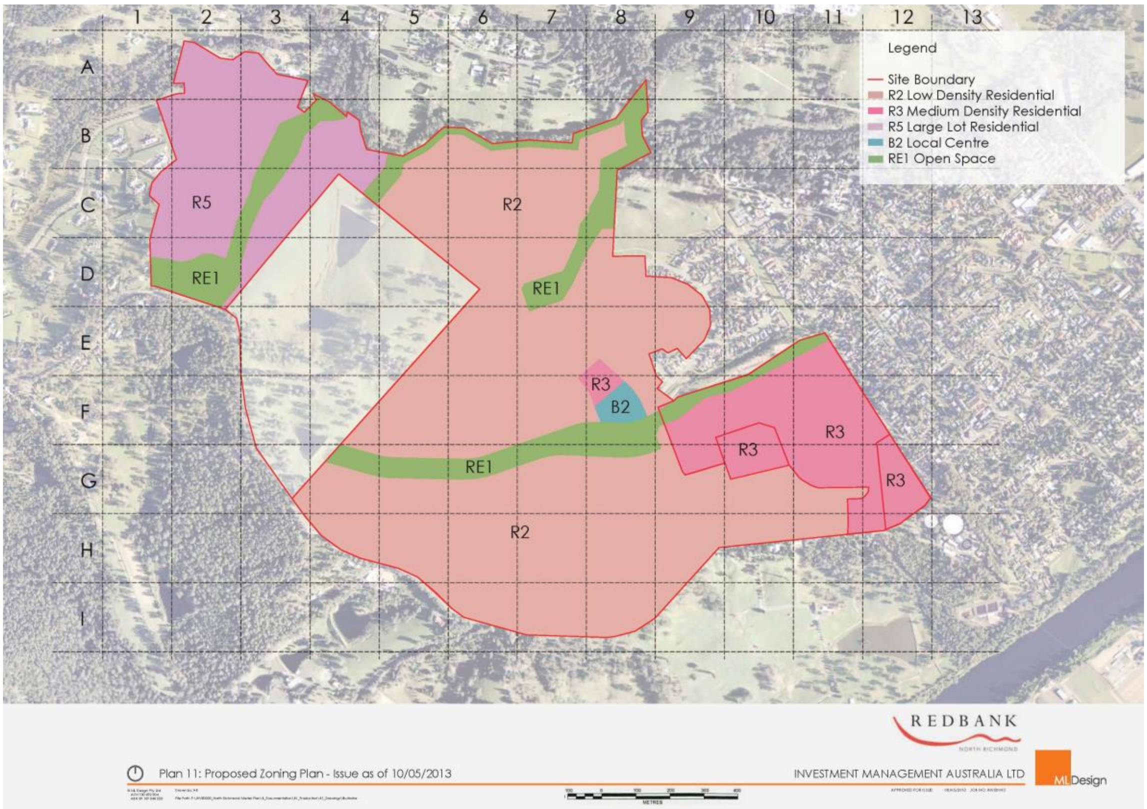


PLATE 3 – PROPOSED DEVELOPMENT CONCEPT PLAN

It is proposed that bio-retention devices and a constructed pond with detention storage capacities be constructed at various locations within the site. Discharges from the detention facilities will be directed through formed drainage channels which will drain to existing drainage structures within the public road systems.

Flood waters impact upon the existing North Richmond Township during major storm events. As part of North Richmond Township – Flood Study (Ref. 9) undertaken for Hawkesbury City Council a number of options have been investigated to alleviate flood impacts within the North Richmond township. One of these options was for the duplication of the existing 1500 mm pipe that is located near Grainger Place and diverts flows to Redbank Creek. These investigations concluded that the inclusion of the additional pipe would reduce flood impacts on number of residents within the North Richmond Township.

It is proposed that this pipe duplication is delivered in conjunction with the Redbank Release Area in order to provide a benefit to the local community. This duplication will divert flows from the Southern Catchment northwards to Redbank Creek and alleviate the current flooding problems experienced within the North Richmond Township. The proposed catchment diversion was also assessed to confirm that there are no negative impacts on existing properties on Redbank Creek.

An indicative layout of the proposed detention systems and bio-retention raingarden devices are shown on Figure 5.

6. DEVELOPMENT GUIDELINES, OPPORTUNITIES AND CONSTRAINTS

6.1 Statutory Requirements

The recommendations contained in the following guidelines have also been addressed in the stormwater master planning process.

6.1.1 Hawkesbury Council Stormwater Drainage DCP

The Hawkesbury Council Stormwater Drainage DCP (Ref. 1) sets objectives and performance targets for the control of stormwater for developments within the Hawkesbury Local Government Area.

Water Quantity The objectives for the control of peak storm flows discharging from the proposed development is addressed in Section 8.21 of the DCP.

As a minimum requirement, the sizing for storage volumes and site discharges shall be designed to match the post-development flowrate to the pre-development flowrate for all recurrence intervals from the 1 year ARI event to the 100 year event. The preference is to restrict discharges to the capacity of the downstream drainage infrastructure.

Water Quality The objectives for the control of runoff water quality is addressed in Section 8.24 of the DCP.

“Consideration shall be given to the impact of development on stormwater and receiving water quality during design of a project…” and the *”…Healthy Rivers Commission has established environmental objectives which need to be met in terms of controlling runoff water quality.”*

Council requires that the pollutant discharge concentrations for the site under developed conditions are equivalent to or less than from the site under existing site conditions.

The development shall also comply with The Hawkesbury-Nepean River Catchment Trust guidelines as well as:

- Department of Housing – Blue Book
- EPA Management of Urban Stormwater, and
- Council’s Stormwater Management Plan

There are no industry guidelines that specify pollutant loading rates for improved pasture or cattle grazing land. The proposed residential development with its typical use of native gardens and implementation of stormwater capture & re-use would result in reduced pollutant discharges when compared to the previous land use on the site.

Consequently, we have not modelled the existing landuse and compared it to post development conditions. However, we have undertaken MUSIC modelling of the post development conditions (refer to Section 7.4), to determine that the system complies with other water quality performance standards.

Indicative locations and preliminary sizing of the stormwater quality treatment and detention devices are shown on the attached Figure 5.

6.1.2 *Healthy Rivers Commission Independent Inquiry into the Hawkesbury Nepean (1998 Final)*

This document (Ref. 3) provides recommendations on a range of actions that the Commission believes should be implemented if the health of the river is to be improved in ways that will meet community expectations and achieve the sustainable development goals inherent in the Government's water reform agenda. A summary of these recommendations with respect to water quality are:

- Action to improve river health should not be delayed pending further research or more detailed studies.
- The water quality objectives (WQOs) for nutrients (listed below for urban areas – tributary stream) should be adopted as criteria for the initial phases of an adaptive management regime for water quality.
- The recommended WQOs should be used with caution and as an aid only to the development of a comprehensive and effective strategy for managing water quality.
- Reductions in phosphorus inputs to the river should at this stage remain the priority strategy for algal control in freshwater sections.

Nutrient Water Quality Objectives	Total Phosphorus	~0.05 mg/l
	Total Nitrogen	~1.0 mg/l

6.1.3 *Middle Nepean Hawkesbury Stormwater Management Plan (1999 – 2000)*

The Middle Nepean Hawkesbury Stormwater Management Plan (1999 – 2000) (Ref. 2) prescribes quantitative post construction phase stormwater management objectives for the reduction of various pollutants for new developments:

Pollutant	ESD Treatment Objective
Post Construction Phase:	
Suspended Solids (TSS)	80% retention of the average annual load
Total Phosphorous (TP)	45% retention of average annual load
Total Nitrogen (TN)	45% retention of average annual load
Litter	Retention of greater than 50mm for flows up to 25% of the 1 year ARI peak flow
Coarse Sediment	Retention of sediment coarser than 0.125 mm for flows up to 25% of the 1 year ARI peak flow
Oil and Grease (Hydrocarbons)	In areas with concentrated hydrocarbon deposition, no visible oils for up to 25% of the 1 year ARI peak flow
Construction Phase:	
Suspended Solids	Effective treatment of 90% of daily runoff events (e.g. <4 months ARI). Effective treatment equates to a 50%ile SS concentration of 50 mg/l
Other Pollutants	Limit the application, generation and mitigation of toxic substances to the maximum extent practicable

Greater levels of pollutant detention than those listed including 'no net increase' in pollutant loads from the pre (existing) development situation, is a requirement under Council's DCP, in pursuit of sub-catchment objectives relating to the protection or restoration of catchment values.

6.1.4 *Managing Urban Stormwater: Environmental Targets (Consultation Draft – 2007)*

The NSW Office of Environment and Heritage (formerly the Department of Environment and Climate Change) (OEH – Ref. 4) recommends that the following environmental targets are adopted by council's and consent authorities for medium to large scale developments.

These targets are those currently used by the Growth Centre Commission and are an update of the targets recommended by the EPA (1997) and widely adopted by Council's. The targets are as follows:

Pollutant	Treatment Removal Objective
Gross Pollutants (GP)	90% retention of the average annual load (> 5 mm)
Suspended Solids (TSS)	85% retention of the average annual load
Total Phosphorous (TP)	65% retention of average annual load
Total Nitrogen (TN)	45% retention of average annual load

6.1.5 *Sydney Regional Environmental Plan No. 20*

The Sydney Regional Environmental Plan No. 20 – Hawkesbury Nepean River (SREP 20) (Ref. 11) provides a number of specific planning policies and recommended strategies for new developments within the Hawkesbury Nepean river system. Those related to stormwater for the UWS Hawkesbury site are.

Water Quality

Policy: Future development must not prejudice the achievement of the goals of use of the river for primary contact recreation and aquatic ecosystem protection in the river system. If the quality of the receiving waters does not currently allow these uses, the current water quality must be maintained, or improved, so as not to jeopardise the achievement of goals in the future.

Strategies:

- Quantify, and assess the likely impact of, any predicted increase in pollutant loads on receiving waters.
- Consider the need to ensure that water quality goals for primary contact recreation and aquatic ecosystem protection are achieved and monitored.
- Protect the habitat of native aquatic plants.
- Consider the need for an Erosion and Sediment Control Plan (to be implemented at the commencement of development) where the development involves the disturbance of soil.
- Minimise or eliminate point source and diffuse source pollution by the use of best management practices.
- Site and orientate development appropriately to ensure bank stability. Plant appropriate native vegetation along banks of the watercourses, but not so as to prevent or inhibit the growth of aquatic plants in the river, and consider the need for a buffer of native vegetation.

Water Quantity

Policy: Aquatic ecosystems must not be adversely affected by development which changes the flow characteristics of surface or groundwater in the catchment.

Strategies:

- Ensure the amount of stormwater run-off from a site and the rate at which it leaves the site does not significantly increase as a result of development. Encourage on-site stormwater retention, infiltration and (if appropriate) reuse.
- Consider the impact of development on the level and quality of the water table.

6.2 Local Flooding

6.2.1 Redbank Creek

Redbank Creek is a regional watercourse with a catchment of over 1500 ha upstream of the site and is a significant tributary of the Hawkesbury/Nepean River system. A couple of recent draft assessments have been undertaken by GHD outlining the Stormwater and Flooding (Ref. 5) and Riparian Areas (Ref. 6). A more recent flood study undertaken by JWP (Ref. 9) was commissioned by Hawkesbury Council, which provided more detail on the impacts of flooding on Redbank Creek and the un-named tributary to the south which discharges through North Richmond residential area.

6.2.2 Un-named Tributary

An un-named, man-made trunk drainage channel drains the Southern Catchment and runs along the northern boundary of the Seniors Living development (under construction). A recent Flood Study prepared by JWP for Redbank Creek and this watercourse (Ref. 9) was commissioned by Hawkesbury Council.

The results of the assessment found that the capacity of the formed drainage channel from Arthur Phillip Drive, located behind the properties fronting Grainger Place, was adequate to convey the pre-development 100 year ARI discharges from the upstream catchment.

However, the existing drainage system within the North Richmond residential development downstream from the site does not provide for formalised overland flow paths. Discharges in excess of the pipe capacities are currently conveyed overland through residential properties.

As determined in the previous assessment undertaken for the approved Seniors Living Development (Ref. 8), the adopted indicative capacities for the existing downstream drainage infrastructure are as follows:

Drainage Line Description	Pipe Configuration	Indicative Drainage Capacity
Main system through existing North Richmond Town Centre	Twin 1200 mm diameter RCP's	4.3 m^3/s
Secondary Line through existing North Richmond Town Centre	750 mm diameter RCP	0.9 m^3/s
Kemsley Downs system, north directly into Redbank Ck	1500 mm diameter RCP	4.5 m^3/s

6.3 Public Safety Guidelines (Drainage and Flooding)

Council's standards for stormwater drainage design stipulate that all detailed drainage designs shall incorporate an assessment of major system flows to ensure that the major system provides a safe and adequate escape route for stormwater from rare and extreme events.

- Council's design standard for the major system is the 100 year ARI event.
- Retarding structures shall be designed to contain a minimum of the 100 year ARI flood event.
- Roads, pathways, open space reserves and drainage reserves are to generally form the flow path by which major system flows are safely routed through a new subdivision.
- Major structures are to be designed for the 100 year ARI storm event.
- These public safety guidelines have been incorporated in the development of the stormwater drainage strategy for the Redbank development Site.

6.4 Site Geology and Soils

A geotechnical assessment was undertaken by RCA Australia in 2006 (Ref. 7) for the whole of Lot 27 of DP 1042890 and was commissioned to assess the site's viability for development.

The soils on the site generally consist of clays with a variable silt and sand content over most of the underlying sandstone and shale bedrock at variable depths. There are also mixtures of clays and silts that exist at the base of the slopes and along the watercourses as alluvial deposits.

The study advised that the site is suitable for development from a geotechnical point of view and indicated that acid sulphate soils were not considered to be an issue.

6.5 Salinity

An assessment of the Western Sydney Salinity Map identifies the site potentially subject to moderate salinity.

Salinity is the accumulation of mineral salts in the soil, groundwater and surface waters. Dryland salinity results when soluble salts are transported to the surface by rising water table. The groundwater itself can also cause soluble salts to migrate under the ground surface and emerge as saline seepage in low lying areas. Salinity can lead to vegetation loss, weed invasion and soil structure decline.

Land use activities can affect groundwater **recharge** and **discharge** and result in rising water tables and saline groundwater seepage. Typical land use practices that can be implemented to avoid salinity impacts include:

- Detention and enhancement of vegetation in strategic areas.
- Resident and public authority education on the need to restrict over-watering of lawns and open space areas to avoid lifting water table levels.
- Encourage residents to grow plants with low water needs (natives); mulch gardens to reduce water use and evaporation; use watering timers with micro irrigation systems.
- Providing sub-surface drainage to ensure that roads and lots do not create impediments to the flow of shallow water tables.

- Ensuring that roof drainage is not connected to on-site recharge pits.
- Ensuring that leakage from water supply services is minimised.
- Maintaining good drainage and reducing waterlogging.
- Avoiding infiltration from water storage tanks.
- In sodic soils, providing polyethylene sheeting under ground bearing slabs, effective damp courses and sub-soil drainage.

We recommend that these techniques are incorporated into the detailed design of the infrastructure within the site.

6.6 Opportunities

In the design of any urban drainage scheme it is desirable to build on the physical and environmental assets of the site to maximise the quality of the ultimate living environment. In particular water should be recognised as an important resource that can enhance and bring a focus to areas accessible to the whole community.

For the proposed residential development of Redbank, there are major opportunities to:

- Integrate open space areas and stormwater treatment devices.
- Ameliorate existing flooding of residential properties downstream of the site.
- Consider opportunities for storage and re-use of water as a resource for maintenance and watering purposes.
- Maintain supply of stormwater (quality and quantity) to downstream users and environment.
- Integrate the heritage and environmental values of the key-line system dams as focal points in the surrounding community and drainage corridors.

6.7 Constraints

The constraints to be considered in the preparation of a drainage strategy for the residential development of Redbank include:

- Piped flows from the existing western portion of Kemsley Downs currently discharge into the watercourse adjacent the site near the intersection of Arthur Phillip Drive and Townsend Road. The existing formed channel downstream of this discharge point has sufficient capacity to drain the entire catchment. However, the main channel upstream of this discharge point has insufficient capacity to convey discharges from the upstream catchment.
- The existing downstream drainage infrastructure through North Richmond has inadequate capacity to convey existing 100 year ARI discharges from the catchments without the flooding of residential properties.
- The existing formed channel, which conveys stormwater from the southern catchment, will be set aside as a drainage corridor, with assessment pending with regards the classification of this corridor with DWE and Council. This drainage / riparian corridor will extend up through the southern portion of the site, draining the Southern Catchment.
- A number of additional drainage / riparian corridors will be required throughout the northern portion of the site linked directly with Redbank Ck riparian corridor.
- Peak discharge rates along Redbank Creek are not to be increased as a result of the Development.

- Water Quality objectives will require allocation of land for stormwater detention and water quality control structures, restrictions in grading and locations may require the provision of separate single-purpose devices.
- Stormwater detention is required to reduce post development flows to pre-development levels as a minimum. Appropriate areas will be required to provide necessary detention storage.
- Potential hazard caused by existing key line dam in Southern Catchment immediately upstream of existing residential properties.

7. STORMWATER MANAGEMENT CONCEPT

7.1 Proposed Stormwater Management Strategy

The stormwater management strategy proposed for the site focuses on minimising the impacts of the development on the total water cycle and maximising the environmental, social and economic benefits achievable by utilising responsible and sustainable stormwater management practices.

To maintain stormwater quality to the required levels, a “treatment train” approach is proposed where various types of pollutants are removed by a number of devices acting in series. Refer to Figure 5 for a schematic layout of the proposed stormwater management strategy.

The stormwater management strategy consists of the following elements.

On Lot Treatments

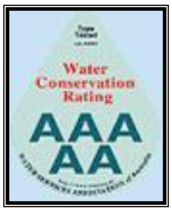
Water Efficiency & Re-use

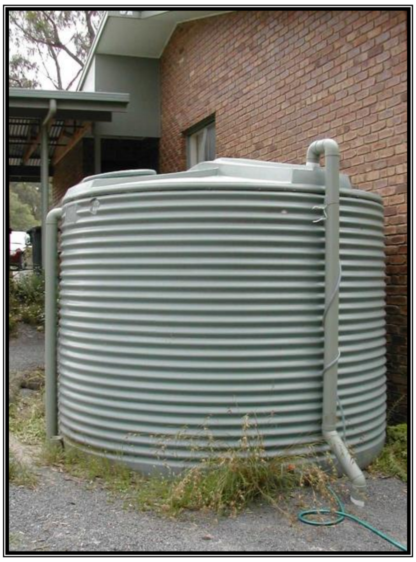
Adoption of appropriate waterwise landscaping practices (native gardens, mulch, micro-irrigation).

Implementation of BASIX compliant water efficient fittings and appliances (dual flush toilets, AAA shower heads, water efficient taps and plumbing).

The provision of rainwater tanks where appropriate (to supplement demand management measures to achieve overall reduction in potable water demand and to achieve reductions in average annual post-development runoff).

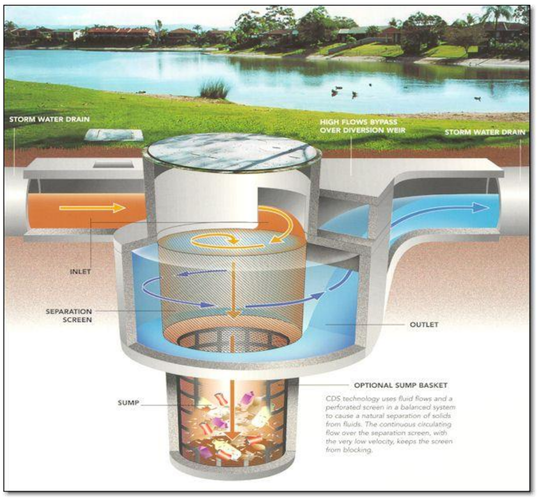
These elements are to be utilised throughout the development for residential and commercial sites.





Street Level Treatments

Gross Pollutant Traps (GPTs)



GPT devices are typically provided at the outlet to stormwater pipes. These systems operate as a primary treatment to remove litter, vegetative matter, free oils and grease and coarse sediments prior to discharge to a downstream (Secondary and Tertiary) treatment devices. They can take the form of trash screens or litter control pits, filter pit inserts and wet sump gross pollutant traps. Council approved GPT units are to be provided at the end of stormwater pipes from urbanised catchments prior to discharging to water quality devices or Redbank Creek.

Sub-catchment / Subdivision Scale Treatments

Bio-Retention Raingardens

Bio-Retention Raingardens are to be utilised to facilitate the removal of suspended solids and nutrients from the proposed development areas. The roadside bio-swales can also be utilised to capture litter and sediment loads that runoff from the development.

The raingardens are to be located in a position to allow the treatment of stormwater runoff from the development. Treated discharge outflows and overflows are directed into the downstream drainage system.

Constructed Ponds

A Constructed Pond will be located within land proposed for drainage reserve. It has also been sited to avoid existing significant vegetation within the site.

Pollutant removal is achieved by the processes of extended detention times, root filtering and nutrient uptake by the plant bed and nutrient stripping by bio-films which establish within the root mass of the macrophytes. A discharge control structure will be configured to promote extended detention times for the treatment flows.

Detention Storages

Detention storage basins are to be integrated with the raingardens or pond and will be located within lands proposed for public reserves. The detention facilities will be sized to manage developed site discharges from the 1 year up to and including the 100 year ARI storm event peak flow discharges to pre-development levels at a minimum, or if possible, to the capacity of the downstream drainage infrastructure.

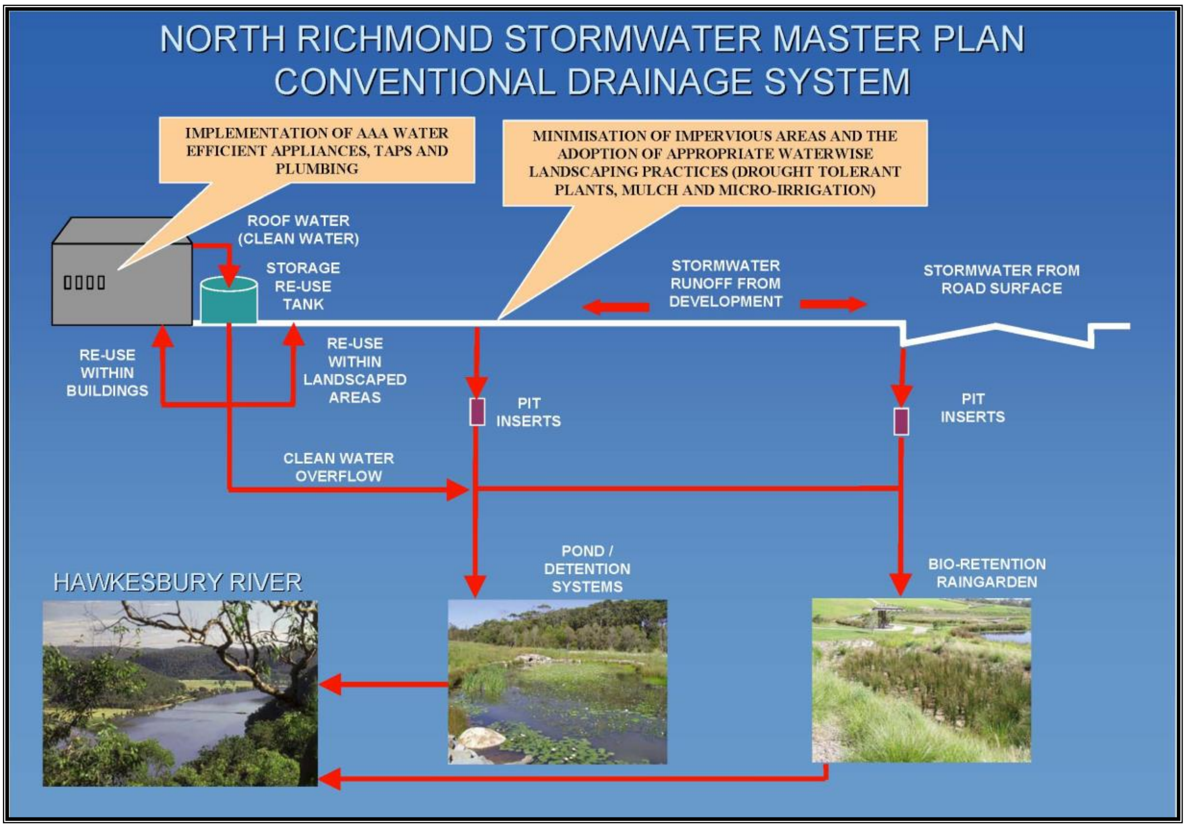


PLATE 4: THE PROPOSED STORMWATER MASTER PLAN CONCEPT FOR REDBANK RELEASE AREA

7.2 Elements in Water Quality Strategy

7.2.1 Stormwater Re-Use (Rainwater Tanks)

BASIX compliant rainwater tanks can be provided on individual residential, commercial and industrial lots for stormwater retention and re-use for irrigation of lawns and gardens, and use in toilets. This will significantly reduce the demand on potable water supplies.

The retention and re-use of stormwater in toilets and over lawns and gardens would also result in a reduction in the total volume of stormwater runoff to catchments, which will go some way to offsetting normal post development increases.

Rainwater tanks are to be used wherever reticulation from a recycled water scheme is not or will not be provided.

7.2.2 Litter and Sedimentation Control (Primary Treatment)

Local drainage throughout the development should be filtered of litter and sediments prior to being discharged into the stormwater quality improvement devices and downstream drainage systems.

GPT devices are typical primary treatment measures provided to remove litter, vegetative matter, free oils and grease and coarse sediments prior to discharge to a downstream (Secondary and Tertiary) treatment device. They can take the form of trash screens or litter control pits, filter pit inserts and wet sump gross pollutant traps. Council approved GPT units are to be provided at source (pit inserts) or at the end of stormwater pipes from urbanised catchments, prior to discharging to water quality treatment devices or Redbank Creek.

If filter pit inserts are to be adopted, it is essential that the inserts be used in every inlet pit as the alternative of providing pit inserts in a portion of the pits will not provide the appropriate water quality treatment requirements.

7.2.3 Bio-Retention Raingardens (Secondary Treatment)

Bio-Retention Raingardens are to be utilised to facilitate the removal of suspended solids and nutrients from the proposed development.

The raingardens are to be utilised to remove fine particulates and nutrients from first flush flows prior to discharge from the North Richmond site. They usually form part of a treatment train system, which requires the removal of gross pollutants prior to discharging into the raingarden system. Discharge from the raingardens will be directed into the downstream drainage systems.

The bio-retention raingardens will be stand-alone treatment devices or integrated within the base of the detention basins. Refer to Figure 5 for indicative bio-retention raingarden locations.

The proposed bio-retention raingardens will consist of a 300 mm deep extended detention zone designed to detain and treat 3 month flows from the upstream catchments. Based on preliminary water quality modelling of generic catchments, the surface areas of the bio-retention raingardens were determined to be equivalent to 1.25% of the catchment for which they service.

The surface of the bio-retention raingardens are to be mass planted with native water tolerant species and the filtration beds will be typically 600 mm deep. Discharge from the bio-retention raingardens will generally be directly to the drainage or riparian corridors.

The requirements for the regular maintenance of the bio-retention devices is to control weeds, remove rubbish, and monitor plant establishment and health. Some sediment build-up may occur on the floor of the bio-retention systems and may require removal to maintain the high standard of stormwater treatment.

Refer to Section 7.4 for the MUSIC modelling of bio-retention raingardens servicing typical residential catchments.

7.2.4 Constructed Ponds/Wetlands (Secondary / Tertiary Treatment)

Ponds are built as deep wet basins, densely vegetated along the waterline that use enhanced sedimentation, fine filtration and pollutant uptake processes to remove pollutants from stormwater. After large rainfall events, water levels are expected to rise but the outlet structures are configured to slowly release flows and bring them back to dry weather levels.

There is a proposal to provide one pond within the site, which will form part of the open space area.

Pollutant removal is generally achieved by the processes of extended detention times, root filtering and nutrient uptake by the plant bed and nutrient stripping by bio-films which establish within the root mass of the macrophytes. A discharge control structure will be configured to promote extended detention times for the treatment flows.

As the pond will also be used for storm flow detention storage, the pond will have an elevated embankment above the static water level to provide the required storage volume for storms from the 1 year ARI up to the 100 year ARI event. Discharge from the pond will be directly into the formed channel draining the catchment.

The pond was not assessed in the water quality modelling, as it is expected to be augmented with bio-retention raingardens. However, the approximate size of the pond is expected to be equivalent to six (6) percent of the total upstream catchment. Detailed MUSIC modelling will be undertaken at a later stage of the development process to confirm this size.

Maintenance requirements for the pond would typically involve plant replacement, weed control, repair of erosion and structural damage and removal of localised sediment build-up. This would be undertaken on a monthly basis.

7.3 Rainwater Re-Use

Stormwater runoff from the roofs of the proposed buildings will be captured and directed to stormwater re-use storage tanks and used for irrigation of the landscaped areas and toilet flushing within each allotment. Once the rainwater re-use tanks are filled with stormwater runoff, overflows from the tanks will be piped and connected into the downstream drainage system.

The future water quality modelling (to be undertaken at sub-catchment planning approval stages) will assume that each individual residential allotment will provide a BASIX compliant system, with 3,000 litre re-use tanks connected to roof drainage systems. The assumed re-use rate of 120 litres per household per day was adopted for the assessment.

7.4 Modelling of Bio-Retention Raingardens with MUSIC

A generic MUSIC model was setup to determine the indicative sizing of the proposed bio-retention raingardens required to treat stormwater runoff from the proposed development.

The model was setup to represent a typical 10 hectare catchment development under each of the three residential usage types proposed for the site:

- Medium Density Residential;
- Low Density Residential; and
- Rural Residential.

The modelling included the use of BASIX compliant rainwater re-use tanks throughout the development (refer to Section 7.3) capturing roofwater runoff, and the use of GPT's to remove the majority of the gross pollutants and sediments from the stormwater runoff prior to discharging into the bio-retention raingarden system.

Refer to Plate 4 below for the generic water quality modelling layout of a typical 10 ha site representing the residential development under Medium Density, Low Density and Rural Residential conditions. Refer to Table 7.1 for the catchment assumptions made in the water quality modelling.

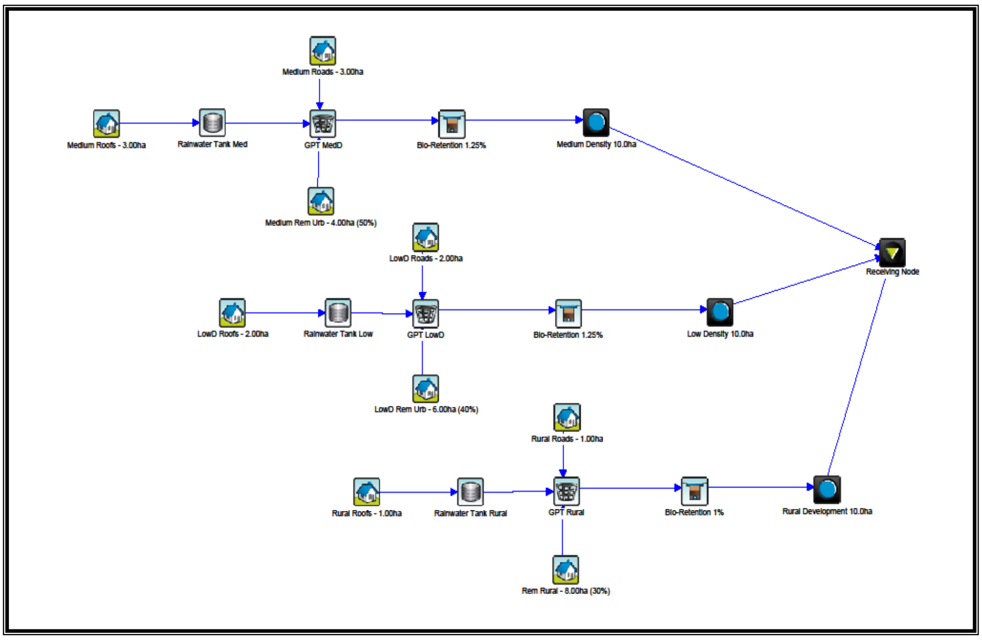


PLATE 5: GENERIC MUSIC MODEL LAYOUT

Table 7.1

CATCHMENT ASSUMPTIONS MADE IN THE WATER QUALITY MODELLING

Residential Landuse Type	Assumed Fraction Imperviousness	Raingarden Area as % of Catchment
Medium Density	75%	1.25%
Low Density	60%	1.25%
Rural Residential	40%	1.00%

It is recommended that a whole of site detailed MUSIC model is prepared at future development stages throughout the site to confirm the bio-retention raingarden areas required to treat the catchment based on the proposed residential landuse type.

7.5 Water Quantity Management

7.5.1 Management Options

It is well recognised that a number of areas throughout the existing residential township of North Richmond, downstream of the development site in the current situation are flood affected for a range of storm events.

Part of the development proposal is to provide infrastructure to assist in alleviating the current flooding problems within the downstream North Richmond Township.

Alternative solutions to assist in reducing the flows discharging through North Richmond from the Southern Catchment that were evaluated included:

- Over attenuation by constructing larger detention basins within the Southern Catchment development.
- Increasing the capacity of the downstream drainage infrastructure through the North Richmond Township.

- Diverting some of the flows north, via a diversion pipe located within the transmission easement, to discharge to Redbank Creek, bypassing North Richmond.

Due to cost and land take of potential developable land, the larger detention basin option was considered to be unviable. Increasing the capacity of the existing drainage system through the North Richmond Township would be very costly and would result in considerable disruption to the local residences, in addition to this; the entire length of the drainage system upgrade would be approximately 1 km, as it would need to extend to Bells Line of Road. The simplest and most viable and cost effective option was to duplicate the existing 1500 mm diameter RCP which diverts primary flows from the Southern Catchment northward, along the transmission easement, into Redbank Creek.

7.5.2 Proposed Strategy

A series of detention storage basins are to be located within the Southern Catchment in land proposed as drainage reserves. The general size and configuration of the basins is dependent on the developed catchment and the downstream drainage system to which the device is draining.

The detention systems will be configured to restrict post development flows to pre-development (rural) levels for storm events of the 1, 2, 5, 10, 20, 50 and 100 year ARI events. Refer to Figure 5 for the indicative location and size of the detention basins. The proposed development will require four detention basins in addition to the two devices located within the approved Seniors Living Development.

Runoff from the developed catchments will be directed through the first-flush bio-retention systems, with 3 month overflows being directed to the detention basins prior to discharging into the downstream environment.

It is proposed to provide additional storage capacity above the bio-retention raingardens (where appropriate), with configured outlet structures for detention purposes. The basins are permanent devices designed to accept and attenuate discharges from their designated catchments of the site, including undeveloped upstream catchments up to Grose Vale Road.

The operation of the proposed systems detaining discharges from the site were evaluated using XP-Storm modelling. The indicative size of the active storage volumes, which will be provided within the detention basins, is shown in Table 7.2.

Due to the timing of flows from the development, detention of flows along the northern catchments that discharge directly into Redbank Creek result in increased discharges within Redbank Creek itself. If undetained post-development flows are allowed to discharge directly into Redbank Creek, peak flows along the Creek are actually maintained or reduced, resulting in less impact on downstream properties affected by flooding of Redbank Creek. In effect, developed discharges from the site are allowed to contribute directly to the Creek flows which continue through to Bells Line of Road prior to the main peak flows from Redbank Creek reaching the site boundary.

It is proposed to increase the capacity of the existing drainage system conveying discharges north to Redbank Creek in order to alleviate the current flooding occurring in the existing North Richmond Township. This is planned to be achieved by duplicating the existing 1500 mm diameter RCP within the transmission easement, to the proposed Peel Park Basin. The basin is to ensure that the additional discharges from the Southern Catchment do not cause an increase in peak flows along Redbank Creek to Bells Line of Road. Preliminary modelling indicates that diversion of more of the primary flows suggest that discharges through North Richmond may be reduced by up to 4 to 5 m³/s.

The drainage systems conveying flows from the development to Redbank Creek will be appropriately sized to convey the full undetained 100 year ARI discharges.

Table 7.2

GENERAL SIZES OF THE DETENTION STORAGES

Node Label	Surface Area (m²)	Storage Base Level (m)	Top Water Level (m)	Detention Depth (m)	Volume (m³)
1.01b	6900	50.00	51.20	1.20	8300
2.01b	6300	44.00	45.00	1.00	6000
1.03b	13000	33.10	34.70	1.60	17800
6.02b	4600	29.20	31.00	1.80	5700
7.01b	2520	29.00	30.50	1.50	2600
PF Basin	15000	24.00	26.50	2.50	20000

Note: Results from JWP XP-Storm model 8601ST_11

7.6 Internal Watercourses and Road Crossings

Watercourses will be constructed within the allocated riparian corridor areas to transfer discharges from the development areas to the downstream drainage infrastructure and Redbank Creek. The channels and culvert crossings will be appropriately sized to convey the post-development 100 year ARI flows.

The allocated widths of the riparian / drainage corridors throughout the site are sufficient to provide the required open drainage channels capable of conveying peak 100 year ARI discharges through the development to the downstream drainage systems.

Refer to Table 7.3 for the estimated corridor widths required to convey 100 year ARI flows through the site and refer to Figure 5 for the Trunk Drainage Channel labels.

Table 7.3

GENERAL SIZES OF RIPARIAN / DRAINAGE CORRIDORS

Channel Designation	Nominated Minimum Riparian Corridor Width (m)	Estimated Maximum Required Channel Width (m)	Adopted Minimum Corridor Width (m)
TC1	60	25	60
TC2	60	10	60
TC3	60	10	60
TC4	60	15	60

There is only expected to be two road crossings of the proposed riparian corridors within the development, which happen to be downstream of the reconstructed pond and detention system within the Southern Catchment. The main link road through the site from Grose Vale Road will form the embankment structure of the device, and the culvert crossing arrangement will effectively form the basin outlet control (culvert crossing A as denoted on Plate 6).

The other crossing, further downstream, is one of the entry points from Arthur Phillip Drive into the approved Seniors Living Development. An appropriately sized culvert has been constructed to cater for the 100 year ARI discharges within the drainage channel (culvert crossing B as denoted on Plate 6).

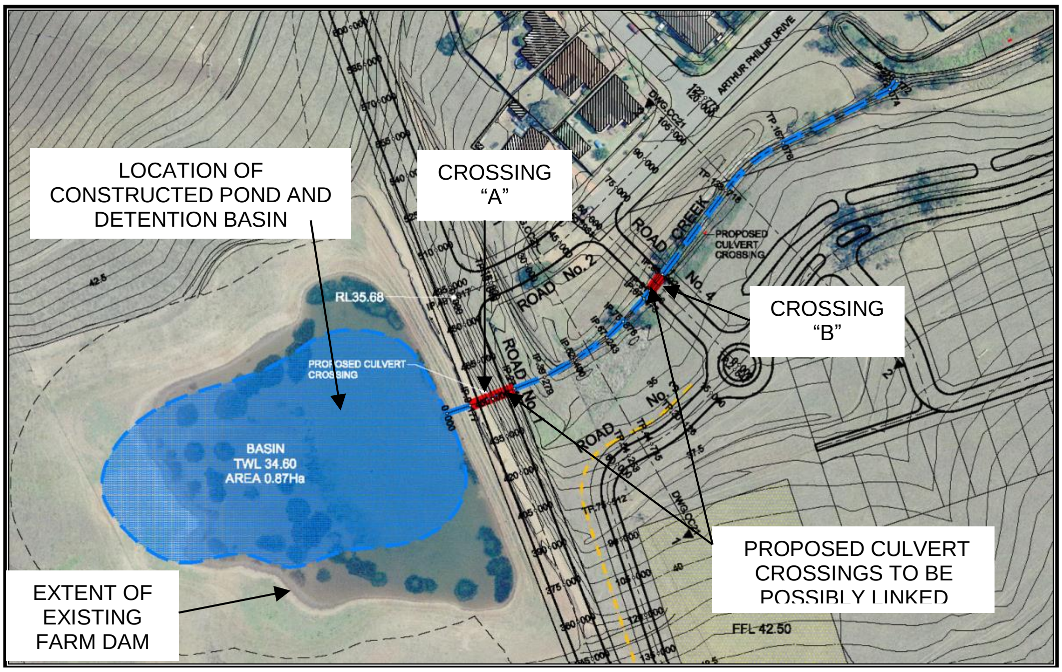


PLATE 6: LAYOUT OF CONSTRUCTED POND AND OUTLET SYSTEM WITH PROPOSED CULVERT CROSSING LOCATIONS

There are locations within the site that are restricted by property boundaries and planning outcomes that result in minor adjustments to the riparian corridor extents (refer to locations denoted as 'X', 'Y' and 'Z' on Figure 4). However, these adjustments are not significant and should be an acceptable outcome for the overall development of the Redbank.

7.7 Construction Stage

Erosion and sediment control measures should be implemented during the construction phase in accordance with the requirements of Hawkesbury City Council and the guidelines set out by the NSW Department of Housing (the "Blue Book" Ref. 12).

Temporary sediment and erosion control ponds are to be provided and will be generally required during the civil and housing construction phases for each development, and all runoff from the disturbed areas within each development will be directed to these devices. Measures such as rock wrapped in geofabric or hay bales will be installed in or around respectively, any stormwater inlet pits receiving water from disturbed catchments.

As the operations of the bio-retention facilities are sensitive to the impact of sedimentation, these controls should generally be maintained until the majority of site building works are complete.

7.8 Operation and Maintenance

Regular maintenance of the stormwater quality treatment devices is required to control weeds, remove rubbish and monitor plant establishment and health. Some sediment build-up is expected on the floor of the bio-retention raingardens and may require removal to maintain the high standard of stormwater treatment.

Proper management and maintenance of the water quality control systems will ensure long-term, functional stormwater treatment. We recommend that a site-specific Operation and Maintenance (O & M) manual be prepared for the site. The O & M manual will provide information on the Best Management Practices (BMP's) for the long-term operation of the treatment devices. The manual should provide site-specific management procedures for:

- Maintenance of the pit inserts including rubbish and sediment removal.
- Management of the bio-retention raingardens including plant monitoring, replanting guidelines, monitoring and replacement of the filtration media and general maintenance (i.e. weed control, sediment removal etc.).

The manual should also specify maintenance responsibilities and provide indicative costs of maintaining the devices within the development.

7.9 Public Safety

Detention basin storages provided within the site will generally be independent devices or additional storage capacity above constructed wetlands. Controls may need to be implemented at DA Stage to manage the risk associated with members of the public being in close proximity to flooded areas and devices such as the constructed wetlands and detention basins.

Roads and open space reserves have generally been used to form the flow path by which major storms are routed through the subdivision.

The designs for the detention basins will ensure that the critical 100 year ARI flood event is satisfactorily contained and that provision can be made for safe and adequate escape of stormwater in major and extreme storm events. Where detention storages have storage depths greater than 1.5 m at 100 year ARI capacity, it will be necessary to provide fencing or landscaping to inhibit access, as well as signage to warn of the potential hazards during times of heavy rainfall events.

7.10 Management of Existing Farm Dams

There are a number of existing farm dams throughout the property. Two-three may be retained with necessary safety modifications. One major water body will be modified substantially and will be utilised as a constructed wetland with detention storage capacity, whilst the remainder of the dams will be removed altogether.

The major existing dam that will be converted to a constructed pond with detention is upstream of existing and proposed residential properties, and the potential danger posed by such an element if the embankment fails is to be assessed in accordance with the NSW Dam Safety Committee (DSC) requirements.

The Dam Safety Committee will require the developer to demonstrate that the proposed constructed pond/retarding basin can safely pass an “appropriate extreme storm commensurate with the consequence category of the dam”. A preliminary assessment of the DSC classification criteria indicates that the appropriate event will be the 0.5 PMF (approx 1:100,000 yr ARI).

The future design of the proposed works to re-construct the existing farm dam to provide a flood retarding basin and constructed pond will need to be carefully configured to ensure that the identified flood hazards on Arthur Phillip Drive are not increased as a result of the works. A preliminary assessment of the likely future works indicate that it may be appropriate to extend the culverts (provided for the approved Seniors Village crossing) up to the Basin Outlet to safely convey the extreme flood event to the downstream side of the road crossing (this may need to be integrated with limited upgrade of the existing channel downstream of the road crossing to ensure that the hazard on existing properties is maintained or improved as a consequence of the development).

The proposed modification of the farm dam into a constructed pond/ basin will need to comply with the requirements of the Dam Safety Committee who have the responsibility (under the Dams Safety Act 1978) to ensure that flood retarding basins are appropriately designed and managed to result in a tolerable risk to the community.

The design of a suitable outlet arrangement will also require the negotiation with the NSW Office of Water in order to secure a controlled activity approval for the works.

8. PRELIMINARY FLOOD ASSESSMENT

JWP are currently in the process of undertaking a Flood Study of the overall North Richmond Township on behalf of Hawkesbury City Council (Ref. 9). This report (which is yet to be finalised at this stage) details the procedures used and presents the results of an assessment of the hydraulic performance of the existing stormwater drainage infrastructure within the township of North Richmond: The extents of the flood assessment under existing site conditions has been expanded to include the Redbank site.

The result of the flood assessment for the Redbank site is provided for the site under existing conditions, further assessments will need to be undertaken at future DA Stages to define the expected flood extents on the site under post-development conditions.

8.1 Flood Study Outcomes

The TUFLOW modelling has established that the majority of flooding within Redbank Creek is completely contained within the allocated riparian corridor extents of Redbank. At this stage, there are no plans to modify the terrain in this area.

There are tracts of land within the Southern Catchment of the Redbank site which are currently impacted by flood waters during the peak 100 year ARI storm event – particularly in the vicinity of the existing large farm dam. It is expected that this dam will be reconstructed as a pond with additional capacity for detention, so the future extents of flooding in this area will be reduced and is subject to future detailed design and further hydraulic assessment.

Flood Hazard Mapping was developed in TUFLOW for the peak 100 year ARI storm events under existing site conditions within Redbank. This mapping is shown on Figure 6 which indicates that the greatest hazards are generally within the Redbank Creek riparian corridor for the Northern Catchments. The development area adjacent Redbank Creek is generally outside the flood extents and any building pad areas will be clear of the 100 year ARI flood extents.

The main hazards within the Southern Catchment are associated with the main drainage channel and the existing large farm dam. The proposed development will incorporate the reconstruction of the existing farm dam and constructed drainage channel within the riparian corridor. These works will ensure that the flood extents will be reduced and remain confined within the riparian corridor such that flooding (and hence, flood hazards) do not encroach upon the proposed Redbank development.

The TUFLOW modelling has identified that the Redbank Release Area is impacted by some flooding which affect low-lying areas of the development and appropriate planning measures can be undertaken to minimise the impact of flooding on proposed development areas. With adequate planning and engineering design, it is expected that all of the 100 year ARI flood extents within the southern catchment can be restricted to the riparian corridor / open space area of the site.

Preliminary investigations suggest that duplication of the existing 1500 mm diameter RCP conveying primary discharges northwards to Redbank Creek (away from the North Richmond Township) has a positive effect on reducing flood levels in North Richmond.

The impact of Redbank on flooding will need to be considered when planning the development, to minimise the potential hazards to residential areas and ensuring that flood levels are not increased due to localised site filling. The extent of peak 100 year ARI flooding on the Redbank site is shown on Figure 2. The outcomes of the flood study should be used by NRJV and Hawkesbury City Council as the basis for planning, assessing flooding extents and flood affectations.

9. RECOMMENDATIONS AND CONCLUSIONS

The Stormwater Management Strategy Report has been prepared to support the Masterplanning process for the Buildev residential development within the Redbank Release Area. The strategy has been prepared to conform to statutory requirements and industry best practices.

The management of stormwater from the site utilises on-site rainwater tanks for re-use with pit inserts, bio-retention raingardens and detention basins treating and detaining discharges from the development.

The strategy consists of a stormwater treatment train utilising the following components (as indicated on Figure 5):

- On-lot treatments such as on-site management systems, BASIX compliant water efficient fittings and rainwater tanks for on-site re-use;
- Enviropod Pit inserts will be used in all surface inlet and kerb inlet pits to treat all runoff from the estate to filter all gross pollutants prior to discharging into the downstream drainage systems;
- Stormwater from the Northern Catchments will be treated by a series of bio-retention raingardens totalling over 7,000 m^2 in bed area adjacent Redbank Creek along the northern fringe of the site,
- Discharges from the Northern Catchments greater than the 3 month ARI to discharge directly into Redbank Creek.
- Stormwater from the Southern Catchment will be treated by a series of bio-retention raingardens totalling over 11,000 m^2 in bed area along the central drainage corridor of the catchment, as well as a constructed pond to assist with pollutant removals; and
- Discharges from the Southern Catchment greater than the 3 month ARI to be captured and detained in a series of basins (including a constructed pond), which are situated within the drainage corridor through the centre of the catchment and has a total active detention volume of over 40,000 m^3, with an additional basin in Peel Park with an expected volume of about 20,000 m^3.
- Duplication of the existing 1500 mm dia. RCP drainage line accepting discharges from the Southern Catchment to drain north to Redbank Creek via the proposed Peel Park Basin.

The proposed Stormwater Management Strategy provides a suitable solution and a basis for the Masterplanning of the proposed residential development. The Strategy ensures that the objectives for stormwater management and site discharge are attained.

The review and investigations undertaken by JWP confirm that the Water Management Strategy developed for Redbank adequately addresses all of the performance objectives and the requirements of the relevant planning controls.

It is recommended that the general principles, objectives and strategies identified in this report be incorporated in the detailed planning and design of the Redbank residential development site.

It is also recommended that the land required for trunk drainage, integrated riparian corridors, stormwater treatment and detention facilities be incorporated into Council's site specific DCP for the Release Area and set aside for these purposes.

10. REFERENCES

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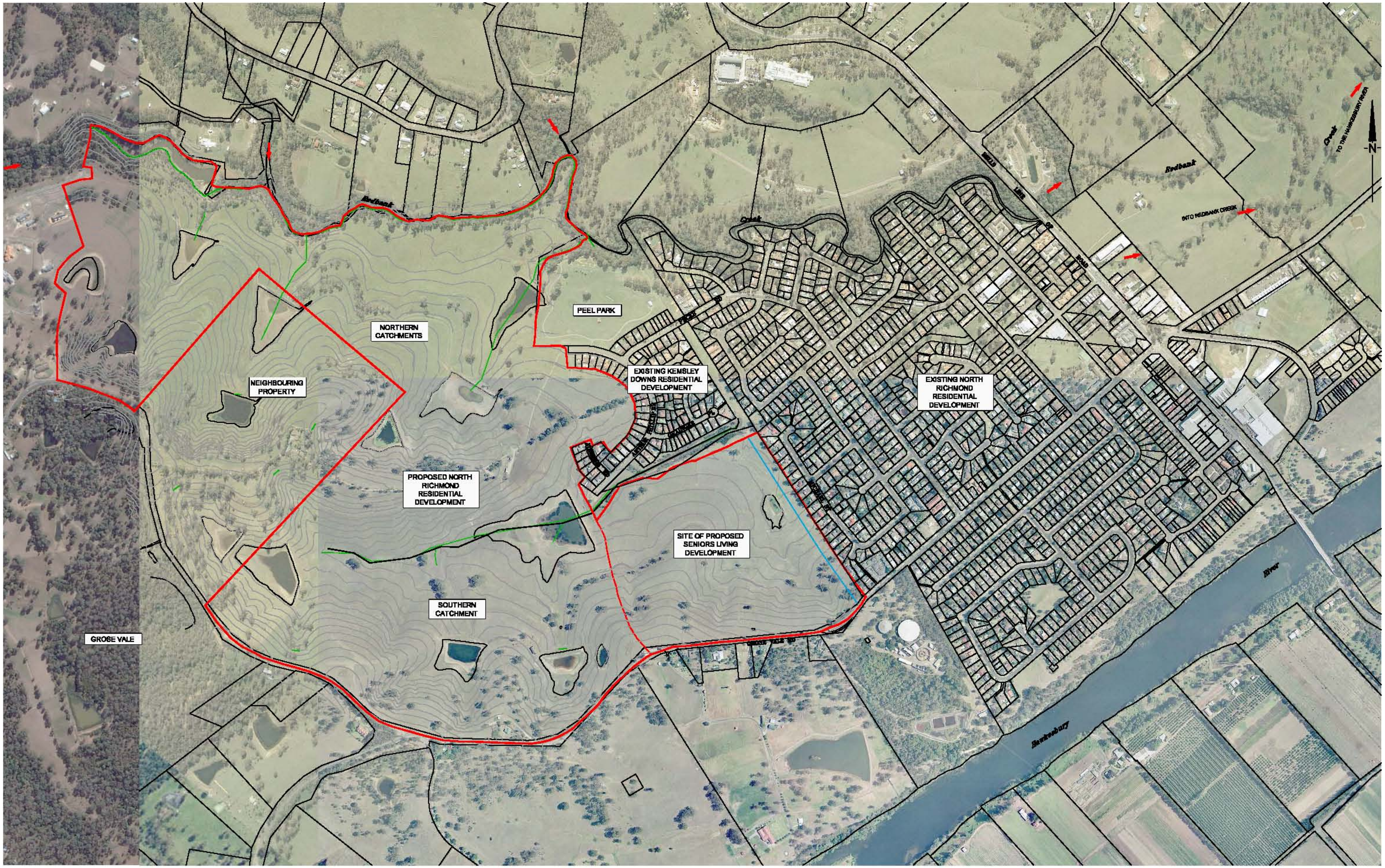
Figures



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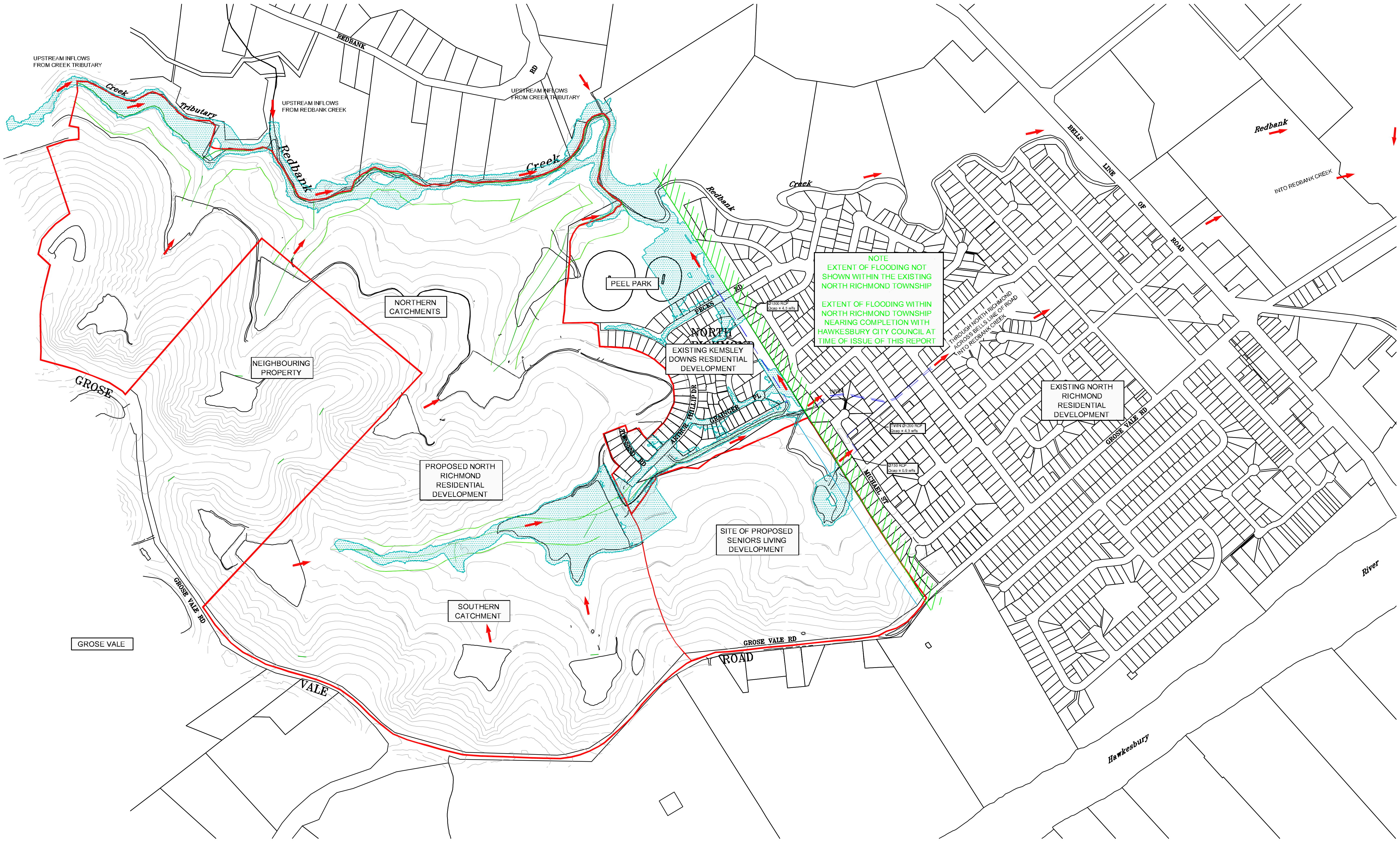
NORTH RICHMOND RELEASE AREA - REDBANK

STORMWATER MASTER PLAN
LOCALITY AND SITE LAYOUT PLAN

FIGURE 1



LEGEND:

- SITE BOUNDARY
- INDICATIVE EXTENT OF 100 YEAR ARI FLOODING
- INDICATIVE FLOW DIRECTION IN DRAINAGE SYSTEM
- RIPARIAN CORRIDOR EXTENTS

1:10000 — 100 50 0 50 100 150 200 250 300 350 400 450 500 METRES

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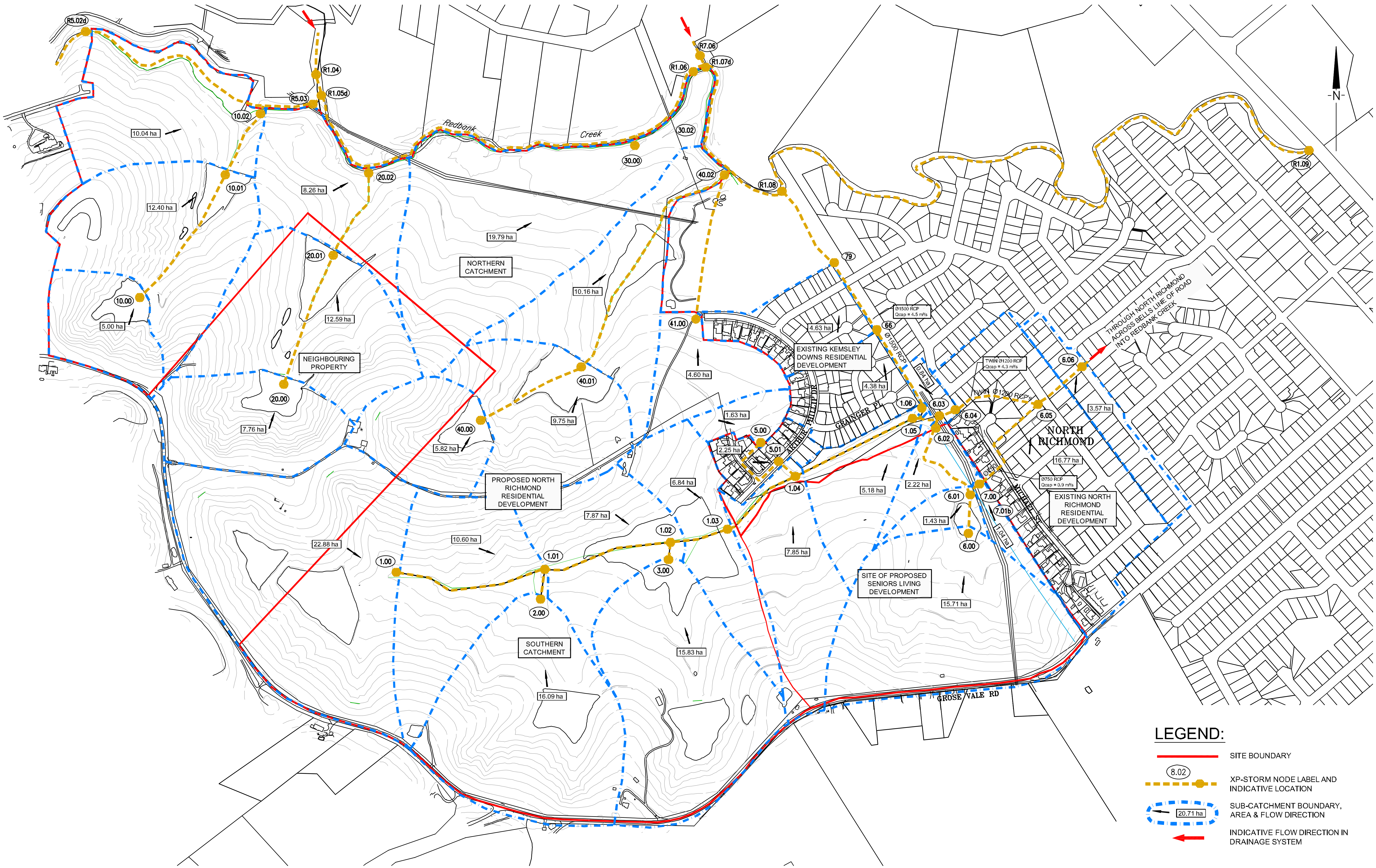
NORTH RICHMOND RELEASE AREA - REDBANK

STORMWATER MASTER PLAN EXISTING DRAINAGE AND 100YR ARI FLOOD EXTENTS

FIGURE 2



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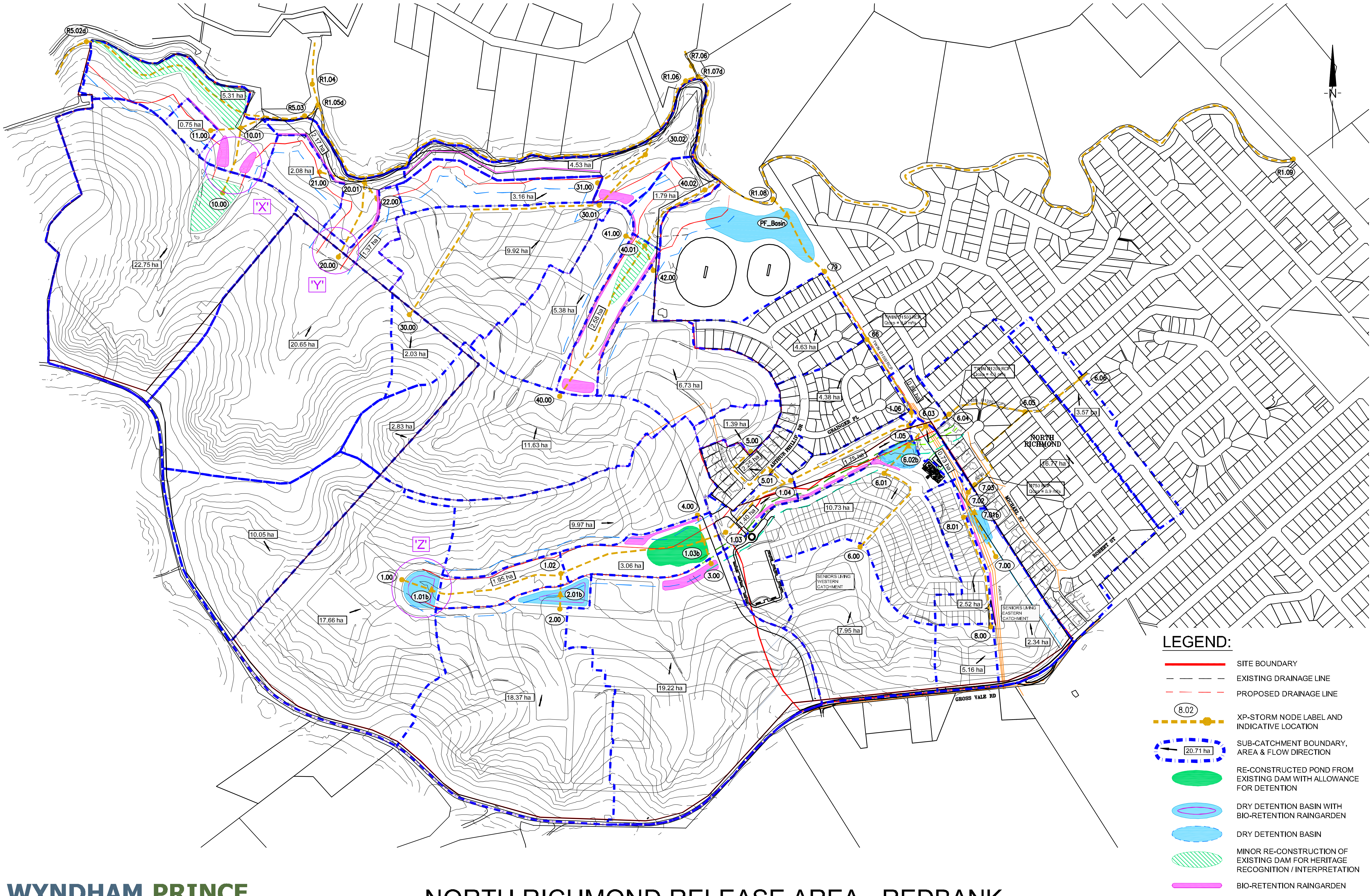
NORTH RICHMOND RELEASE AREA - REDBANK

STORMWATER MASTER PLAN
PRE DEVELOPMENT CATCHMENT LAYOUT PLAN

FIGURE 3



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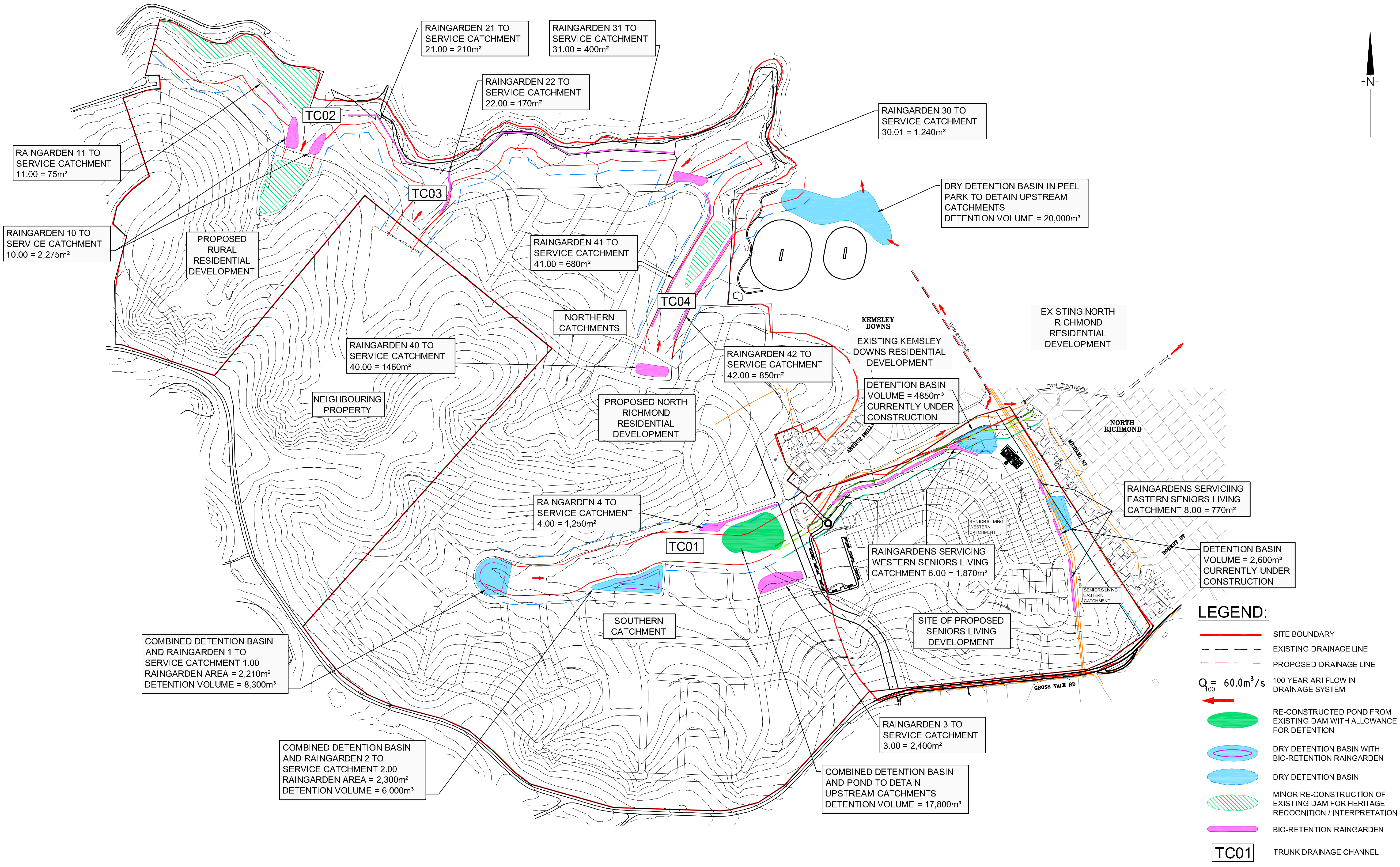
NORTH RICHMOND RELEASE AREA - REDBANK

WATER CYCLE MANAGEMENT STRATEGY
POST DEVELOPMENT CATCHMENT LAYOUT PLAN

FIGURE 4



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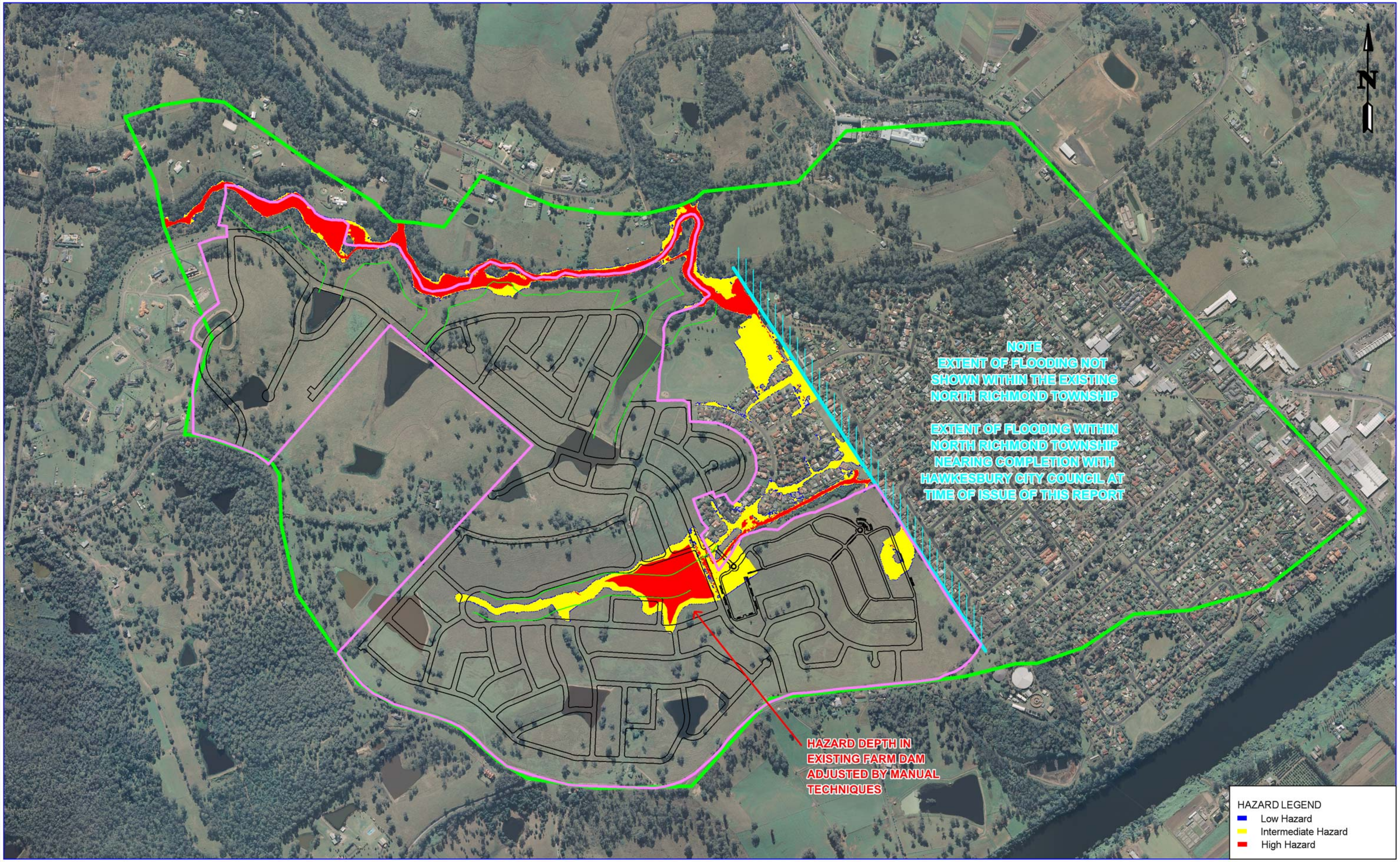
NORTH RICHMOND RELEASE AREA - REDBANK

1:8000 — 100 0 100 200 300 400 METRES

STORMWATER MASTER PLAN
STORMWATER MANAGEMENT DEVICE LAYOUT PLAN

FIGURE 5



CLIENT:
NORTH RICHMOND JOINT VENTURE

C/- BULDEV NSW

NORTH RICHMOND RELEASE AREA - REDBANK STORMWATER MASTER PLAN

FIGURE 6

ISSUE	AMENDMENT	DATE	BY
A	FIRST ISSUE	07/12/11	JC

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DRAWN:________
CHECKED:________

DATUM:
SCALES:
Scale 1: 5,000 @ A3

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100 YR ARI MAXIMUM FLOOD HAZARD MAP

PLAN No. 8505_SW06 A
FILE No. 8505_SW06_Fig_6.wor
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