YARRABILBA PRECINCT 3
STORMWATER QUALITY MANAGEMENT PLAN

VERSION 2

PLANS AND DOCUMENTS
referred to in the PDA
DEVELOPMENT APPROVAL

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Prepared for Lendlease

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Inherent natural variability in soils and plants

Where particular types of soils are recommended, such recommendations are based on information provided by soils suppliers, laboratories and published industry guidelines. There can be inconsistencies in the behaviour of soils under field conditions compared to laboratory conditions, and, for both natural and blended soils, many soils are non-homogenous and properties and behaviour can be variable. Where particular plant species have been recommended, such recommendations are based on botanical knowledge and observations of similar species growing in similar, but not identical conditions. Plants can be sensitive to subtle changes in climate, hydrology, soil and surrounding ecological conditions. Further to this, plant health is often closely linked to the level of maintenance provided. No warranty or guarantee, whether explicit or implied is made with respect to the suitability or performance of soils or plant species recommended in this report

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1 INTRODUCTION

The Yarrabilba Priority Development (PDA) is located within the Logan City Council area and occupies a former pine plantation located south of Logan Village. The Yarrabilba PDA was declared by regulation under the Economic Development Act (2012). Yarrabilba is part of a regional growth area identified in the South East Queensland Regional Plan, which identifies a need for a further 70,000 dwellings across a number a localities in the Logan council area by 2031. The Yarrabilba development aims to provide approximately 17,000 dwellings for a population of 45,000.

Precinct 3 covers an area of approximately 245 ha which includes approximately 137ha of development (lots, road, schools, parks) and approximately 108ha of environmental and conservation land. The drainage from the Precinct leaves the site to the north via Quinzeh Creek and a drainage easement through along Steele Road.

This document presents the stormwater quality management strategy for Yarrabilba Precinct 3 to meet the water quality requirements required by the State Planning Policy, *Yarrabilba Total Water Cycle Management Strategy* (DesignFlow, 2012) and *Yarrabilba Stormwater Infrastructure Master Plan* (DesignFlow, 2012). This reports provides details of the proposed stormwater treatment measures including location and conceptual sizing. In addition, updates to catchments and treatment sizes for portions of Precinct 2 development that drain into Precinct 3 treatment zones are included in this report. Conceptual earthworks plans for each stormwater treatment systems will be provided to support the Reconfiguring a Lot applications for Precinct 3.

This report focusses on the stormwater quality strategy only. Separate reports detail waterway stability assessments and flood management approaches for Precinct 3.

2 SITE CHARACTERISTICS

2.1 LOCATION

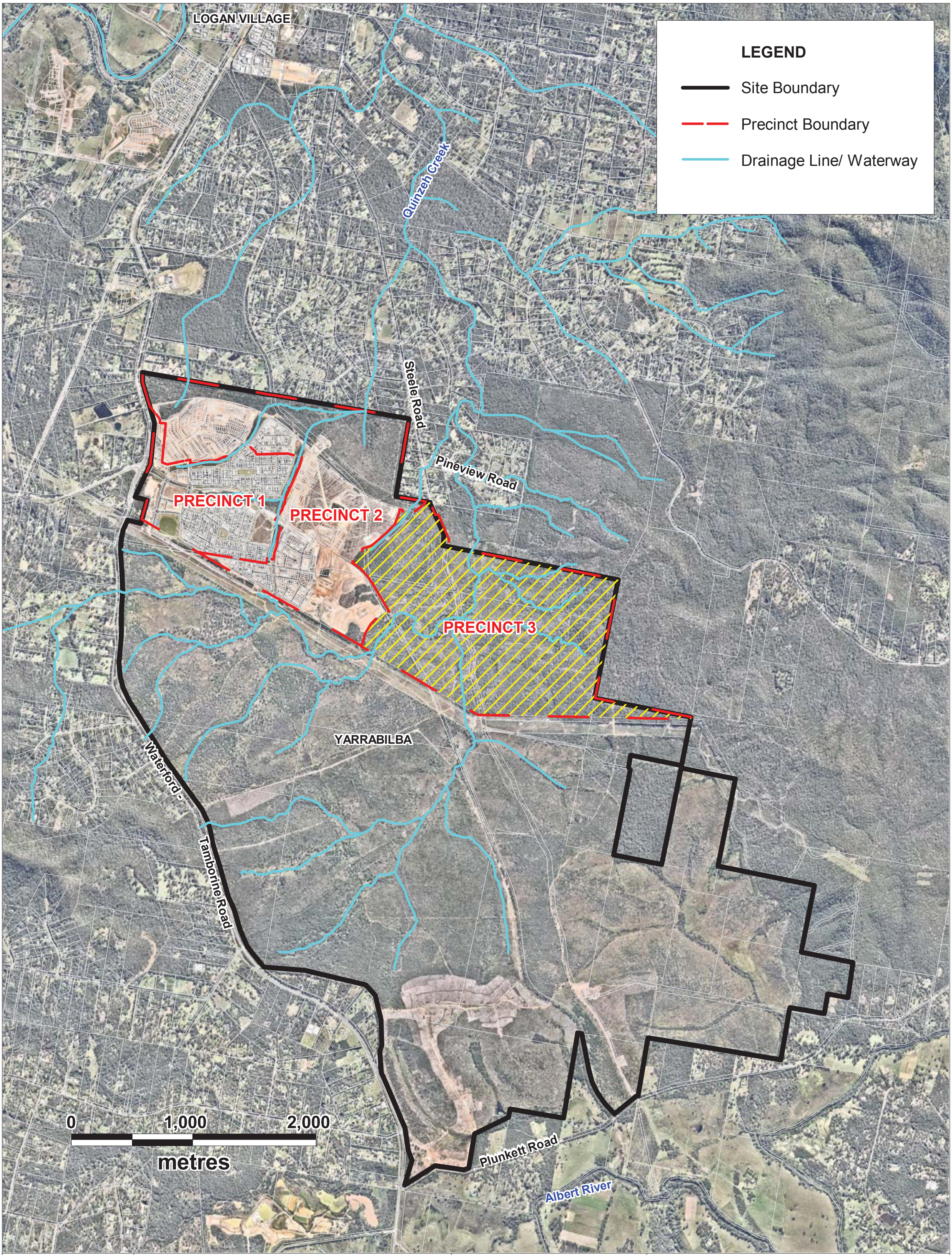
Development Precinct 3 (subject of this report) is the third major development area to be released at Yarrabilba and lies in the north eastern portion of the Lendlease site extending from Precinct 2 across to the eastern site boundary adjoining Plunkett Reserve as shown in Figure 1. The precinct covers a total area of 254 ha which includes a significant proportion of waterway and conservation open space (approximately 157 ha or 60% of Precinct 3) as well as a major powerline easement buffer bordering the southern edge of the precinct.

2.2 TOPOGRAPHY, CATCHMENTS AND DRAINAGE

The general topography across the site ranges from moderate grades (generally typically 2-6%) with broad flat zones along Quinzeh Creek (0.5%). Elevations range from 100m AHD at the south eastern corner of the site area to approximately 23mAHD at the northern boundary at the discharge of Quinzeh Creek.

Precinct 3 sits within Catchments 3 and 4 of the broad Yarrabilba development site as outlined in *Yarrabilba Precinct 3 Flood Study* (DesignFlow, 2016). As illustrated in Figure 2 the majority of Precinct 3 development drains toward Quinzeh Creek (Catchment 4), which discharges north of the site. At the north-west corner of the development approximately 20ha of Precinct 3 drains into Catchment 3 (total 47ha) which discharges from the site with flow from Precinct 2 via a flat wide depression to the northern boundary of the size.

A number of streams in the eastern half of the development area will receive drainage from Precinct 3B and C, prior to discharge to Quinzeh Creek. At the southern end of Precinct 3, a natural wetland area has been mapped and will be protected.



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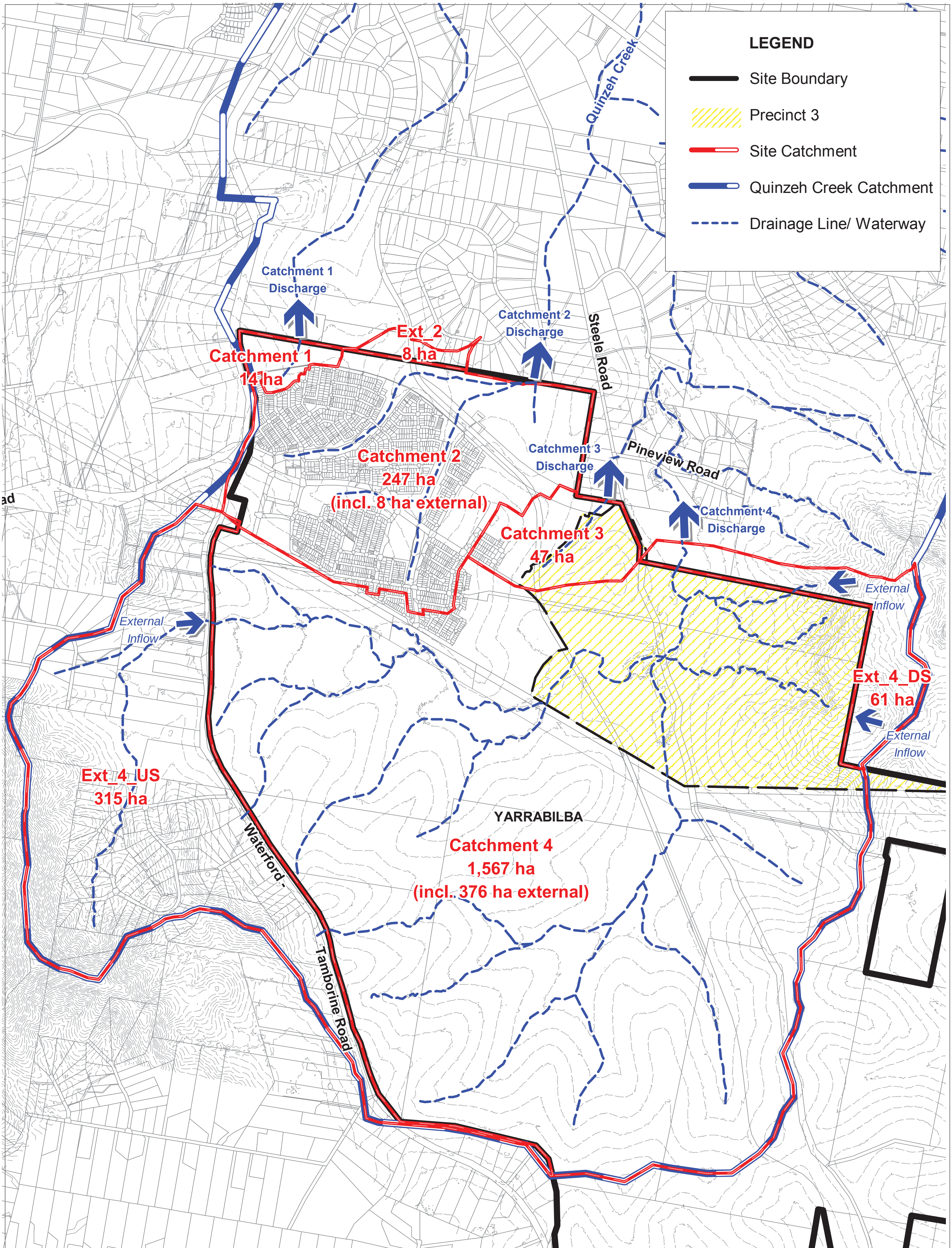
Project: 4284 Yarrabilba Precinct 3 Stormwater Quality Management Plan	Scale: 1 : 40,000 (A4)	FIGURE 1 Site Locality
Client: Lend Lease	Date: 11 July 2016	



Prepared by: DesignFlow For: lendlease	Project: 4284 Yarrabilba Precinct 3 Stormwater Quality Management Plan	N S W E Scale: 1 : 30,000 (A4)	**FIGURE 2** **Topography, Catchments and Drainage**
	Client: Lend Lease	Date: 11 July 2016	

2.3 LAWFUL POINT OF DISCHARGE

The lawful point of discharge for stormwater from Precinct 3 is illustrated in Figure 3 and described below:

- Quinzeh Creek – The creek is a Declared Watercourse under the Water Act (2000). This means that no works (i.e. dams, crossings, earthworks) can occur within the waterway unless approval from the State Government has been granted and thus ensuring all upstream drainage rights from Yarrabilba are preserved.

- Steele Road easement – A drainage easement exists through the private properties along Steele Road and Louise Court. The easement provide a discharge point for Catchment 3 of Yarrabilba.

Refer to *Yarrabilba Precinct 3 Flood Study* (DesignFlow, 2016) for further details regarding preserving peak flood flows at these locations. The management of frequent minor flows is required along Steele Road easement. Lendlease is in discussion with residents regarding drainage works within the Steele Road easement to convey these flows.

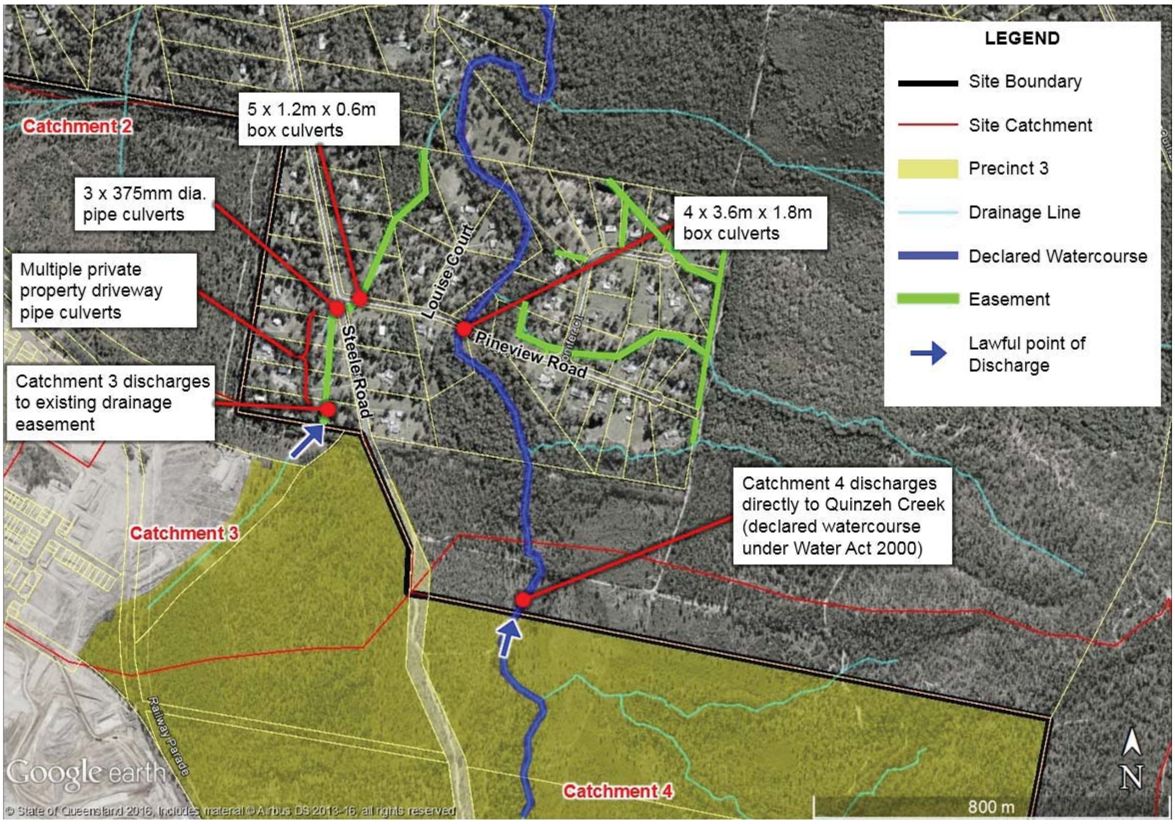


Figure 3 Lawful point of discharge

2.4 GEOLOGY AND SOILS

Geological mapping indicates Precinct 3 is located across three geological units:

- Woogaroo sub-group (RJbw)
- Ipswich Coal measure (Ri)
- Qa-QLD (Qa) - Alluvium

Broad scale geotechnical investigations completed across the site (Bowler, 2004) indicate subsurface soils are typically sands overlying silty clays and weathered sandstones. Soils are typically dispersive across the site. The soil conditions for Precinct 3, particularly Precinct 3A, are not expected to vary significantly from those encountered for Precincts 1 and 2. Some variances may occur, particularly in the eastern side of the Precinct (Precincts 3B and C) where geology changes to Ipswich Coal measures. In this instance higher strength rock and more saturated deep sand profiles may occur, mainly along drainage lines, although in general areas where development will occur for Precincts 3B and C are likely to be similar to Precinct 3A conditions. Further site specific geotechnical investigations will occur to confirm soil conditions.

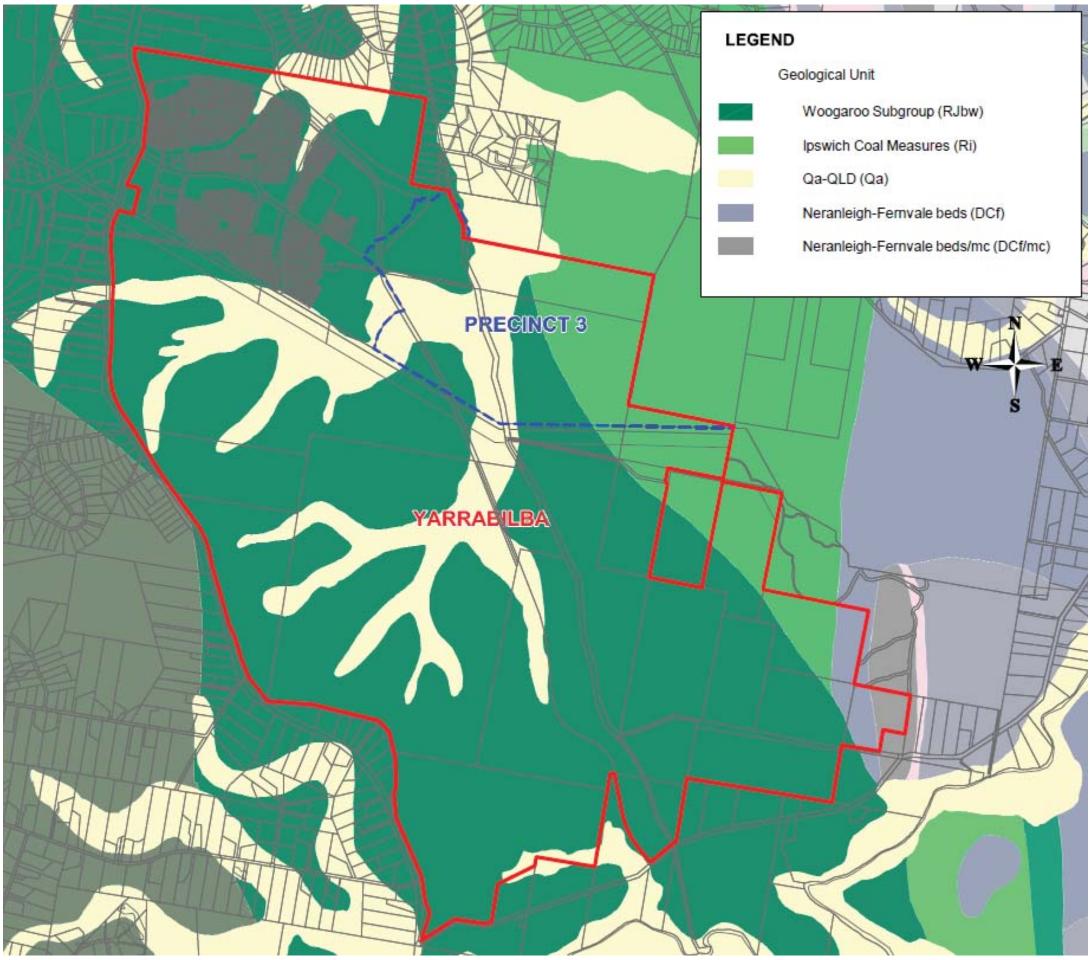


Figure 4 Geology and soils

2.5 VEGETATION

The majority of the Yarrabilba site was previously pine plantation, with most vegetation associated with grassland or pine and eucalypt/acacia regrowth of limited ecological value. Historical aerial imagery illustrates grassland and pine areas represent roughly 80% of the existing land use across the Yarrabilba site, which have subsequently been covered with regrowth. Dense vegetation generally occurs along drainage lines in the development area.

Vegetation management will generally be undertaken in accordance with *Yarrabilba Development: Natural Environment Site Strategy* (Natura Consulting, 2012) which highlights vegetation management procedures with regards to clearing approvals, revegetation, monitoring/compliance and design requirements.

The fauna corridor and Plunkett Conservation Park represent the main ecological constraint for development within the Precinct 3 boundary. The *Natural Environment Site Strategy (NESS)* (Natura Consulting, 2012) provides an overarching strategy that pulls together the individual Infrastructure Master Plans, such as Fauna Corridor Master Plan (Natura Consulting, 2012). Figure 5 provides an overall summary of ecological constraints for the Precinct 3 development (source: Natura Consulting).

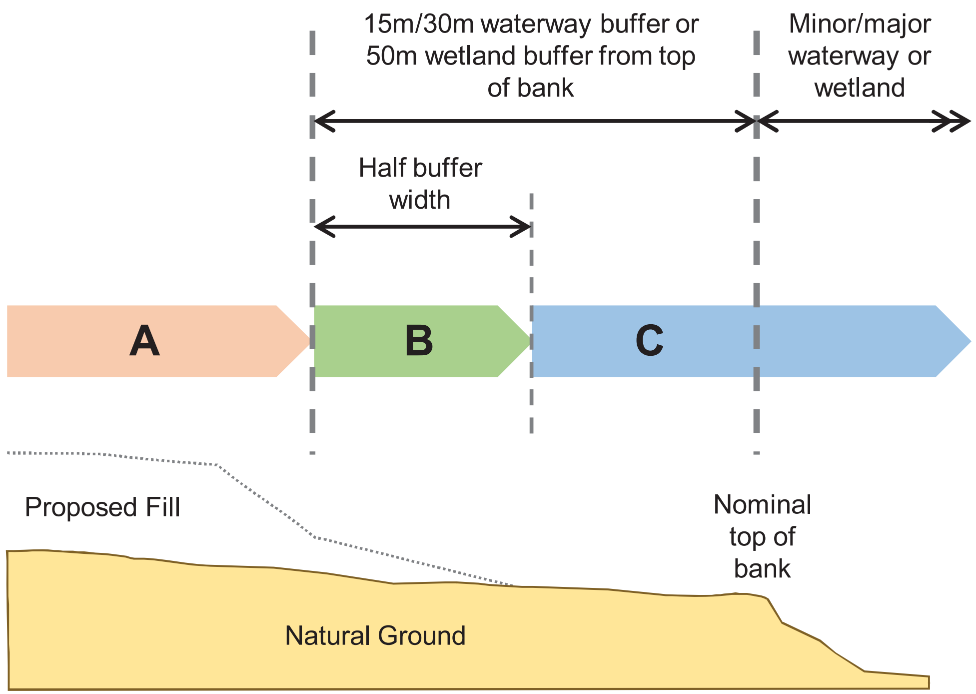
2.6 WATERWAYS

The drainage lines and waterway corridors within Precinct 3 exhibit a range of conditions. Some of the riparian zones are in a healthy condition whereas others are affected by weeds and historical vegetation clearing. The vegetation directly adjacent and within the waterways of Precinct 3 is broadly described as below:

- Waterways and streams are densely vegetated
- Ephemeral vegetation communities such as Lomandra, Xanthorea, Blady grass, Melaleuca and Eucalyptus are common throughout the waterways, with increase grass communities in lower lying areas

The invert of the waterways is generally sandy with minor vegetation coverage. Waterways are to be provided through buffers in accordance with the *Yarrabilba Context Plan Area Strategy – Precinct 3* (Lendlease, 2016) and *Yarrabilba Stormwater Infrastructure Master Plan* (DesignFlow, 2012).

The waterways and associated waterway corridor requirements outlined in the *Yarrabilba Stormwater Infrastructure Master Plan* (DesignFlow, 2012) and the *Yarrabilba Context Plan Area Strategy – Precinct 3* (Lendlease, 2016) have been used with the ecological requirements to set the development layout. Where waterway buffer allowances are not constrained by other setbacks (i.e. vegetation protection) and are degraded, it may be practical to co-locate low impact uses such as vegetated stormwater treatment infrastructure or passive recreational infrastructure partly within the buffer in conjunction with rehabilitation. Figure 6 outlines the permissible uses within the defined waterway and wetland buffer widths. Refer to *Yarrabilba Precinct 3 Waterway Stability Assessment* (DesignFlow, 2016) for further details of waterway protection and stabilisation.



Where a more conservative setback to earthworks or infrastructure is required for vegetation, fauna corridor or bushfire buffers, these will override the minimum buffers identified here for waterway riparian corridors. Refer to Strategy 14 for details.

Note: Buffers and permissible uses apply to land disturbing activities. Design must therefore allow for constructability to ensure encroachment/ disturbance beyond allowable zones does not occur during construction.

Permissible Uses within Waterway or Wetland Buffers:

Zone A

No restrictions to development or infrastructure from waterway/ wetland riparian buffers

Zone B

Permitted:

- Vegetated stormwater treatment systems with batters 1:4 max.
- Development batters 1:10 max. (vegetated)
- Pathways
- Zone C allowances (see below)

Not Permitted:

- Building allotments
- Road reserve (other than for waterway crossings)
- Retaining walls
- Scheduled maintenance areas of stormwater treatment systems (e.g. forebays)

Zone C

Permitted :

- Stormwater outlets/headwalls
- Waterway stabilisation works
- Riparian rehabilitation planting
- Road/water/sewer/flood bund/pathway crossings of waterway

Not Permitted:

- All other general development earthworks and infrastructure

Figure 6 Waterway buffer permissible works

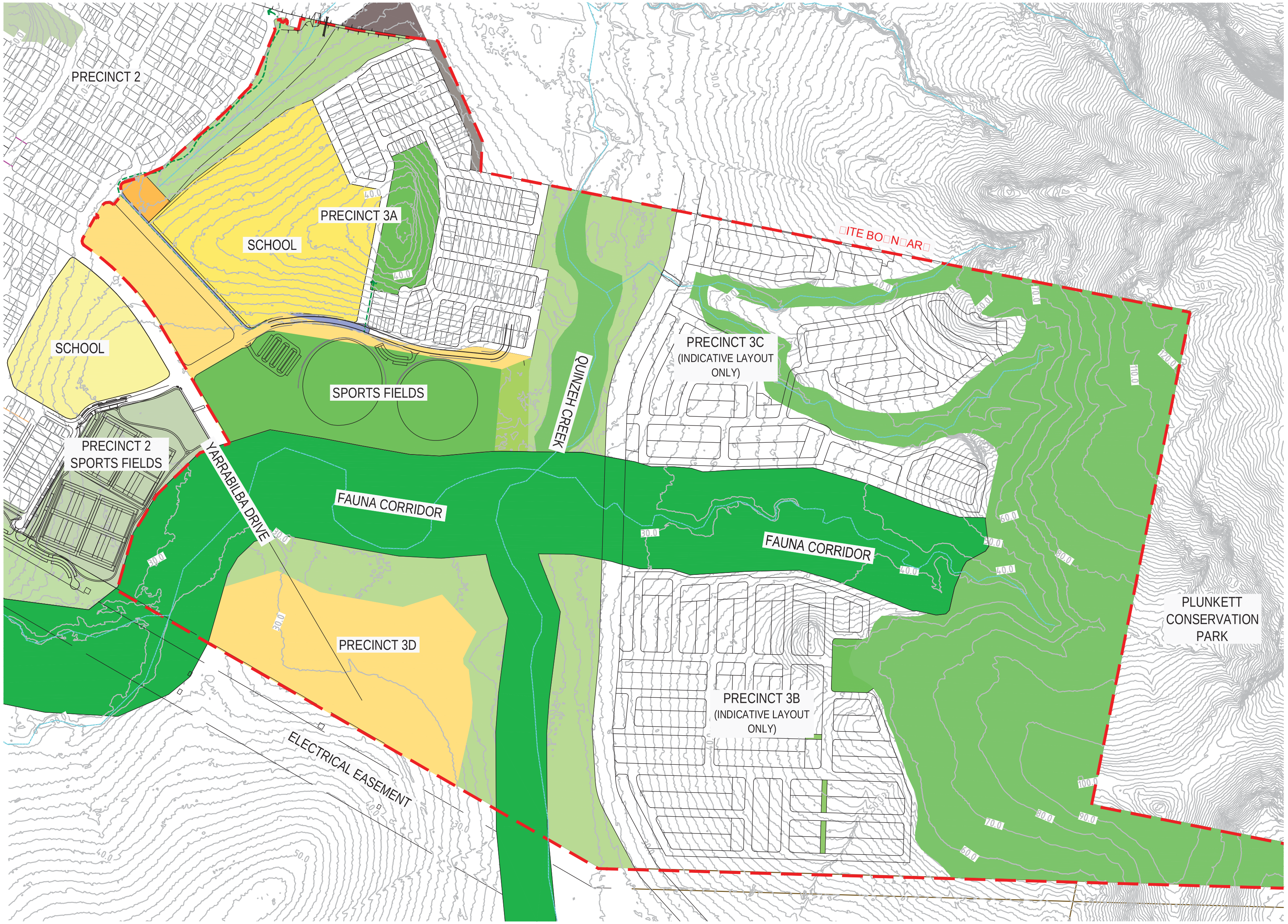
2.7 PROPOSED DEVELOPMENT

The Yarrabilba Precinct 3 development is located at the northern end of the Yarrabilba development area and is bisected by Quinzeh Creek. The total area of Precinct 3 development boundary is approximately 245ha. As illustrated in Figure 7, a significant portion of Precinct 3 development is associated with fauna, waterway and conservation corridors (>50%).

Precinct 3 is divided into 3 development zones (refer to Figure 7):

- Precinct 3A (61.4 ha)
- Precinct 3B (31.9 ha)
- Precinct 3C (24.8 ha)
- Precinct 3D (12.3ha)

Precinct 3A includes a mix of residential development (8.9 ha), roads (7.53ha), open space (18.82ha) a school site (12.34 ha) and community use (3.28 ha) and a child care centre (0.50ha). Precincts 3B and 3C are mainly residential development areas only while Precinct 3D is designated for infrastructure/employment.



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PRECINCT 3 BOUNDARY

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PRECINCT 3 DEVELOPMENT LAYOUT
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3 EROSION AND SEDIMENT CONTROL

3.1 DESIGN OBJECTIVE

The management of stormwater runoff during the construction phase is a critical part of protecting the Yarrabilba waterways and drainage lines. Construction phase design objectives for Precinct 3 are provided in Table 1 as defined by the *Yarrabilba – Stormwater Infrastructure Master Plan* (DesignFlow, 2012) and the State Planning Policy (DSDIP, 2016).

Table 1 Construction phase stormwater quality

Issue		Design Objectives
Drainage control	Temporary drainage works	1. Design life and design storm for temporary drainage works: • Disturbed area open for <12 months—1 in 2-year ARI event • Disturbed area open for 12–24 months—1 in 5-year ARI event • Disturbed area open for > 24 months—1 in 10-year ARI event 2. Design capacity excludes minimum 150 mm freeboard 3. Temporary culvert crossing—minimum 1 in 1-year ARI hydraulic capacity
Erosion control	Erosion control measures	1. Minimise exposure of disturbed soils at any time 2. Divert water run-off from undisturbed areas around disturbed areas 3. Determine the erosion risk rating using local rainfall erosivity, rainfall depth, soil-loss rate or other acceptable methods 4. Implement erosion control methods corresponding to identified erosion risk rating
Sediment control	Sediment control measures Design storm for sediment control basins Sediment basin dewatering	1. Determine appropriate sediment control measures using: • potential soil loss rate, or • monthly erosivity, or • average monthly rainfall 2. Collect and drain stormwater from disturbed soils to sediment basin for design storm event: • design storm for sediment basin sizing is 80th% five-day event or similar 3. Site discharge during sediment basin dewatering: • TSS < 50 mg/L • Turbidity not >10% receiving waters turbidity, and • pH 6.5–8.5
Water quality	Litter and other waste, hydrocarbons and other contaminants	1. Avoid wind-blown litter; remove gross pollutants 2. Ensure there is no visible oil or grease sheen on released waters 3. Dispose of waste containing contaminants at authorised facilities
Waterway stability and flood flow management	Changes to the natural waterway hydraulics and hydrology	1. For peak flow for the 1-year and 100-year ARI event, use constructed sediment basins to attenuate the discharge rate of stormwater from the site

3.2 SEDIMENT MANAGEMENT STRATEGY

3.2.1 Local erosion and sediment control

Erosion and sediment control will occur on a development stage by stage basis in accordance with Best Practice Erosion and Sediment Control (IECA, 2008) to achieve the objectives listed in Table 1. This will involve a combination of:

- Erosion control - Ensuring that all exposed surfaces are stabilised as soon as possible and that erosion of un-stabilised areas of works are minimised
- Drainage control - Ensuring that provision is made to control all on site runoff to designated treatment areas and to enable appropriate bypass of external flows which do not require treatment
- Sediment capture - Ensuring that mobilised sediment is captured through a combination of source controls such as silt fences and appropriately designed sediment basins. Where possible sediment basins for construction will be located within the voids required for the future stormwater quality treatment systems (sediment basins, bioretention basins, wetlands etc.).

The details of the local erosion and sediment controls for each stage of development are not provided in this report given the high level nature of the document. However, prior to any works commencing on a particular development stage in Precinct 3, a site specific Erosion and Sediment Control Plan (E&SCP) will be documented for the development stage in question prior to works starting. This will occur as part of the operational works application but can be adjusted by the contractor and site supervisor prior to commencement of construction provided the E&SCP complies with Best Practice Erosion and Sediment Control (IECA, 2008) and delivered the objectives listed in Table 1.

3.2.2 High efficiency sediment (HES) basins

Given the importance of managing construction runoff into the waterways downstream of Yarrabilba and the potential impact on the ecology and residents, HES sediment basins are being strategically adopted across Precinct 3. HES basins offer an improved technology for construction sediment management which essentially converts batch sediment basins into continuous flow treatment systems that respond in real time to storm events. This is achieved by applying chemical engineering principles to a civil construction practice. The design sought to be achieved by HES basins that ensures *at least 80% of the average annual runoff volume treated to 50mg/L TSS or less*

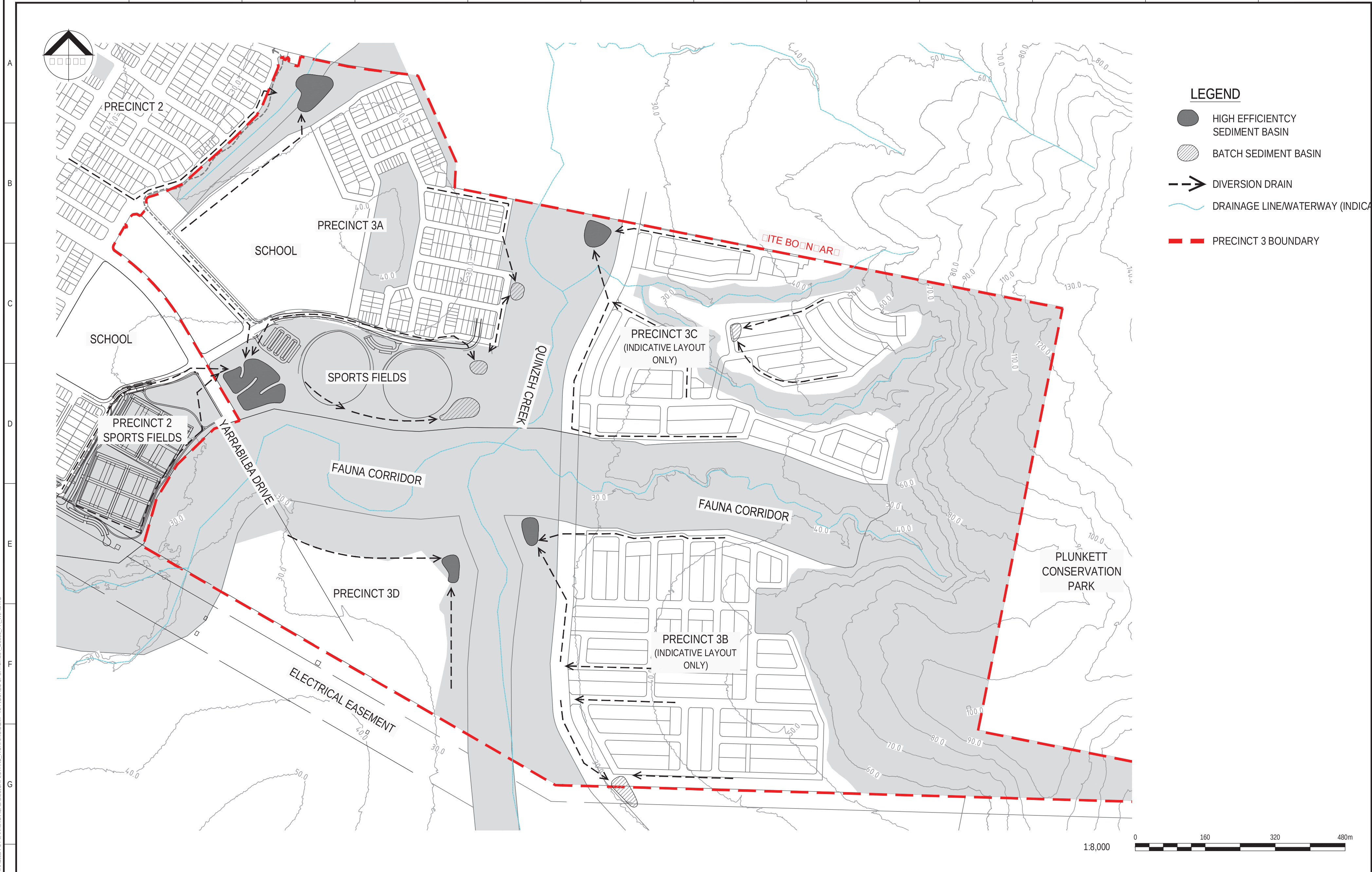
The HES basin essentially comprises:

- Flocculent dosing system
- Inlet zone for mixing, flow distribution and efficient removal of coarse sediment
- Settling basin
- Outlet(s)

Implementation of HES basins has the potential to significantly reduce the fine and dispersive sediment load discharge from the site by a further 50% compared to traditional batch sediment basins. To date, HES basin designs have been developed for flood basins 6, 9 and Precinct 3 wetland. Separate design reports are available for each of these designs.

3.3 MONITORING AND AUDITING

Erosion and sediment control audits will occur on a monthly basis (as a minimum) to ensure the erosion and sediment control being delivered onsite is compliant with the State Planning Policy.



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4 STORMWATER QUALITY MANAGEMENT STATEGY

4.1 DESIGN OBJECTIVES

The stormwater quality management objectives that apply to the operational phase of Yarrabilba Precinct 3 are listed in Table 2 as defined by the *Yarrabilba – Stormwater Infrastructure Master Plan* (DesignFlow, 2012), which are consistent with the State Planning Policy (DSDIP, 2016).

These objectives require the reduction of pollutant loads discharged from the development site once all construction works is complete. These load reductions are aimed at protecting the environmental values of downstream receiving waterways for the impacts of urban stormwater runoff.

Table 2 Stormwater quality objectives

Pollutant	Discharge criteria (% reduction in mean annual load)
Total suspended solids (TSS)	80%
Total phosphorous (TP)	60%
Total nitrogen (TN)	45%
Gross pollutants (GP)	90%

Note: Waterway stability assessment and management for Precinct 3 streams and waterways are presented in *Precinct 3 Waterway Stability Assessment* (DesignFlow, 2016).

4.2 MANAGEMENT STRATEGY

A stormwater quality management strategy has been developed for Precinct 3 based on a review of the site characteristics, constraints, masterplan for the proposed development zones and discussions with Lendlease. The proposed strategy has been developed in collaboration with the design team to ensure the proposed strategy is well integrated with both engineering and landscape aspects of the design.

When developing the treatment strategy a number of guiding principles were considered:

- Adopt multi use open space principles where possible
- Where possible co-locate stormwater treatment and flood basins in a common footprint
- Locate treatments in waterway buffer zones, where applicable, as per *Yarrabilba – Stormwater Infrastructure Master Plan* (DesignFlow, 2012) and the *Yarrabilba Context Plan Area Strategy – Precinct 3* (Lendlease, 2016).

- Adopt similar treatment philosophy as per Precinct 1 and 2 development to retain consistency across the development
- Avoid numerous small treatments
- Apply at source treatment within school sites (by others)
- Integrate with landscape outcomes
- Minimize the impact on existing vegetation and adjacent aquatic ecosystems

The strategy is divided into for main treatment zones:

1. Precinct 3A West (Flood Basin 9)
2. Precinct 3A East (Sports fields and Quinzeh Creek)
3. Precinct 3B and 3C
4. Precinct 3D

Figure 9 shows the overall proposed treatment strategy for Precinct 3 with details provided in Figure 10, 11 and 12. Table 3 provides an overall summary of the treatment strategy including catchments contributing to each treatment. Further details of performance assessments of the proposed treatment strategy are presented in Section 5.

NOTE: Precinct 3 strategy includes catchments in Precinct 2 (P2) development (Villages 3B and 4B) that contribute to treatment zones in Precinct 3. Treatments for these areas are included in the performance assessments for Precinct 3 treatment.

Photo: Example of natural ephemeral wetland zone onsite

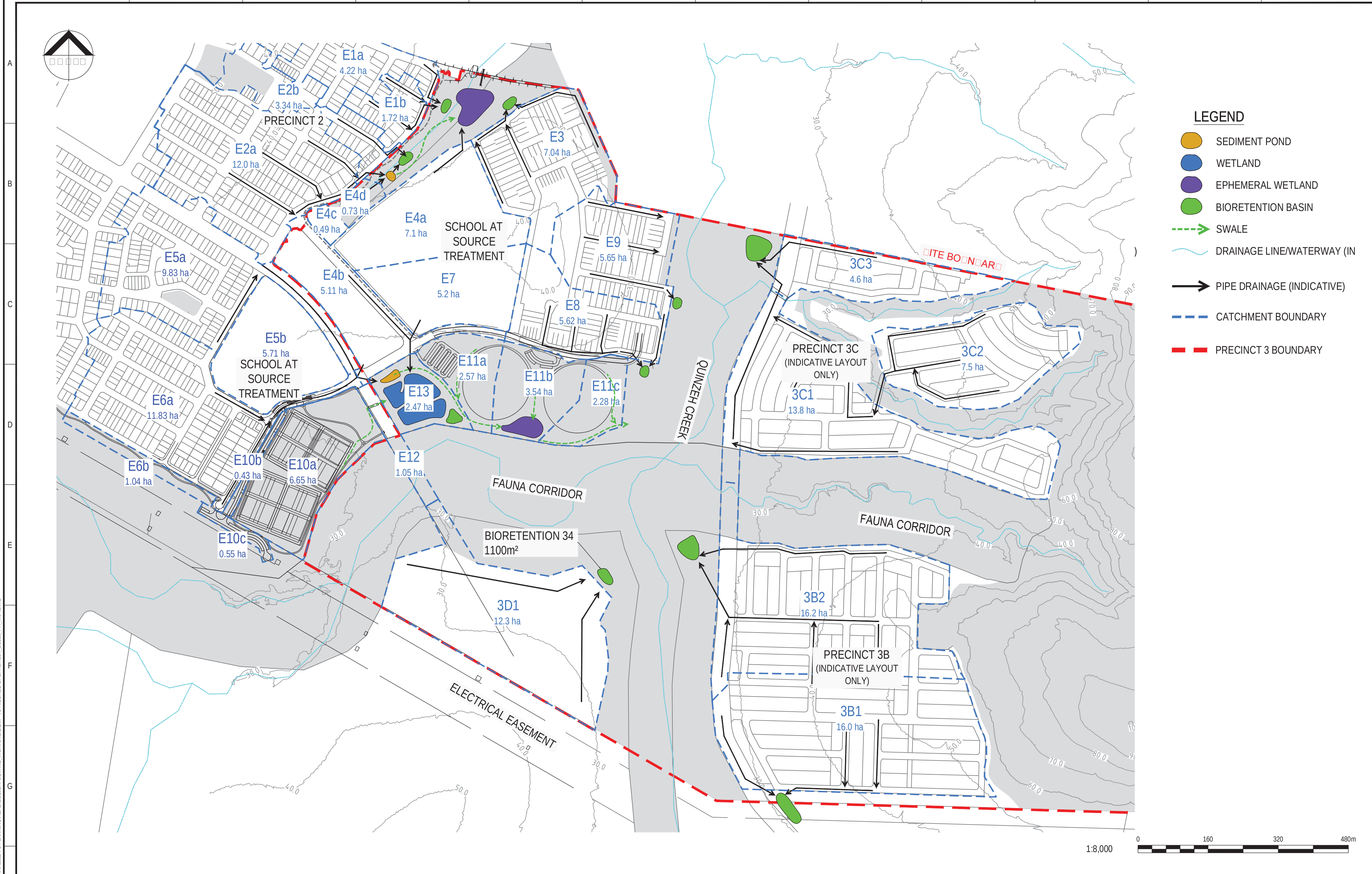

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Table 3 Stormwater treatment elements

Treatment Type and ID	Treatment Size	Contributing Catchments (ha)	Comment
Precinct 3A West (Flood Basin 9)			
Sediment pond E2a	360 m²	13.22 (E2a+E4c+E4d)	Pre-treats runoff from P2 Village 4B catchments
Bioretention E2b	650 m²	16.56 (E2a+E4c+E4d +E2b)	Includes diverted low flows from Sed E2a
Swale 1	100 m	16.56 (as above)	Conveys overflow from Sed E2a and treated outflow from Bio E2b
Bioretention E1	550 m²	5.94 (E1a+E1b)	Treats runoff from P2 Village 4B catchments
Bioretention E3	620 m²	7.04 (E3)	Treats runoff from northern portion of Precinct 3A
School on-site treatment	-	7.10 (E4a)	On-site treatment (by others) required to meet objectives
Ephemeral Wetland E4	5,000 m²	36.64 (as above – all)	Final polishing. Receives treated flows from upstream areas
Precinct 3A East (Sports fields and Quinzeh Creek)			
Swale 2	100 m	7.63 (E10a,b,c)	Conveys runoff from Precinct 2 sports fields
School on-site treatment	-	5.71 (E5b)	On-site treatment (by others) required to meet objectives
Wetland E5a	10,000 m²	38.52 (7.63+5.71+E5a, E6a, E12+E13)	Receives treated inflows from P2 Village 3B catchments, Swale 2 and school
Bioretention E5b	800 m²	38.52 (as above)	Treats overflows from Wetland E5a
School on-site treatment	-	5.21 (E7)	On-site treatment (by others) required to meet objectives
Swale 3	200 m	48.84 (38.52+5.21+E4b)	Conveys bypass flows from Wetland E5a, School and car park
Swale 4	100 m	2.57 (E11a)	Conveys runoff from P3 sports field area (west)
Swale 6	100 m	3.54 (E11b)	Conveys runoff from P3 sports field area (central)
Ephemeral wetland E5c	3,000 m²	54.95 (48.84+2.57+3.54)	Final polishing. Receives treated flows from upstream catchments
Swale 6	100m	2.28 (E11c)	Conveys runoff from P3 sports field area (east)
Bioretention E8	450 m²	5.62 (E8)	Treats Precinct 3A northeast area
Bioretention E9	450 m²	5.65 (E9)	Treats Precinct 3A southeast area
Precincts 3B and 3C			
Bioretention 31	1,300 m²	16.0 (3B1)	Treats southern portion of Precinct 3B
Bioretention 32	1,200 m²	15.7 (3B2)	Treats northern portion of Precinct 3B
Bioretention 33	1800 m²	25.9 (3C1, 3C2, 3C3)	Treats Precinct 3C
Precinct 3D			
Bioretention 34	1100 m²	12.3 (3D1)	Treats Precinct 3D

4.2.1 Precinct 3A West (Flood 9)

This treatment zone uses an integrated approach to combine flood storage with stormwater treatment (Figure 10) and open space corridor. Treatment elements used in this zone include a sediment pond, end of pipe bioretention basins (x 3), swale and an ephemeral wetland. The school site is treated at source with treated flows discharging to the open space corridor and ephemeral wetland zone.

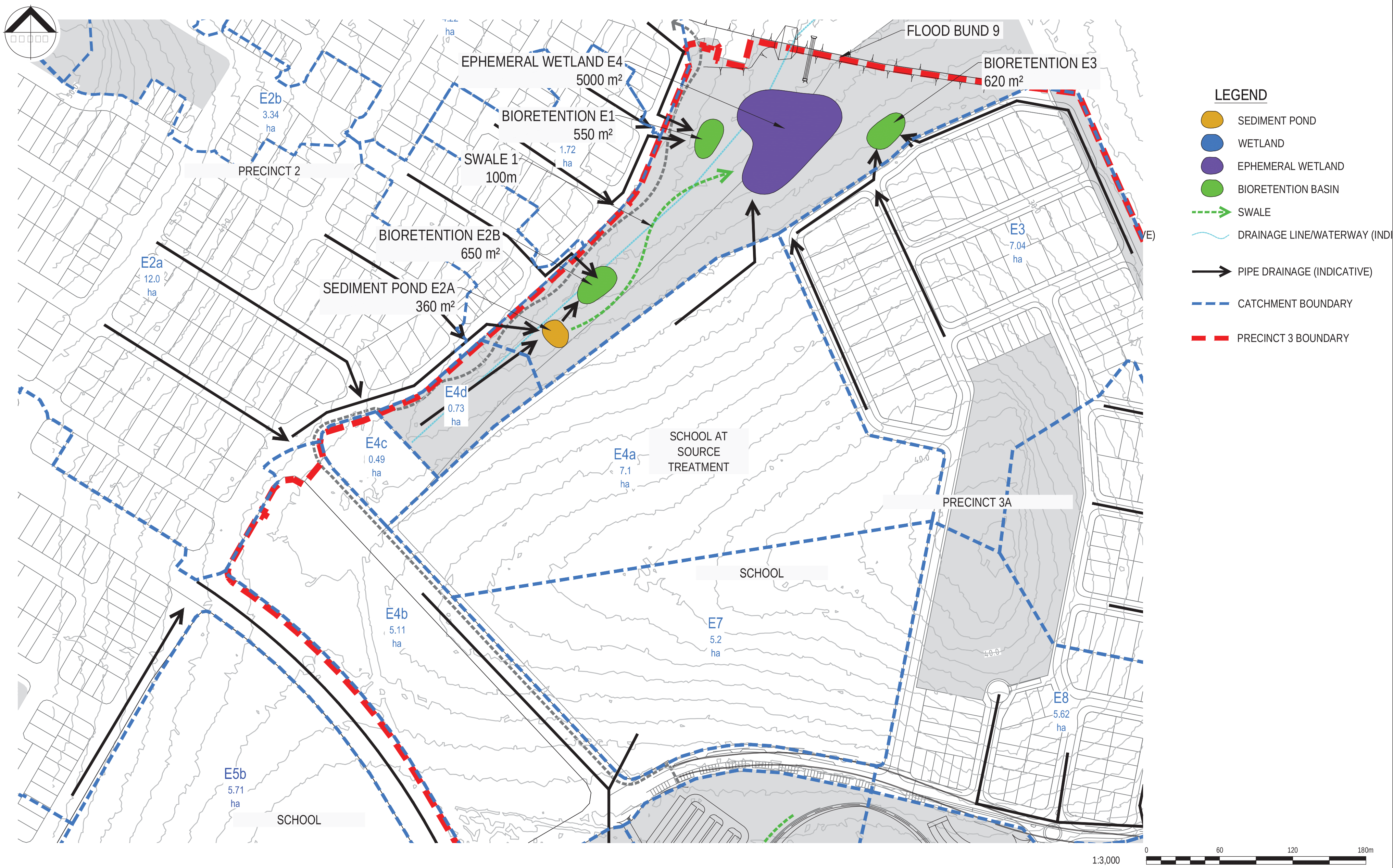
This treatment zone manages stormwater from the north-western portion of Precinct 3A (catchment E3 - 7.04ha) plus outflow from the school site (catchment E4a - 7.1ha) as well as catchments associated with Village 4b in Precinct 2 (total area 22.5ha).

The sediment pond (Sed. E2a - 360m²) will provide primary treatment of upstream catchment areas contributing to this treatment zone (catchment E2a, E4c and E4d - 13.22ha). Outflows from this sediment pond will be initially directed to bioretention basin E2b (650m²) via a minor culvert connection, whilst overflows will spill over a high flow weir from the sediment pond and continue down the vegetated waterway (swale 1 - 100m long) to the ephemeral wetland zone (Eph. wetland E4 – 5000m²) in the floor of Flood Basin 9 at the downstream end.

Pipe discharges from Catchments E2b (3.34ha), E1a/E1b (5.94ha) and E3 (7.04ha) will be initially directed to bioretention basins E2b (650m²), E1 (550m²) and E3 (620m²) respectively. Treated outflows and overflows will continue down the drainage line to Ephemeral Wetland E4.

Ephemeral wetland E4 ultimately receives all treated discharges and provides a final polishing treatment function prior to discharge downstream of the Yarrabilba development boundary. The configuration of the ephemeral wetland will be a broad shallow depressed area to 300mm depth, with earthworks shaped to direct very minor flows to a stabilised central drainage line. An outlet control structure (integrated into Flood 9 outlet) will create backwater ponding throughout the vegetated zone during and after storm events for both flood mitigation (over several hours) and water quality improvement (final 300mm drawing down over subsequent days) prior to draining back to invert levels through outflow and infiltration to in-situ soils. This provides a wetting and drying cycle intended for this area. The area will be planted with a mix of trees (e.g. Melaleucas) and sedges that mimics existing natural areas of ephemeral wetland throughout Yarrabilba as illustrated in the image in Section 4.2 previously.

Ecological appraisal of a number of these existing ephemeral areas (formed both naturally and from historical track/bund crossings of drainage lines in former site use) indicates they are highly resilient to wetting and drying cycles experienced in this region (particularly melaleuca species). Seasonal and interannual variability in available moisture will cause associated changes in dominant vegetation (i.e. in undergrowth rather than trees) but this is commensurate with natural vegetation areas. This is a desirable outcome in terms of recreating and integrating with the surrounding natural environment to enhance the urban area.



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SCALE	1:3,000 — A3
PROJECT	YARRABILBA PRECINCT 3
DRAWING TITLE	PRECINCT 3A (FLOOD 9) STORMWATER TREATMENT STRATEGY
PROJECT No	4284
DRAWING No	FIGURE 10
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4.2.2 Precinct 3A East (Sports field and Quinzeh Creek)

Treatment in this zone uses a multi-use open space approach where treatments are co-located with open space areas and provide a buffer/transition into the waterways and fauna corridor adjoining this precinct. This offers opportunities for enhanced amenity and recreational values in the park area.

At the western boundary of the Precinct 3 sports fields a 1.0 ha wetland is proposed (Wetland E5a). Runoff from Precinct 2 Village 3B (38.52ha, including a school site – 5.71ha) is diverted under Yarrabilba Drive to the wetland. Treated outflows from the wetland will be discharged to the adjacent waterway.

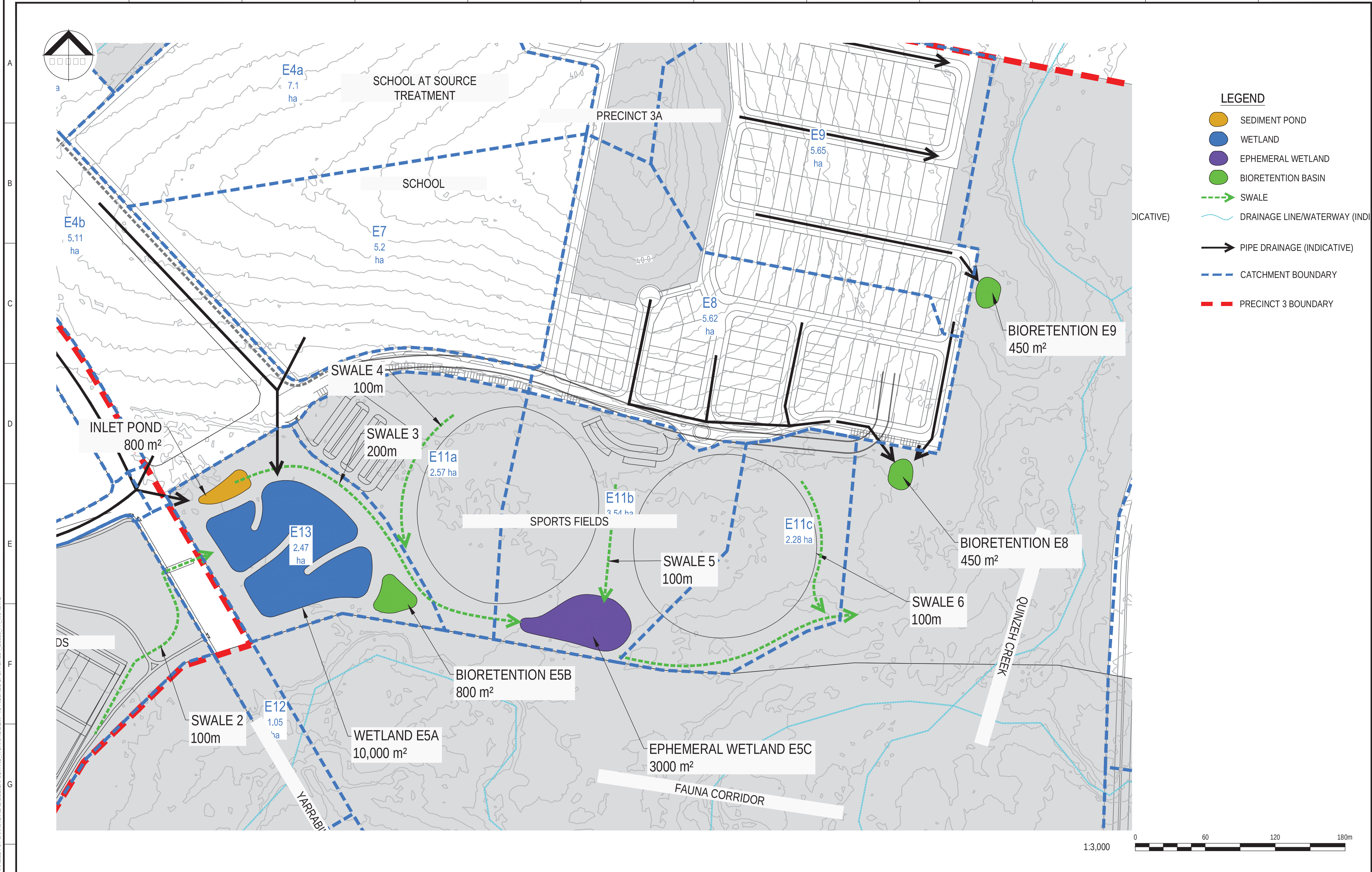
In order to limit the size of the wetland (to maintain open space use requirements), a bioretention basin E5b (800m²) has been integrated into the wetland design that engages the top 0.1-0.2m of wetland extended detention (via weir) to increase treatment capacity. The bioretention basin will be constructed as a saturated zone system (as per all other bioretention basins in Yarrabilba) to retain water a sub-surface reservoir for plant roots to access during extended dry periods. The design of the wetland outlet will also make provision for a connection to the bioretention basin saturated zone to ensure saturated zone water levels are maintained. Treated flows from the bioretention will be discharged the waterway at the location of the wetland discharge to enable combined stable outlet.

On-site treatment of the school site (catchment E5b) is proposed to meet stormwater quality objectives at source, however treated outflows will still be directed to the wetland as drainage separation within the pipe networks is not practical.

Downstream of wetland E5a and bioretention E5b a 3,000m² ephemeral wetland zone (ephemeral wetland E11) is proposed. This ephemeral wetland will receive bypass flow from wetland E5a/bioretention E5b and will also provide treatment for the community/mixed use zone (catchment E4b - 5.11ha) and Precinct 3 sports field areas that drain via swales to this wetland (6.11ha total). Treated runoff from the school north of Precinct 3 sports fields (catchment E7 – 5.2ha) will also be directed to this ephemeral wetland. Similar to Ephemeral Wetland E4 (Flood 9), Ephemeral Wetland E11 will be designed with a stabilised low flow channel with downstream outlet/overflow structure to create backwater ponding throughout the vegetated zone for days following rain. The risk of mosquito breeding in these areas is not considered to be an issue due to the low likelihood of ponded water for more than a few days (due to outflow, evaporation and infiltration). As discussed previously in Section 4.2.1, the proposed ephemeral wetland zones are resilient to wetting and drying based on an appraisal of similar natural areas onsite.

Discharges from the ephemeral wetland zone will continue down a vegetated swale (100m) prior to discharge as broad shallow sheet flow to Quinzeh Creek (as occurs currently). All swales less than 1% grade are not proposed as turf swales (no mowing) but are to be planted out with dense but flexible grasses and sedges (e.g. *Imperata cylindrica*) found throughout low gradient drainage lines onsite. The exception will be Swale 2 (Precinct 2 sports field) which will require sub-surface drainage to prevent saturated ground conditions in the invert. This sports field area is currently under detailed design by others.

Pipe discharges from Precinct 3A catchments E8 (5.62ha) and E9 (5.65ha) will be directed to end of pipe bioretention basins E8 (450m^2) and E9 (450m^2) respectively prior to discharge to Quinzeh Creek. These bioretention basins are proposed to be located partly within in the degraded areas of the waterway buffer zone in accordance with the rules outlined in *Yarrabilba – Stormwater Infrastructure Master Plan* (DesignFlow, 2012) and the *Yarrabilba Context Plan Area Strategy – Precinct 3* (Lendlease, 2016). This allows the waterway buffer to be improved with vegetation stormwater treatment measures where the area currently has little or no vegetation of value.



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PROJECT	YARRABILBA PRECINCT 3
DRAWING TITLE	PRECINCT 3A EAST (SPORTSFIELD & QUINZEH CREEK) STORMWATER TREATMENT STRATEGY
PROJECT No	4284
DRAWING No	FIGURE 11
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4.2.3 Precincts 3B and 3C

Stormwater runoff from Precincts 3B and 3C will be treated in end of line bioretention basins prior to discharge to Quinzeh Creek. As illustrated in Figure 12 the bioretention basins are proposed to be located between Quinzeh Creek and the development edge in accordance with *Yarrabilba – Stormwater Infrastructure Master Plan* (DesignFlow, 2012) and the *Yarrabilba Context Plan Area Strategy – Precinct 3* (Lendlease, 2016).

The southern portion of Precinct 3B will be drained to one or more bioretention basins (generally shown as Bio 31 totalling 1300m^2 in area) at the southwestern fringe of development interfacing the main waterway and/or the powerline easement.

The northern portion of Precinct 3B will drain to an end of pipe bioretention basin (Bio 32 – 1200m^2). Little opportunity exists to locate this treatment elsewhere at the edge of the precinct due to waterway buffer, vegetation setback and fauna corridor constraints. This basin will therefore likely comprise multiple bioretention cells fed by an inlet flow distribution structure or sediment pond in the location generally shown in Figure 12.

Similar to northern Precinct 3B, there are few opportunities to locate stormwater treatment for Precinct 3C other than the lowest part of the catchment. Bioretention basin 33 (total 1800m^2) will receive flows from catchments 3C1, 3C2 and 3c3 and again, likely comprise an inlet pond/flow distribution structure to multiple bioretention cells.

The urban design and civil earthworks of Precinct 3B and 3C will dictate the ultimate location and layout of this/these basins and further refinement of the design (including split catchment MUSIC modelling) will occur as part of the relevant development application.

4.2.4 Precinct 3D

Stormwater runoff from Precinct 3D will be treated in an end of line bioretention basin(s) (nominated as Bio 34) prior to discharge to Quinzeh Creek (refer to Figure 9). The basin(s) will be located in the linear parkland area between the development footprint and Fauna Corridor along Quinzeh Creek. As for Precinct 3B and 3C, refinement of the layout and design will occur as part of the development application for this precinct.

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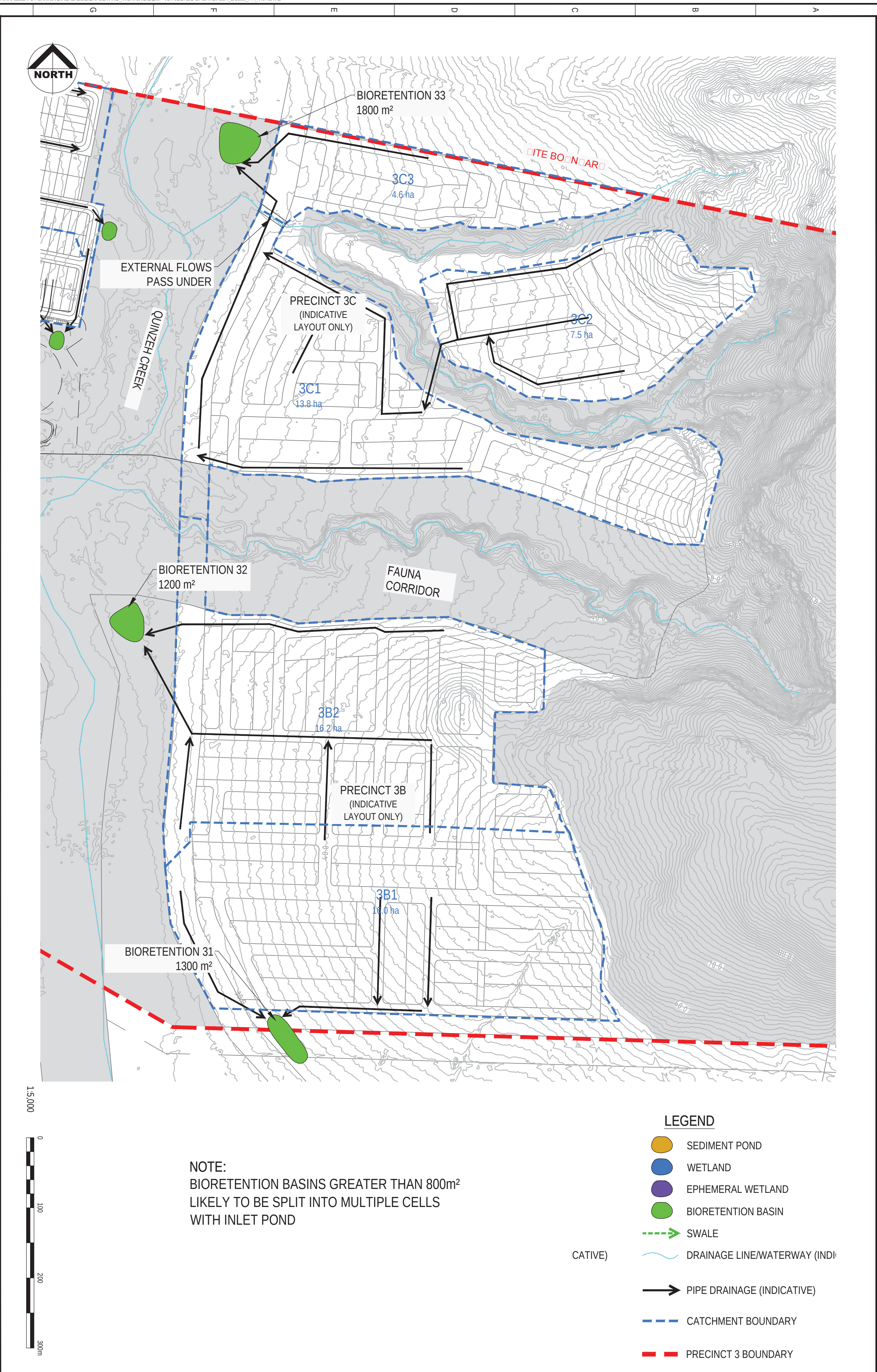

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PROJECT: YARRABILBA PRECINCT 3
DRAWING TITLE: PRECINCT 3B AND 3C STORMWATER TREATMENT STRATEGY
PROJECT No: 4284
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5 STORMWATER TREATMENT PERFORMANCE ASSESSMENT

MUSIC modelling was conducted to assess the stormwater treatment performance of the proposed treatment strategy. MUSIC Version 6.2 was used for the assessments.

5.1 MODEL STUCTURE

The structure of the MUSIC model is shown in Figure 13 with the general data upon which the model is based provided in Table 4. Three separate model zones were developed to model each development zone (refer Section 4.2) independently. This ensures each treatment zone meets water quality objectives prior to discharge to receiving environments.

MUSIC model parameters were adopted generally in accordance with *the MUSIC Modelling Guidelines* (Water by Design, 2010) using 10 years (1990-2000) of modified Shailer Park meteorological data. Six minute rainfall data and monthly average evapotranspiration data was used. The Shailer Park station was selected for adaption as it is the closest rainfall station to the site with 6 minute data. The rainfall data set was modified to generate a data set closer representing Logan Village rainfall. The Shailer Park 6 minute rainfall was reduced by a factor of 0.849 to produce a rainfall data set with the same annual total to Logan Village (950mm) for the period considered.

Key modelling assumptions

1. Water quality management measures are sized only for the portion of each catchment undergoing development
2. A split catchment approach was adopted for Precinct 3A (and existing parts of Precinct 2) where sufficient urban design detail was available to do so, while for Precinct 3B to 3D, a lumped approach adopted until further refinement of the urban design is available at subsequent development applications.
3. Split land use percent imperviousness in accordance with Table 3.5 for MUSIC Modelling Guidelines with allowance for 70% for schools and 90% for commercial/community land use, 10% for parks with embellishments/paths and 0% for sports fields (car parks/building split separately).
4. Bioretention default values for TN and OP content have been reduced to 400mg/kg and 30mg/kg respectively as per Water by Design advice (http://healthywaterways.org/initiatives/waterbydesign/stormwater)
5. Wetland k and C* parameters for TN have been reduced to 200 m/yr and 0.75mg/L respectively for Constructed Wetland E5a only. A sensitivity assessment is provided to compare to former guideline values. Ephemeral wetlands have retained default values.

Note: Water By Design have recently completed a review of important default values for wetlands and bioretention basins. The parameters in items 4 and 5 above are supported in principle by Water By Design and are intended to be incorporated in an updated version of the *MUSIC Modelling Guidelines* due for release in August 2016.

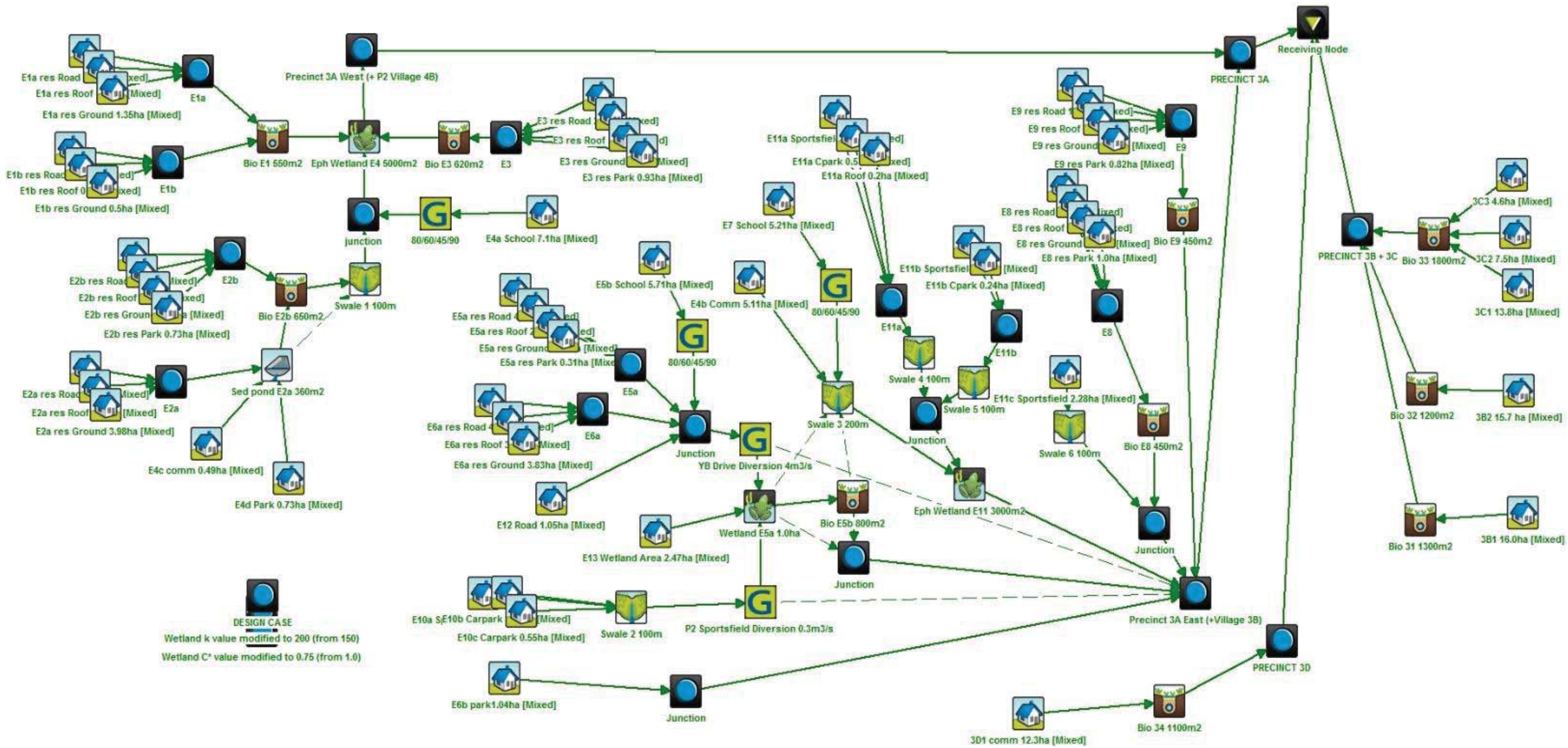

Figure 13 MUSIC model structure for Precinct 3

Table 4 MUSIC modelling parameters

Parameter	Value
Source Data	
Rainfall data set	1990-2000 - Modified Shailer Park Station 040715.
Modelled time step	6 minute
Mean annual rainfall 1990-2000	950 mm
Potential evapotranspiration	1,446 mm
Soil properties (runoff generation parameters)	Table 3.7 Music Modelling Guidelines (as appropriate depending on land use)
Pollutant concentrations (base and storm flow concentration parameters)	Table 3.8 Music Modelling Guidelines (as appropriate depending on land use)
Percent impervious	Table 3.5 and 3.6 Music Modelling Guidelines(as appropriate depending on land use)
Treatment Devices	
Bioretention	Filter media depth = 0.6 m Extended detention depth = 0.3 m Seepage = 0 mm/hr TN content 400 mg/kg Orthophosphate content 30mg/kg
Constructed Wetland	Extended detention depth = 0.4 m Permanent pool = 0.3 m (average) Inlet pond volume = 10% of wetland area x 2 m deep Notional detention time = 48 hr Evaporative loss 125% of PET Seepage = 0 mm/hr TN k = 200 m/yr, TN C*=0.75mg/L (Sensitivity undertaken on TN k = 150 m/yr, TN C*=1.0 mg/L)
Ephemeral Wetland	Extended detention depth = up to 0.2 m Permanent pool = 0.1 m (maximum) Inlet pond volume = $0m^3$ Notional detention time = 48 hr Evaporative loss 125% of PET Seepage = 0 mm/hr TN k = 150 m/yr, TN C*=1.0 mg/L (defaults)
Swale	Slope – catchment dependent typ. 0.5-1.0% Base width = varies Top width = varies Depth = varies 0.5-0.75m Vegetation height = 0.05m turf; 0.25m sedges/rushes Seepage = 0mm/hr

Catchment data

The catchment areas draining to each treatment system have been derived from the latest urban and drainage layouts for Precinct 3A and the concept layouts for 3B to 3D where available. Percent impervious values are assigned based on the land use, as per Table 4 values presented. Table 3 previously identified catchments areas contributing to each treatment element. Table 5 below lists the catchment area, land use and percent impervious for each sub-catchment modelled.

Table 5 Catchment data

Catchment ID	Area (ha)	Land use	Land Use Modelling	Impervious %
E1a	4.22	Residential	Split	Varies
E1b	1.72	Residential	Split	Varies
E2a	12.0	Residential	Split	Varies
E2b	3.34	Residential	Split	Varies
E3	7.04	Residential	Split	Varies
E4a	7.1	School	Lumped	70
E4b	6.11	Community	Lumped	90
E4c	0.49	Child Care	Lumped	90
E4d	0.73	Park	Split	10
E5a	9.83	Residential	Split	Varies
E5b	5.71	School	Lumped	70
E6a	11.83	Residential	Split	Varies
E6b	1.04	Park	Split	10
E7	5.21	School	Lumped	70
E8	5.62	Residential	Split	Varies
E9	5.65	Residential	Split	Varies
E10a	6.65	Sports Field	Split	5
E10b	0.43	Carpark	Split	90
E10c	0.55	Carpark	Split	90
E11a	1.5	Sports Field/ Carpark	Split	Varies
E11b	3.54	Sports Field/ Carpark	Split	Varies
E11c	2.28	Sports Field	Split	0
E12	1.05	Major Road	Lumped	90
E13	2.47	Wetland Area	Lumped	60
3B1	16.0	Residential	Lumped	60
3B2	15.7	Residential	Lumped	60
3C1	13.8	Residential	Lumped	60
3C2	7.5	Residential	Lumped	60
3C3	4.6	Residential	Lumped	60
3D1	12.3	Residential	Lumped	60

As mentioned in Section 4.2.3 and 4.2.4, refinement of Precincts 3B to 3D treatment layout and design (including split catchment MUSIC modelling) will be undertaken in conjunction with the relevant Development Application for each precinct sub-stage. A supporting technical note will be submitted with the applications verifying these details.

5.2 RESULTS

The results of the MUSIC modelling for each treatment zone are presented in **Table** 6 based on the latest data associated with constructed wetland treatment performance (i.e. total nitrogen (TN) k and C* parameter variation). Note, these updated parameters have only been applied to the Constructed Wetland E5a and not the ephemeral wetlands (which use defaults).

A sensitivity assessment was undertaken on the adoption of the default TN k and C* values in Constructed Wetland E5a to quantify the impact of these parameters. Results presented in Table 6 shown in ***(bold italics)*** against Precinct 3A – East (containing Wetland E5a).

Table 6 MUSIC modelling results summary

Treatment ID	Pollutant	Inflows (kg/yr)	Outflows (kg/yr)	Reduction achieved (%)	Water quality objective
Precinct 3A - West	TSS TP TN GP	41900 89.6 504 5520	7370 26.4 257 0	82.4 70.5 49.0 100	TSS: 80% TP: 60% TN: 45% GP: 90%
Precinct 3A – East	TSS TP TN GP	79000 171 918 9200	11800 47.2 502 81.2	85.0 72.4 45.3 ***(42.2)**** 99.1	
Precincts 3B and 3C	TSS TP TN GP	72900 141 694 9420	12800 35.3 342 0	82.4 75.0 50.8 100	
Precinct 3D	TSS TP TN GP	20700 54.7 319 2500	3870 13.4 149 0	81.3 75.5 53.5 100	
TOTAL	TSS TP TN GP	215000 456 2440 26600	35900 122 1250 81.2	83.2 73.2 48.7 ***(47.5)**** 99.7	

* Total nitrogen (TN) reduction achieved with default wetland TN k and C* values shown in *italics*

Discussion

The sensitivity assessment indicates that the revised wetland k and C* values adopted in this report result in a 3.1% increase in the TN load removed from catchments in Precinct 3A-east compared to the default values formerly adopted in MUSIC (45.3% compared to 42.2% in Table 6). Under the default scenario, this part of the overall catchment falls short of the water quality objective (45% for TN) by 2.8%.In order to achieve the objectives for this catchment (under default values), the wetland would require over 50% increase in size.

It is for this reason that the current wetland treatment parameters are being revised to more accurately represent the optimal treatment efficiency of constructed wetland. Oversizing treatment infrastructure for only very marginal benefit is not considered to represent best practice nor sustainable in the long term, both in capital cost and ongoing maintenance burden.

Overall however, the minor shortfall in TN reduction for Precinct 3A – East under default wetland K and C* parameters is offset by the enhanced treatment occurring in bioretention basin dominated catchments, resulting in the overall Precinct 3 objectives being achieved. The overall stormwater quality management strategy developed does not therefore result in any major divergence from the intent of the State Planning Policy.

6 RECONFIGURING A LOT (PRELIMINARY EARTHWORKS)

As the urban design for each of the villages within Precinct 3 is progressed, suitable space will be allowed in the layout for the stormwater management systems. As part of the Reconfiguring a Lot applications preliminary earthworks plans will be provided to illustrate the proposal has considered the spatial requirements for stormwater treatment systems (i.e. treatment area, batters, embankments and maintenance).

The intent is that stormwater management will remain consistent with this *Precinct 3 Stormwater Quality Management Plan*. However where the development layout results in changes in catchment and/or the location and size of treatment systems this will be described in a technical note and certified as part of the Reconfiguring a Lot application for each of the relevant Precinct 3A, 3B, 3C and 3D applications.

7 CONCLUSION

A stormwater quality management strategy for Yarrabilba Precinct 3 development has been developed to meet the requirements of the *Yarrabilba Stormwater Infrastructure Master Plan (DesignFlow, 2012)* which is consistent with the *State Planning Policy* (DSDIP, 2016).

The strategy includes a range of treatment measures including swales, wetlands, bioretention systems and ephemeral wetlands. The proposed measures treat not only Precinct 3 but also parts of Precinct 2 ensuring the stormwater quality objectives are achieved at each of the discharge points to receiving environments.

Suitable space has been allowed in the development layout for the treatment measures which will be illustrated via preliminary earthworks plan to be submitted as part of the Reconfiguring a Lot applications for each sub-precinct.

Construction phase stormwater management objectives have been established for the site, in accordance with *State Planning Policy* (DSDIP, 2016). The preliminary locations of sediment basins has been provided with Erosion and Sediment Control Plans to be developed as part of detailed design. Audits will be completed during construction to ensure compliance with *State Planning Policy* (DSDIP, 2016).

8 REFERENCES

DesignFlow (2012) *Yarrabilba Total Water Cycle Management Strategy*

DesignFlow (2012) *Yarrabilba Stormwater Infrastructure Master Plan*

(DesignFlow, 2016) *Yarrabilba Precinct 3 Waterway Stability Assessment*

DesignFlow (2016) *Yarrabilba Precinct 3 Flood Study*

DSDIP (2016) *State Planning Policy*

Lendlease (2016) *Yarrabilba Context Plan Area Strategy – Precinct 3*

Natura Consulting (2012) *Yarrabilba Development: Natural Environment Site Strategy*

Natura Consulting (2012) *Natural Environment Site Strategy (NESS)*