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Waterway Management Consultants

ARMSTRONG CREEK WEST PRECINCT (ACWP)

STORMWATER MANAGEMENT STRATEGY

VERSION 3

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Neil M Craigie

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TABLE OF CONTENTS

1. INTRODUCTION

Neil M Craigie Pty Ltd and Water Technology Pty Ltd were appointed by Armstrong Creek Developments Pty Ltd, as a team to complete hydrologic, hydraulic and water quality modelling tasks for the Armstrong Creek West Precinct (ACWP).

Water Technology have since completed RORB and MIKE modelling of Armstrong Creek between Ghazepore Road and Surf Coast Highway for both existing and fully developed ACWP conditions. That work has utilised assumptions developed by the team about subcatchment drainage systems and wetland location and sizing along the Armstrong Creek floodplain margins and has culminated in a separate report entitled Armstrong Creek West Precinct Flooding Investigations Stage 2, October 2011.

This report presents more detail information regarding subcatchment urban drainage systems, sediment basin and wetland sizing and levelling and includes the results of MUSIC modelling to confirm compliance with best practice conditions and requirements of the relevant authorities-the City of Greater Geelong (CoGG) and the Corangamite Catchment Management Authority (CCMA).

This report forms an appendix to the Water Technology document and should be read in conjunction with it.

2. THE SUBCATCHMENT DRAINAGE SYSTEMS

Definition of subcatchment drainage systems has evolved during the course of investigations, in response to emerging flora and fauna and cultural heritage constraints and in accord with evolution of overall precinct development planning. Critical assumptions that have been made are as follows:

- Existing drainage crossings of the Railway line will remain into the future as the only external catchment flow inputs to the ACWP.

- Existing development north of the Railway line is assumed to have no water quality treatment systems in place.

- Future development of land north of the Railway line will have best practice water quality treatment systems in place.

- The existing pipe outfall from the Birkenhead Estate extending from the Railway to Airport Road and thence south to Armstrong Creek will be retained as part of the ACWP drainage systems. However modifications will be made to re-direct low flows.

- The proposed east-west road corridor reservation is treated as rural land for the purposes of sizing of water quality and urban trunk drainage systems.

- All other lands within the precinct will be developed in accord with the current overall masterplan shown at Figure 1.

- The existing filled embankment forming the airport east-west runway will be effectively removed as part of redevelopment, so that its current flood retardation capacity will be removed.

- Piped drainage connections will be provided to all separate titles within the ACWP with overland flows to be conveyed in roads or reserves depending on flow magnitudes and road floodway safety guidelines. In regard to the latter the relevant guideline that has been followed is Appendix A of the Melbourne Water Land Development Manual.

- Land in the north east corner of the ACWP drains northwesterly into the Horseshoe Bend Precinct. Existing retarding basins and constructed drainage lines are in place. The majority of that land will be taken up by approach/departure ramps for the east-west road and for the present time this area has been excluded from detailed assessment.

- Subcatchment and piped drainage system layouts have attempted to follow land ownership and existing road boundaries as far as practicable having regard to the natural fall of the land, so as to simplify as much possible, future implementation of works.

- The future Industrial Precinct south of Armstrong Creek west of Airport Road is treated as rural for ACWP flow and water quality calculations, but drainage outfall provision is made within the ACWP system as appropriate to maintain natural drainage line continuity.

Figure 1 (Sheets 1 and 2) illustrates the conceptual layout of subcatchments and main drainage lines.

3. STORMWATER MANAGEMENT ASSETS

3.1 Objectives

The proposed strategy for management of stormwater peak flows and quality in the ACWP is an integrated approach considering both quality and quantity. It is based first and foremost on ensuring:

- stormwater quality from the ACWP land is treated to contemporary best practice objectives, as measured/referenced at Surf Coast Highway;

- no significant change to stormwater discharges in Armstrong Creek for critical storm durations up to 100 years Average Recurrence Interval (ARI) events, as measured/referenced at Airport Road and Surf Coast Highway;

- as far as practically feasible, protecting Armstrong Creek from the impacts of altered hydrology arising from urbanisation.

In determining the most appropriate form and location of management assets the strategy has also considered the following objectives:

- retention and enhancement of Armstrong Creek and its floodplain within a creek, habitat and passive recreation corridor upstream of Surf Coast Highway;
- no direct connection of stormwater drainage systems to Armstrong Creek itself;
- creation of stormflow mitigation storages that avoid the use of high embankments (safety and cost grounds);
- protection of key flora/fauna habitat areas and sites of cultural heritage value;
- consolidation of drainage management assets wherever possible to minimise ongoing maintenance costs;
- encouragement for reuse of stormwater.

3.2 Creek Flow Regime Issues

Urbanisation inevitably leads to increased discharge of surface runoff and reduced accessions to groundwater and losses to evapotranspiration.

In round figures mean annual runoff for Armstrong Creek under existing conditions can be expected to average 1.3 ML/ha/year (obtained using the MUSIC model and Geelong rainfall for the 1980-89 period). After residential development at average imperviousness of 50%, mean annual runoff will rise to about 2.6 ML/ha/yr from the same rainfall (200% increase). For average imperviousness of 60%, mean annual runoff will rise to about 2.9 ML/ha/yr (220% increase). Since the average imperviousness of the bulk of the ACWP development area will be 60%, existing conditions (mean annual) runoff will be about 45% at most of future runoff.

Infiltration losses cannot offset any of this increase (unless costly pressure injection schemes are found to be feasible and can be economically implemented), simply because potential infiltration areas are markedly reduced by sealing of land surfaces. The only practical ways to make some offsets against the impacts of increased surface runoff regimes are (a) reuse of water instead of discharging it to the creek, and/or (b) bypassing excess “development” flows around the sensitive creek environment.

Normally a primary opportunity is reuse of roofwater (via raintanks before it is contaminated by pavement runoff) and at the lot scale.

However Class A recycle water supply is to be provided in the ACWP by Barwon Water. Class A effectively competes for the same demand uses as roofwater and stormwater. In the Armstrong Creek East Precinct (ACEP) Barwon Water set conditions on development that mandated connection of all lots to the Class A recycle supply and actively discouraged the effective reuse of roofwater. Such conditions are expected to be applied across the ACWP and other precincts as well.

As it is a "free water supply" unlike the Class A recycle supply, it is likely that voluntary uptake of rainwater tanks by future residents will prove significant over time and such action is to be encouraged through the SWMS in order to assist with further improving stormwater management outcomes and reducing potable water supply demands for the development. Regrettably however the Barwon Water conditions rule out storage and reuse of stormwater at the allotment scale, as a formal integrated part of the SWMS (ie., it cannot be incorporated into water quality and quantity modelling as a guaranteed offset).

The Barwon Water conditions leave alternative reuse on a precinct or regional scale as the only possible alternatives for water reuse to be incorporated into the ACWP SWMS. The main opportunity within ACWP will be in the upstream (western) end for the purposes of irrigation of the regional open space (ROS) facilities. An opportunity for an integrated sediment basin/reuse storage is identified adjacent to the Ghazepore Road tributary near its confluence with Armstrong Creek. However only minor development areas in ACWP drain to the waterways which flank the ROS area. Hence creation of water storage assets in the ROS will largely depend on drainage sourced from development areas external to ACWP and this opportunity has therefore been excluded from the SWMS.

Lesser opportunities may be afforded within ACWP by extraction from wetland systems. However constraints on extraction must be imposed to protect dependent aquatic plantings so that wetlands have limited ability to support extraction in dry times of the year when demand is highest.

As was concluded in the ACEP SWMS, there remains the opportunity for the water authority (Barwon Water) to enter the picture and install a larger scale stormwater reuse system from the proposed terminal wetland/storage system east of Barwon Heads Road in that ROS. That opportunity is very significant, given that Barwon Water could use water generated at high reliability in winter/spring periods from both ACEP and ACWP lands when ROS irrigation is offline. However as an external opportunity, it is beyond the scope of this SWMS to further quantify and no further consideration is made in this report.

In light of the above constraints and unknowns regarding reuse opportunities, the adopted strategy for ACWP must focus on flow diversion systems to protect creek hydrology.

3.3 Strategy Components

Having regard to the listed objectives and the constraints imposed on asset design by existing identified flora/fauna communities and cultural heritage sites, the adopted strategy contains the following components:

- retention and restoration of the Armstrong Creek waterway and floodplain as an environmental corridor;

- a network of tributary pipelines arranged to best suit asset treatment locations and land ownership boundaries;

- a network of sediment basins and wetlands located on line to tributary pipe drainage systems and integrated with the Armstrong Creek floodplain corridor;

- provision of a pipe bypass system on both sides of Armstrong Creek, linking the various sediment basins and wetlands so that existing creek hydrology in ACWP can be protected as far as practicable from altered hydrology;

- retention of the existing 1050 mm diameter Birkenhead Estate outfall pipe in Airport Road but with diversion of low flows away from the existing creek outfall and through the ACWP treatment systems (this effectively treats developed drainage waters emanating from lands external to ACWP);

- connection of creek bypass flows to the "bridge pool" at Surf Coast Highway from whence it is to be connected back into the pipe diversion on the south side of the creek in the ACEP. This pipe directs development drainage low flows to treatment systems downstream of Horseshoe Bend Road. Hence the ACWP and ACEP assets together effectively retain protection for the whole remnant reach of Armstrong Creek as an integrated system.

Associated flood management works are also included as set out in the Water Technology report:

- Enhanced floodplain storage created by a culvert restriction under the proposed north-south road crossing midway between Airport Road and Surf Coast Highway.

- Enhanced protection of Surf Coast Highway from flooding via provision of a low barrier along the ACWP frontage.

3.4 Armstrong Creek Corridor Asset Concepts

Figure 1 (Sheets 1 and 2) illustrates the conceptual layout of subcatchments, main stormwater pipelines, sediment basins and wetlands, plus the linking creek diversion pipelines. Figure 2 shows locations of the main treatment assets while Figure 3 (Sheets 1-3) shows concept designs for each and link pipelines along the creek corridor.

Table 1 summarises the catchments and design parameters for each of the treatment assets along the Armstrong Creek corridor.

TABLE 1 Proposed Stormwater Quality and Quantity Management Assets (refer to Figures 2 and 3 (Sheets 1-3))

Asset	External Catchment Areas (ha)		Precinct Catchment Areas (ha)		Average Impervious	NTWL (m)	WSA at NTWL (m2)	Ponded Volume at NTWL (m3)	Inlet Pond Volume (m3)	EDD (m)	Hydraulic Controls	Flood overflow to waterway	
	Rural	R1Z	Developed	DOT								Overflow level (m)	Total Retarding storage (m3)
WLRB1		7.0			60%	42.00	9,250	6,000	500	0.5	150 mm submerged orifice @ 42.00 1 m weir @ 42.50 m. 10 l/s minimum link pipe to Airport Road/SB2	43.50	15,000
			5.5		80%								
			11.5		80%								
			3.0		70%								
			11.6		70%								
				4.0	5%								
SB2	59.0				5%	31.00	4,000	3,500	-	0.5	200 mm submerged orifice 1 m weir @ 31.50 Discharges to WLRB2	32.00	4,500
		73.0			50%								
			2.2		80%								
			29.5		65%								
			10.4		60%								
			21.0		60%								
			4.6		60%								
				8.8	5%								
WLRB2			10.6		50%6	28.50	4,070	2,200	500	0.5	100 mm submerged orifice @ 28.50 1 m weir @ 29.00. 50 l/s minimum link pipe to WLRB3	29.50	4,300
WLRB3			41.3		60%	26.50	7,610	5,000	750	0.5	150 mm submerged orifice @ 26.50 10 m weir @ 27.00 50 l/s minimum link pipe to WLRB4	27.50	8,000
			72.0		60%								
				11.0	5%								
WLRB4			13.8		65%	23.00	13,980	9,000	500	0.5	150 mm submerged orifice @ 23.00 2 m weir @ 23.50 Discharges to WLRB5	24.30	13,000
			58.6		65%								
WLRB5						22.00	7,490	5,000		0.5	150 mm submerged orifice @ 22.00 5 m weir @ 22.50 Discharges to Surf Coast Hwy bridge pool	23.00	8,000
WLRB6	57.0				5%	24.00	7,690	5,000	500	0.5	150 mm submerged orifice @ 23.00 1 m weir @ 24.50. Discharges to WLRB7	25.00	8,000
	30.0				5%								
			39.1		60%								
			23.6		60%								
WLRB7			28.0		50%	23.00	7,360	5,000	500	0.5	150 mm submerged orifice @ 23.00 1 m weir @ 23.50. Discharges to WLRB8	24.00	8,000
WLRB8	53.0				5%	22.00	8,980	6,000	500	0.5	150 mm submerged orifice @ 23.00 5 m weir @ 22.50. Discharges to Surf Coast Hwy bridge pool	23.20	12,000
			50.0		60%								
Totals	199.0	80.0	436.3	23.8			70,430	46,700					80,800

* SB=Sediment Basin, WLRB=Wetland/Retarding Basin
** NTWL=Normal Top Water Level (m)
*** WSA=water surface area (m2)
**** EDD=Extended Detention Depth (m)

4. MUSIC MODELLING

The MUSIC model (Version 3) was used to:

- assess likely minimum link pipe capacities to maintain creek hydrologic regimes as close to existing conditions as possible, and

- simulate water quality treatment performance of the assets listed and described in Table 1.

The model was run with the 6 minute continuous rainfall sequence for Geelong North for 1974. This year provides a more conservative test (higher rainfall-578 mm) than the usual 10 year sequence for 1980-89 (mean annual rainfall 521 mm) but the latter will be used for all detail design.

4.1 Best Practice Quality Treatment Targets

Best Practice Environmental stormwater quality treatment standards require mean annual removal rates of 80%/45%/45%/70% for Total Suspended Solids (TSS), Total Phosphorus (TP), Total Nitrogen (TN) and Gross Pollutants (GP) respectively, from the typical urban loads generated from the development area.

The design intent for the treatment systems is to ensure adequate sediment removal occurs on all outlets prior to discharge to Armstrong Creek, with minimum best practice standards being achieved at Surf Coast Highway.

In regard to operation of the sedimentation systems, adequate TSS removal is usually set at 70% of the typical urban load.

4.2 Results

4.2.1 Water Quality

Table 2 summarises all mean annual MUSIC results for each of the treatment assets for Flow, TSS, TP, TN and GP. The removal volumes were then tested against total ACWP source loads to verify that best practice outcomes can be achieved.

Table 3 summarises the total pollutant load removal performance of the ACWP treatment assets at Surf Coast Highway.

The results confirm best practice treatment outcomes are achieved.

4.2.2 Creek Flow Regime

To maintain a similar overflow regime to Armstrong Creek at WLRB1, WLRB2, WLRB3 overflows, trial and error runs established that relatively small pipe capacities would suffice, due to the retarding effect these basins exert in the more frequently occurring flood events which tend to dominate mean annual flow volumes.

The figures in Table 3 show that total source runoff within ACWP development areas will be 1,522 ML/yr. From Section 3.2, existing conditions runoff is about 45% of this or roughly 685 ML/yr.

Table 2 shows that with the adopted link capacities, 614 ML/yr on average will be overflowed out of WLRB1, SB2/WLRB2 and WLRB3 into the creek which is about 40% of mean annual flow. This is just under the "existing conditions" flow.

> *(Note: In periods of high flood additional surcharges occur from pipe systems flanking the creek corridor. Pipes running parallel to Armstrong Creek need to deliver no more than 1 year ARI flows to the treatment assets)*

Further detail assessment will need to be carried out to check impacts on a seasonal basis (and in turn impacts on creek flooding regimes via Water Technology's hydraulic model), before confirming each link pipe capacity and indeed the final configuration of outlet controls on each storage. However the results to date indicate that to maintain mean annual flow volumes in the creek, the minimum link flow capacities need be no more than 50 l/s, averaged over the extended detention depths in each WLRB.

At Surf Coast Highway the link pipe systems and flow diversions through the wetlands come to an end and all the excess water has to be returned at the "bridge pool" from WLRB5 and WLRB8.

To avoid detrimental impacts on the creek downstream of Surf Coast Highway to Horseshoe Bend Road, the ACEP SWMS incorporates a similar flow bypass pipeline system along the south side of the creek corridor.

It is necessary to properly integrate the ACWP and ACEP link pipe systems and complete the overall creek hydrology protection. This can be achieved by constructing a link pipe out from the bridge pool on the immediate downstream side of Surf Coast Highway, and connecting it to the ACEP pipe.

The total flow sourced from the ACWP catchments and arriving at Surf Coast Highway is about 1,980 ML/yr so the connection pipe on the downstream side of the highway should be able to divert about 900 ML/yr out of the creek. For estimating purposes a 600 mm diameter pipe can be adopted with length of about 200 m.

This link pipe connection to the ACEP pipe will be a DCP item for ACWP but possibly constructed as part of the ACEP development.

TABLE 2 MUSIC Model results for ACWP Treatment Assets (Geelong 1974 6 min rainfall)						
Asset	**Parameter**	**Inflow Loads**	**Outflow Loads**	**Volume discharged to Link Pipe system**	**Volume overflowed to Armstrong Ck**	**Load removed in asset**
WLRB1	Flow (ML/yr)	151	139	69	70	12
	TSS (Kg/yr)	29,200	4,700			24,500
	TP (Kg/yr)	60	16			44
	TN (Kg/yr)	432	198			234
	GP (Kg/yr)	5,980	0			5,980
SB2	Flow (ML/yr)	630	627	627	-	3
	TSS (Kg/yr)	101,000	41,200			59,800
	TP (Kg/yr)	216	130			86
	TN (Kg/yr)	1,630	1,350			280
	GP (Kg/yr)	18,500	118			18,382
WLRB2	Flow (ML/yr)	662	655	359	296	7
	TSS (Kg/yr)	48,000	37,900			10,100
	TP (Kg/yr)	144	119			25
	TN (Kg/yr)	1,450	1,300			150
	GP (Kg/yr)	1,560	0			1,560
WLRB3	Flow (ML/yr)	756	743	495	248	13
	TSS (Kg/yr)	79,800	43,000			36,800
	TP (Kg/yr)	195	139			56
	TN (Kg/yr)	1,660	1,410			250
	GP (Kg/yr)	15,500	0			15,500
WLRB4	Flow (ML/yr)	749	726	726	-	23
	TSS (Kg/yr)	55,600	19,900			35,700
	TP (Kg/yr)	157	95			62
	TN (Kg/yr)	1,470	1,120			350
	GP (Kg/yr)	10,400	0			10,400
WLRB5	Flow (ML/yr)	726	714	-	714*	12
	TSS (Kg/yr)	19,900	16,400			3,500
	TP (Kg/yr)	95	87			12
	TN (Kg/yr)	1,120	1,080			40
	GP (Kg/yr)	0	0			0
WLRB6	Flow (ML/yr)	347	337	337	-	10
	TSS (Kg/yr)	55,500	25,300			30,200
	TP (Kg/yr)	125	71			54
	TN (Kg/yr)	957	661			296
	GP (Kg/yr)	8,980	0			8,980
WLRB7	Flow (ML/yr)	422	412	412	-	10
	TSS (Kg/yr)	41,100	26,500			14,600
	TP (Kg/yr)	103	80			23
	TN (Kg/yr)	898	781			117
	GP (Kg/yr)	3,320	0			3,320
WLRB8	Flow (ML/yr)	663	650	-	650*	13
	TSS (Kg/yr)	69,300	48,300			21,000
	TP (Kg/yr)	173	131			42
	TN (Kg/yr)	1,450	1,240			210
	GP (Kg/yr)	7,080	0			7,080

*** Excess flows diverted out of creek on downstream side of Surf Coast Highway into bypass pipe in ACEP.**

TABLE 3 MUSIC Model results for ACWP							
Location	**Parameter**	**Total source loads for catchments to ACWP assets**	**Source loads external to ACWP boundaries**	**ACWP developed source loads**	**Residual loads after treatment**	**Load removed in ACWP Assets**	**% Removal of ACWP source loads**
Surf Coast Highway	Flow (ML/yr)	2,080	558	1,522	1,977	103	7
	TSS (Kg/yr)	370,000	80,900	289,100	133,800	236,200	82
	TP (Kg/yr)	794	189	605	390	404	67
	TN (Kg/yr)	5,780	1,480	4,300	3,853	1,927	45
	GP (Kg/yr)	71,200	10,600	60,600	0	71,200	>100

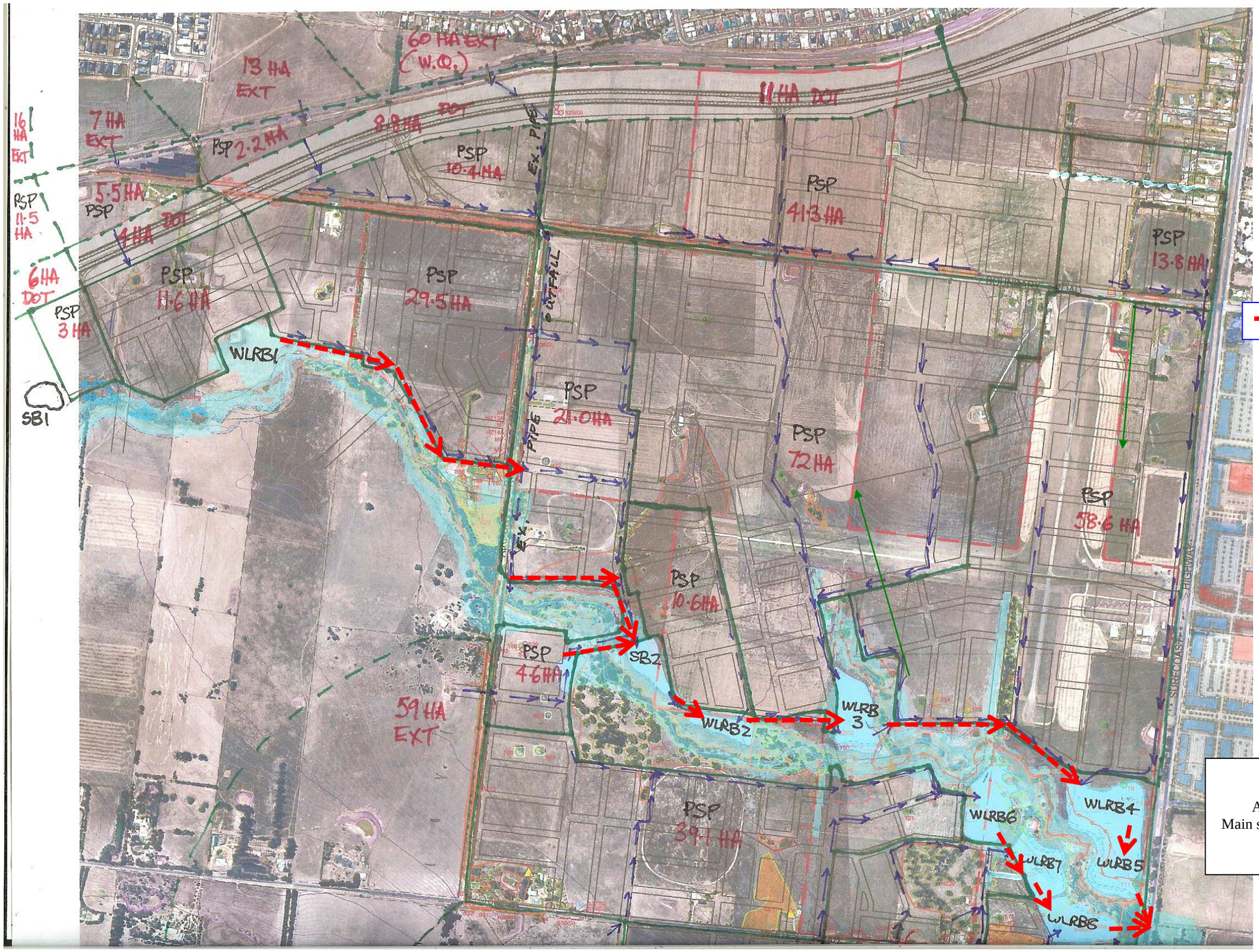
5. CONCLUSIONS

The proposed SWMS for the ACWP:

- complies with flora/fauna and cultural heritage constraints;
- will significantly enhance environmental diversity, landscape and recreational values along the Armstrong Creek corridor;
- will effectively protect the Armstrong Creek through the precinct from significant hydrologic change arising from urbanisation;
- in conjunction with the proposed works in the Armstrong Creek East Precinct, will protect the entire remnant reach of Armstrong Creek between Ghazepore Road and Horseshoe Bend Road;
- will ensure compliance with best practice stormwater quality treatment standards at Surf Coast Highway;

In conjunction with the strategy and designs adopted for the ACEP, the ACWP SWMS will provide the opportunity for large-scale reuse of treated stormwater at the downstream side of Barwon Heads Road. This opportunity can only be exploited by Barwon Water as part of its overall water supply and reuse strategies.

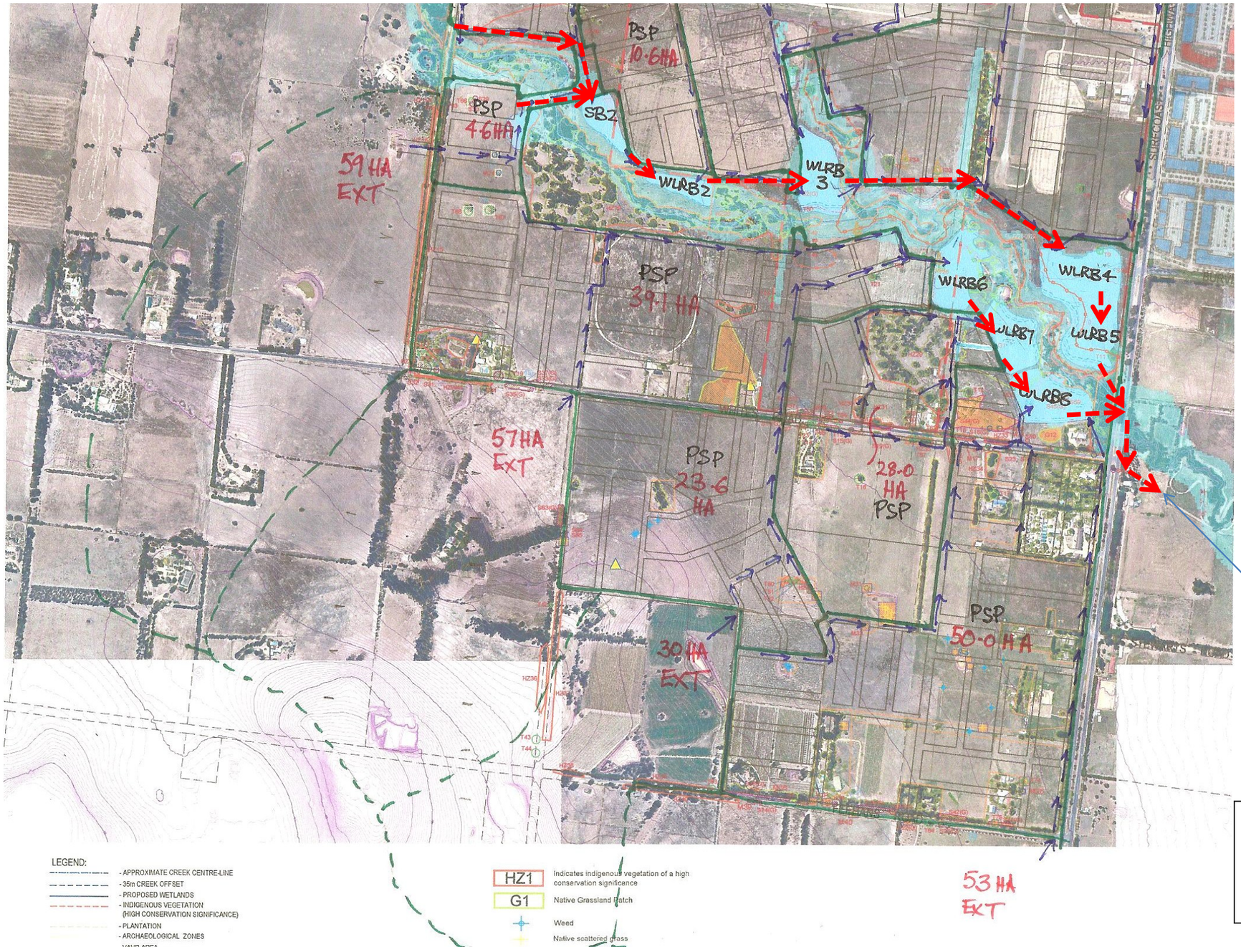
Neil M Craigie



Link pipelines

Figure 1 (Sheet 1 of 2)

Armstrong Creek West Precinct (ACWP) plan
Main subcatchments, pipe alignments and locations of primary stormwater treatment assets
(Refer Table 1 for sizings)



Link pipelines

Link pipe connection to ACEP bypass diversion pipe-adopt 200 m of 600 mm diameter pipe

Figure 1 (Sheet 2 of 2)

Armstrong Creek West Precinct (ACWP) plan
Main subcatchments, pipe alignments and locations of primary stormwater treatment assets
(Refer Table 1 for sizings)

			BROWN Smart Consulting ©2011 www.brownconsulting.com.au BROWN CONSULTING (VIC) PTY LTD Engineers, Town Planners and Surveyors Level 2, 66 Southbank Boulevard Southbank VIC 3006 T: 03 9203 9000	PROJECT: ARMSTRONG CREEK CLIENT: ARMSTRONG CREEK DEVELOPMENT PTY LTD SIGNED / DATE	SCALE: 1:10000 DRAWN: H.TANG DESIGN: T.PALIOS DIRECTOR: T.PALIOS DATE: 22/08/2011	TITLE: ARMSTRONG CREEK WEST PRECINCT CITY OF GREATER GEELONG DEVELOPMENT CONTRIBUTION PLAN WETLAND KEY PLAN DRAWING NUMBER: M100611-DCP1W-ARIAL
A	25/08/2011	GENERAL				
STATUS	DATE	COMMENTS				

Figure 2

Armstrong Creek West Precinct (ACWP) plan
Locations of primary stormwater treatment assets
(Refer Table 1 for sizings and Figure 3 (Sheets 1-3) for concept designs)

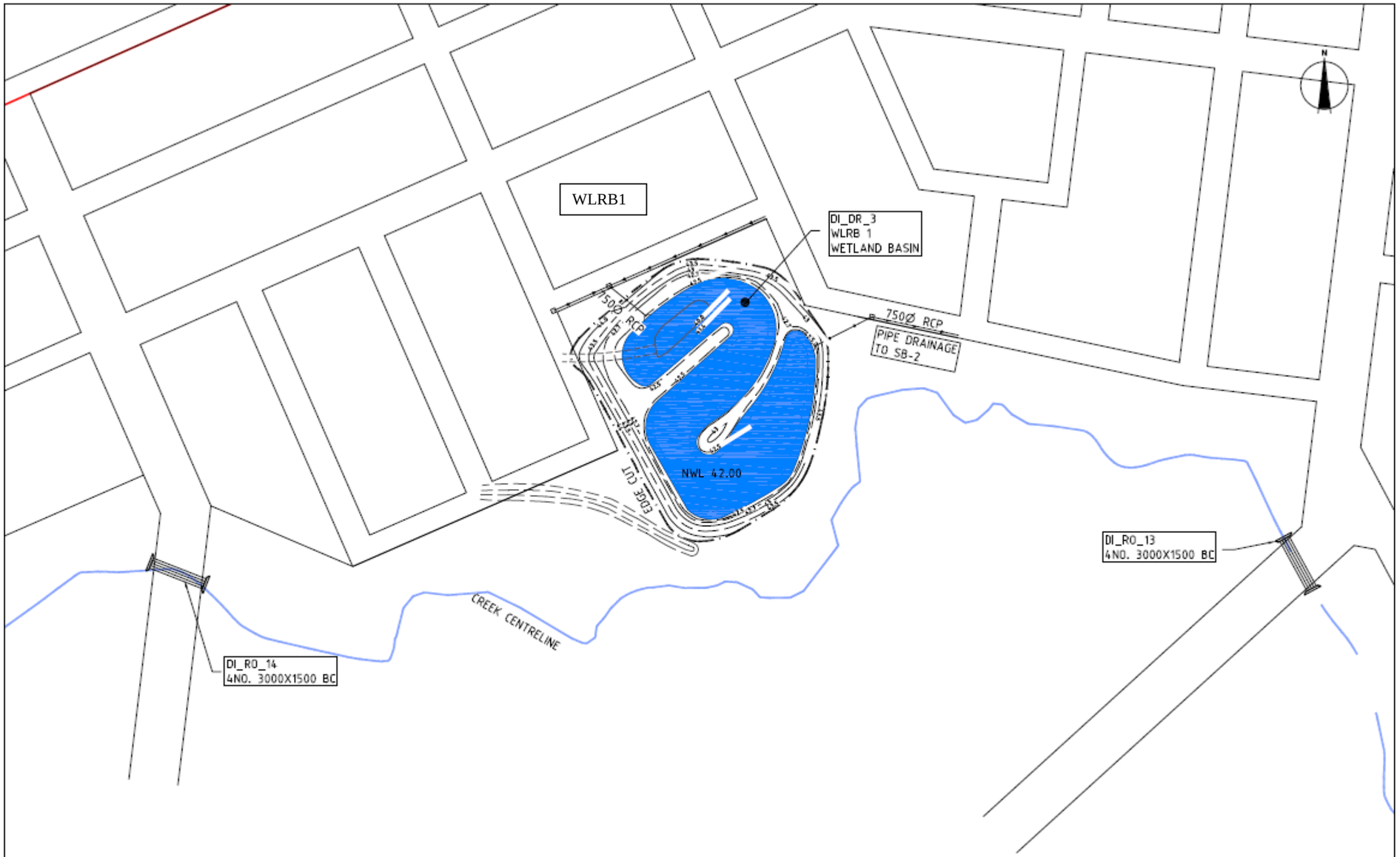


Figure 3 (Sheet 1 of 3)

Armstrong Creek West Precinct (ACWP) plan
Concept design for WLRB1
(Refer Table 1 for sizings)

Figure 3 (Sheet 2 of 3)

Armstrong Creek West Precinct (ACWP) plan Concepts for SB2, WLRB2 and WLRB3. Refer Table 1 for sizings.

Figure 3 (Sheet 3 of 3)

Armstrong Creek West Precinct (ACWP) plan
Concept designs for WLRB 4-WLRB8
(Refer Table 1 for sizings)