

Site:	R11			
Botanist:	Udani Sirisena & Melissa Hay	Date:	24/10/2014 & 17/05/2016	
Site type:	Releve	NW corner (GDA94):	50J 408314mE, 6495194mN	
Habitat:	Drainage line on a plain			
Surface layer:	Brown-black sandy-clay loam on banks and bed			
Vegetation condition:	6 (Degraded, Keighery 1994)	Fire history:	No signs of fire	
Disturbance types:	High level weeds, high level grazing, partial clearing, litter			
Phase 1		Phase 2		
				
Taxa	Cover (%)			Stratum
	Phase 1	Phase 2		
<i>Arctotheca calendula</i>		0.1		Herb
<i>Avena barbata</i>	50	80		Tussock grass - low
<i>Briza maxima</i>	2			Tussock grass - low
<i>Briza minor</i>	1			Tussock grass - low
<i>Bromus diandrus</i>	2			Tussock grass - low
<i>Cynodon dactylon</i>		3		Tussock grass - low
<i>Ehrharta longiflora</i>	0.1			Tussock grass - low
<i>Eucalyptus rudis subsp. rudis</i>	50	50		Tree - low to mid
<i>Lolium rigidum</i>	5	7		Tussock grass - low
<i>Lupinus cosentinii</i>		0.1		Herb
<i>Moraea flaccida</i>		5		Herb
<i>Oxalis pes-caprae</i>	2	10		Herb
<i>Oxalis purpurea</i>		0.1		Herb
<i>Raphanus raphanistrum</i>		0.1		Herb
<i>Zantedeschia aethiopica</i>	0.1	0.1		Herb

Site:	R12		
Botanist:	Udani Sirisena	Date:	24/10/2014
Site type:	Releve	NW corner (GDA94):	50J 409590mE, 6495570mN
Habitat:	Hillslope (midslope, gentle east facing slope)		
Surface layer:	Brown-white sandy-clay loam, with no rocks		
Vegetation condition:	6 (Degraded, Keighery 1994)	Fire history:	No signs of fire
Disturbance types:	High level weeds, high level grazing, partial clearing, litter		

Phase 1			
			

Taxa	Cover (%)		Stratum
	Phase 1	Phase 2	
<i>Arctotheca calendula</i>	1		Herb
<i>Avena fatua</i>	1		Tussock grass - low
<i>Briza maxima</i>	1		Tussock grass - low
<i>Briza minor</i>	1		Tussock grass - low
<i>Bromus diandrus</i>	1		Tussock grass - low
<i>Corymbia calophylla</i>	60		Tree - low
<i>Hordeum leporinum</i>	1		Tussock grass - low
<i>Lolium rigidum</i>	1		Tussock grass - low

Site:	R13		
Botanist:	Udani Sirisena	Date:	24/10/2014
Site type:	Releve	NW corner (GDA94):	50J 408893mE, 6495550mN
Habitat:	Plain - cleared paddock		
Surface layer:	Brown sandy-clay loam, with no rocks		
Vegetation condition:	7 (Completely degraded, Keighery 1994)	Fire history:	No signs of fire
Disturbance types:	Parkland cleared		

Phase 1



Taxa	Cover (%)		Stratum
	Phase 1	Phase 2	
<i>Avena barbata</i>	25		Tussock grass - low
<i>Arctotheca calendula</i>	1		Herb
<i>Bromus diandrus</i>	40		Tussock grass - low
<i>Lupinus cosentinii</i>	30		Herb
<i>Trifolium angustifolium</i> var. <i>angustifolium</i>	5		Herb
<i>Trifolium arvense</i> var. <i>arvense</i>	0.1		Herb

Site:	R14		
Botanist:	Udani Sirisena	Date:	24/10/2014
Site type:	Releve	NW corner (GDA94):	50J 408910mE, 6495551mN
Habitat:	Plain - cleared paddock		
Surface layer:	Brown sandy-clay loam, with no rocks		
Vegetation condition:	7 (Completely degraded, Keighery 1994)	Fire history:	No signs of fire
Disturbance types:	Parkland cleared		

Phase 1



Taxa	Cover (%)		Stratum
	Phase 1	Phase 2	
<i>Avena barbata</i>	0.1		Tussock grass - low
<i>Arctotheca calendula</i>	1		Herb
<i>Lupinus cosentinii</i>	1		Herb
<i>Trifolium angustifolium</i> var. <i>angustifolium</i>	1		Herb
<i>Trifolium campestre</i> var. <i>campestre</i>	1		Herb
<i>Triticum aestivum</i>	90		Tussock grass - low

Site:	R15		
Botanist:	Melissa Hay	Date:	16/05/2016
Site type:	Releve	NW corner (GDA94):	50J 409678mE, 6495912mN
Habitat:	Hillslope (hilltop, gentle slope)		
Surface layer:	Brown sandy-clay loam, with few granite pebbles		
Vegetation condition:	6 (Degraded, Keighery 1994)	Fire history:	No signs of fire
Disturbance types:	High level weeds, high level grazing, partial clearing		

Phase 1



Taxa	Cover (%)		Stratum
	Phase 1	Phase 2	
<i>Acacia pulchella</i>		0.1	Shrub - mid
<i>Arctotheca calendula</i>		0.1	Herb
<i>Avena barbata</i>		90	Tussock grass - low
<i>Corymbia calophylla</i>		10	Tree - low
<i>Eucalyptus wandoo</i> subsp. <i>wandoo</i>		20	Tree - low
<i>Moraea flaccida</i>		0.1	Herb
<i>Oxalis corniculata</i>		0.1	Herb
<i>Rytidosperma setaceum</i>		3	Tussock grass - low
<i>Solanum linnaeanum</i>		0.1	Shrub - mid

Site:	R16		
Botanist:	Melissa Hay	Date:	17/05/2016
Site type:	Releve	NW corner (GDA94):	50J 411249mE, 6496024mN
Habitat:	Hillslope (footslope, moderate west-facing slope)		
Surface layer:	Brown sandy-clay loam, with no rocks		
Vegetation condition:	6 (Degraded, Keighery 1994)	Fire history:	No signs of fire
Disturbance types:	High level weeds, high level grazing, partial clearing, litter		

Phase 1



Taxa	Cover (%)		Stratum
	Phase 1	Phase 2	
<i>Arctotheca calendula</i>		3	Herb
<i>Avena barbata</i>		80	Tussock grass - low
<i>Eucalyptus rudis</i> subsp. <i>rudis</i>		25	Tree - low
<i>Gomphocarpus fruticosus</i>		0.1	Shrub - mid
<i>Moraea flaccida</i>		5	Herb
<i>Sonchus oleraceus</i>		0.1	Herb
<i>Stachys arvensis</i>		0.1	Herb

Site:	R17		
Botanist:	Melissa Hay	Date:	17/05/2016
Site type:	Releve	NW corner (GDA94):	50J 410780mE, 6496418mN
Habitat:	Drainage line on footslope		
Surface layer:	Brown-white sandy-clay loam on banks, with common pebbles and stones of granite along drainage line		
Vegetation condition:	6 (Degraded, Keighery 1994)	Fire history:	No signs of fire
Disturbance types:	High level weeds, high level grazing, partial clearing, litter		

Phase 1



Taxa	Cover (%)		Stratum
	Phase 1	Phase 2	
<i>Asparagus asparagoides</i>		0.1	Climber
<i>Avena barbata</i>		80	Tussock grass - low
<i>Cyperus tenuiflorus</i>		0.1	Sedge - low
<i>Eucalyptus rudis</i> subsp. <i>rudis</i>		80	Tree - low
<i>Lepidosperma leptostachyum</i>		0.1	Shrub - low
<i>Lysimachia arvensis</i>		0.1	Herb
<i>Oxalis pes-caprae</i>		3	Herb
<i>Oxalis purpurea</i>		1	Herb
<i>Rumex hypogaeus</i>		0.1	Herb
<i>Stachys arvensis</i>		0.1	Herb

Site:	R18		
Botanist:	Melissa Hay	Date:	17/05/2016
Site type:	Releve	NW corner (GDA94):	50J 409999mE, 6496285mN
Habitat:	Drainage line on a plain		
Surface layer:	Brown-white sandy-clay loam on banks, with few pebbles and stones of quartz and granite along drainage line		
Vegetation condition:	6 (Degraded, Keighery 1994)	Fire history:	No signs of fire
Disturbance types:	High level weeds, high level grazing, partial clearing, litter		

Phase 1



Taxa	Cover (%)		Stratum
	Phase 1	Phase 2	
<i>Arctotheca calendula</i>		0.1	Herb
<i>Asparagus asparagoides</i>		0.1	Climber
<i>Avena barbata</i>		90	Tussock grass - low
<i>Cynodon dactylon</i>		0.1	Tussock grass - low
<i>Eucalyptus rudis</i> subsp. <i>rudis</i>		50	Tree - low
<i>Gomphocarpus fruticosus</i>		1	Shrub - mid
<i>Juncus pallidus</i>		0.1	Rush - low
<i>Lolium rigidum</i>		15	Tussock grass - low
<i>Oxalis pes-caprae</i>		10	Herb
<i>Oxalis purpurea</i>		0.1	Herb
<i>Solanum linnaeanum</i>		0.1	Shrub - mid
<i>Stachys arvensis</i>		0.1	Herb

Site:	R19		
Botanist:	Melissa Hay	Date:	17/05/2016
Site type:	Releve	NW corner (GDA94):	50J 408324mE, 6495550mN
Habitat:	Drainage line on a plain		
Surface layer:	Brown-white sandy-clay loam on banks, with few pebbles and stones of quartz and granite along drainage line		
Vegetation condition:	6 (Degraded, Keighery 1994)	Fire history:	No signs of fire
Disturbance types:	High level weeds, high level grazing, partial clearing, litter		

Phase 1



Taxa	Cover (%)		Stratum
	Phase 1	Phase 2	
<i>Arctotheca calendula</i>		0.1	Herb
<i>Avena barbata</i>		70	Tussock grass - low
<i>Cynodon dactylon</i>		5	Tussock grass - low
<i>Eucalyptus rudis</i> subsp. <i>rudis</i>		50	Tree - low to mid
<i>Gomphocarpus fruticosus</i>		0.1	Shrub - mid
<i>Lolium rigidum</i>		5	Tussock grass - low
<i>Lupinus cosentinii</i>		0.1	Herb
<i>Moraea flaccida</i>		0.1	Herb
<i>Oxalis pes-caprae</i>		40	Herb
<i>Oxalis purpurea</i>		20	Herb
<i>Rumex hypogaeus</i>		0.1	Herb
<i>Sonchus oleraceus</i>		0.1	Herb

Site:	R20		
Botanist:	Melissa Hay	Date:	17/05/2016
Site type:	Releve	NW corner (GDA94):	50J 408303mE, 6495448mN
Habitat:	Drainage line on a plain		
Surface layer:	Brown-white sandy-clay loam on banks, with common pebbles and stones of quartz and granite along drainage line		
Vegetation condition:	6 (Degraded, Keighery 1994)	Fire history:	No signs of fire
Disturbance types:	High level weeds, high level grazing, partial clearing, litter		

Phase 1



Taxa	Cover (%)		Stratum
	Phase 1	Phase 2	
<i>Avena barbata</i>		80	Tussock grass - low
<i>Cynodon dactylon</i>		3	Tussock grass - low
<i>Eucalyptus rudis</i> subsp. <i>rudis</i>		60	Tree - low to mid
<i>Eucalyptus wandoo</i> subsp. <i>wandoo</i>		15	Tree - low
<i>Gomphocarpus fruticosus</i>		0.1	Shrub - mid
<i>Juncus pallidus</i>		1	Rush - low
<i>Lepidosperma squamatum</i>		0.1	Sedge - low
<i>Lolium rigidum</i>		5	Tussock grass - low
<i>Moraea flaccida</i>		1	Herb
<i>Oxalis pes-caprae</i>		20	Herb
<i>Oxalis purpurea</i>		3	Herb

Site:	R21		
Botanist:	Melissa Hay	Date:	16/05/2016
Site type:	Releve	NW corner (GDA94):	50J 409299mE, 6495081mN
Habitat:	Hillslope (footslope, gentle west-facing slope)		
Surface layer:	Brown sandy-clay loam, with few granite pebbles		
Vegetation condition:	6 (Degraded, Keighery 1994)	Fire history:	No signs of fire
Disturbance types:	High level weeds, high level grazing, partial clearing		

Phase 1



Taxa	Cover (%)		Stratum
	Phase 1	Phase 2	
<i>Acacia pulchella</i>		3	Shrub - mid
<i>Avena barbata</i>		90	Tussock grass - low
<i>Corymbia calophylla</i>		40	Tree - low
<i>Hibbertia commutata</i>		0.5	Shrub - low
<i>Lepidosperma leptostachyum</i>		1	Shrub - low
<i>Moraea flaccida</i>		3	Herb
<i>Nuytsia floribunda</i>		1	Shrub - tall

Site:	R22		
Botanist:	Melissa Hay	Date:	16/05/2016
Site type:	Releve	NW corner (GDA94):	50J 410307mE, 6496953mN
Habitat:	Drainage line on hillslope (footslope, moderate west-facing slope)		
Surface layer:	Brown-white sandy-clay loam on banks, with common pebbles of quartz and granite along drainage line		
Vegetation condition:	6 (Degraded, Keighery 1994)	Fire history:	No signs of fire
Disturbance types:	High level weeds, high level grazing, partial clearing, litter		

Phase 1



Taxa	Cover (%)		Stratum
	Phase 1	Phase 2	
<i>Acacia pulchella</i>		2	Shrub - mid
<i>Acacia saligna</i> subsp. <i>lindleyi</i>		1	Shrub - tall
<i>Corymbia calophylla</i>		60	Tree - low
<i>Eucalyptus rudis</i> subsp. <i>rudis</i>		15	Tree - low
<i>Hakea erinacea</i>		0.1	Shrub - mid
<i>Lepidosperma squamatum</i>		2	Sedge - low
<i>Lysimachia arvensis</i>		5	Herb

Site:	R23		
Botanist:	Melissa Hay	Date:	16/05/2016
Site type:	Releve	NW corner (GDA94):	50J 410852mE, 6496017mN
Habitat:	Hillslope (midslope, gentle east facing slope)		
Surface layer:	Brown sandy-clay loam, with no rocks		
Vegetation condition:	6 (Degraded, Keighery 1994)	Fire history:	No signs of fire
Disturbance types:	High level weeds, high level grazing, partial clearing		

Phase 1



Taxa	Cover (%)		Stratum
	Phase 1	Phase 2	
<i>Arctotheca calendula</i>		10	Herb
<i>Avena barbata</i>		90	Tussock grass - low
<i>Eucalyptus wandoo subsp. wandoo</i>		10	Tree - low
<i>Moraea flaccida</i>		10	Herb
<i>Oxalis corniculata</i>		5	Herb
<i>Rytidosperma setaceum</i>		2	Tussock grass - low
<i>Solanum linnaeanum</i>		0.1	Shrub - mid
<i>Sonchus oleraceus</i>		0.1	Herb

Site:	R24		
Botanist:	Melissa Hay	Date:	16/05/2016
Site type:	Releve	NW corner (GDA94):	50J 410724mE, 6495501mN
Habitat:	Hillslope (hilltop, gentle slope)		
Surface layer:	Brown sandy-clay loam, with many pebbles, stones and boulders of laterite		
Vegetation condition:	6 (Degraded, Keighery 1994)	Fire history:	No signs of fire
Disturbance types:	High level weeds, high level grazing, partial clearing		

Phase 1



Taxa	Cover (%)		Stratum
	Phase 1	Phase 2	
<i>Arctotheca calendula</i>		10	Herb
<i>Avena barbata</i>		60	Tussock grass - low
<i>Corymbia calophylla</i>		40	Tree - low
<i>Dioscorea hastifolia</i>		0.1	Climber
<i>Jacksonia floribundum</i>		5	Shrub - tall
<i>Moraea flaccida</i>		5	Herb
<i>Oxalis corniculata</i>		10	Herb
<i>Phyllanthus calycinus</i>		0.1	Shrub - low

Site:	R25		
Botanist:	Melissa Hay	Date:	17/05/2016
Site type:	Releve	NW corner (GDA94):	50J 410558mE, 6495446mN
Habitat:	Hillslope (footslope, gentle west-facing slope)		
Surface layer:	Brown sandy-clay loam, with no rocks		
Vegetation condition:	6 (Degraded, Keighery 1994)	Fire history:	No signs of fire
Disturbance types:	High level weeds, high level grazing, partial clearing		

Phase 1



Taxa	Cover (%)		Stratum
	Phase 1	Phase 2	
<i>Arctotheca calendula</i>		2	Herb
<i>Avena barbata</i>		70	Tussock grass - low
<i>Avena barbata</i>		0.1	Tussock grass - low
<i>Eucalyptus wandoo</i> subsp. <i>wandoo</i>		60	Tree - low
<i>Moraea flaccida</i>		30	Herb
<i>Oxalis corniculata</i>		1	Herb
<i>Rytidosperma setaceum</i>		0.1	Tussock grass - low
<i>Solanum linnaeanum</i>		0.1	Shrub - mid

Site:	R26		
Botanist:	Melissa Hay	Date:	16/05/2016
Site type:	Releve	NW corner (GDA94):	50J 410907mE, 6496063mN
Habitat:	Drainage line on hillslope (midslope, moderate east-facing slope)		
Surface layer:	Brown sandy-clay loam, with few granite boulders		
Vegetation condition:	6 (Degraded, Keighery 1994)	Fire history:	No signs of fire
Disturbance types:	High level weeds, high level grazing, partial clearing		

Phase 1



Taxa	Cover (%)		Stratum
	Phase 1	Phase 2	
<i>Arctotheca calendula</i>		10	Herb
<i>Avena barbata</i>		90	Tussock grass - low
<i>Cheilanthes distans</i>		0.1	Herb
<i>Eucalyptus rudis</i> subsp. <i>rudis</i>		10	Tree - low
<i>Moraea flaccida</i>		10	Herb
<i>Oxalis corniculata</i>		5	Herb
<i>Rytidosperma setaceum</i>		2	Tussock grass - low
<i>Solanum linnaeanum</i>		0.1	Shrub - mid
<i>Sonchus oleraceus</i>		0.1	Herb

Site:	R27		
Botanist:	Melissa Hay	Date:	16/05/2016
Site type:	Releve	NW corner (GDA94):	50J 410773mE, 6496186mN
Habitat:	Hillslope (footslope, gentle west-facing slope)		
Surface layer:	Brown sandy-clay loam, with no rocks		
Vegetation condition:	6 (Degraded, Keighery 1994)	Fire history:	No signs of fire
Disturbance types:	High level weeds, high level grazing, partial clearing		

Phase 1



Taxa	Cover (%)		Stratum
	Phase 1	Phase 2	
<i>Avena barbata</i>		70	Tussock grass - low
<i>Corymbia calophylla</i>		30	Tree - low
<i>Moraea flaccida</i>		20	Herb
<i>Oxalis corniculata</i>		2	Herb
<i>Solanum linnaeanum</i>		0.1	Shrub - mid
<i>Sonchus oleraceus</i>		0.1	Herb

This page has been left blank intentionally.

APPENDIX D SITE BY SPECIES MATRIX

RPS Bullsbrook Project

[illegible]

RPS Bullsbrook Project

Taxon	OPP	Q01	Q02	Q03	Q04	Q05	Q06	R01	R02	R03	R04	R05	R06	R07	R08	R09	R10	R11	R12	R13	R14	R15	R16	R17	R18	R19	R20	R21	R22	R23	R24	R25	R26	R27
<i>Lepidosperma squaratum</i>						5			5	3		10	0.1	20		1	1		7	1							15	5	5	0.1				
<i>Lolium rigidum</i>						0.1								2				30																
<i>Lotus angustissimus</i>													0.1	0.1				50	0.1		30	1					0.1							
<i>Lupinus cosentinii</i>														2											0.1									
<i>Lysimachia arvensis</i>															2																			
<i>Macrosamia riedlei</i>																																		
<i>Melia azedarach</i>																																		
<i>Monocilius monstrosus</i>	0.1																																	
<i>Monaea flaccida</i>		1																																
<i>Neuraiche alopecuroides</i>																																		
<i>Neurisia flaribunda</i>		1								1				0.1																				
<i>Olea europaea</i> subsp. <i>europaea</i>	0.1																																	
<i>Orobanchie minor</i>																																		
<i>Oxalis corniculata</i>																																		
<i>Oxalis pes-caprae</i>																																		
<i>Oxalis purpurea</i>																																		
<i>Patersonia occidentalis</i>																																		
<i>Pentameris araloides</i>																																		
<i>Phyllanthus calycinus</i>																																		
<i>Phyllanthus irroratus</i>																																		
<i>Phyllanthus raphanistrum</i>																																		
<i>Raphanus raphanistrum</i>																																		
<i>Ricinus communis</i>	0.1																																	
<i>Rumex hypogaeus</i>																																		
<i>Rydaspisma setaceum</i>																																		
<i>Schinus molle</i>																																		
<i>Solanum linnaeanum</i>	0.1																																	
<i>Solanum nigrum</i>																																		
<i>Sonchus asper</i>																																		
<i>Sonchus oleraceus</i>																																		
<i>Stachys arvensis</i>																																		
<i>Stylidium affine</i>	1																																	
<i>Stylidium bulbiferum</i>	0.1																																	
<i>Stylidium elegans</i>																																		
<i>Thlasia foliosa</i>																																		
<i>Thysanotus paterasii</i>	1	1																																
<i>Trachyantha divanata</i>	0.1																																	
<i>Trifolium angustifolium</i> var. <i>angustifolium</i>																																		
<i>Trifolium arvense</i> var. <i>arvense</i>																																		
<i>Trifolium arvense</i> var. <i>arvense</i>																																		

This page has been left blank intentionally.



APPENDIX E FLORA SPECIES LIST

Family	Taxon	Phase 1	Phase 2
Anacardiaceae	<i>*Schinus molle</i>		x
Apiaceae	<i>Daucus glochidiatus</i>	x	
Apiaceae	<i>Xanthosia candida</i>	x	x
Apocynaceae	<i>*Gomphocarpus fruticosus</i> (Declared Pest - not at Project area)	x	x
Araceae	<i>*Zantedeschia aethiopica</i> (Declared Pest - at Project area)	x	x
Asparagaceae	<i>*Asparagus asparagoides</i> (WONS)		x
Asparagaceae	<i>Thysanotus patersonii</i>	x	x
Asphodelaceae	<i>*Trachyandra divaricata</i>	x	
Asteraceae	<i>*Arctotheca calendula</i>	x	x
Asteraceae	<i>*Hypochaeris glabra</i>	x	x
Asteraceae	<i>*Monoculus monstrosus</i>	x	
Asteraceae	<i>*Sonchus asper</i>	x	
Asteraceae	<i>*Sonchus oleraceus</i>	x	x
Asteraceae	<i>*Ursinia anthemoides</i>	x	
Brassicaceae	<i>*Raphanus raphanistrum</i>	x	x
Colchicaceae	<i>Burchardia congesta</i>	x	x
Cyperaceae	<i>*Cyperus involucratus</i>		x
Cyperaceae	<i>*Cyperus tenuiflorus</i>		x
Cyperaceae	<i>Lepidosperma leptostachyum</i>		x
Cyperaceae	<i>Lepidosperma</i> sp.1 (inadequate material)		x
Cyperaceae	<i>Lepidosperma squamatum</i>	x	x
Dilleniaceae	<i>Hibbertia commutata</i>	x	x
Dilleniaceae	<i>Hibbertia hypericoides</i> subsp. <i>hypericoides</i>	x	x
Dioscoreaceae	<i>Dioscorea hastifolia</i>		x
Droseraceae	<i>Drosera macrantha</i>		x
Euphorbiaceae	<i>*Ricinus communis</i>		x
Fabaceae	<i>Acacia ?baileyana</i>		x
Fabaceae	<i>Acacia ?applanata</i>		x
Fabaceae	<i>*Acacia podalyriifolia</i>		x
Fabaceae	<i>Acacia pulchella</i>	x	x
Fabaceae	<i>Acacia saligna</i> subsp. <i>lindleyi</i>		x
Fabaceae	<i>Acacia urophylla</i>		x
Fabaceae	<i>Bossiaea eriocarpa</i>	x	x
Fabaceae	<i>Gastrolobium retusum</i>	x	
Fabaceae	<i>Gastrolobium spinosum</i>	x	x
Fabaceae	<i>Jacksonia sternbergiana</i>		x
Fabaceae	<i>*Lotus angustissimus</i>	x	
Fabaceae	<i>*Lupinus cosentinii</i>	x	x
Fabaceae	<i>*Trifolium angustifolium</i> var. <i>angustifolium</i>	x	x
Fabaceae	<i>*Trifolium arvense</i> var. <i>arvense</i>	x	
Fabaceae	<i>*Trifolium campestre</i> var. <i>campestre</i>	x	
Geraniaceae	<i>*Erodium botrys</i>		x
Goodeniaceae	<i>Goodenia coerulea</i>	x	
Haemodoraceae	<i>Haemodorum laxum</i>	x	
Iridaceae	<i>*Babiana angustifolia</i>	x	
Iridaceae	<i>*Hesperantha falcata</i>	x	
Iridaceae	<i>*Moraea flaccida</i> (Declared Pest - not at Project area)	x	x
Iridaceae	<i>Patersonia occidentalis</i>		x
Juncaceae	<i>Juncus pallidus</i>	x	x
Lamiaceae	<i>*Stachys arvensis</i>	x	x
Loranthaceae	<i>Nuytsia floribunda</i>	x	x
Malvaceae	<i>Lasiopetalum floribundum</i>		x
Malvaceae	<i>Thomasia foliosa</i>	x	x
Meliaceae	<i>*Melia azedarach</i>		x
Myrtaceae	<i>Corymbia calophylla</i>	x	x
Myrtaceae	<i>Eucalyptus rudis</i> subsp. <i>rudis</i>	x	x
Myrtaceae	<i>Eucalyptus wandoo</i> subsp. <i>wandoo</i>	x	x
Myrtaceae	<i>Hypocalymma angustifolium</i>	x	x
Nyctaginaceae	<i>*Bougainvillea glabra</i>		x
Oleaceae	<i>*Olea europaea</i> subsp. <i>europaea</i>		x
Orchidaceae	<i>Eriochilus dilatatus</i> subsp. <i>undulatus</i>		x
Orobanchaceae	<i>*Orobanche minor</i>	x	
Oxalidaceae	<i>*Oxalis corniculata</i>		x
Oxalidaceae	<i>*Oxalis pes-caprae</i>	x	x
Oxalidaceae	<i>*Oxalis purpurea</i>		x
Papaveraceae	<i>*Fumaria capreolata</i>	x	
Phormiaceae	<i>Dianella revoluta</i>	x	
Phyllanthaceae	<i>Phyllanthus calycinus</i>		x

Family	Taxon	Phase 1	Phase 2
Poaceae	* <i>Avena barbata</i>	x	x
Poaceae	* <i>Avena fatua</i>	x	
Poaceae	* <i>Briza maxima</i>	x	
Poaceae	* <i>Briza minor</i>	x	
Poaceae	* <i>Bromus diandrus</i>	x	
Poaceae	* <i>Bromus hordeaceus</i>	x	
Poaceae	* <i>Cenchrus clandestinus</i>	x	
Poaceae	* <i>Cenchrus setaceus</i>		x
Poaceae	* <i>Cynodon dactylon</i>		x
Poaceae	* <i>Digitaria ciliaris</i>		x
Poaceae	* <i>Ehrharta calycina</i>	x	
Poaceae	* <i>Ehrharta longiflora</i>	x	
Poaceae	* <i>Eragrostis curvula</i>		x
Poaceae	* <i>Hordeum leporinum</i>	x	
Poaceae	* <i>Lolium rigidum</i>	x	x
Poaceae	<i>Neurachne alopecuroidea</i>	x	
Poaceae	* <i>Pentameris airoides</i>	x	x
Poaceae	<i>Rytidosperma setaceum</i>	x	x
Poaceae	* <i>Triticum aestivum</i>	x	
Poaceae	* <i>Vulpia bromoides</i>	x	
Poaceae	* <i>Vulpia myuros</i>	x	
Polygonaceae	* <i>Rumex hypogaeus</i> (Declared Pest - not at Project area)		x
Primulaceae	* <i>Lysimachia arvensis</i>	x	x
Proteaceae	<i>Hakea erinacea</i>	x	x
Proteaceae	<i>Hakea lissocarpa</i>	x	x
Proteaceae	<i>Hakea undulata</i>		x
Proteaceae	<i>Isopogon</i> sp. 1 (inadequate material)	x	
Proteaceae	<i>Adenanthos cygnorum</i> subsp. <i>cygnorum</i>		x
Proteaceae	<i>Banksia armata</i> var. <i>armata</i>		x
Proteaceae	<i>Banksia sessilis</i> var. <i>sessilis</i>		x
Pteridaceae	<i>Cheilanthes distans</i>		x
Restionaceae	<i>Desmocladus flexuosus</i>		x
Rhamnaceae	<i>Trymalium odoratissimum</i> subsp. <i>odoratissimum</i>		x
Santalaceae	? <i>Exocarpos sparteus</i>		x
Solanaceae	* <i>Solanum linnaeanum</i> (Declared Pest - not at Project area)	x	x
Solanaceae	* <i>Solanum nigrum</i>		x
Stylidiaceae	<i>Stylidium affine</i>	x	x
Stylidiaceae	<i>Stylidium bulbiferum</i>	x	
Stylidiaceae	<i>Stylidium repens</i>		x
Tropaeolaceae	* <i>Tropaeolum majus</i>		x
Typhaceae	* <i>Typha ?orientalis</i>		x
Xanthorrhoeaceae	<i>Xanthorrhoea preissii</i>	x	x
Zamiaceae	<i>Macrozamia riedlei</i>		x

This page has been left blank intentionally.

APPENDIX F INTRODUCED FLORA LOCATIONS

Taxon	Easting	Northing	Estimated number of plants
WONS & Declared Pest - s22(2) (C3, whole of state)			
* <i>Asparagus asparagoides</i>	410780	6496418	1
* <i>Asparagus asparagoides</i>	409999	6496285	1
Declared Pest - s22(2) (C3, whole of state)			
* <i>Zantedeschia aethiopica</i>	408377	6496136	1
* <i>Zantedeschia aethiopica</i>	408314	6495194	1
* <i>Zantedeschia aethiopica</i>	408332	6495220	1
* <i>Zantedeschia aethiopica</i>	408302	6495413	1
* <i>Zantedeschia aethiopica</i>	408314	6495194	1
Environmental Weed			
* <i>Acacia ?baileyana</i>	409721	6496169	4
* <i>Acacia podalyriifolia</i>	409454	6496133	5
* <i>Arctotheca calendula</i>	409265	6496316	1
* <i>Arctotheca calendula</i>	408314	6495194	1
* <i>Arctotheca calendula</i>	409678	6495912	1
* <i>Arctotheca calendula</i>	409999	6496285	1
* <i>Arctotheca calendula</i>	408324	6495550	1
* <i>Arctotheca calendula</i>	409325	6496342	5
* <i>Arctotheca calendula</i>	410559	6495446	5
* <i>Arctotheca calendula</i>	411249	6496024	10
* <i>Arctotheca calendula</i>	410852	6496017	20
* <i>Arctotheca calendula</i>	410724	6495501	20
* <i>Arctotheca calendula</i>	410908	6496063	20
* <i>Arctotheca calendula</i>	408829	6496254	1
* <i>Arctotheca calendula</i>	409590	6495570	1
* <i>Arctotheca calendula</i>	408893	6495550	1
* <i>Arctotheca calendula</i>	408910	6495551	1
* <i>Avena barbata</i>	410559	6495446	1
* <i>Avena barbata</i>	411402	6496313	50
* <i>Avena barbata</i>	409265	6496316	500
* <i>Avena barbata</i>	410985	6495619	500
* <i>Avena barbata</i>	409325	6496342	500
* <i>Avena barbata</i>	410724	6495501	500
* <i>Avena barbata</i>	408377	6496136	1,000
* <i>Avena barbata</i>	408324	6495550	1,000
* <i>Avena barbata</i>	410559	6495446	1,000
* <i>Avena barbata</i>	410773	6496186	1,000
* <i>Avena barbata</i>	408324	6495277	1,000
* <i>Avena barbata</i>	408310	6495369	1,000
* <i>Avena barbata</i>	408314	6495194	1,000
* <i>Avena barbata</i>	411249	6496024	1,000
* <i>Avena barbata</i>	410780	6496418	1,000
* <i>Avena barbata</i>	408303	6495448	1,000
* <i>Avena barbata</i>	409678	6495912	1,000
* <i>Avena barbata</i>	409999	6496285	1,000
* <i>Avena barbata</i>	409299	6495081	1,000
* <i>Avena barbata</i>	410852	6496017	1,000
* <i>Avena barbata</i>	410908	6496063	1,000
* <i>Avena barbata</i>	410176	6496615	10
* <i>Avena barbata</i>	409289	6495096	100
* <i>Avena barbata</i>	409301	6496030	1
* <i>Avena barbata</i>	408778	6496250	1
* <i>Avena barbata</i>	408340	6495317	100
* <i>Avena barbata</i>	408893	6495550	30
* <i>Avena barbata</i>	408910	6495551	1
* <i>Avena fatua</i>	408829	6496254	100
* <i>Avena fatua</i>	409590	6495570	10
* <i>Babiana angustifolia</i>	409322	6496336	3
* <i>Bougainvillea glabra</i>	408366	6496167	1
* <i>Briza maxima</i>	410176	6496615	10
* <i>Briza maxima</i>	408324	6495277	10
* <i>Briza maxima</i>	408310	6495369	50
* <i>Briza maxima</i>	409289	6495096	50
* <i>Briza maxima</i>	409325	6496342	1
* <i>Briza maxima</i>	408377	6496136	50
* <i>Briza maxima</i>	408778	6496250	10
* <i>Briza maxima</i>	408314	6495194	50

Taxon	Easting	Northing	Estimated number of plants
*Briza maxima	409590	6495570	10
*Briza minor	408324	6495277	1
*Briza minor	409325	6496342	1
*Briza minor	408778	6496250	1
*Briza minor	408314	6495194	10
*Briza minor	409590	6495570	10
*Bromus diandrus	408324	6495277	50
*Bromus diandrus	408310	6495369	100
*Bromus diandrus	409265	6496316	10
*Bromus diandrus	409325	6496342	100
*Bromus diandrus	408778	6496250	10
*Bromus diandrus	408314	6495194	50
*Bromus diandrus	409590	6495570	10
*Bromus diandrus	408893	6495550	500
*Bromus hordeaceus	408263	6495372	1
*Bromus hordeaceus	408262	6495372	1
*Bromus hordeaceus	409289	6495096	50
*Bromus hordeaceus	408829	6496254	100
*Cenchrus clandestinus	408324	6495277	1
*Cenchrus setaceus	410488	6495423	5
*Cynodon dactylon	409999	6496285	1
*Cynodon dactylon	408310	6495369	50
*Cynodon dactylon	408314	6495194	50
*Cynodon dactylon	408303	6495448	50
*Cynodon dactylon	409325	6496342	50
*Cynodon dactylon	408377	6496136	50
*Cynodon dactylon	408324	6495550	50
*Cynodon dactylon	408324	6495277	100
*Cynodon dactylon	408336	6496059	15
*Cyperus involucratus	408324	6495376	2
*Cyperus involucratus	408336	6496064	5
*Cyperus tenuiflorus	410780	6496418	1
*Digitaria ciliaris	408329	6495612	20
*Ehrharta calycina	409325	6496342	500
*Ehrharta longiflora	408829	6496254	10
*Ehrharta longiflora	408314	6495194	1
*Eragrostis curvula	408329	6495612	20
*Eragrostis curvula	408336	6496067	5
*Erodium botrys	411372	6496132	100
*Fumaria capreolata	408377	6496136	5
*Gomphocarpus fruticosus	408324	6495277	1
*Gomphocarpus fruticosus	408310	6495369	1
*Gomphocarpus fruticosus	411249	6496024	1
*Gomphocarpus fruticosus	408324	6495550	1
*Gomphocarpus fruticosus	408303	6495448	1
*Gomphocarpus fruticosus	409999	6496285	1
*Gomphocarpus fruticosus	409981	6496385	10
*Gomphocarpus fruticosus	410187	6495805	15
*Gomphocarpus fruticosus	408325	6495305	1
*Gomphocarpus fruticosus	408319	6495350	1
*Gomphocarpus fruticosus	408317	6495474	1
*Gomphocarpus fruticosus	411248	6496138	1
*Gomphocarpus fruticosus	408320	6495267	2
*Gomphocarpus fruticosus	410724	6495501	2
*Gomphocarpus fruticosus	410869	6495974	2
*Gomphocarpus fruticosus	408330	6495529	30
*Gomphocarpus fruticosus	408322	6495489	4
*Gomphocarpus fruticosus	408319	6495285	5
*Gomphocarpus fruticosus	408328	6495665	5
*Gomphocarpus fruticosus	410641	6496326	5
*Gomphocarpus fruticosus	411194	6496233	5
*Hesperantha falcata	411560	6496144	1
*Hesperantha falcata	410176	6496615	1
*Hesperantha falcata	409289	6495096	10
*Hesperantha falcata	409325	6496342	5
*Hesperantha falcata	408340	6495317	1
*Hordeum leporinum	408324	6495277	100

Taxon	Easting	Northing	Estimated number of plants
* <i>Hordeum leporinum</i>	408310	6495369	10
* <i>Hordeum leporinum</i>	408829	6496254	100
* <i>Hordeum leporinum</i>	409265	6496316	10
* <i>Hordeum leporinum</i>	408377	6496136	50
* <i>Hordeum leporinum</i>	409301	6496030	10
* <i>Hordeum leporinum</i>	408778	6496250	10
* <i>Hordeum leporinum</i>	409590	6495570	10
* <i>Hypochaeris glabra</i>	408377	6496136	1
* <i>Hypochaeris glabra</i>	409325	6496342	1
* <i>Lolium rigidum</i>	411402	6496313	1
* <i>Lolium rigidum</i>	409265	6496316	1
* <i>Lolium rigidum</i>	408310	6495369	50
* <i>Lolium rigidum</i>	408324	6495277	50
* <i>Lolium rigidum</i>	408324	6495550	50
* <i>Lolium rigidum</i>	408303	6495448	50
* <i>Lolium rigidum</i>	408314	6495194	50
* <i>Lolium rigidum</i>	409999	6496285	100
* <i>Lolium rigidum</i>	409325	6496342	100
* <i>Lolium rigidum</i>	408829	6496254	100
* <i>Lolium rigidum</i>	409301	6496030	10
* <i>Lolium rigidum</i>	408778	6496250	10
* <i>Lolium rigidum</i>	409590	6495570	10
* <i>Lotus angustissimus</i>	409325	6496342	5
* <i>Lotus angustissimus</i>	408340	6495317	20
* <i>Lupinus cosentinii</i>	408377	6496136	1
* <i>Lupinus cosentinii</i>	408314	6495194	1
* <i>Lupinus cosentinii</i>	408324	6495550	1
* <i>Lupinus cosentinii</i>	409325	6496342	1
* <i>Lupinus cosentinii</i>	408340	6495317	30
* <i>Lupinus cosentinii</i>	408893	6495550	30
* <i>Lupinus cosentinii</i>	408910	6495551	1
* <i>Lysimachia arvensis</i>	410780	6496418	1
* <i>Lysimachia arvensis</i>	410307	6496953	10
* <i>Lysimachia arvensis</i>	408338	6496065	10
* <i>Lysimachia arvensis</i>	410176	6496615	1
* <i>Lysimachia arvensis</i>	408377	6496136	5
* <i>Melia azedarach</i>	410015	6496307	1
* <i>Monoculus monstrosus</i>	411560	6496144	1
* <i>Moraea flaccida</i>	408310	6495369	1
* <i>Moraea flaccida</i>	409678	6495912	1
* <i>Moraea flaccida</i>	408324	6495550	1
* <i>Moraea flaccida</i>	408303	6495448	1
* <i>Moraea flaccida</i>	409299	6495081	10
* <i>Moraea flaccida</i>	409265	6496316	10
* <i>Moraea flaccida</i>	408314	6495194	10
* <i>Moraea flaccida</i>	411249	6496024	10
* <i>Moraea flaccida</i>	410724	6495501	10
* <i>Moraea flaccida</i>	409325	6496342	10
* <i>Moraea flaccida</i>	410985	6495619	20
* <i>Moraea flaccida</i>	408324	6495277	20
* <i>Moraea flaccida</i>	410852	6496017	20
* <i>Moraea flaccida</i>	410908	6496063	20
* <i>Moraea flaccida</i>	410773	6496186	20
* <i>Moraea flaccida</i>	410559	6495446	30
* <i>Moraea flaccida</i>	409322	6496336	2
* <i>Olea europaea subsp. europaea</i>	408360	6496128	1
* <i>Orobancha minor</i>	408377	6496136	5
* <i>Oxalis corniculata</i>	409678	6495912	1
* <i>Oxalis corniculata</i>	410985	6495619	1
* <i>Oxalis corniculata</i>	410559	6495446	1
* <i>Oxalis corniculata</i>	410900	6495623	5
* <i>Oxalis corniculata</i>	410773	6496186	5
* <i>Oxalis corniculata</i>	410852	6496017	10
* <i>Oxalis corniculata</i>	410908	6496063	10
* <i>Oxalis corniculata</i>	410724	6495501	20
* <i>Oxalis pes-caprae</i>	410780	6496418	10
* <i>Oxalis pes-caprae</i>	409265	6496316	10

Taxon	Easting	Northing	Estimated number of plants
* <i>Oxalis pes-caprae</i>	409325	6496342	20
* <i>Oxalis pes-caprae</i>	408377	6496136	20
* <i>Oxalis pes-caprae</i>	408314	6495194	20
* <i>Oxalis pes-caprae</i>	409999	6496285	20
* <i>Oxalis pes-caprae</i>	408310	6495369	20
* <i>Oxalis pes-caprae</i>	408303	6495448	20
* <i>Oxalis pes-caprae</i>	408324	6495277	30
* <i>Oxalis pes-caprae</i>	408324	6495550	30
* <i>Oxalis purpurea</i>	408377	6496136	1
* <i>Oxalis purpurea</i>	408314	6495194	1
* <i>Oxalis purpurea</i>	409999	6496285	1
* <i>Oxalis purpurea</i>	408310	6495369	1
* <i>Oxalis purpurea</i>	409265	6496316	1
* <i>Oxalis purpurea</i>	410780	6496418	1
* <i>Oxalis purpurea</i>	409325	6496342	5
* <i>Oxalis purpurea</i>	408303	6495448	10
* <i>Oxalis purpurea</i>	408324	6495277	20
* <i>Oxalis purpurea</i>	408324	6495550	20
* <i>Pentameris airoides</i>	408336	6496059	10
* <i>Pentameris airoides</i>	411560	6496144	10
* <i>Pentameris airoides</i>	408340	6495317	100
* <i>Raphanus raphanistrum</i>	408324	6495277	1
* <i>Raphanus raphanistrum</i>	408310	6495369	1
* <i>Raphanus raphanistrum</i>	408377	6496136	1
* <i>Raphanus raphanistrum</i>	408314	6495194	1
* <i>Raphanus raphanistrum</i>	408366	6496167	20
* <i>Ricinus communis</i>	409629	6495556	5
* <i>Rumex hypogaeus</i>	408310	6495369	1
* <i>Rumex hypogaeus</i>	410780	6496418	1
* <i>Rumex hypogaeus</i>	408324	6495550	1
* <i>Rumex hypogaeus</i>	408316	6495284	5
* <i>Schinus molle</i>	410017	6496326	2
* <i>Solanum linnaeanum</i>	408377	6496136	1
* <i>Solanum linnaeanum</i>	409678	6495912	1
* <i>Solanum linnaeanum</i>	409999	6496285	1
* <i>Solanum linnaeanum</i>	410852	6496017	1
* <i>Solanum linnaeanum</i>	410559	6495446	1
* <i>Solanum linnaeanum</i>	410908	6496063	1
* <i>Solanum linnaeanum</i>	410773	6496186	1
* <i>Solanum linnaeanum</i>	410734	6496261	100
* <i>Solanum linnaeanum</i>	410003	6496282	10
* <i>Solanum linnaeanum</i>	410899	6495955	10
* <i>Solanum linnaeanum</i>	408318	6495342	1
* <i>Solanum linnaeanum</i>	408317	6495288	1
* <i>Solanum linnaeanum</i>	408325	6495629	1
* <i>Solanum linnaeanum</i>	410141	6496395	200
* <i>Solanum linnaeanum</i>	408323	6495584	4
* <i>Solanum linnaeanum</i>	410602	6496349	500
* <i>Solanum linnaeanum</i>	410304	6495654	50
* <i>Solanum linnaeanum</i>	409325	6496342	1
* <i>Solanum linnaeanum</i>	409301	6496030	1
* <i>Solanum nigrum</i>	411315	6496220	10
* <i>Solanum nigrum</i>	408298	6495179	1
* <i>Solanum nigrum</i>	408319	6495285	2
* <i>Solanum nigrum</i>	408337	6496064	5
* <i>Sonchus asper</i>	411560	6496144	1
* <i>Sonchus oleraceus</i>	410852	6496017	1
* <i>Sonchus oleraceus</i>	410908	6496063	1
* <i>Sonchus oleraceus</i>	410773	6496186	1
* <i>Sonchus oleraceus</i>	411404	6496303	1,000
* <i>Sonchus oleraceus</i>	411249	6496024	1
* <i>Sonchus oleraceus</i>	409265	6496316	1
* <i>Sonchus oleraceus</i>	408324	6495550	1
* <i>Sonchus oleraceus</i>	410900	6495623	10
* <i>Sonchus oleraceus</i>	408300	6495414	1
* <i>Sonchus oleraceus</i>	408324	6495277	1
* <i>Sonchus oleraceus</i>	408310	6495369	1

Taxon	Easting	Northing	Estimated number of plants
* <i>Stachys arvensis</i>	409265	6496316	1
* <i>Stachys arvensis</i>	411249	6496024	1
* <i>Stachys arvensis</i>	410780	6496418	1
* <i>Stachys arvensis</i>	409999	6496285	1
* <i>Stachys arvensis</i>	408377	6496136	5
* <i>Trachyantha divaricata</i>	408324	6495277	1
* <i>Trachyantha divaricata</i>	408310	6495369	1
* <i>Trifolium angustifolium</i> var. <i>angustifolium</i>	408336	6496064	5
* <i>Trifolium angustifolium</i> var. <i>angustifolium</i>	410176	6496615	1
* <i>Trifolium angustifolium</i> var. <i>angustifolium</i>	408324	6495277	10
* <i>Trifolium angustifolium</i> var. <i>angustifolium</i>	408310	6495369	10
* <i>Trifolium angustifolium</i> var. <i>angustifolium</i>	409325	6496342	1
* <i>Trifolium angustifolium</i> var. <i>angustifolium</i>	408893	6495550	10
* <i>Trifolium angustifolium</i> var. <i>angustifolium</i>	408910	6495551	1
* <i>Trifolium arvense</i> var. <i>arvense</i>	408893	6495550	1
* <i>Trifolium campestre</i> var. <i>campestre</i>	408324	6495277	1
* <i>Trifolium campestre</i> var. <i>campestre</i>	409325	6496342	1
* <i>Trifolium campestre</i> var. <i>campestre</i>	409301	6496030	1
* <i>Trifolium campestre</i> var. <i>campestre</i>	408778	6496250	1
* <i>Trifolium campestre</i> var. <i>campestre</i>	408910	6495551	1
* <i>Triticum aestivum</i>	408910	6495551	1
* <i>Triticum aestivum</i>	408910	6495551	1,000
* <i>Tropaeolum majus</i>	408349	6495680	1,000
* <i>Typha ?orientalis</i>	410213	6495866	100
* <i>Ursinia anthemoides</i>	411560	6496144	1
* <i>Ursinia anthemoides</i>	410176	6496615	1
* <i>Vulpia bromoides</i>	409289	6495096	10
* <i>Vulpia myuros</i>	410176	6496615	10
* <i>Vulpia myuros</i>	408340	6495317	1

Datum GDA94, Zone 50J

This page has been left blank intentionally.

Appendix B

Aboriginal heritage sites



Search Criteria

Site 3583

Disclaimer

Aboriginal sites exist that are not recorded on the Register of Aboriginal Sites, and some registered sites may no longer exist. Consultation with Aboriginal communities is on-going to identify additional sites. The AHA protects all Aboriginal sites in Western Australia whether or not they are registered.

Copyright

Copyright in the information contained herein is and shall remain the property of the State of Western Australia. All rights reserved. This includes, but is not limited to, information from the Register of Aboriginal Sites established and maintained under the Aboriginal Heritage Act 1972 (AHA).

Legend

Restriction	Access	Coordinate Accuracy
N No restriction	C Closed	Accuracy is shown as a code in brackets following the site coordinates.
M Male access only	O Open	[Reliable] The spatial information recorded in the site file is deemed to be reliable, due to methods of capture.
F Female access	V Vulnerable	[Unreliable] The spatial information recorded in the site file is deemed to be unreliable due to errors of spatial data capture and/or quality of spatial information reported.

Status

L - Lodged	ACMC Decision Made
Information lodged, awaiting assessment	R - Registered Site I - Insufficient information S - Stored Data

Spatial Accuracy

Index coordinates are indicative locations and may not necessarily represent the centre of sites, especially for sites with an access code "closed" or "vulnerable". Map coordinates (Lat/Long) and (Easting/Northing) are based on the GDA 94 datum. The Easting / Northing map grid can be across one or more zones. The zone is indicated for each Easting on the map, i.e. '5000000.Z50' means Easting=5000000, Zone=50.

Sites Shown on Maps

Site boundaries may not appear on maps at low zoom levels

List of Registered Aboriginal Sites with Map

Site ID	Status	Access	Restriction	Site Name	Site Type	Additional Info	Informants	Coordinates	Site No.
3583	R	C	N	Ki-It Monger Brook 2	Ceremonial, Mythological, Modified Tree		*Registered Informant names available from DIA.	Not available for closed sites	S02408



Search Criteria

Site 3525

Disclaimer

Aboriginal sites exist that are not recorded on the Register of Aboriginal Sites, and some registered sites may no longer exist. Consultation with Aboriginal communities is on-going to identify additional sites. The AHA protects all Aboriginal sites in Western Australia whether or not they are registered.

Copyright

Copyright in the information contained herein is and shall remain the property of the State of Western Australia. All rights reserved. This includes, but is not limited to, information from the Register of Aboriginal Sites established and maintained under the Aboriginal Heritage Act 1972 (AHA).

Legend

Restriction	Access	Coordinate Accuracy
N No restriction	C Closed	Accuracy is shown as a code in brackets following the site coordinates.
M Male access only	O Open	[Reliable] The spatial information recorded in the site file is deemed to be reliable, due to methods of capture.
F Female access	V Vulnerable	[Unreliable] The spatial information recorded in the site file is deemed to be unreliable due to errors of spatial data capture and/or quality of spatial information reported.

Status

L - Lodged	ACMC Decision Made
Information lodged, awaiting assessment	R - Registered Site I - Insufficient information S - Stored Data

Spatial Accuracy

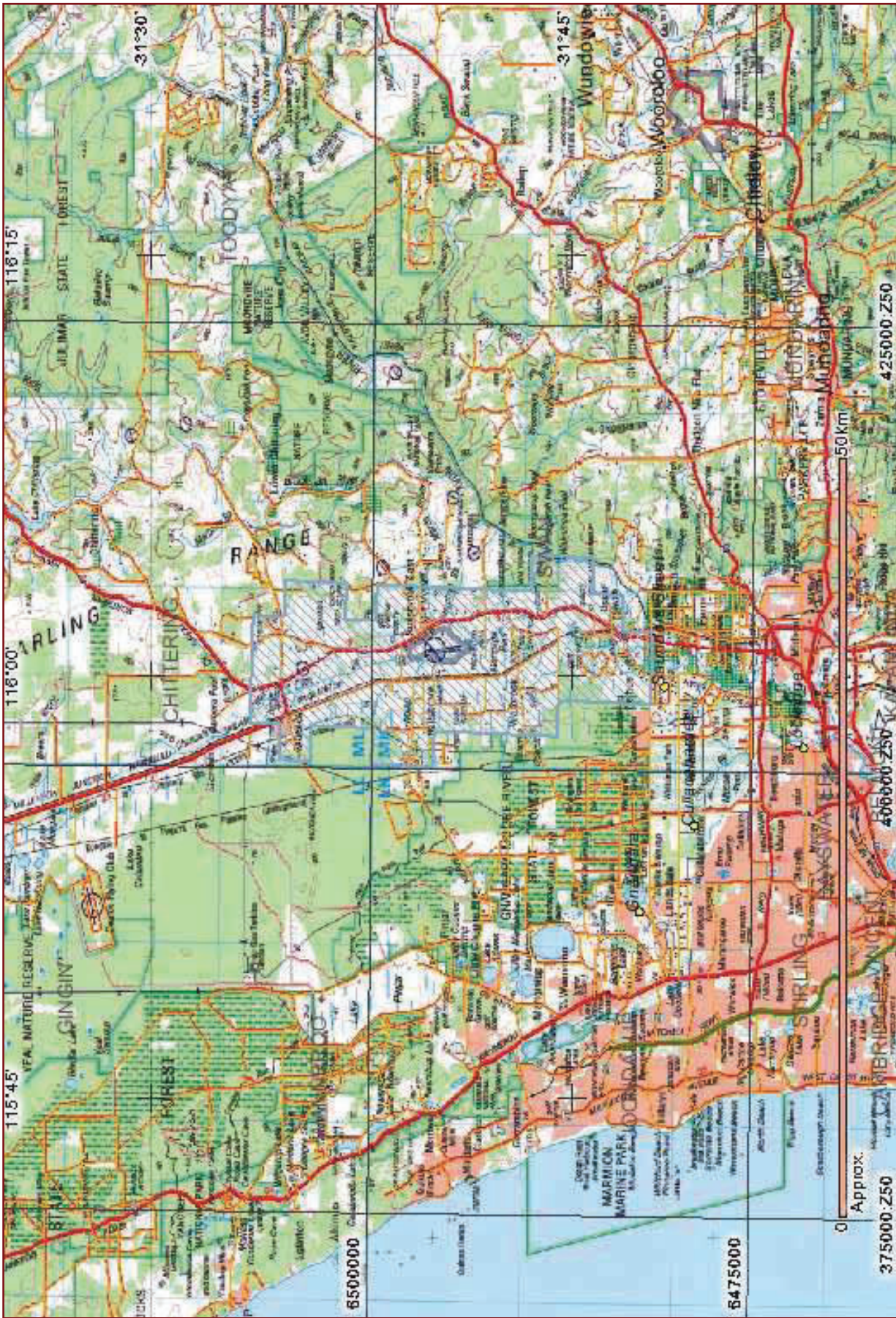
Index coordinates are indicative locations and may not necessarily represent the centre of sites, especially for sites with an access code "closed" or "vulnerable". Map coordinates (Lat/Long) and (Easting/Northing) are based on the GDA 94 datum. The Easting / Northing map grid can be across one or more zones. The zone is indicated for each Easting on the map, i.e. '5000000.Z50' means Easting=5000000, Zone=50.

Sites Shown on Maps

Site boundaries may not appear on maps at low zoom levels

List of Other Heritage Places with Map

Site ID	Status	Access	Restriction	Site Name	Site Type	Additional Info	Informants	Coordinates	Site No.
3525	I	C	N	Ellen Brook: Upper Swan	Mythological		*Registered Informant names available from DIA.	Not available for closed sites	S02516



Legend

Selected Heritage Sites

Other Heritage Places

Town

Map Area

Search Area

Copyright for base map information shall at all times remain the property of the Commonwealth of Australia, Geoscience Australia - National Mapping Division. All rights reserved.

Cadastral, Local Government Authority, Native Title boundary data copyright © Western Australian Land Information Authority trading as Landgate (2012).

Geothermal Application, Geothermal Title, Mining Tenement, Petroleum Application, Petroleum Title boundary data copyright © the State of Western Australia (DMP) (2012.12).

For further important information on using this information please see the Department of Indigenous Affairs' Terms of Use statement at <http://www.dia.wa.gov.au/Terms-Of-Use/>

Search Criteria

Site 3941

Disclaimer

Aboriginal sites exist that are not recorded on the Register of Aboriginal Sites, and some registered sites may no longer exist. Consultation with Aboriginal communities is on-going to identify additional sites. The AHA protects all Aboriginal sites in Western Australia whether or not they are registered.

Copyright

Copyright in the information contained herein is and shall remain the property of the State of Western Australia. All rights reserved. This includes, but is not limited to, information from the Register of Aboriginal Sites established and maintained under the Aboriginal Heritage Act 1972 (AHA).

Legend

Restriction	Access	Coordinate Accuracy
N No restriction	C Closed	Accuracy is shown as a code in brackets following the site coordinates.
M Male access only	O Open	[Reliable] The spatial information recorded in the site file is deemed to be reliable, due to methods of capture.
F Female access	V Vulnerable	[Unreliable] The spatial information recorded in the site file is deemed to be unreliable due to errors of spatial data capture and/or quality of spatial information reported.

Status

L - Lodged	ACMC Decision Made
Information lodged, awaiting assessment	R - Registered Site I - Insufficient information S - Stored Data

Spatial Accuracy

Index coordinates are indicative locations and may not necessarily represent the centre of sites, especially for sites with an access code "closed" or "vulnerable". Map coordinates (Lat/Long) and (Easting/Northing) are based on the GDA 94 datum. The Easting / Northing map grid can be across one or more zones. The zone is indicated for each Easting on the map, i.e. '5000000.Z50' means Easting=5000000, Zone=50.

Sites Shown on Maps

Site boundaries may not appear on maps at low zoom levels

List of Other Heritage Places with Map

Site ID	Status	Access	Restriction	Site Name	Site Type	Additional Info	Informants	Coordinates	Site No.
3941	I	O	N	Ki-It Monger Brook 1.	Artefacts / Scatter	Camp		409553mE 6496882mN Zone 50 [Reliable]	S01480



Search Criteria

Site 22669

Disclaimer

Aboriginal sites exist that are not recorded on the Register of Aboriginal Sites, and some registered sites may no longer exist. Consultation with Aboriginal communities is on-going to identify additional sites. The AHA protects all Aboriginal sites in Western Australia whether or not they are registered.

Copyright

Copyright in the information contained herein is and shall remain the property of the State of Western Australia. All rights reserved. This includes, but is not limited to, information from the Register of Aboriginal Sites established and maintained under the Aboriginal Heritage Act 1972 (AHA).

Legend

Restriction	Access	Coordinate Accuracy
N No restriction	C Closed	Accuracy is shown as a code in brackets following the site coordinates.
M Male access only	O Open	[Reliable] The spatial information recorded in the site file is deemed to be reliable, due to methods of capture.
F Female access	V Vulnerable	[Unreliable] The spatial information recorded in the site file is deemed to be unreliable due to errors of spatial data capture and/or quality of spatial information reported.

Status

L - Lodged	ACMC Decision Made
Information lodged, awaiting assessment	R - Registered Site I - Insufficient information S - Stored Data

Spatial Accuracy

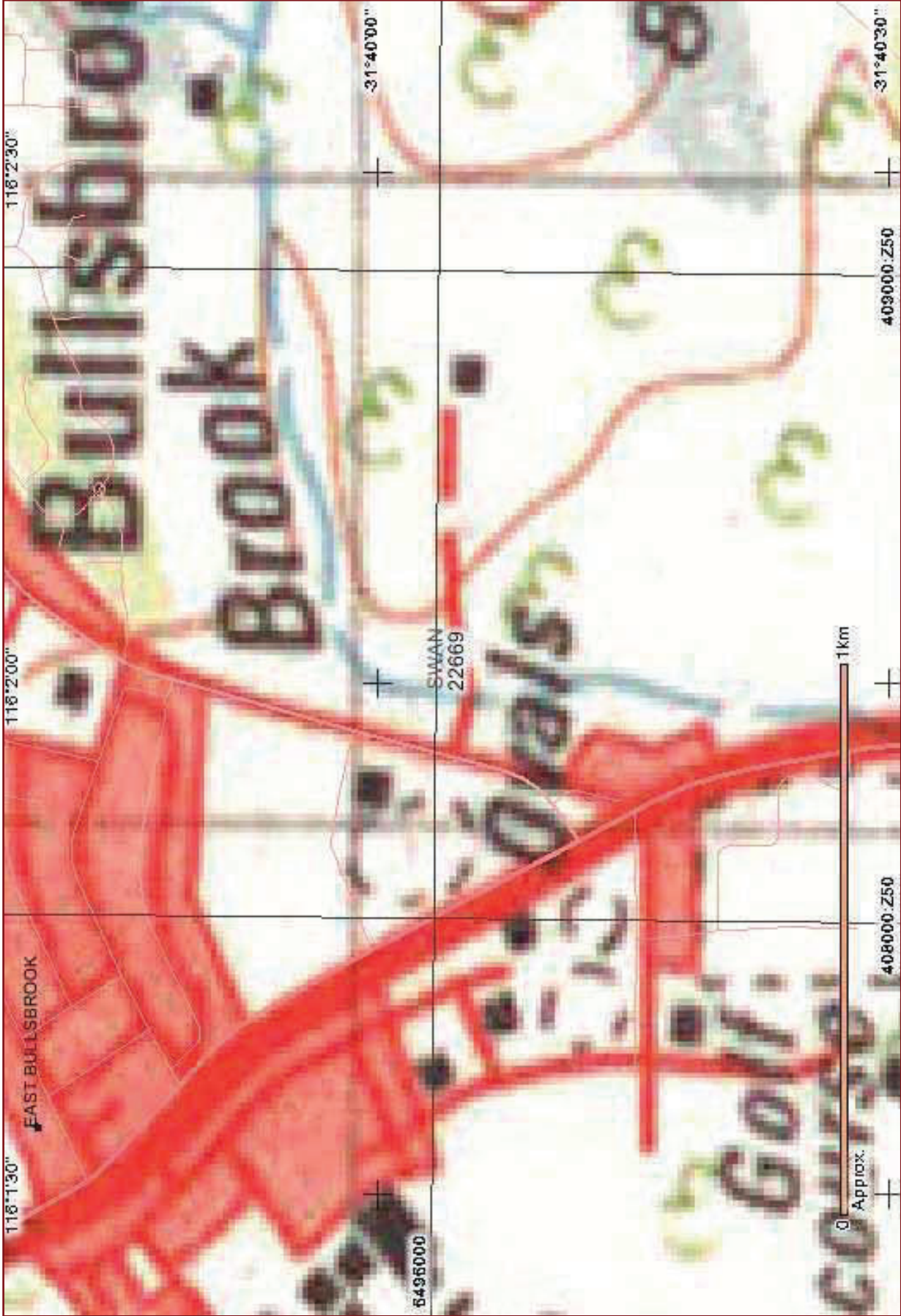
Index coordinates are indicative locations and may not necessarily represent the centre of sites, especially for sites with an access code "closed" or "vulnerable". Map coordinates (Lat/Long) and (Easting/Northing) are based on the GDA 94 datum. The Easting / Northing map grid can be across one or more zones. The zone is indicated for each Easting on the map, i.e. '5000000.Z50' means Easting=5000000, Zone=50.

Sites Shown on Maps

Site boundaries may not appear on maps at low zoom levels

List of Other Heritage Places with Map

Site ID	Status	Access	Restriction	Site Name	Site Type	Additional Info	Informants	Coordinates	Site No.
22669	L	O	N	Bullya Spring	Mythological	Natural Feature, Water Source	*Registered Informant names available from DIA.	408402mE 6495971mN Zone 50 [Unreliable]	



Legend

Selected Heritage Sites

Other Heritage Places

Town

Map Area

Search Area

Copyright for base map information shall at all times remain the property of the Commonwealth of Australia, Geoscience Australia - National Mapping Division. All rights reserved.

Cadastre, Local Government Authority, Native Title boundary data copyright © Western Australian Land Information Authority trading as Landgate (2012).

Geothermal Application, Geothermal Title, Mining Tenement, Petroleum Application, Petroleum Title boundary data copyright © the State of Western Australia (DMP) (2012.12).

For further important information on using this information please see the Department of Indigenous Affairs' Terms of Use statement at <http://www.dia.wa.gov.au/Terms-Of-Use/>

Appendix 5

Transport Impact Assessment

(Transcore)

Kingsford Local Structure Plan, Bullsbrook

Transport Impact Assessment

PREPARED FOR:
Okeland Communities

September 2021

Document history and status

Author	Revision	Approved by	Date approved	Revision type
R White	r01		16/12/2016	
R White	r01a	B Bordbar	27/01/2017	
R White	r01b	B Bordbar	9/06/2017	Revised
R White	r01c	B Bordbar	5/07/2017	Revised
R White	r01d	B Bordbar	20/09/2017	Revised
A Rasouli	r01e	B Bordbar	20/09/2017	Revised
A Rasouli	r01f	B Bordbar	26/09/2017	Revised
R White	r01g	B Bordbar	4/12/2017	Revised
R White	r01h	B Bordbar	2/02/2018	Revised
R White	r01i	B Bordbar	8/08/2018	Revised
R White	r01j	B Bordbar	7/02/2019	Revised
R White	r01k	B Bordbar	14/02/2019	Revised
R White	r01l	B Bordbar	13/09/2021	Revised

File name: t16274-rw-r01l.docx

Author: Robin White

Project manager: Behnam Bordbar

Client: Okeland Communities

Project: Bullsbrook Local Structure Plan

Document revision: r01l

Project number: t16.274

2021 Copyright in all drawings, reports, specifications, calculations and other documents provided by the Consultant in connection with the Project shall remain the property of the Consultant.

The Client alone shall have a license to use the documents referred to above for the purpose of completing the Project, but the Client shall not use, or make copies of, such documents in connection with any work not included in the Project, unless written approval is obtained from the Consultant or otherwise agreed through a separate contract.

TABLE OF CONTENTS

1	INTRODUCTION.....	1
2	PROPOSED LOCAL STRUCTURE PLAN	2
3	EXISTING SITUATION.....	4
3.1	EXISTING LAND USE	4
3.2	EXISTING ROAD NETWORK.....	5
3.3	EXISTING TRAFFIC VOLUMES.....	7
3.4	HEAVY VEHICLE ROUTES.....	7
3.5	PUBLIC TRANSPORT.....	9
3.6	PEDESTRIAN AND CYCLIST FACILITIES	10
3.7	CHANGES TO SURROUNDING ROAD NETWORK.....	10
4	PROPOSED TRANSPORT NETWORK.....	11
4.1	ROAD HIERARCHY.....	11
4.2	PUBLIC TRANSPORT.....	12
4.3	PEDESTRIAN AND CYCLIST FACILITIES	13
5	INTEGRATION WITH SURROUNDING AREA.....	15
6	ANALYSIS OF THE TRANSPORT NETWORK.....	16
6.1	ASSESSMENT PERIOD	16
6.2	TRAFFIC GENERATION	16
6.3	TRAFFIC FLOW FORECASTS	16
6.4	ROADS AND INTERSECTIONS	18
6.5	INTERSECTION ANALYSIS.....	21
6.6	ACCESS TO FRONTAGE PROPERTIES	21
7	CONCLUSIONS.....	23

APPENDIX A: LOCAL STRUCTURE PLAN

APPENDIX B: TYPICAL ROAD CROSS-SECTIONS

APPENDIX C: 2031 TRAFFIC VOLUMES

APPENDIX D: SIDRA INTERSECTION ANALYSIS

REPORT FIGURES

Figure 1: Site location 1

Figure 2: Bullsbrook Townsite District Structure Plan (2018).....3

Figure 3: Existing Land Use 4

Figure 4: Existing road hierarchy 5

Figure 5: Existing speed limits 6

Figure 6: Restricted Access Vehicles Network 8

Figure 7: Existing bus routes 9

Figure 8: Proposed road hierarchy 11

Figure 9: Pedestrian / Cycle Network 14

Figure 10: 2031 traffic flows 18

Figure 11: Key intersections 19

Figure 12: Potential Hurd Rd / Alto Way / Burley Rd intersection treatment 20

REPORT TABLES

Table 1: Existing Traffic Volumes 7

1 Introduction

This Transport Impact Assessment has been prepared by Transcore on behalf of Okeland Communities with regard to the Kingsford Local Structure Plan at Bullsbrook in the City of Swan.

The subject site is located on the southeast side of the existing Bullsbrook townsite as shown in Figure 1.

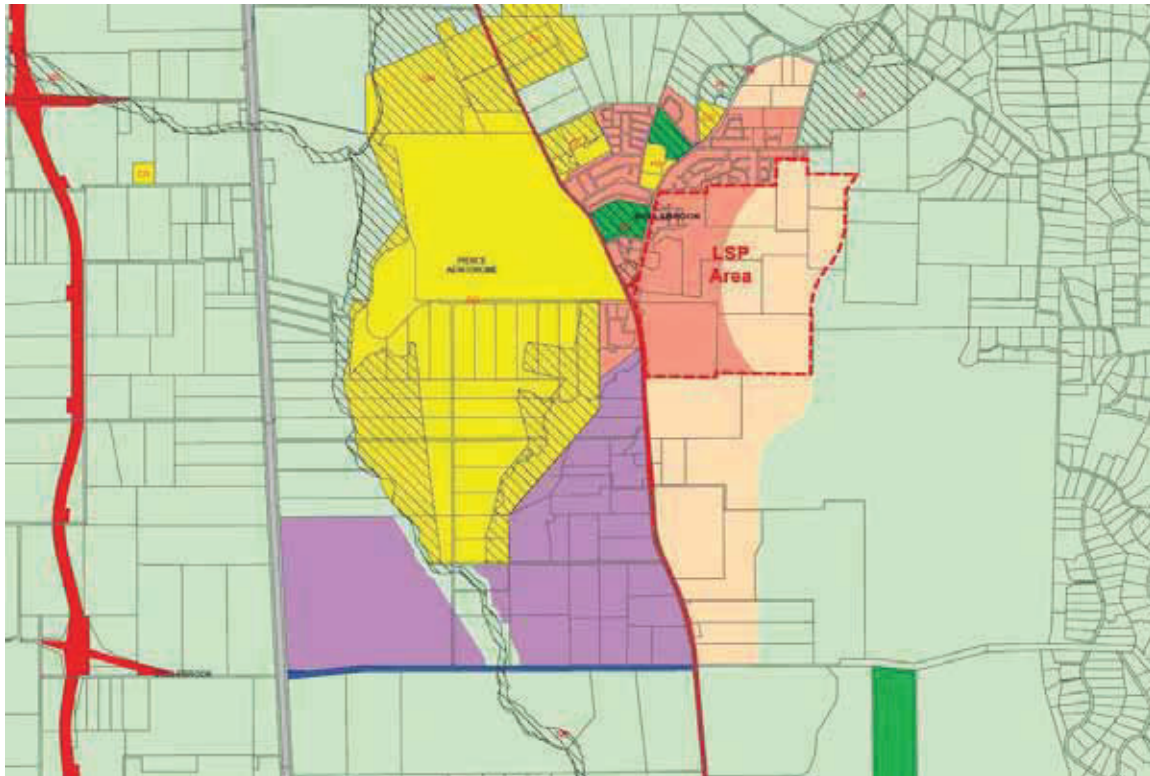


Figure 1: Site location

Urban development of this site is envisaged in the City of Swan's *Bullsbrook Townsite District Structure Plan* (approved April 2018). Separate applications have already been lodged for lifting of the Urban Deferment from the Urban Deferred zoned land within the site and for rezoning from Rural to Urban for the remainder of the site.

2 Proposed Local Structure Plan

The proposed Local Structure Plan (LSP) for this site is included at Appendix A.

This site is part of one of the urban expansion areas identified in the Western Australian Planning Commission (WAPC) Perth and Peel @ 3.5million (draft, May 2015) report and its supporting North-East Sub-regional Planning Framework (draft, May 2015). That urban expansion area also extends further north and south of Bullsbrook on the eastern side of Great Northern Highway.

The City of Swan's Bullsbrook Townsite District Structure Plan (approved April 2018) (BTDSP) and the previous version called the Bullsbrook Townsite Land Use Master Plan (2014) (BTLUMP), also reflects a similar extent of future urban development around the Bullsbrook Townsite, as shown in Figure 2.

The BTDSP indicates that Bullsbrook townsite is anticipated to grow to approximately 6600 dwellings by 2031 with a potential further 2800 dwellings beyond 2031. It also proposes a district activity centre of 10,000m² net lettable area of commercial floor space by 2031, which is ultimately expected to grow to 20,000m² NLA.

The proposed LSP area shown in Appendix A includes the Sacri site on the southeast side of Chittering Road (the church site and land immediately east and south of the church). This LSP area is anticipated to yield approximately 2740 residential lots. It would also include a primary school site and the proposed district activity centre site shown in the BTDSP.

The BTDSP proposes two north south spine road corridors through the subject site parallel to Great Northern Highway. One is an activity corridor on the eastern side of the district activity centre, which would connect from Chittering Road in the north to Great Northern Highway at Lage Road. The other spine road would connect from Chittering Road in the north to Great Northern Highway at Stock Road at the southern end of the BTLUMP area, as shown in Figure 2.

The alignment of the westernmost of these two spine roads will be on the eastern side of the district activity centre as proposed in the BTDSP but will then run westwards to connect to an extension of Chittering Road within the LSP area. This will also function as the proposed activity corridor adjacent to the district activity centre as envisaged by the BTDSP.

The activity corridor is identified in BTDSP as a potential rapid transit corridor route connecting to the rapid transit route planned at Ellenbrook. This potential future public transport route option is maintained in the proposed LSP for this site.

The BTDSP (and the previous BTLUMP) proposes a new 4-way intersection on Great Northern Highway adjacent to the district activity centre. It anticipated a future signalised intersection at that location based on Main Roads Western Australia (MRWA) practice in 2014 when the BTLUMP report was being prepared (which was also in accordance with the intersection treatment indicated in that vicinity (nominally

at Brig Way) in the 2011 MRWA Great Northern Highway West Swan to Muchea Access Strategy report) but more recent discussions with MRWA advised that this should be planned as a roundabout instead in accordance with current MRWA practice.

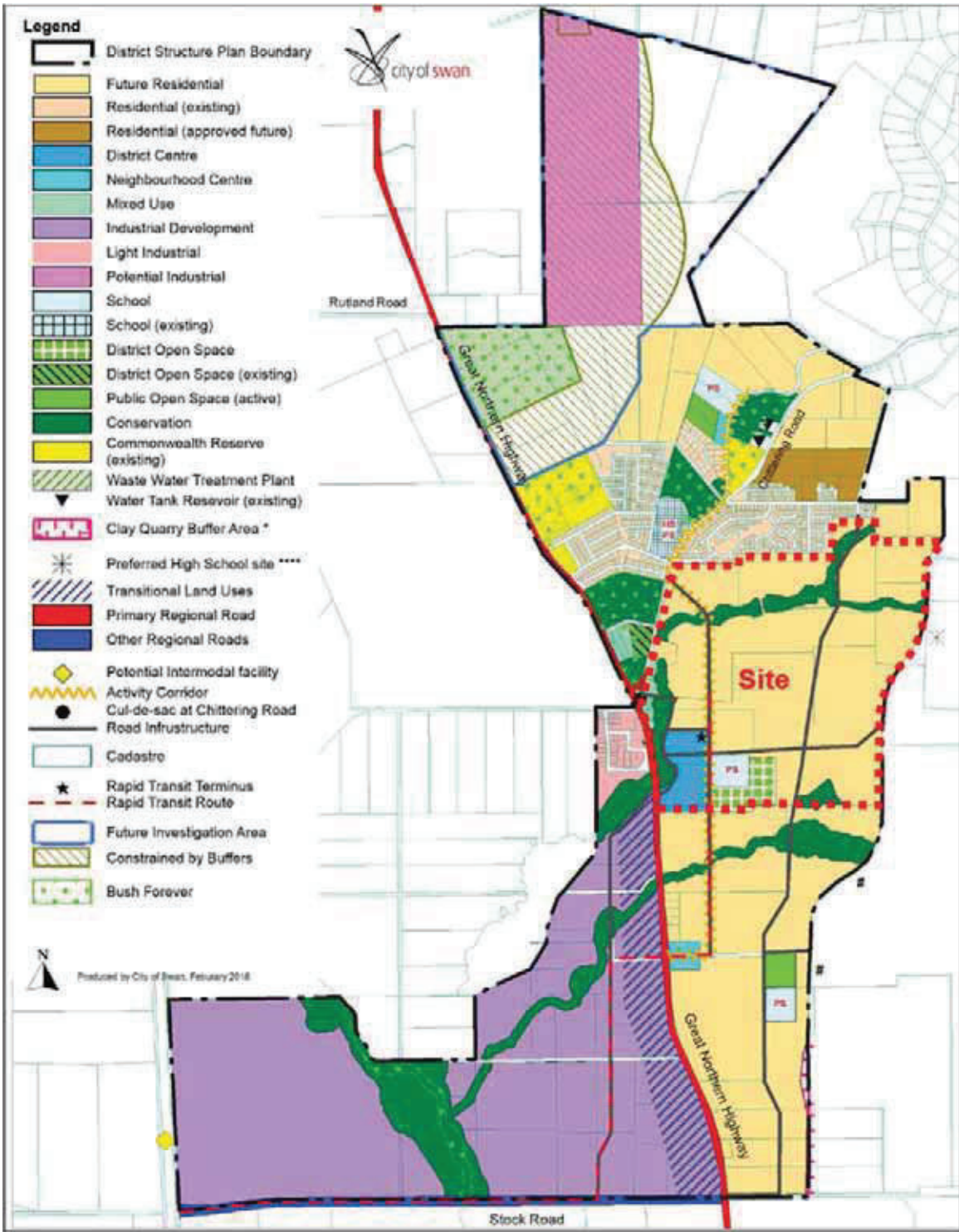


Figure 2: Bullsbrook Townsite District Structure Plan (2018)

3 Existing Situation

3.1 Existing Land Use

Existing land uses within the subject site are predominantly rural, plus a closed quarry on Lot 2792 accessed from Great Northern Highway, as shown in Figure 3. The first stages of residential subdivision have commenced in the northwest corner of the subject site with access into the site from Chittering Road.



Figure 3: Existing Land Use

North and west is the existing Bullsbrook townsite residential area as can be seen in Figure 3.

The existing Bullsbrook town centre is located around the Bullsbrook Road and Chittering Road intersections on Great Northern Highway. Commercial and light industrial development extends along the western side of Great Northern Highway opposite the subject site and RAAF Pearce Aerodrome is further to the west with main access from Great Northern Highway north of Chittering Road.

3.2 Existing Road Network

The existing road network and its classification in the Main Roads WA functional road hierarchy is illustrated in Error! Reference source not found..

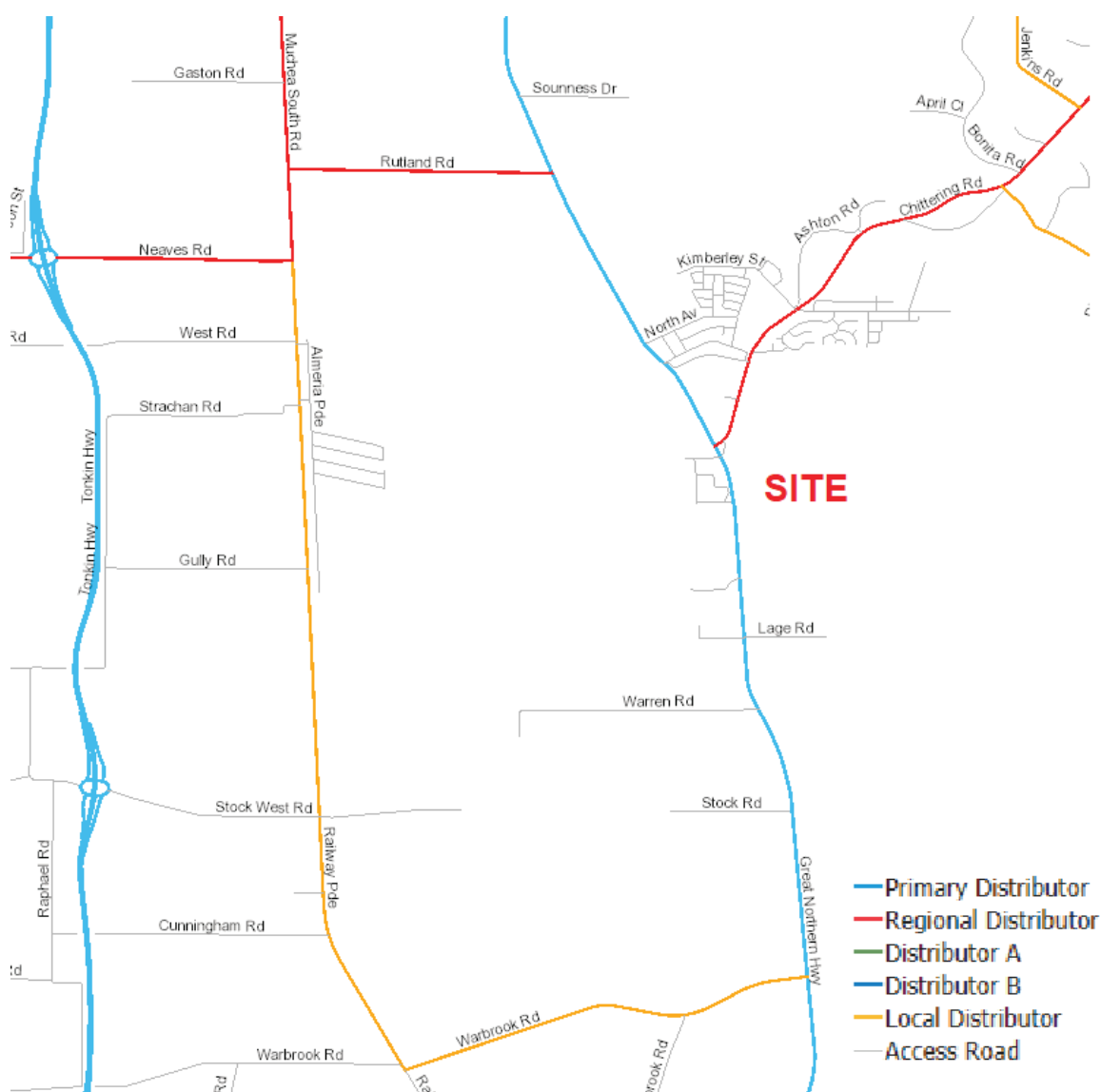


Figure 4: Existing road hierarchy

Great Northern Highway is constructed as a two-lane rural highway (without median) adjacent to the subject site. A painted median is added through the Bullsbrook town centre with traffic islands and right turn lanes at key intersections.

The posted speed limit on Great Northern Hwy is 60km/h through the Bullsbrook townsite and adjacent to the subject site but increases to 80km/h south of Butternab Road and 100km/h south of Lage Road, as shown in Figure 5.

Great Northern Highway is classified as a Primary Distributor in the Main Roads WA functional road hierarchy and is covered by a Primary Regional Roads reservation (a red road) in the MRS, as shown in Figure 1. It is a State road under the care and control of Main Roads WA.

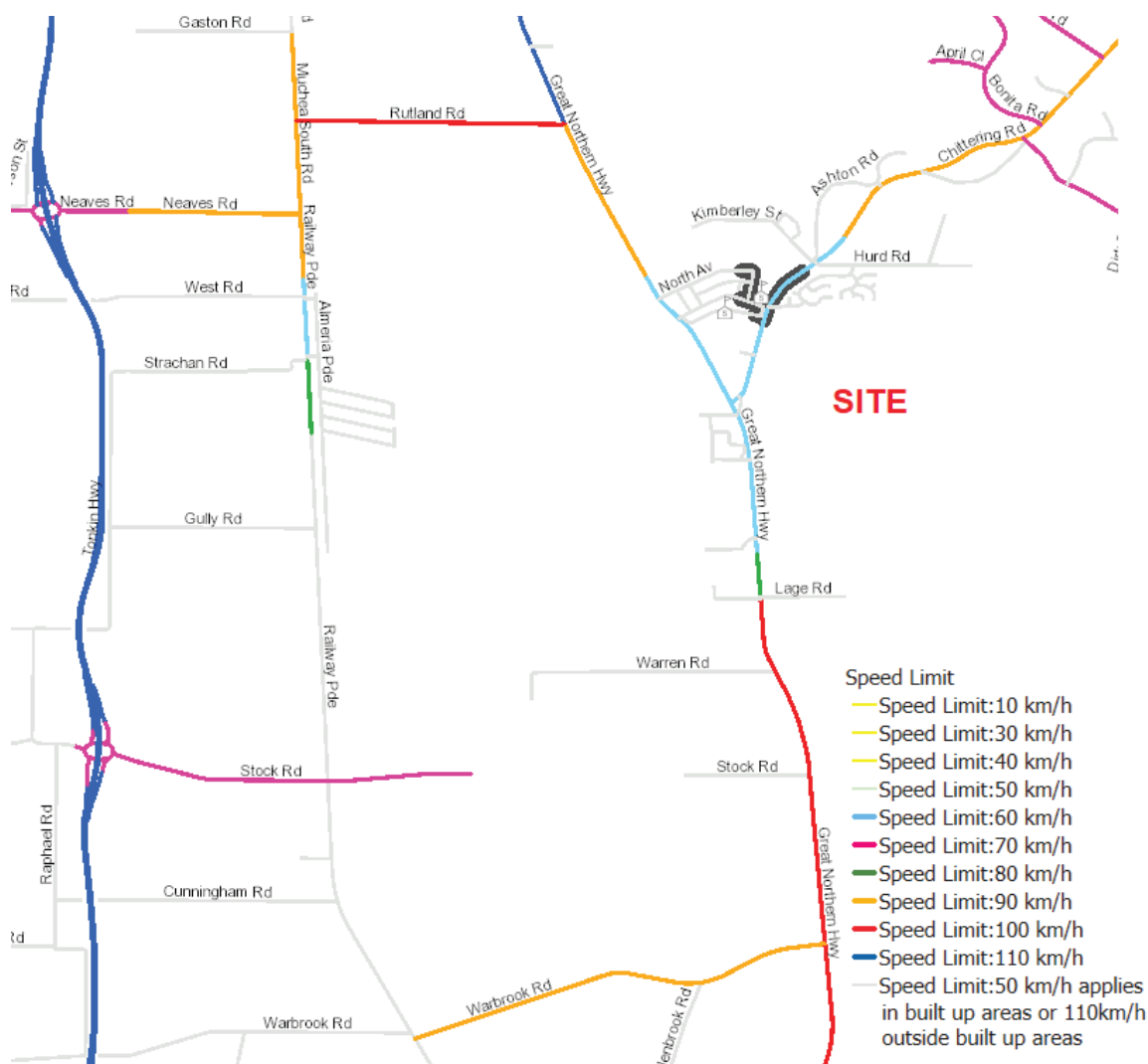


Figure 5: Existing speed limits

Chittering Road is constructed as a two lane road 7.4m wide between kerbs within the Bullsbrook townsite and reverts to two-lane rural road standard northeast of Hurd Road.

It has a posted speed limit of 60km/h within the townsite and increases to 90km/h northeast of Hurd Road. A 40km/h school zone applies in the vicinity of the high school and primary school site before and after school hours on school days.

Chittering Road is classified as a Regional Distributor in the Main Roads WA functional road hierarchy. It is a local authority road under the care and control of the City of Swan.

All of the intersections along Great Northern Highway and Chittering Road in this area operate under priority control (i.e. Stop or Give Way control), except for a new single-lane roundabout recently constructed at the Chittering Rd / Maroubra Ave / Brookbank Dr intersection to provide access into the first stages of residential subdivision development in this LSP area.

3.3 Existing Traffic Volumes

Existing average weekday traffic (AWT) volumes on the study area road network have been obtained from Main Roads WA and are summarised in Table 1.

Table 1: Existing Traffic Volumes

Road Name	Location	AWT (HV)	AM Peak	PM Peak	Date
Great Northern Hwy	South of Bullsbrook Rd	8,502 (19.9%)	662vph 0700-0800	748vph 1530-1630	2020/21
Great Northern Hwy	North of Rutland Rd	4,190 (20.9%)	329vph 0815-0915	405vph 1515-1615	2020/21
Chittering Rd	700m east of Great Northern Hwy	5,990 (13.6%)	522vph 0800-0900	585vph 1515-1615	2020/21

3.4 Heavy Vehicle Routes

Restricted Access Vehicle (RAV) Network routes are designated for access by large heavy vehicle combinations that require special permits for each trip. Main Roads WA manages the RAV Networks and the permits for trucks to use them. Figure 6 shows the roads that are permitted for use by RAV Networks 3, (light blue), 4 (dark blue), 5 (light green), 6 (dark green) and 7 (light purple) vehicles. RAV Networks 2, 3 and 4 permit access by a number of vehicle combinations up to 27.5m long and RAV Networks 5, 6 and 7 (which includes Great Northern Highway) extend this to vehicles up to 36.5m long including double road trains.

It should be noted that RAV Networks 2 to 7 on this section of Great Northern Highway now have the following condition imposed, since the Tonkin Highway extension (NorthLinkWA project) was opened in April 2020 and took over as the primary freight route in this corridor:

“This section of road must not be used as a through route. This section of road may be used as access to pick-up goods, deliver goods, or garage vehicles to properties located on this section of road, or on roads only accessible via this section of road. Drivers must carry documentation as proof of local delivery, pickup or garaging address.”

However, Great Northern Highway is still the high wide load route in this corridor, so even wider or higher vehicles and loads can be permitted.



Figure 6: Restricted Access Vehicles Network

3.5 Public Transport

The closest existing bus route to the subject site is Bus Route 311 (Midland Station – Bullsbrook), as shown in Figure 7.

Route 311 runs on Great Northern Highway adjacent to the subject site. It provides six bus services each way on weekdays and two on Saturdays, Sundays and public holidays.

Existing bus service times are primarily designed for journeys to and from work, school and other trips to and from Midland during business hours such as shopping or personal business trips.

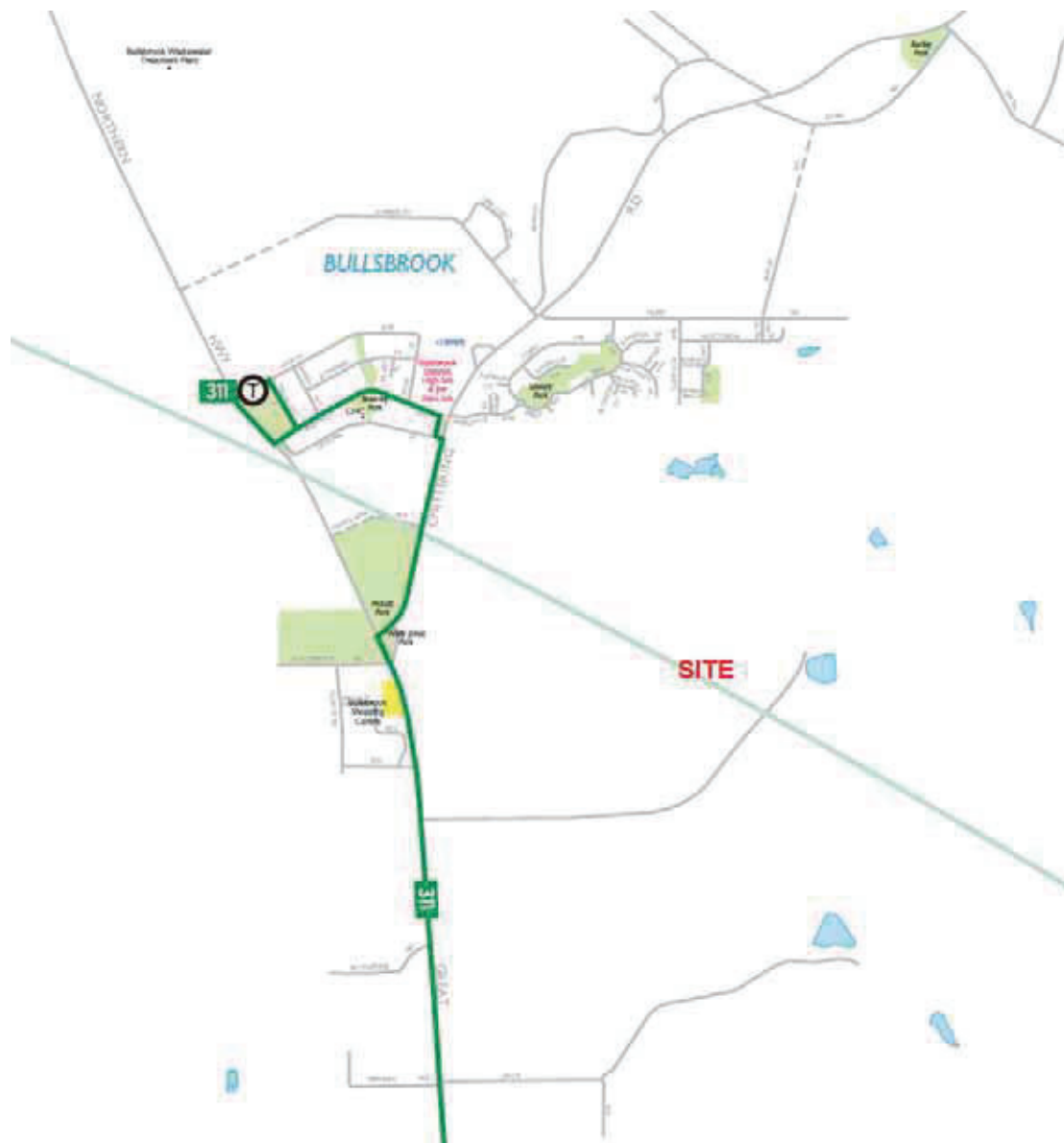


Figure 7: Existing bus routes

3.6 Pedestrian and Cyclist Facilities

A comprehensive path network is progressively being constructed as part of each stage of subdivision development within the LSP area.

There are no formal pedestrian or cyclist facilities on Great Northern Highway adjacent to the subject site although footpaths are provided through the Bullsbrook town centre.

Chittering Road has a 2m shared path on one side within the Bullsbrook townsite and on both sides in the vicinity of the existing high school and primary school site.

3.7 Changes to Surrounding Road Network

The Tonkin Highway extension (NorthLink WA project) was completed in April 2020. Traffic volumes on Great Northern Highway through Bullsbrook and the proportion of heavy vehicles have both reduced significantly as a result of completion of that project.

The BTLUMP report included as an appendix the *Bullsbrook Development Traffic Modelling and Analysis Report for City of Swan* (July 2013). This included details of MRWA regional operational model (ROM) traffic forecasts for 2031 for the BTLUMP area. The traffic model shows future traffic volumes of 20,700vpd on Great Northern Hwy south of Stock Road and 27,200vpd on Chittering Road northeast of the townsite. The high volume of traffic flows modelled between Chittering Road (northeast) and Great Northern Hwy (south) was the reason why the two north south spine road routes east of Great Northern Hwy were indicated in the BTLUMP as described in section 2.

However, liaison with the City of Swan during the preparation of this LSP prompted the City to review the land use assumptions modelled for BTLUMP. City officers subsequently confirmed that the land use data modelled for 2031 was correct in terms of total numbers but the large traffic zones modelled had resulted in a substantial population component being modelled as accessing Chittering Road at the northeast end of the townsite instead of being modelled as separate zones representing northern extension of the townsite itself and the rural-residential areas accessed from Chittering Road northeast of the townsite. Therefore, further disaggregation of the modelled traffic zones has been undertaken for this LSP transport impact assessment and significantly reduced the modelled traffic flows on Chittering Road, as discussed in section 6. The revised traffic modelling also reflects full development of the South Bullsbrook Industrial Precinct in accordance with traffic modelling for the BTLUMP Transport Impact Assessment undertaken for the City of Swan by Transcore in November 2017 and subsequent revised modelling for BTLUMP Precinct Traffic Contributions (October 2019) for the City of Swan, which takes into consideration the refusal of Metropolitan Region Scheme Amendment 1325/41 which would have rezoned land from Rural to Urban Deferred in the North Bullsbrook Precinct.

4 Proposed Transport Network

4.1 Road Hierarchy

The proposed hierarchy of roads in and around the subject site is illustrated in Figure 8 using the road hierarchy defined in the Western Australian Planning Commission Liveable Neighbourhoods (LN) policy.

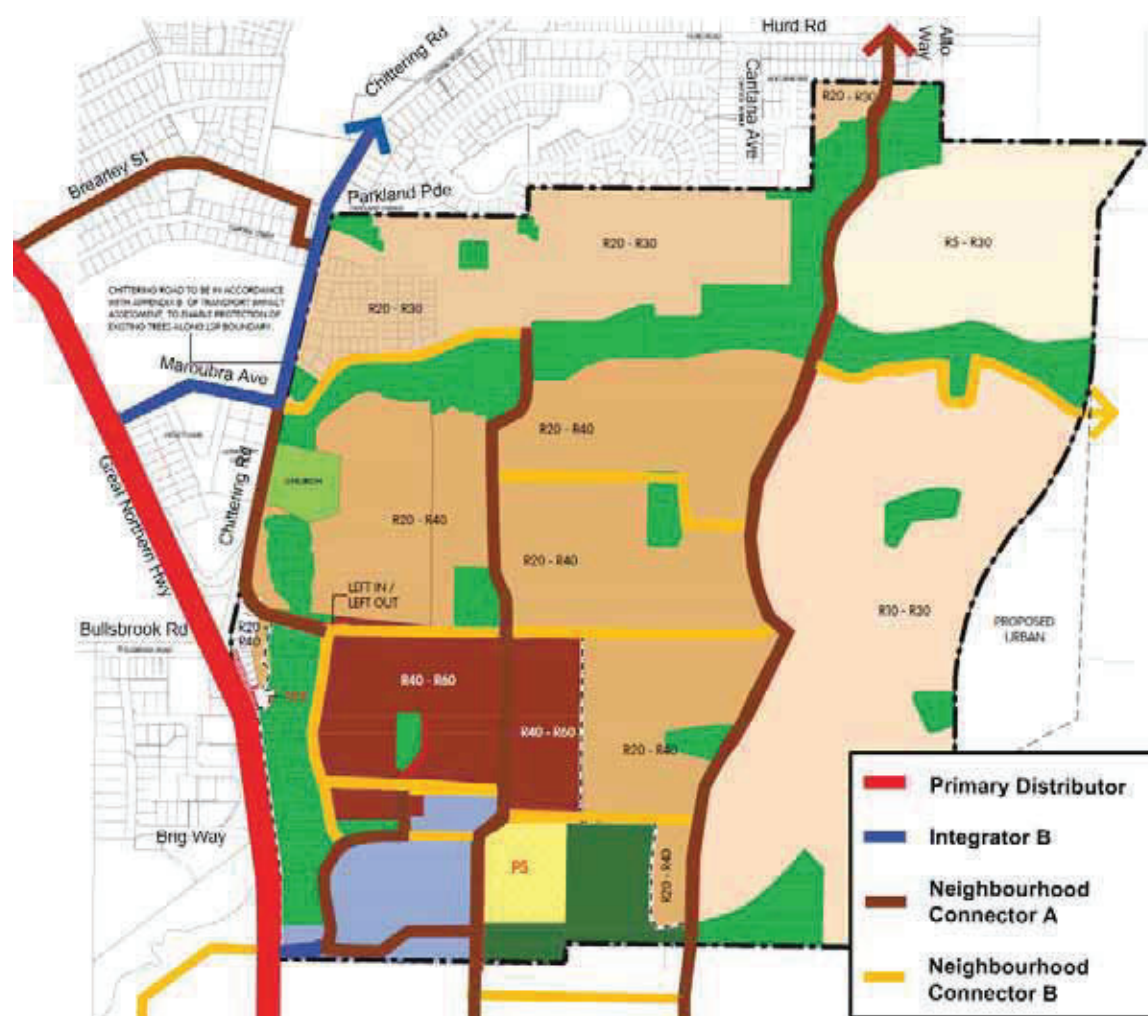


Figure 8: Proposed road hierarchy

The classification of roads in Figure 8 is based on preliminary analysis of future traffic flows at section 6.3 of this report. All of the roads identified on the LSP form sufficiently long and continuous routes to be classified as integrator arterials or neighbourhood connectors.

Integrator B roads are suitable for traffic flows up to 15,000vpd and can accommodate traffic flows up to 20,000vpd with suitable intersection treatments.

Neighbourhood Connector A roads are suitable for up to 7000vpd but some degree of flexibility with this upper limit may be appropriate in localised situations to avoid overdesigning some lengths of road. The main difference between Integrator B and Neighbourhood Connector A cross-sections is only the width of the median (6m versus 2m) and Liveable Neighbourhoods policy does allow for the median of an Integrator B to be reduced in width on sections that do not require right turn lanes in the median.

Neighbourhood Connector B roads are suitable for traffic flows up to 3000vpd but again some degree of flexibility with this upper limit should be considered appropriate in localised situations.

Standard cross-sections from the WAPC Liveable Neighbourhoods policy for these Integrator and Neighbourhood Connector roads are shown in Appendix B. Further discussion of potential reduction of these road reserve widths is also included in Appendix B.

One variation required is that the section of north south Neighbourhood Connector A spine road on the eastern side of the district activity centre, with the primary school site on its eastern side, is to have parking bays increased to 2.5m wide.

The existing section of Chittering Road adjacent to the LSP area and its extension and realignment across the southern corner of the Sacri landholding has Bush Forever land on the western side and POS, landscaping or proposed frontage roads within the LSP area, which will remove any requirement for on-street parking on these sections of Chittering Rd and substantially reduce the verge width required for underground services along Chittering Road. It is therefore proposed that the existing 20m road reserve width of these sections of Chittering Road will accommodate a suitable upgrading of Chittering Road, as shown in the indicative cross sections in Appendix B. Transcore understands that this proposed road cross section for Chittering Road has been developed in consultation with the City of Swan with support from the City's technical officers as tree retention along Chittering Road was considered a high priority.

The standard integrator arterial and neighbourhood road reserve widths elsewhere within the LSP area are proposed to be as follows (see Appendix B for indicative cross sections):

- 27m Integrator B
- 24.4m Neighbourhood Connector A
- 19.4m Neighbourhood Connector B

4.2 Public Transport

The existing bus service along Great Northern Hwy and Chittering Road adjacent to the site is noted in section 3.5 and the potential future rapid transit route along the north south activity corridor identified in the BTLUMP is noted in section 2.

All of the proposed neighbourhood connectors and integrator B roads shown on Figure 8 would be of suitable standard to accommodate bus services through this area, providing suitable options for one, two or three bus routes to service this area. This allows suitable flexibility for the Public Transport Authority to plan future bus routes within this area.

4.3 Pedestrian and Cyclist Facilities

All of the proposed neighbourhood connectors and integrator B roads shown on Figure 8 would have paths on both sides in accordance with Liveable Neighbourhoods guidelines, including a shared path on one side (or in the median amongst trees on one section of the eastern Neighbourhood Connector A spine road).

Paths would be required on at least one side of all roads in accordance with Liveable Neighbourhoods guidelines.

On-street cycle lanes are normally included only on Neighbourhood Connector A roads and above, due to traffic flows above 3000vpd on these categories of roads.

The resultant path network within the LSP area is indicated in Figure 9 (source: Emerge Associates, with notes added by Transcore). This also includes indicative location of additional shared path (or dual use path) links on the local road network and along foreshore reserves. The standard and location of all paths would be subject to agreement with the City of Swan at subdivision stage.

The potential for provision of cycle lanes physically separated from motorised traffic will be investigated at subdivision stage in proximity to the primary school.



Figure 9: Pedestrian / Cycle Network

5 Integration with Surrounding Area

The Bullsbrook Townsite District Structure Plan (BTDSP) provides an overall plan to ensure coordination of future development of the subject site and the surrounding area. The proposed local structure plan for the subject site respects the principles and external connections of the BTDSP to ensure that good connectivity and integration with the surrounding area are achieved.

6 Analysis of the Transport Network

6.1 Assessment Period

The traffic assessment undertaken for the subject site is based on the 2031 ROM modelling undertaken for the BTLUMP, with full development of all land uses within the subject site taken into consideration, including ultimate full development of the Kingsford Town Centre (district activity centre).

6.2 Traffic Generation

The traffic flows generated by the land uses in the LSP area and the wider BTDSP / BTLUMP area for the traffic modelling undertaken for this assessment have been derived directly from a subarea trip matrix from the ROM model used for the BTLUMP traffic study. To check that the modelled traffic flows for the LSP area are consistent with the land uses anticipated in the LSP area a separate calculation of traffic generation has also been undertaken.

For that traffic generation calculation the daily traffic generation rate used in the LSP area is 8 vehicle trips per day (vpd) per dwelling, which corresponds to peak hour trip generation rates recommended in the Western Australian Planning Commission (WAPC) Transport Impact Assessment Guidelines (2016). The anticipated yield of approximately 2,740 dwellings of the LSP area will therefore generate approximately 22,000vpd.

A typical primary school of 540 students would generate approximately 1080vpd but based on advice from City of Swan officers it has already been modelled as 600 students (1200vpd) to reflect potential student numbers with the numbers of young families likely when the area is first established.

Trip rates published in the NSW Guide to Traffic Generating Developments indicate a 20,000m² shopping centre would generate traffic flows of approximately 15,600vpd on a busy weekday.

6.3 Traffic Flow Forecasts

The subarea trip matrix from the ROM model used for the BTLUMP traffic study has been progressively adjusted and refined based on principles advised by the City of Swan's traffic modelling consultant (Urbsol) in 2017 and subsequent changes as the BTDSP has evolved.

This included redistribution of a proportion of the "Chittering Road" (zone 546) trips to a new north Bullsbrook zone, addition of a 400-lot rural-residential zone southeast of the BTLUMP area accessed via extension of Lage Road, addition of two southern primary school zones and further refinement of the traffic zone system. The revised

traffic modelling also reflects full development of the South Bullsbrook Industrial Precinct in accordance with traffic modelling for the BTLUMP Transport Impact Assessment and BTLUMP Precinct Traffic Contributions report undertaken for the City of Swan by Transcore in November 2017 and June 2018, respectively. The revised trip matrix has increased the number of traffic zones (including external zones) from 14 to 45 and maintains the pattern of internal and external trips from the original subarea trip matrix, except that LSP area trip generation has been revised to reflect current proposed distribution of residential density in the LSP area, the industrial precinct does become a more significant destination for local work trips from the BTLUMP area, traffic generation of zones in the northern and southern urban precincts has been rationalised to better match these future development areas (outside of the LSP area) and rationalisation of access to future urban land uses previously modelled south of Stock Road.

The trip matrix was subsequently further revised to remove the trips allocated to the part of the northern urban precinct that has been excluded from future urban development as a result of refusal of MRS Amendment 1325/41.

Further revision of the trip matrix has been undertaken for this latest revision of the TIA report including revisions within the LSP area and deletion of a potential second high school site previously proposed to the east outside of the LSP area, based on updated advice from the Department of Education.

The resultant 2031 daily trip matrix has been assigned onto the proposed road network of the LSP area and the surrounding BTLUMP area in an EMME transport model by Transcore.

The resultant total daily traffic flows on the modelled road network are shown in the EMME traffic volume diagram at Appendix C. A second diagram (a “selected links” plot) is also included which only shows those traffic flows that are generated by or attracted to the land uses in the LSP area. Traffic flows in and adjacent to the LSP area are also shown in Figure 10.

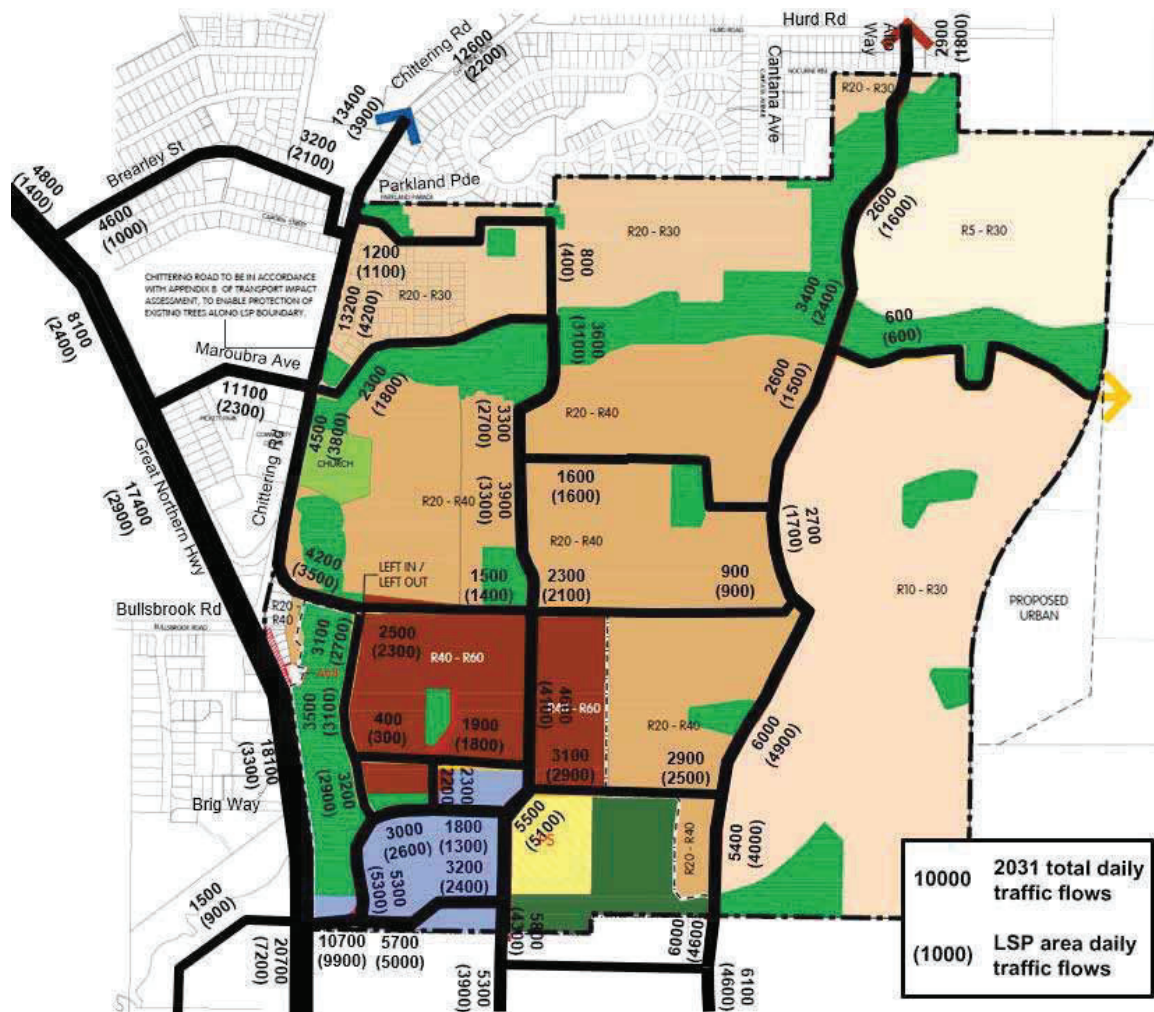


Figure 10: 2031 traffic flows

6.4 Roads and Intersections

The anticipated future road network around the subject site has been detailed in section 4 of this transport impact assessment, including discussion of the proposed road hierarchy in section 4.1.

The key intersection for the proposed LSP area is the proposed 4-way intersection on Great Northern Highway near the district activity centre. This would either be a signalised intersection as previously proposed in the BTLUMP or a roundabout, as currently advised by MRWA. A roundabout would need to be large enough to accommodate the largest size vehicle permitted on Great Northern Highway (36.5m B-double and dog trailer configuration and high wide load vehicles). Current plans for this proposed roundabout are based on a central island diameter of approximately 52m.

Another important intersection for the LSP area will be the intersection of Chittering Road and Maroubra Avenue. A 4-way roundabout has now been constructed at this

The Neighbourhood Connector A road on the western side of the district centre will have a left in / left out intersection treatment at its northern end to restrict traffic flows on this link and the Chittering Road extension / realignment to the north. This is intended to encourage a greater proportion of traffic to use the north south spine road on the eastern side of the district centre instead.

The map displays the proposed urban area, bounded by a dashed line. Key features include:

- Streets:** Breanley St, Chatterton Rd, Parkland Pde, Hurd Rd, Carlinga Ave, Maroubra Ave, Great Northern Hwy, Bullsbrook Rd, and Big Way.
- Zones:** K20 - K30, K20 - K40, K20 - K60, K20 - K80, K20 - K100, K20 - K120, K20 - K140, K20 - K160, K20 - K180, K20 - K200, K20 - K220, K20 - K240, K20 - K260, K20 - K280, K20 - K300, K20 - K320, K20 - K340, K20 - K360, K20 - K380, K20 - K400, K20 - K420, K20 - K440, K20 - K460, K20 - K480, K20 - K500, K20 - K520, K20 - K540, K20 - K560, K20 - K580, K20 - K600, K20 - K620, K20 - K640, K20 - K660, K20 - K680, K20 - K700, K20 - K720, K20 - K740, K20 - K760, K20 - K780, K20 - K800, K20 - K820, K20 - K840, K20 - K860, K20 - K880, K20 - K900, K20 - K920, K20 - K940, K20 - K960, K20 - K980, K20 - K1000.
- Infrastructure:** Roundabouts (indicated by red circles), Left in / Left out (indicated by red arrows), and Proposed Urban (indicated by a dashed line).
- Other Features:** A church is located near the center of the map. A note states: "STREETS WOULD BE IN ACCORDANCE WITH AMENDMENTS OF TRANSPORT IMPROVEMENT, TO ENABLE PROTECTION OF EXISTING TREES ALONG LIP BOUNDARY."

Other intersections within the LSP area will be relatively straightforward to determine at subdivision stage when the local road network is identified. Roundabouts or priority-controlled intersections will be appropriate within this area. Anticipated locations of some of the 4-way intersections that would be constructed as roundabouts are also illustrated in Figure 11.

The Hurd Rd / Alto Way / Burley Rd intersection on the eastern spine road is located outside of the LSP area and not directly addressed in Figure 11. This would be relatively close to the roundabout proposed at Nocturne Rise and would not warrant another roundabout as the eastern section of Hurd Road currently only provides access to a few dwellings. A potential intersection treatment is illustrated in Figure 12 (source: JDSi Consulting Engineers), which would make the north south spine road the priority road and offset the eastern leg of Hurd Road at this intersection. This intersection treatment would be subject to further investigation in consultation with the City of Swan as part of planning for the future upgrade of this north south spine road north of the LSP area.



Figure 12: Potential Hurd Rd / Alto Way / Burley Rd intersection treatment

6.5 Intersection Analysis

Intersection capacity analysis has been undertaken for the key Great Northern Highway intersection near the district activity centre as a dual-lane 4-way roundabout for the weekday AM peak and PM peak hour flows that correspond to the modelled 2031 daily traffic flows in Figure 10. Based on current Main Roads WA requirements this analysis includes division of heavy vehicles into four separate types of vehicles (Austroads classes 2-5, 6-9, 10 and 11) so that the performance characteristics of the significant numbers of 19m semi-trailers, 27.5m B-doubles and 36.5m double road trains on Great Northern Highway are specifically taken into consideration.

The Chittering Rd / Maroubra Ave intersection has also been analysed as a single-lane 4-way roundabout to confirm that this new roundabout will be a suitable treatment at that location for the future traffic flows.

Capacity analysis of these intersections has been undertaken using the SIDRA computer software package. SIDRA is an intersection modelling tool commonly used by traffic engineers for all types of intersections. SIDRA outputs are presented in the form of Degree of Saturation, Level of Service, Average Delay and 95% Queue. These characteristics are defined as follows:

- Degree of Saturation is the ratio of the arrival traffic flow to the capacity of the approach during the same period. The Degree of Saturation ranges from close to zero for infrequent traffic flow up to one for saturated flow or capacity.
- Level of Service is the qualitative measure describing operational conditions within a traffic stream and the perception by motorists and/or passengers. In general, there are 6 levels of service, designated from A to F, with Level of Service A representing the best operating condition (i.e. free flow) and Level of Service F the worst (i.e. forced or breakdown flow).
- Average Delay is the average of all travel time delays for vehicles through the intersection.
- 95% Queue is the queue length below which 95% of all observed queue lengths fall.

The results of the SIDRA analysis are summarised in Appendix D and satisfactory intersection performance is shown for each of the intersection options shown in Appendix D.

6.6 Access to Frontage Properties

The WAPC Liveable Neighbourhoods policy requires that “*Development along integrator B and neighbourhood connector streets with ultimate vehicle volumes over 5,000 vehicles per day should be designed either so vehicles entering the street can do so travelling forward, or are provided with alternative forms of vehicle access.*”

One alternative suggested in Liveable Neighbourhoods involves wider lots with paired driveways and protected reversing areas in the parking lane but the City of Swan has advised that this strategy will not be supported in this LSP area.

Accordingly, there is to be no direct driveway access to residential development on zoned land within the LSP area from Great Northern Highway, Chittering Road or other roads carrying more than 5,000vpd. On Great Northern Highway no direct driveway access is proposed to any development on zoned land within the LSP area.

This restriction will apply to the higher density residential lots fronting the north south spine road on the eastern side of the district activity centre and some sections of the eastern spine road within the LSP area as traffic volumes on these roads will be in excess of 5,000vpd when this area is fully developed. Therefore, all lots along these sections will have access from rear laneways, side roads or frontage roads parallel to the spine road.

The proposed Chittering Road realignment / extension through to the north south spine road on the eastern side of the district activity centre will be the “activity corridor” proposed in the BTLUMP and is an important element of the identity and function of the new Bullsbrook Townsite.

Recognising its classification generally as a Neighbourhood Connector A, and an Integrator B (Town Centre Main Street) on the section adjacent to the primary school, and the requirements of Liveable Neighbourhoods it is intended to have two distinct frontage treatments as follows:

- Rear lane access through the Town Centre to enable a variety of density housing types that front directly to the street, provide a cottage style street appearance with street front parking and controlled access; and
- No direct residential lot access to the remaining section, consistent with the country character of the existing Bullsbrook Townsite and Chittering Road frontage in particular.

It is intended that the existing sections of Chittering Road adjacent and to the north of the site would maintain the existing road reserve and access arrangements.

All of the other roads in the LSP area are expected to carry less than 5,000vpd, so no restriction on vehicular access is required.

7 Conclusions

This transport impact assessment relates to the Kingsford Local Structure Plan (LSP) at Bullsbrook in the City of Swan.

Urban development of this site is envisaged in the City of Swan's Bullsbrook Townsite District Structure Plan (approved April 2018) (BTDSP) and the previous version called the Bullsbrook Townsite Land Use Master Plan (2014) (BTLUMP). Separate applications have already been lodged for lifting of the Urban Deferment from the Urban Deferred zoned land within the site and for rezoning from Rural to Urban for the remainder of the site.

The proposed LSP area (including the Sacri landholding) will accommodate approximately 2,740 dwellings, a primary school site and the future district activity centre of up to 20,000m² net lettable area that will serve as the expanded town centre for the planned future growth of Bullsbrook townsite.

Future traffic flows within the LSP area and the surrounding BTDSP area have been modelled in consultation with the City of Swan utilising revised and refined trip matrices consistent with Main Roads WA ROM traffic modelling previously undertaken for the BTLUMP study.

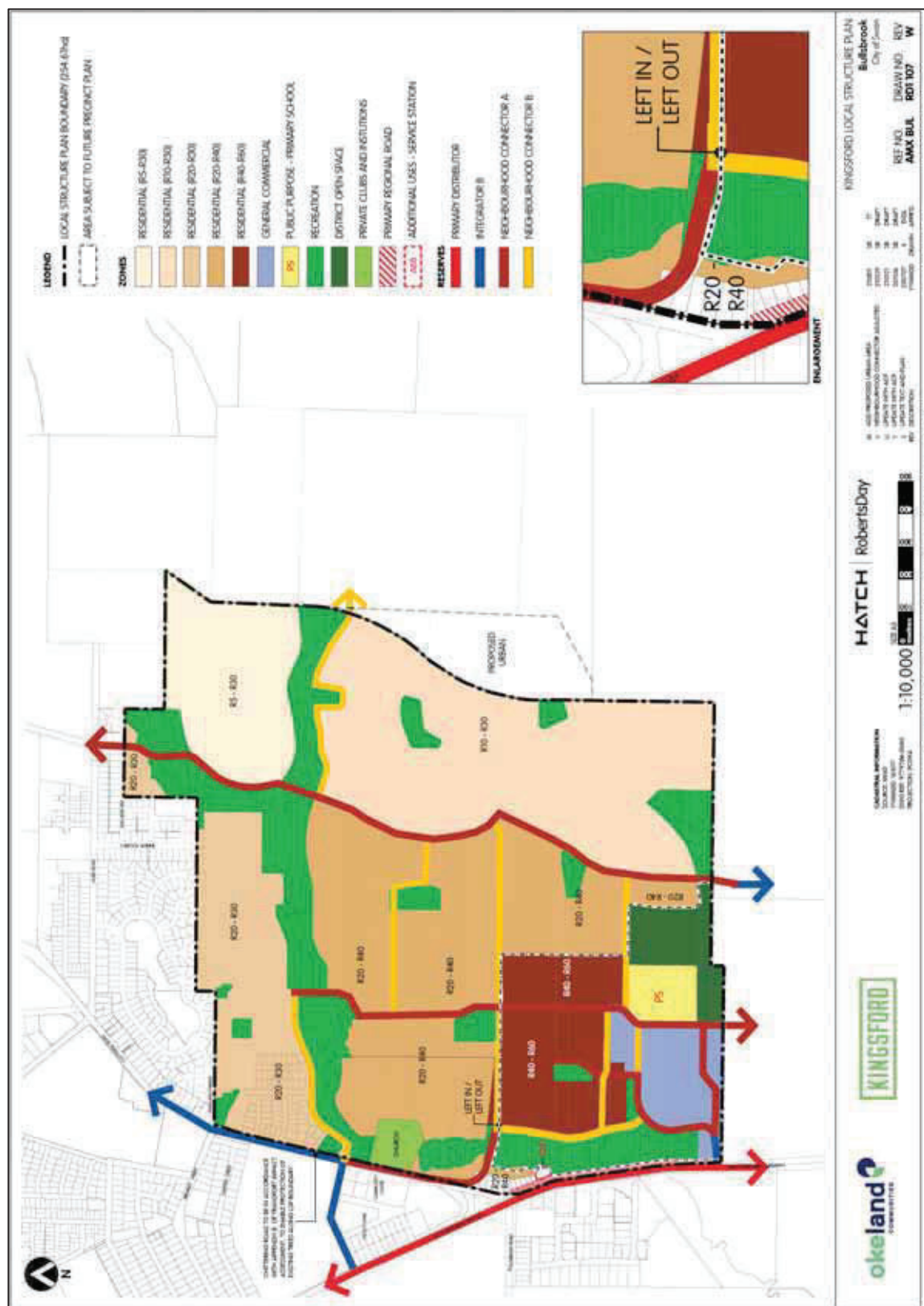
Two new north south spine road links are required through the subject site to support the road network planning of the BTDSP and these are provided for in the proposed LSP plan developed for the subject site. The alignment of the westernmost of these two spine roads will be on the eastern side of the district activity centre then run westwards to connect to an extension of Chittering Road within the LSP area. This will also function as a proposed activity corridor adjacent to the district activity centre that could also accommodate a future rapid transit route envisaged by the BTDSP.

The key intersection for the proposed LSP area is the proposed 4-way intersection on Great Northern Highway near the district activity centre. Main Roads WA has advised that this should be planned ultimately as a dual-lane roundabout. Intersection capacity analysis confirms this roundabout would be able to accommodate the projected 2031 traffic flows.

The recently constructed single-lane 4-way roundabout at the Chittering Rd / Maroubra Ave / Brookbank Dr intersection has also been analysed to confirm that this roundabout would be a suitable treatment at that location to accommodate the future traffic flows when this area is fully developed.

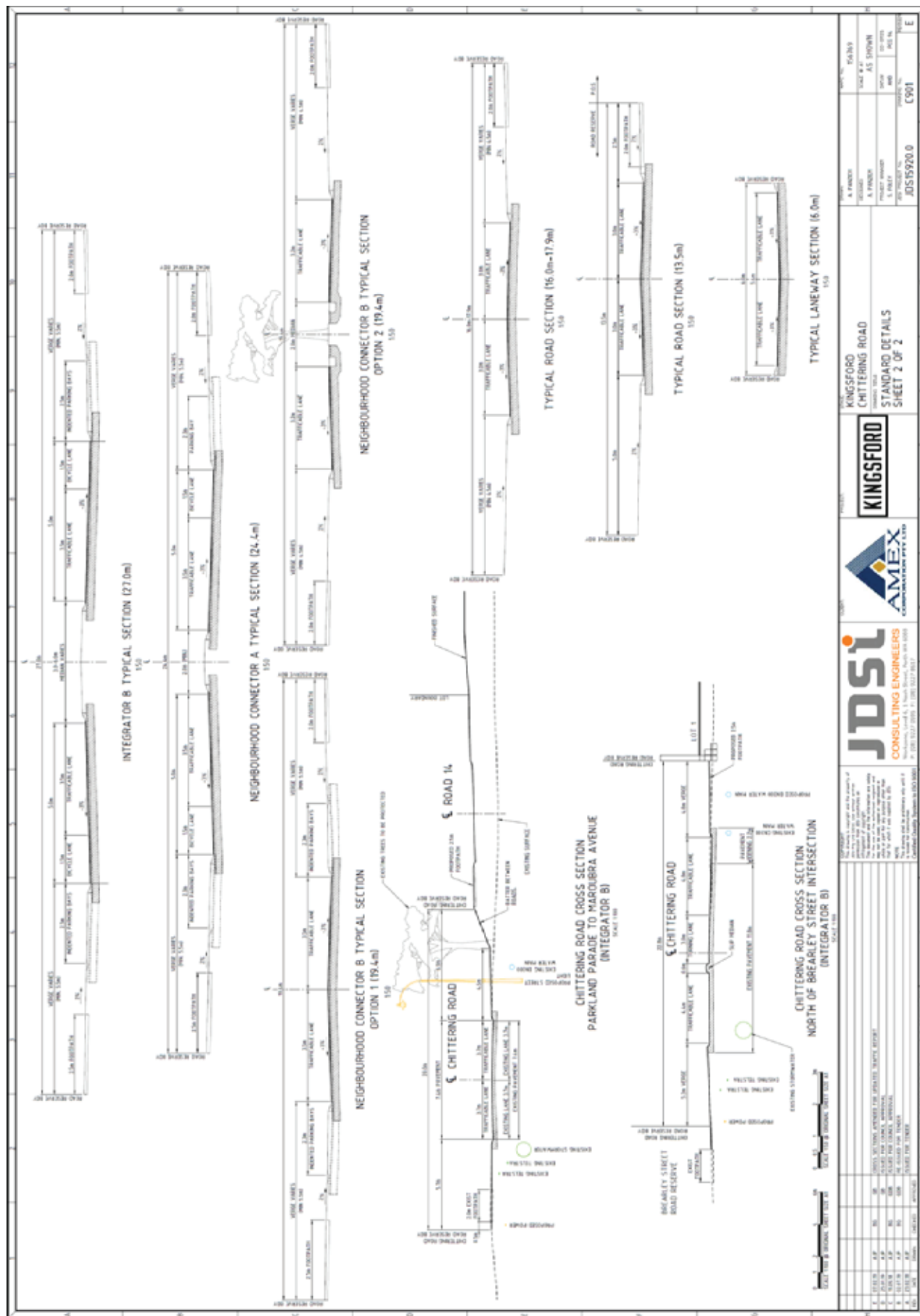
Appendix A

LOCAL STRUCTURE PLAN



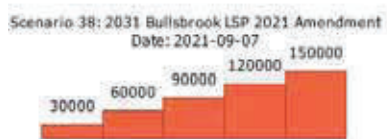
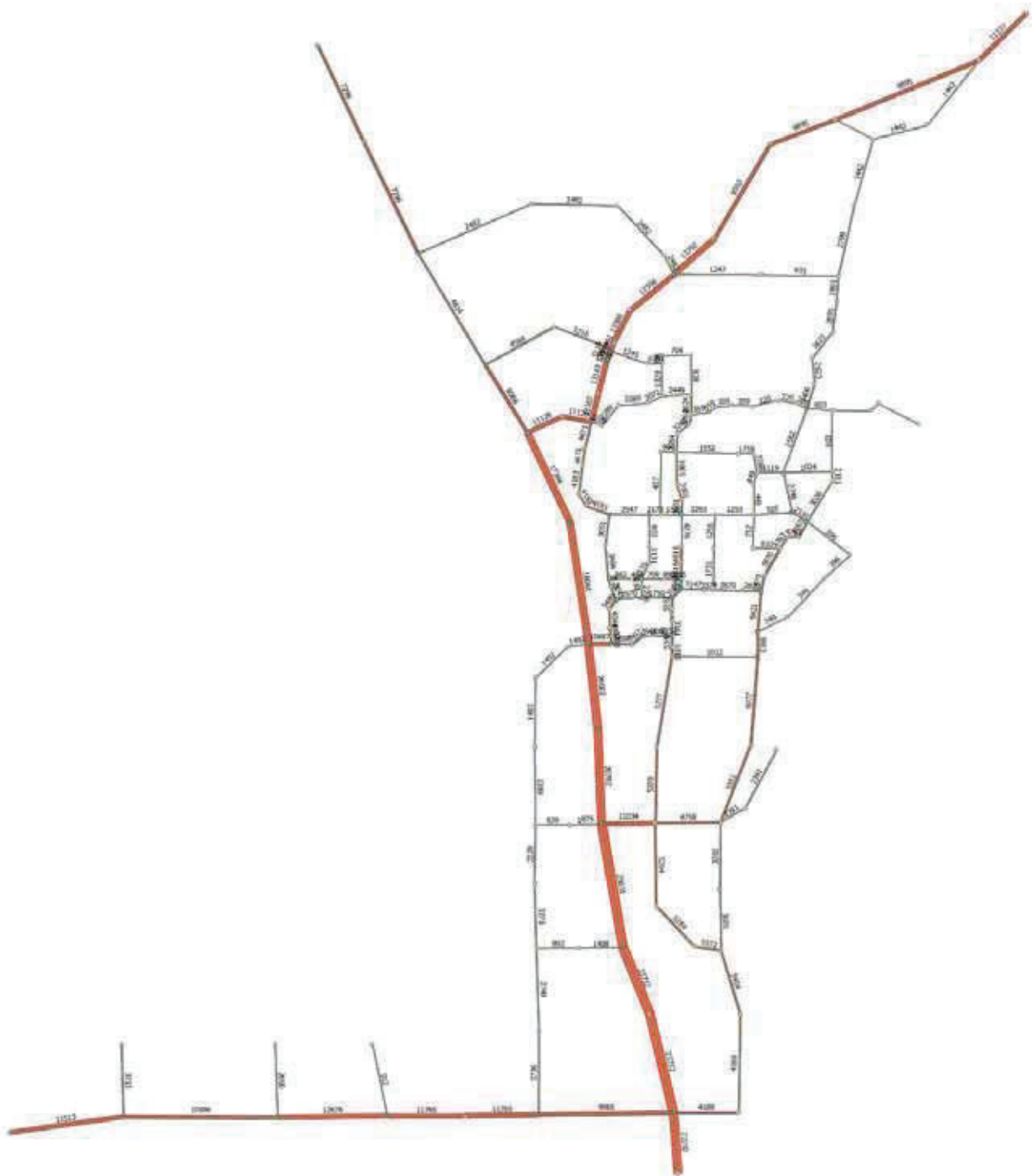
Appendix B

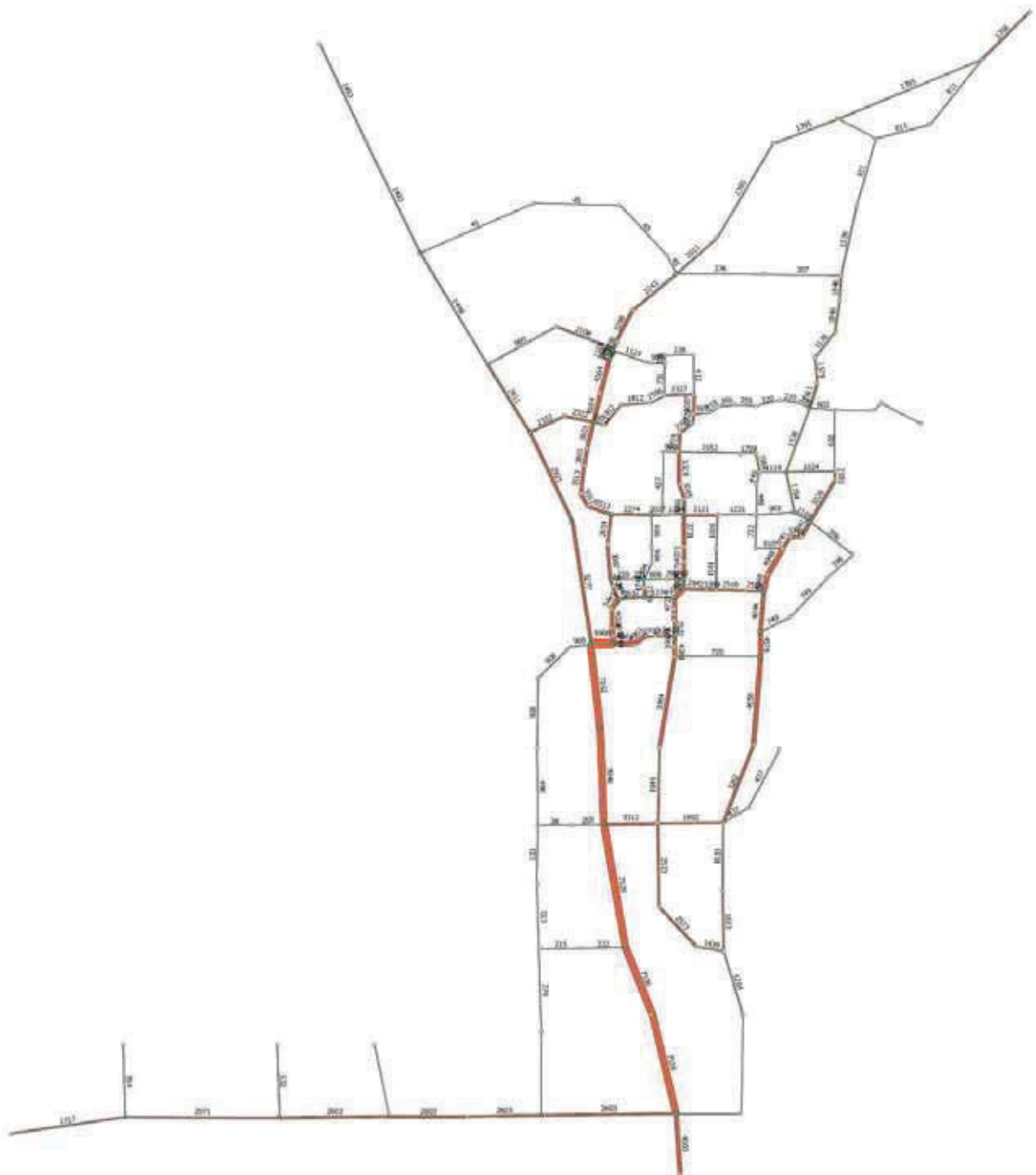
TYPICAL ROAD CROSS-SECTIONS



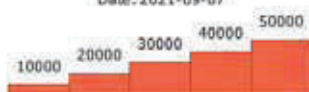
Appendix C

2031 TRAFFIC VOLUMES





Scenario 38: 2031 Bullbrook LSP 2021 Amendment
Traffic to/from selected links
Date: 2021-09-07



Traffic flows with trip origin and/or destination within the LSP area.

Appendix D

SIDRA INTERSECTION ANALYSIS

Layout pictures are schematic functional drawings reflecting input data. They are not design drawings.

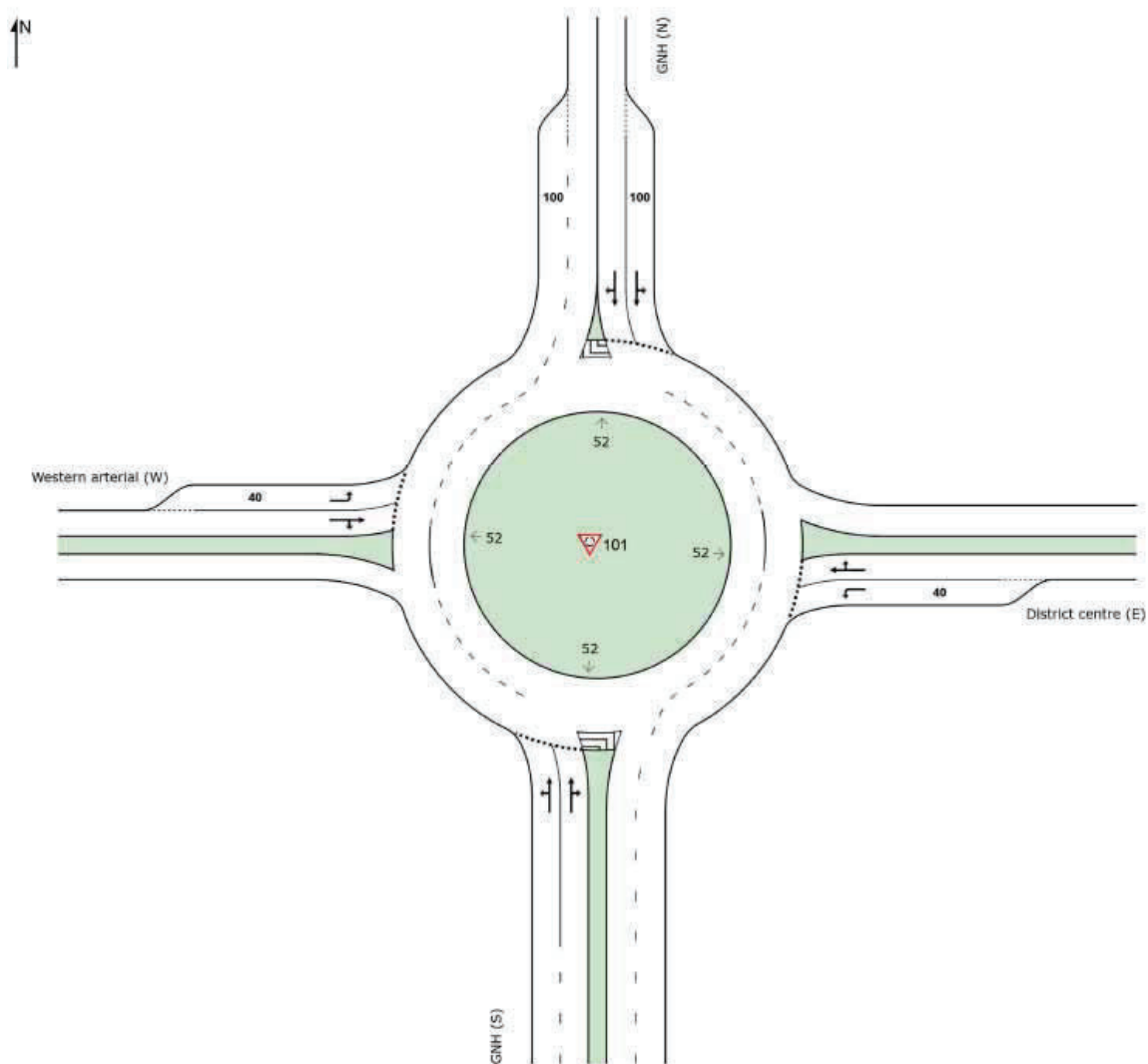


Figure D1. Great Northern Hwy / Bullsbrook district centre ultimate dual-lane roundabout layout analysed in SIDRA

Table D1a. SIDRA results – Great Northern Hwy / Bullsbrook district centre
dual-lane roundabout – 2031 weekday AM peak with full development

Vehicle Movement Performance														
Mov ID	Turn	INPUT VOLUMES		DEMAND FLOWS		Deg. Satn	Aver. Delay	Level of Service	95% BACK OF QUEUE		Prop. Que	Effective Stop Rate	Aver. No. Cycles	Aver. Speed
		[Total veh/h	HV] %	[Total veh/h	HV] %	v/c	sec		[Veh. veh	Dist] m				km/h
South: GNH (S)														
1	L2	10	10.0	11	10.0	0.209	3.8	LOS A	0.9	8.6	0.40	0.33	0.40	55.9
2	T1	405	22.7	426	22.7	0.246	3.7	LOS A	1.2	10.6	0.39	0.41	0.39	57.4
3	R2	177	3.3	186	3.3	0.246	10.3	LOS B	1.2	10.6	0.39	0.49	0.39	48.3
Approach		592	16.7	623	16.7	0.246	5.6	LOS A	1.2	10.6	0.39	0.43	0.39	55.2
East: District centre (E)														
4	L2	449	3.3	473	3.3	0.353	3.5	LOS A	1.4	11.0	0.51	0.52	0.51	53.3
5	T1	86	3.3	91	3.3	0.274	3.5	LOS A	1.0	7.5	0.50	0.71	0.50	53.7
6	R2	178	3.3	187	3.3	0.274	10.5	LOS B	1.0	7.5	0.50	0.71	0.50	54.4
Approach		713	3.3	751	3.3	0.353	5.2	LOS A	1.4	11.0	0.51	0.59	0.51	53.7
North: GNH (N)														
7	L2	105	3.3	111	3.3	0.315	3.3	LOS A	1.5	13.7	0.31	0.30	0.31	45.7
8	T1	693	22.7	729	22.7	0.315	2.9	LOS A	1.5	13.7	0.32	0.32	0.32	58.8
9	R2	40	10.0	42	10.0	0.315	10.4	LOS B	1.4	13.2	0.34	0.34	0.34	57.2
Approach		838	19.7	882	19.7	0.315	3.3	LOS A	1.5	13.7	0.32	0.32	0.32	57.4
West: Western arterial (W)														
10	L2	12	10.0	13	10.0	0.014	5.4	LOS A	0.0	0.4	0.47	0.52	0.47	55.7
11	T1	15	3.3	16	3.3	0.021	3.3	LOS A	0.1	0.6	0.46	0.49	0.46	36.3
12	R2	10	10.0	11	10.0	0.021	10.9	LOS B	0.1	0.6	0.46	0.49	0.46	55.4
Approach		37	7.3	39	7.3	0.021	6.1	LOS A	0.1	0.6	0.46	0.50	0.46	47.9
All Vehicles		2180	13.3	2295	13.3	0.353	4.6	LOS A	1.5	13.7	0.40	0.44	0.40	55.7

Table D1b. SIDRA results – Great Northern Hwy / Bullsbrook district centre
dual-lane roundabout – 2031 weekday PM peak with full development

Vehicle Movement Performance														
Mov ID	Turn	INPUT VOLUMES		DEMAND FLOWS		Deg. Satn	Aver. Delay	Level of Service	95% BACK OF QUEUE		Prop. Que	Effective Stop Rate	Aver. No. Cycles	Aver. Speed
		[Total veh/h	HV %	[Total veh/h	HV %	v/c	sec		[Veh. veh	Dist] m				km/h
South: GNH (S)														
1	L2	10	10.0	11	10.0	0.399	3.5	LOS A	1.9	18.3	0.33	0.29	0.33	56.4
2	T1	764	22.7	804	22.7	0.470	3.8	LOS A	2.6	21.8	0.32	0.38	0.32	57.7
3	R2	442	3.3	465	3.3	0.470	10.0	LOS B	2.6	21.8	0.31	0.50	0.31	48.0
Approach		1216	15.5	1280	15.5	0.470	6.0	LOS A	2.6	21.8	0.32	0.42	0.32	54.8
East: District centre (E)														
4	L2	224	3.3	236	3.3	0.178	3.1	LOS A	0.7	5.2	0.43	0.46	0.43	53.8
5	T1	43	3.3	45	3.3	0.134	3.0	LOS A	0.5	3.5	0.43	0.64	0.43	54.1
6	R2	89	3.3	94	3.3	0.134	10.0	LOS A	0.5	3.5	0.43	0.64	0.43	54.8
Approach		356	3.3	375	3.3	0.178	4.8	LOS A	0.7	5.2	0.43	0.53	0.43	54.1
North: GNH (N)														
7	L2	262	3.3	276	3.3	0.323	4.2	LOS A	1.9	15.9	0.53	0.46	0.53	44.3
8	T1	486	22.7	512	22.7	0.323	4.1	LOS A	1.9	15.9	0.54	0.46	0.54	57.5
9	R2	28	10.0	29	10.0	0.323	11.6	LOS B	1.6	15.3	0.54	0.46	0.54	56.1
Approach		776	15.7	817	15.7	0.323	4.4	LOS A	1.9	15.9	0.53	0.46	0.53	53.8
West: Western arterial (W)														
10	L2	23	10.0	24	10.0	0.034	7.9	LOS A	0.1	1.1	0.64	0.69	0.64	54.9
11	T1	37	3.3	39	3.3	0.051	5.2	LOS A	0.3	2.0	0.69	0.59	0.69	35.7
12	R2	10	10.0	11	10.0	0.051	12.7	LOS B	0.3	2.0	0.69	0.59	0.69	54.8
Approach		70	6.5	74	6.5	0.051	7.1	LOS A	0.3	2.0	0.67	0.62	0.67	44.9
All Vehicles		2418	13.5	2545	13.5	0.470	5.4	LOS A	2.6	21.8	0.41	0.45	0.41	54.1

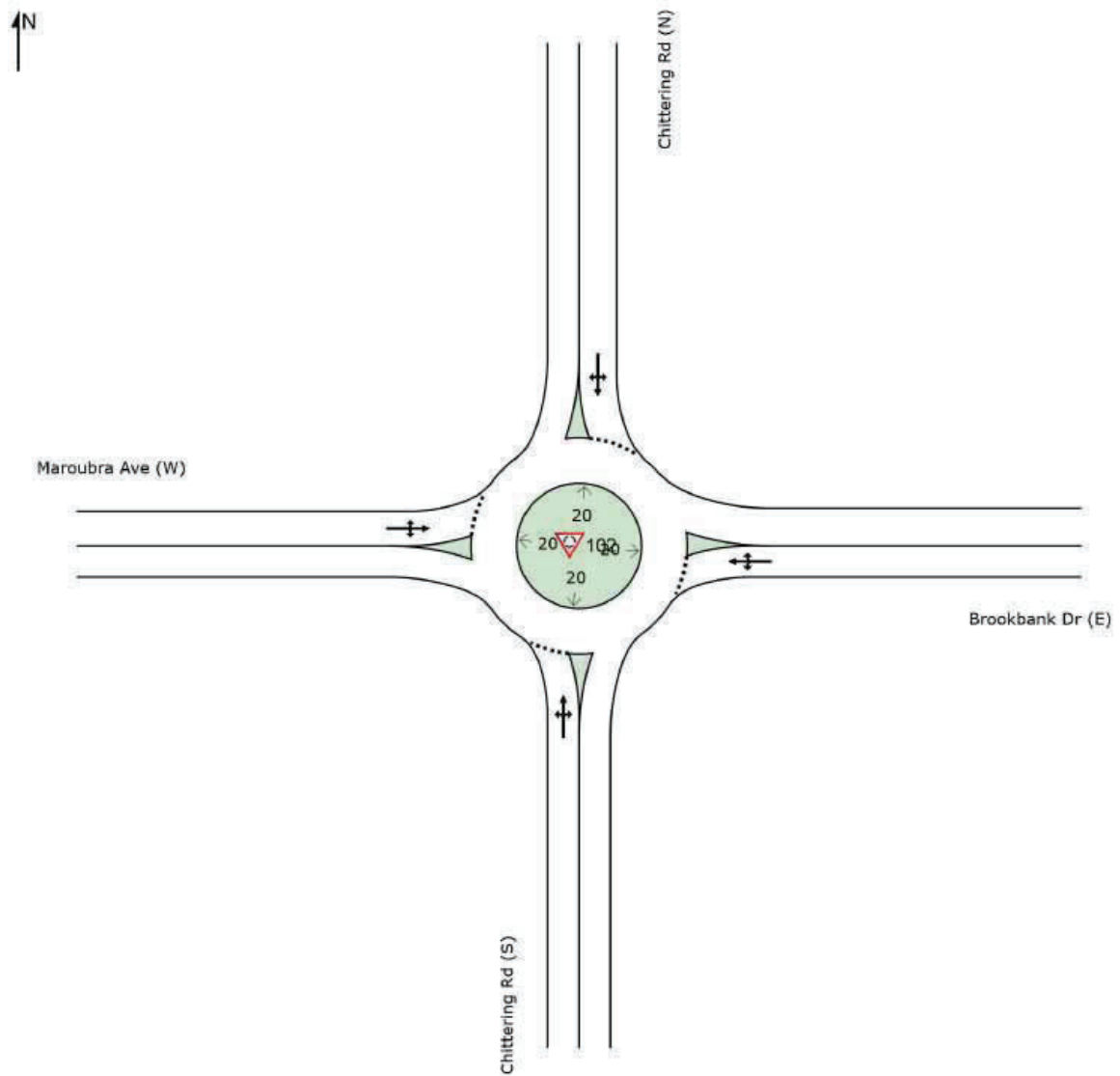


Figure D2. Chittering Rd / Maroubra Ave roundabout layout analysed in SIDRA

Table D2a. SIDRA results – Chittering Rd / Maroubra Ave roundabout – 2031
weekday AM peak with full development

Vehicle Movement Performance														
Mov ID	Turn	INPUT VOLUMES		DEMAND FLOWS		Deg. Satn	Aver. Delay	Level of Service	95% BACK OF QUEUE		Prop. Que	Effective Stop Rate	Aver. No. Cycles	Aver. Speed
		[Total veh/h	HV %	[Total veh/h	HV %	v/c	sec		[Veh. veh	Dist m				km/h
South: Chittering Rd (S)														
7	L2	15	3.3	16	3.3	0.236	9.4	LOS A	1.4	10.9	0.79	0.82	0.79	44.3
8	T1	123	3.3	129	3.3	0.236	9.2	LOS A	1.4	10.9	0.79	0.82	0.79	45.2
9	R2	3	3.3	3	3.3	0.236	13.7	LOS B	1.4	10.9	0.79	0.82	0.79	45.3
Approach		141	3.3	148	3.3	0.236	9.3	LOS A	1.4	10.9	0.79	0.82	0.79	45.1
East: Brookbank Dr (E)														
10	L2	1	3.3	1	3.3	0.309	11.1	LOS B	2.0	15.2	0.86	0.91	0.86	43.0
11	T1	127	3.3	134	3.3	0.309	10.9	LOS B	2.0	15.2	0.86	0.91	0.86	43.9
12	R2	35	3.3	37	3.3	0.309	15.4	LOS B	2.0	15.2	0.86	0.91	0.86	44.0
Approach		163	3.3	172	3.3	0.309	11.8	LOS B	2.0	15.2	0.86	0.91	0.86	43.9
North: Chittering Rd (N)														
1	L2	13	3.3	14	3.3	0.712	3.5	LOS A	5.4	45.3	0.35	0.55	0.35	45.2
2	T1	206	3.3	217	3.3	0.712	3.2	LOS A	5.4	45.3	0.35	0.55	0.35	46.3
3	R2	694	16.2	731	16.2	0.712	8.0	LOS A	5.4	45.3	0.35	0.55	0.35	45.8
Approach		913	13.1	961	13.1	0.712	6.8	LOS A	5.4	45.3	0.35	0.55	0.35	45.9
West: Maroubra Ave (W)														
4	L2	210	16.2	221	16.2	0.272	3.8	LOS A	1.3	10.8	0.33	0.50	0.33	46.3
5	T1	44	3.3	46	3.3	0.272	3.3	LOS A	1.3	10.8	0.33	0.50	0.33	47.8
6	R2	40	3.3	42	3.3	0.272	7.9	LOS A	1.3	10.8	0.33	0.50	0.33	47.9
Approach		294	12.5	309	12.5	0.272	4.2	LOS A	1.3	10.8	0.33	0.50	0.33	46.7
All Vehicles		1511	11.0	1591	11.0	0.712	7.1	LOS A	5.4	45.3	0.44	0.60	0.44	45.8

Table D2b. SIDRA results – Chittering Rd / Maroubra Ave roundabout – 2031
weekday PM peak with full development

Vehicle Movement Performance														
Mov ID	Turn	INPUT VOLUMES [Total HV] veh/h %		DEMAND FLOWS [Total HV] veh/h %		Deg. Satn v/c	Aver. Delay sec	Level of Service	95% BACK OF QUEUE [Veh. Dist] veh m		Prop. Que	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
South: Chittering Rd (S)														
7	L2	37	3.3	39	3.3	0.390	5.5	LOS A	2.2	16.7	0.60	0.64	0.60	46.0
8	T1	309	3.3	325	3.3	0.390	5.3	LOS A	2.2	16.7	0.60	0.64	0.60	47.0
9	R2	7	3.3	7	3.3	0.390	9.9	LOS A	2.2	16.7	0.60	0.64	0.60	47.1
Approach		353	3.3	372	3.3	0.390	5.4	LOS A	2.2	16.7	0.60	0.64	0.60	46.9
East: Brookbank Dr (E)														
10	L2	1	3.3	1	3.3	0.095	5.1	LOS A	0.4	3.4	0.52	0.60	0.52	45.8
11	T1	64	3.3	67	3.3	0.095	4.9	LOS A	0.4	3.4	0.52	0.60	0.52	46.8
12	R2	18	3.3	19	3.3	0.095	9.4	LOS A	0.4	3.4	0.52	0.60	0.52	46.9
Approach		83	3.3	87	3.3	0.095	5.9	LOS A	0.4	3.4	0.52	0.60	0.52	46.9
North: Chittering Rd (N)														
1	L2	32	3.3	34	3.3	0.416	3.5	LOS A	2.1	17.6	0.32	0.56	0.32	45.4
2	T1	103	3.3	108	3.3	0.416	3.2	LOS A	2.1	17.6	0.32	0.56	0.32	46.5
3	R2	347	16.2	365	16.2	0.416	8.0	LOS A	2.1	17.6	0.32	0.56	0.32	46.0
Approach		482	12.6	507	12.6	0.416	6.6	LOS A	2.1	17.6	0.32	0.56	0.32	46.1
West: Maroubra Ave (W)														
4	L2	525	16.2	553	16.2	0.683	6.6	LOS A	6.2	52.3	0.71	0.79	0.82	45.3
5	T1	111	3.3	117	3.3	0.683	6.0	LOS A	6.2	52.3	0.71	0.79	0.82	46.7
6	R2	20	3.3	21	3.3	0.683	10.6	LOS B	6.2	52.3	0.71	0.79	0.82	46.8
Approach		656	13.6	691	13.6	0.683	6.7	LOS A	6.2	52.3	0.71	0.79	0.82	45.6
All Vehicles		1574	10.4	1657	10.4	0.683	6.3	LOS A	6.2	52.3	0.55	0.68	0.60	46.1

Appendix 6

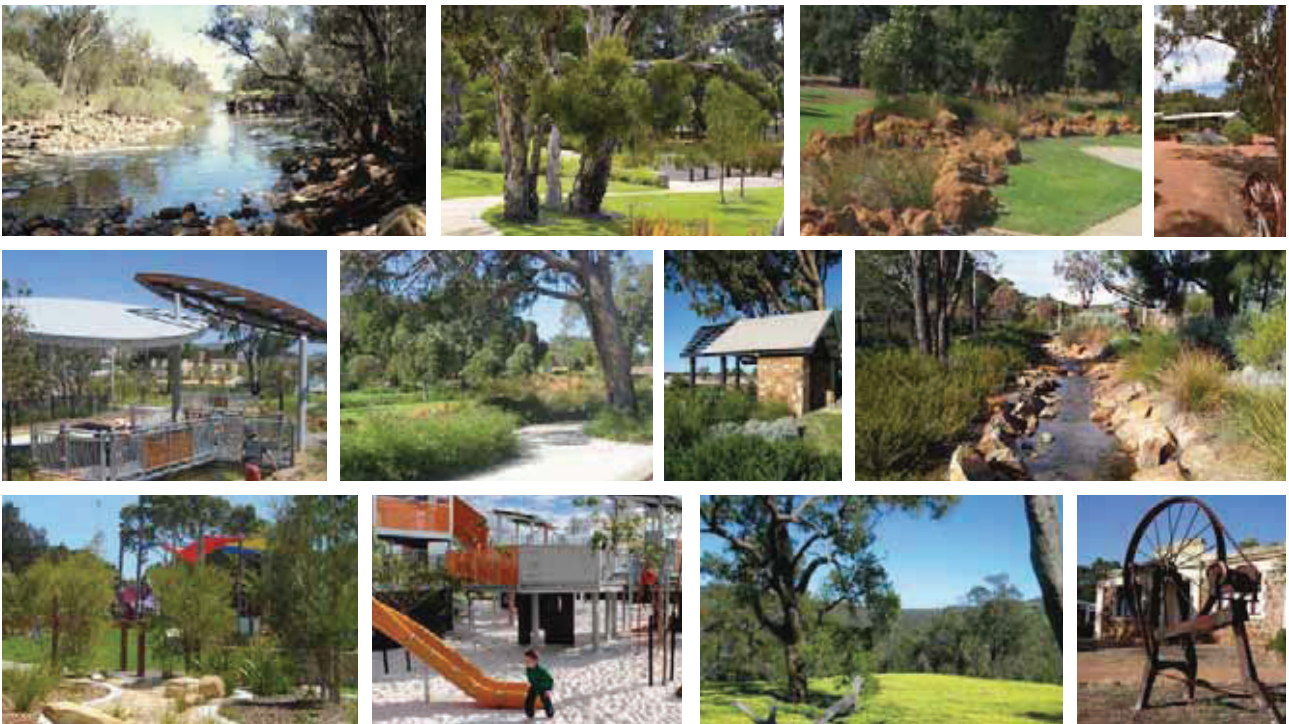
Landscape Strategy

(Emerge)

August 2021

BULLSBROOK for Okeland

Local Structure Plan - Landscape and Irrigation Strategy



REV L -30/08/2021

1. CONTENTS

1.	LANDSCAPE PRINCIPLES.....	3
1.1.	Introduction	3
2.	PUBLIC OPEN SPACE TYPOLOGIES	5
2.1.	Linear Open Space Networks	6
2.2.	Neighbourhood Parks.....	6
2.3.	District Park/Playing Fields	6
2.4.	Living Streams	7
2.5.	Ki-It Monger Brook	8
2.6.	Streetscapes	12
2.7.	Proposed Planting in the Public Realm.....	15
2.8.	Retained Vegetation	16
2.9.	Entry Treatments.....	16
2.10.	Drainage/Stormwater	17
2.11.	Drainage Treatments Adjacent to POS	17
2.12.	Irrigation Strategy.....	18
2.13.	Site Furniture	19
2.14.	Public Art.....	19
2.15.	Maintenance Minimisation	20
3.	IMPLEMENTATION.....	21
3.1.	Approvals	21
3.2.	Practical Completion	21
3.3.	Landscape Maintenance Responsibility	21
3.4.	Scheduled Handover	21
4.	APPENDIX A LANDSCAPE MASTERPLAN.....	22
5.	APPENDIX B PEDESTRIAN / CYCLE NETWORK	23
6.	APPENDIX C STREET HIERARCHY	24
7.	APPENDIX D FACILITIES PLAN	25
8.	POS STRATEGY - GREEN STREETS	26
9.	POS STRATEGY - NEIGHBOURHOOD PARKS.....	27
10.	POS STRATEGY - DISTRICT POS/PLAYING FIELDS.....	28
11.	POS STRATEGY - CONSERVATION AREA	29
12.	POS STRATEGY - KI-IT MONGER BROOK	30
13.	PROPOSED PLANT PALETTE	31
13.1	Ki-It Monger Brook and Living Stream Revegetation	31
13.2	Parkland Planting (POS Areas/Boulevards).....	33
13.3	Drainage Basin Planting (POS Areas / Linear parks)	34
13.4	Streetscape Planting.....	35
13.5	Tree Species Selection	36
	Native Species	36
	Exotic Species	37

1. LANDSCAPE PRINCIPLES

1.1. INTRODUCTION

The development of Bullsbrook provides the opportunity for the rural context of the existing locale to be interpreted and be sensibly projected within practical limits through the project area.

Hence the key Landscape Principles to be explored during the design phase shall be:

- The rural/village environment and the elements that define Bullsbrook as a place is an avenue that is to be explored and referenced in the design of the landscape.
- Respecting the ecological corridors/buffers and incorporating these into a linear Public Open Space (POS) network and adopting a programme of revegetation and rehabilitation.
- Understanding that the linear POS network provides the opportunity to establish a highly legible and pedestrian/cycle friendly framework within the estate.
- Retention of existing stands of scattered and isolated Eucalypts via incorporation into public open space or through the creation of wider road reserves.
- Views to the hills to the east are to be framed through the street layout and enhanced through sensitive landscape design.
- Views into the site and outwards from the site are to be screened or framed where appropriate to retain a sense of rural context.
- Appreciation that a balanced approach is required to ensure the social and recreational requirements of the future residents are balanced with the ecological and engineering constraints imposed by the site.
- Respect existing Bush Forever sites.
- Provide a balanced variety of outdoor public space for recreational and social opportunities appropriate to the size of the proposed community.
- Provide a legible network of walking and cycle paths linking the town centre and areas of public open space, schools and other community infrastructure.
- Mitigate post development drainage flows through incorporation of upstream treatment drains within the open space network and widened road reserves. Ensure drainage corridors are treated in such a way so as to allow multiple public use.



The project will be developed around offering a range of open space opportunities. The public open space within Bullsbrook has been planned to provide a network of parkland and corridors which integrate with the Ki-It Monger Brook and aims to contribute to the ecological and social fabric of the Bullsbrook community. Being strategically located, they will provide accessibility and connectivity through the development whilst also playing an important role in protecting the sites natural assets which are unique to the Bullsbrook locale.

The areas of POS within Bullsbrook have been separated into broad categories based on their specific treatments and design:

- Small Open Space
- Local and/ or Linear Open Space
- Neighbourhood Open Space
- District Open Space / Playing Fields
- Civic POS / High order Neighbourhood Open Space
- Conservation & Buffer Areas
- Ki-It Monger Brook

See Figure 7 for “Facilities Plan” which shows the locations of these POS categories. These are described in detail as follows:



2. PUBLIC OPEN SPACE TYPOLOGIES

The Public Open Space Network consists of the following and are as defined where appropriate under Liveable Neighbourhoods:

- **Linear POS:**
Open spaces which provide a connection between smaller recreational nodes (neighbourhood POS) and specifically allows an integration/connection with the Ki-It Monger Brook. Provides legibility and sense of place for local residents. Also enables retention of existing trees and allows for low level drainage conveyance through the site.
- **Neighbourhood POS:**
Located throughout the development (3,000 - 5,000m²) and provides local residents with areas of turf and planting for informal kick-about play and passive uses. Also provides seating areas under shelter/shade and are typically within 400m of most dwellings. Are able to service approx. 600 dwellings within the surrounding area.
- **District POS/Playing Fields:**
Approximately 2.5 - 7ha and notionally able to serve three neighbourhoods. Provides local residents and community with an open area capable for servicing district sports, events and gatherings. Caters for the combination of passive (including informal play areas) and active recreation and are generally within 1km of most dwellings. Natural and human made changes in elevation need to be considered in context to district POS as they also serve a drainage function to the development.
- **Civic POS:**
Provision for a main street and town/village square within Bullsbrook development. Predominantly hard paved and located at the conjunction of major thoroughfares and town/village centre in order to provide a landmark for community gatherings and events.
- **Conservation and Buffer Areas:**
As the proposed development area includes the Ki-It Monger Brook; conservation and buffer zones are designed to rehabilitate/protect the natural assets of the site to the benefit of the environment and greater community. These areas will provide opportunities for passive recreation (walking trails) and serve a critical role in drainage detention.
- **Ki-It Monger Brook**
The Ki-It Monger Brook will become the primary POS and ecological corridor of the development. It represents a unique asset which serves a critical ecological role. Sensitive design will ensure existing vegetation will be retained and rehabilitated. This objective will be achieved by designating nodes for recreational/educational opportunities; allowing for vegetated areas to be retained and protected along the existing Brook corridor. Continuous pedestrian/cycling paths will link these interspersed nodes which include amenities in the form of play spaces, boardwalks and interpretative signage.

2.1. LINEAR OPEN SPACE NETWORKS

In order to address the requirements of retaining site topography and the principle of protecting existing trees and ecological linkages, the structure plan includes a series of linear open spaces. The design intent of these spaces is to rehabilitate existing vegetation as well as incorporate existing stands of isolated trees and drainage alignments. Through respecting the existing topography in these areas, the linear POS will provide a necessary drainage function as well as provide visual amenity to the public realm.

As surrounding lots and roads require imported fill to ensure suitable structural conditions for housing, these linear parks will sit at a lower grade. This will ensure that drainage will flow towards these areas and discrete bio-filtration and detention basins will be incorporated along the length of the linear parks. A system of inlet and overflow structures will ensure designated parkland areas are kept dry and usable.

Linear parks and widened road reserves as well as serving an environmental and drainage function also provide an efficient means of supporting a legible cycle and pedestrian network. Which will be designed to encourage passive surveillance from overlooking residents in accordance with Liveable Neighbourhood guidelines and best practice in terms of 'Designing out Crime'.

2.2. NEIGHBOURHOOD PARKS

Neighbourhood Parks are to be larger POS areas catering as a destination along the linear POS network or larger individual parcels within the developed area. The landscape treatment of these spaces will be generally informal in nature and characterised by revegetation and native parkland plantings which encourage passive recreation uses. Localised areas of turf that cater for informal active recreation may also feature. Typically this park will consist of an area of retained remnant vegetation with a central built feature and playground. Path systems will link to the adjoining residential streets and to the linear POS network to provide access as necessary.

Drainage areas may be required in these open spaces, and where provided will be landscaped basins, serving a recreational and amenity function. Drainage swales catering for events greater than 1:5 within Neighbourhood POS areas will have turf to enable multiple use and ease of maintenance.

The extent of hardscape and the urbanity of the space will increase in proximity to the town centre.

2.3. DISTRICT PARK/PLAYING FIELDS

Typically covering areas between 2.5 - 7ha, district POS/Playing Fields serve a critical role in providing vegetation and large open turfed spaces capable of servicing a diverse range of passive and recreational activities. These large open spaces serve as a landmark or destination for residents and community groups as they provide amenities such as large kickabout areas, shelters, BBQ, nature play and exercise nodes. The landscape treatment of these spaces will be more formalised in nature with the provision of distinct active/passive zones amongst activities and age groups. Planting will typically be used to provide shade for resting and play areas. In addition, perimeter planting will be implemented to allow for a visual buffer between road/path networks.

Playing Fields

Located adjacent to the future zoned primary school and town/village centre, the proposed playing field represents an opportunity to co-locate amenities capable of servicing the local school, residents and the greater Bullsbrook community. Due to its potential in servicing the proposed school as well as providing for seasonal sporting activities and everyday recreational use, areas may be set aside for multipurpose fields, hardcourts, potential amenity block, carparking and a grandstand for spectators. Its capacity to allow for organised sporting and large scale community events will contribute towards nurturing social interaction and promoting local fabric within the community. All facilities will require confirmation of funding through the Developer's Contributions Scheme.

Another important aspect to District POS/Playing fields will be its critical role as a drainage area during large stormwater and flooding events.

2.4. LIVING STREAMS

Due to the requirement to convey stormwater reliably away from high use areas; a system of shallow 'living streams' will be created in the larger POS areas, broader sections of linear parkland and widened road reserves. This system will seek to mimic pre development flows and enable upstream bio-filtration and recharge of the groundwater table.

Through the linear parks the living stream may include an interface with a dual use path (DUP). There will be native shrub planting on the banks and native reed/sedge planting to enhance nutrient uptake. With planting to consist of endemic species with a variety of tree, shrub, groundcover, reed and sedge species. Bank stabilisation will be incorporated into the design and a variety of tree species will be used to provide a diverse tree canopy. Treatment along the length of the stream will be dependent upon the width of the corridor and the engineering constraints. The Living Stream will provide not only a viable drainage function but also a variety of ecological zones and restoration opportunities.



2.5. KI-IT MONGER BROOK

The Ki-It Monger Brook provides a valuable natural landscape resource that contains existing remnant vegetation along a natural drainage corridor. Adjacent to the Brook is a broad interface area which offers a reduced fire hazard area and provides a buffer from the residential development. Currently, existing remnant vegetation along the brook's interface are in a degraded state with little or no undergrowth. Works will be undertaken to remove any dead material so it becomes a reduced hazard area, with any additional planting to be in accordance with the Fire Management Plan.

Proposed planting in the interface areas shall take into consideration the recommendations of the Fire Management Report and comply with the proposed Hazard Separation Zones. Proposed plant species shall be waterwise, native species or a nominated FESA fire retardant species.

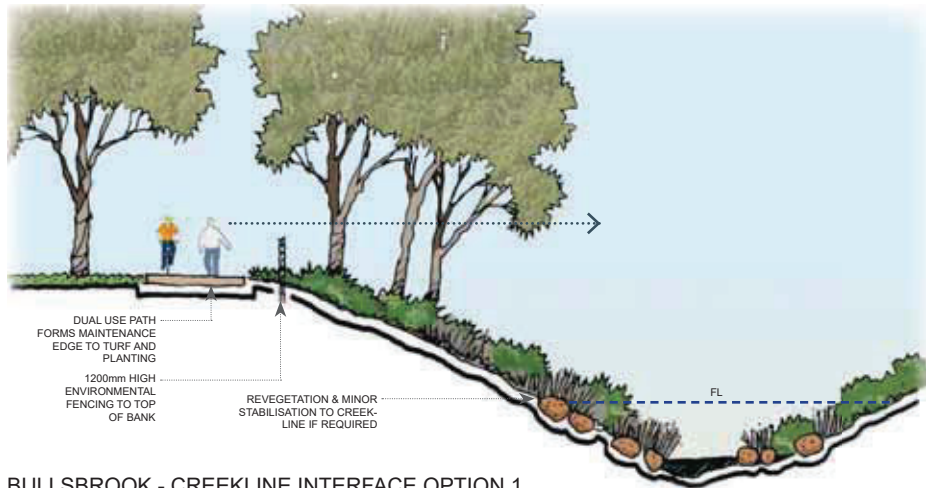
The interface areas shall consist of rehabilitated endemic planting interlaced with passive recreation opportunities through walk trails and formalised parkland nodes. These nodes will form Neighbourhood POS and provide settings for picnics and informal gatherings as well as opportunities to incorporate nature play areas. Supplemental planting adjacent to the brook shall limit direct public access and where possible an informal dual use path system shall extend along the length of the interface area to define public use and to discourage turf/weed encroachment.

- Potential exists for interpretive signage to be located along footpaths and boardwalks informing the community of the importance of local flora/fauna and the significance of the Bush forever site and interface zones.
- The dual use and pedestrian path systems shall be designed to allow vehicular crossing and access points for maintenance purposes.
- The Interface Area shall be composed of 95% endemic vegetation, with irrigation and exotic planting restricted to small recreational nodes (less than 5,000m²).
- It is not proposed that any drainage be introduced into the interface areas beyond that required to maintain pre development flows.
- Additional planting adjacent to the Ki-It Monger Brook and mapped wetland interface area is to be in accordance with an approved Foreshore and/or Wetland Management Plan.

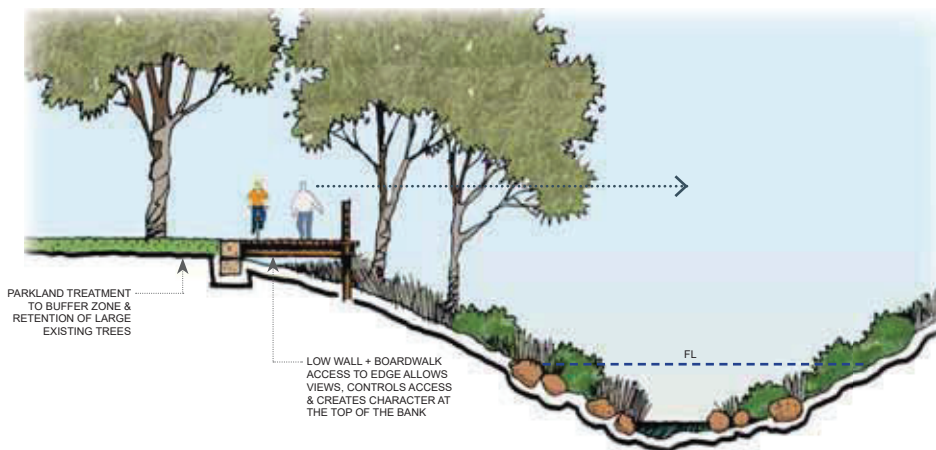


Figure: Ki-It Monger Brook through a Recreational Activity Node

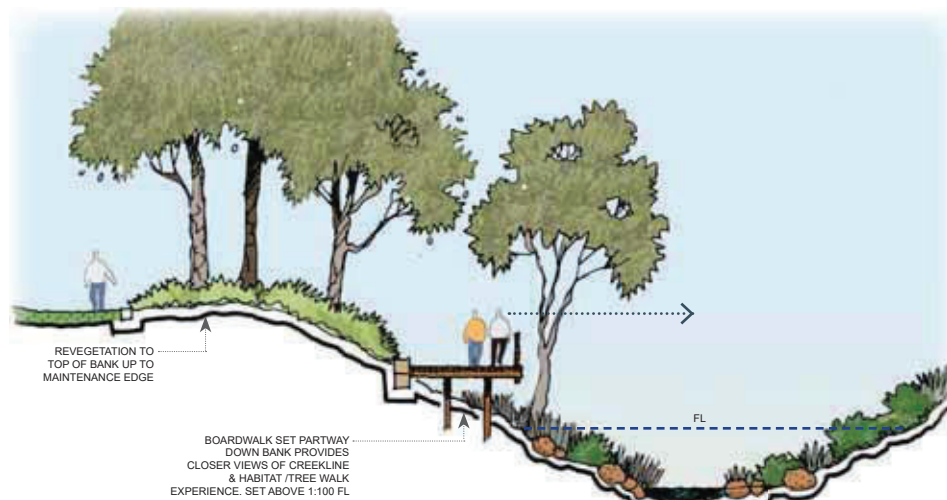




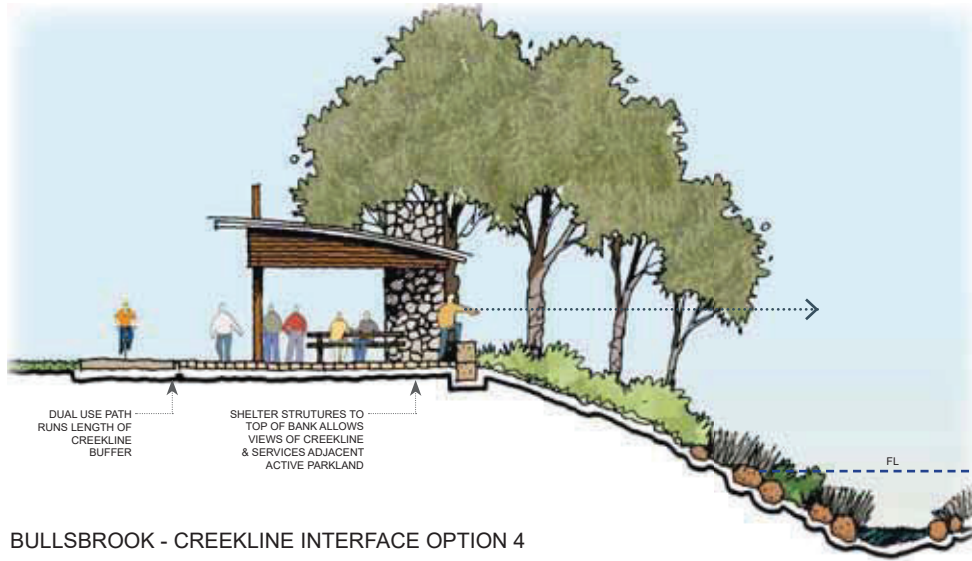
BULLSBROOK - CREEKLINE INTERFACE OPTION 1



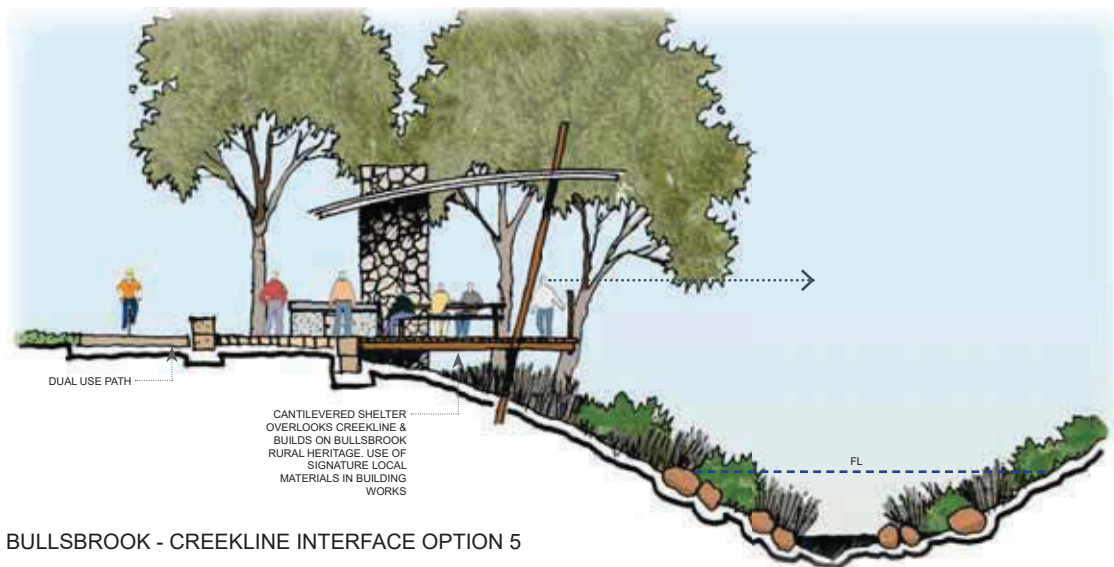
BULLSBROOK - CREEKLINE INTERFACE OPTION 2



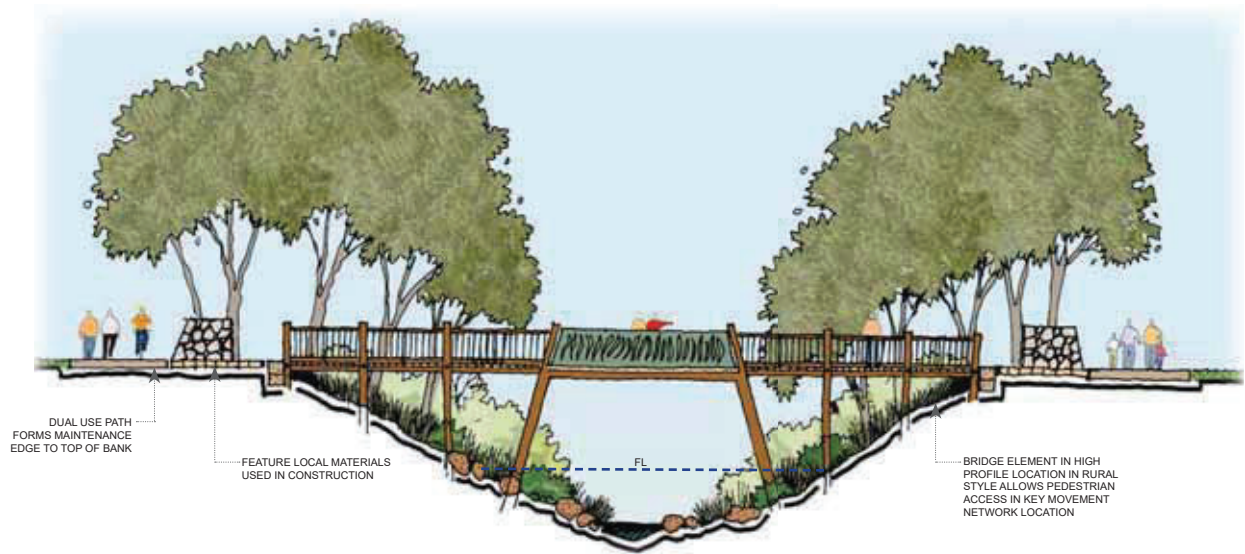
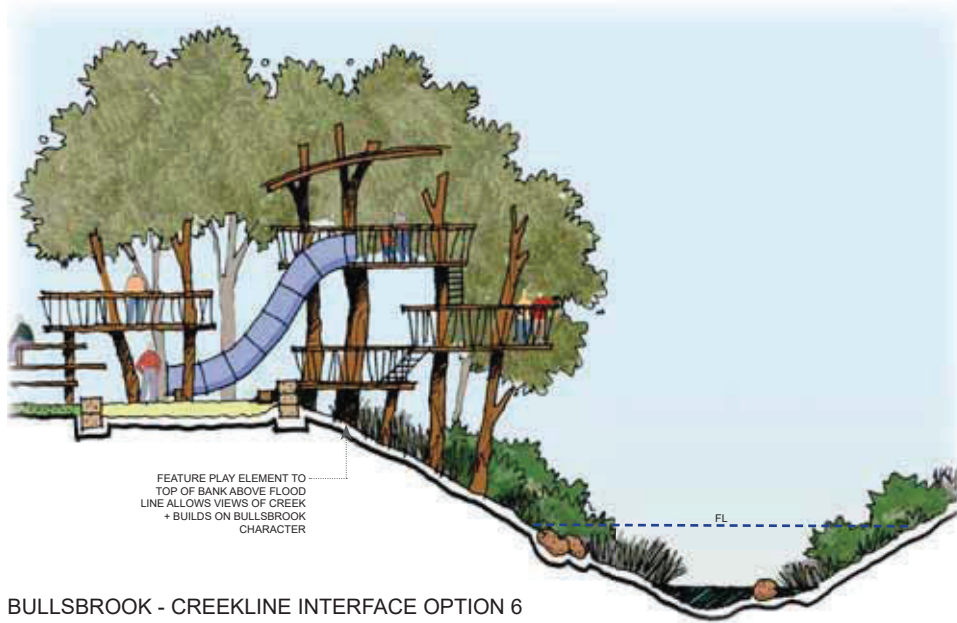
BULLSBROOK - CREEKLINE INTERFACE OPTION 3



BULLSBROOK - CREEKLINE INTERFACE OPTION 4



BULLSBROOK - CREEKLINE INTERFACE OPTION 5



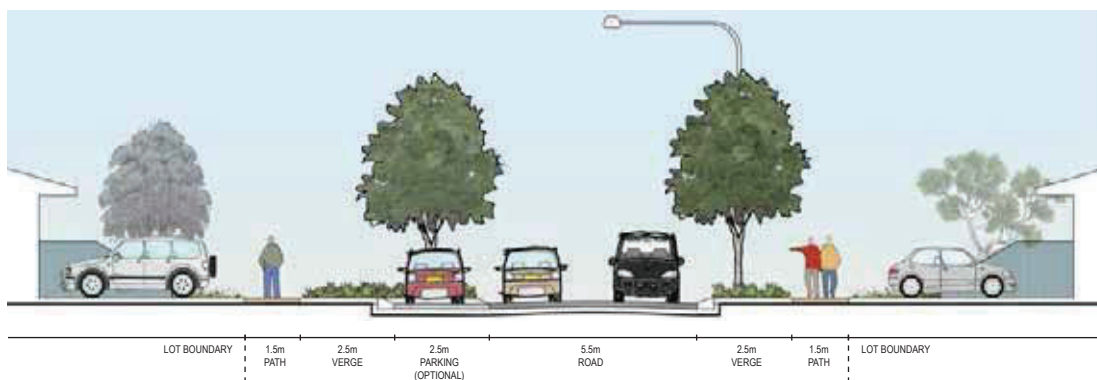
2.6. STREETSCAPES

Streetscapes throughout the development shall incorporate a variety of treatments in response to the road hierarchy system. In all cases, landscape works shall incorporate tree planting in accordance with the accepted traffic standards. Treatments may include soft works such as street trees, smaller shrubs and groundcovers.

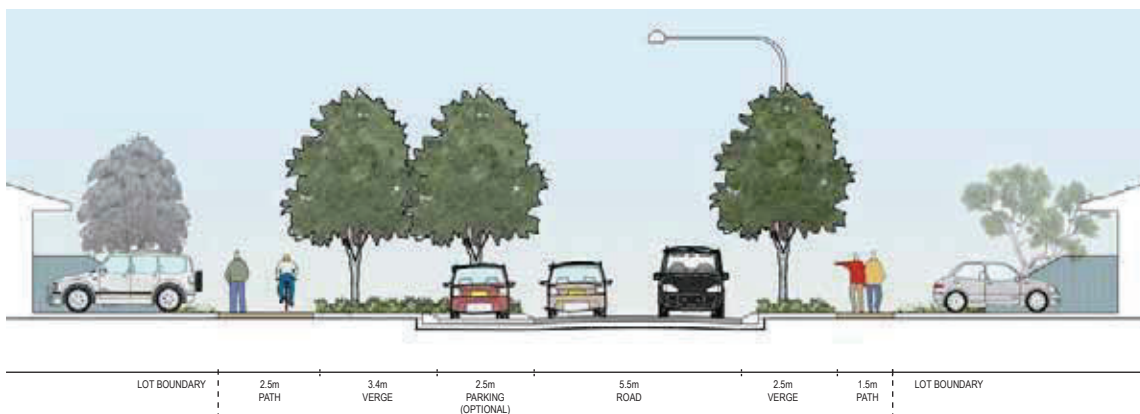
It is envisaged that the stormwater runoff from residential roads will be contained upstream mainly in a system of bio-retention basins distributed along road reserves and the linear open space network.

Tree species are yet to be allocated however it is anticipated that within the POS's predominantly native trees will be used. It is proposed that species selections for streetscapes will also include species which reference the historic and cultural influences in the area. Deciduous exotic species historically used around rural homesteads will be used for major roads and civic areas to provide landmarks and promote legibility through the street network. The timing of installation (pre or post home construction) is yet to be determined.

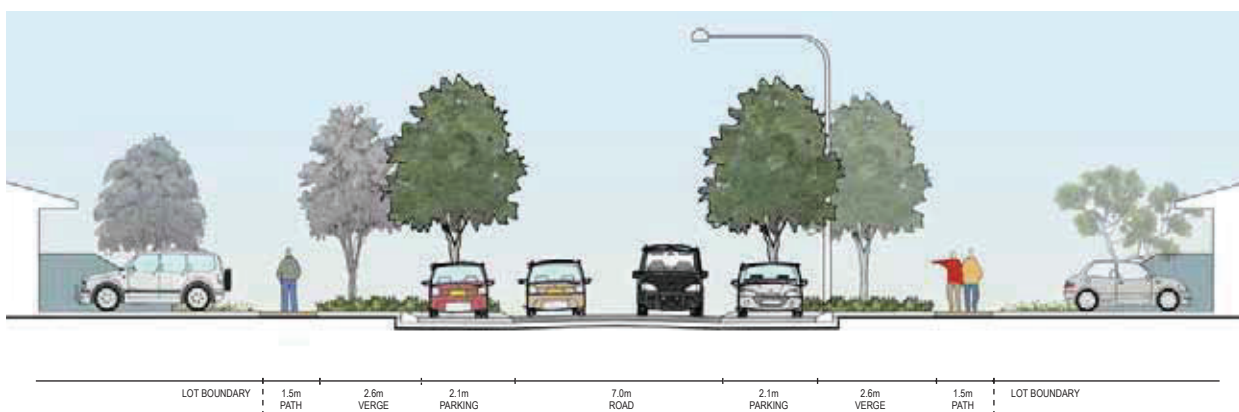
The below cross-sections are indicative only and will be subject to further detailed design at the subdivision stage. The streetscapes have taken into consideration the work undertaken by Transcore's Traffic Impact Assessment for Bullsbrook and provide an embellished/suggested approach for the incorporation of supplementary landscaping solutions.



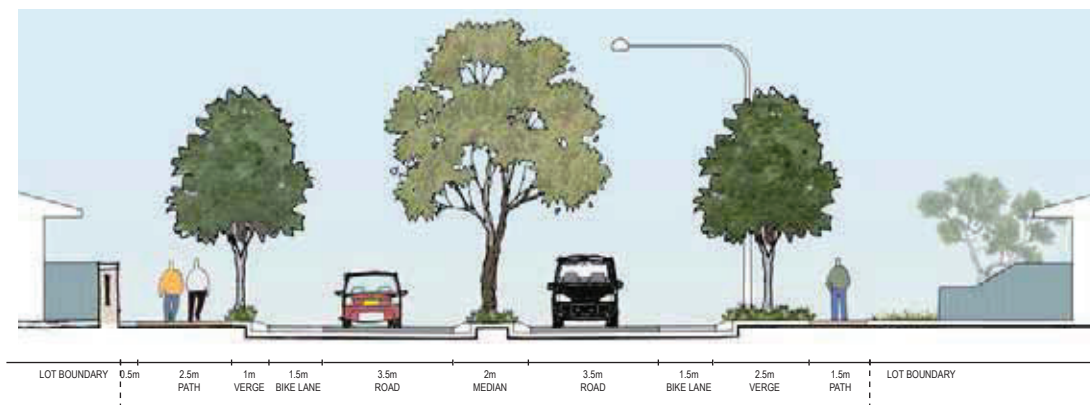
ACCESS STREET C - 16m



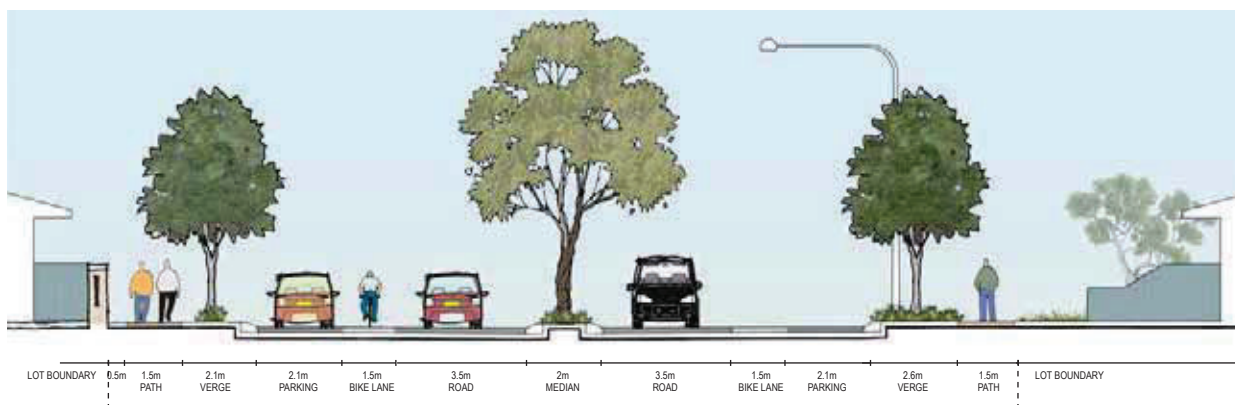
ACCESS STREET B - 17.9m



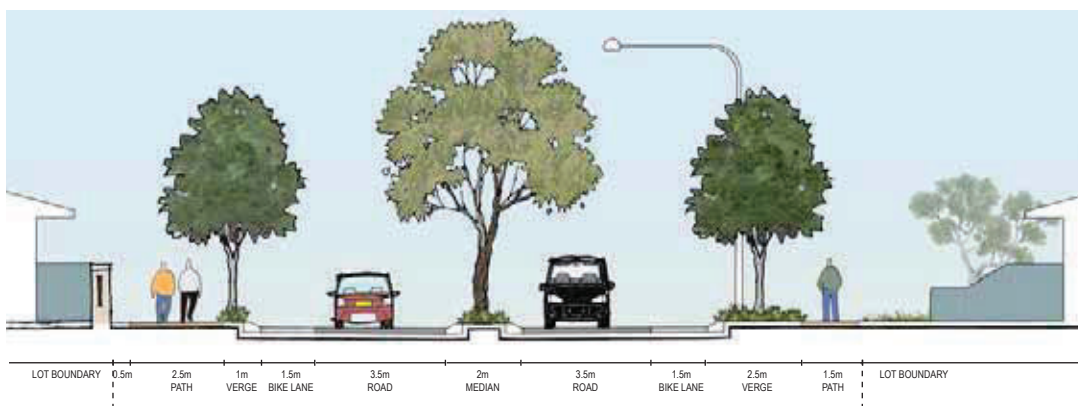
NEIGHBOURHOOD CONNECTOR B - 19.4m



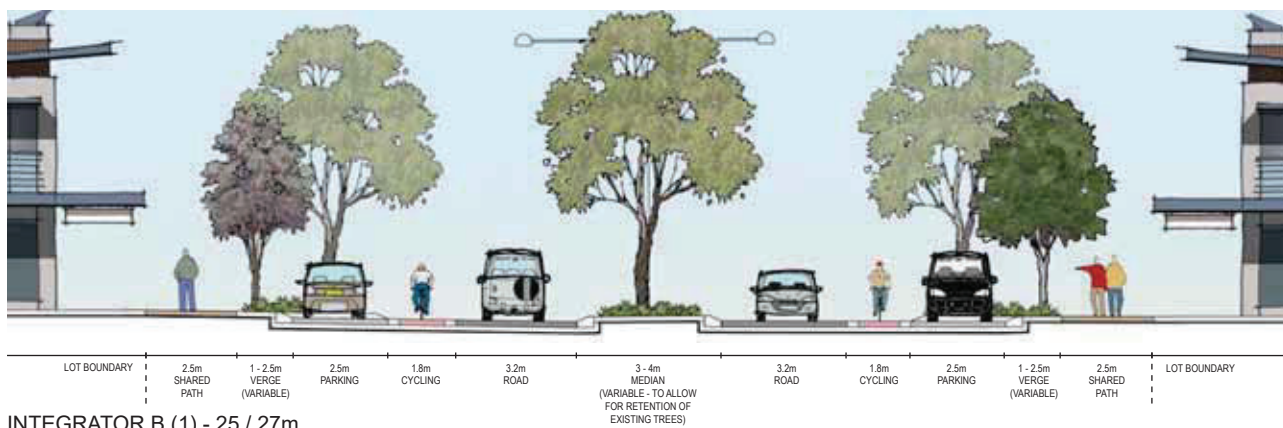
NEIGHBOURHOOD CONNECTOR A (1) - 20m



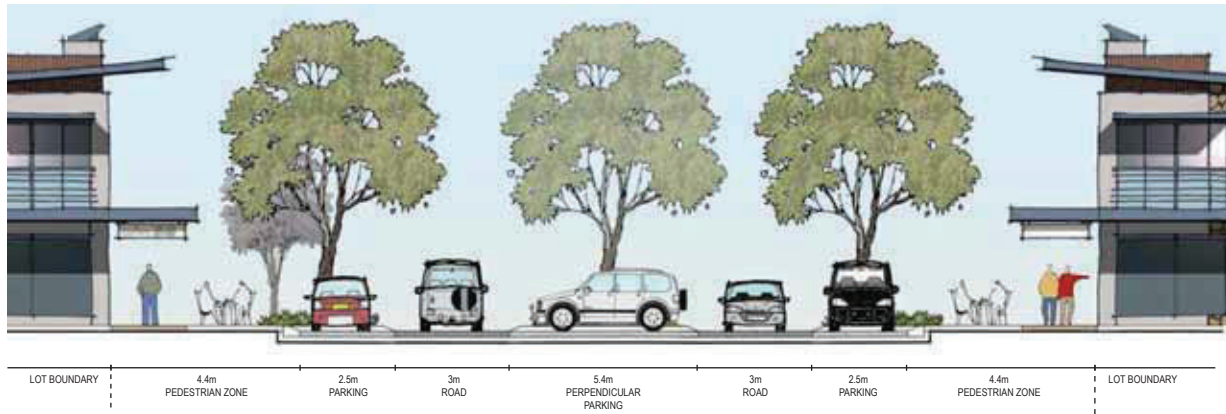
NEIGHBOURHOOD CONNECTOR A (2) - 24.4m



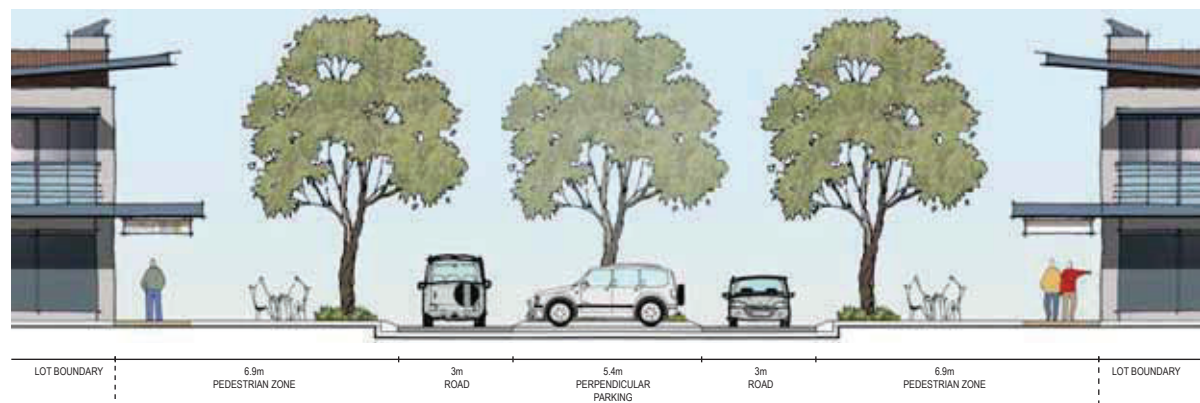
INTEGRATOR B (2) - 20m



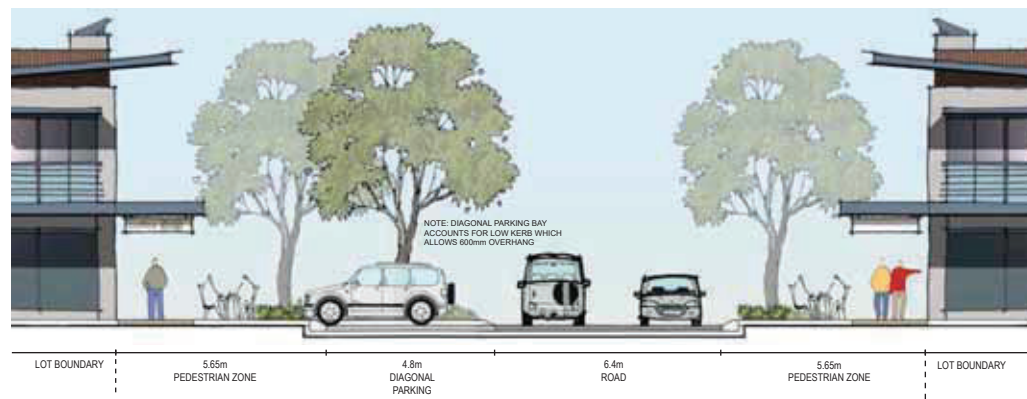
INTEGRATOR B (1) - 25 / 27m



TOWN CENTRE INTEGRATOR - 25.2m (OPTION 1)



TOWN CENTRE INTEGRATOR - 25.2m (OPTION 2)



MAIN STREET - 22.5m

2.7. PROPOSED PLANTING IN THE PUBLIC REALM

The provision of planting in public areas and streetscapes serves to provide character, shade, interest, habitat and a point of reference in major streets or feature locations. Refer to section 12 for proposed species lists.

The locations of planting and types of vegetation will include;

- Predominantly native tree species are to be nominated throughout the estate.
- Exotic specimen, shade and historical/cultural reference trees are to be nominated in high profile street or entry locations.
- Smaller scale exotic trees may be nominated in feature locations and avenue plantings to secondary residential streets,
- Bushland and habitat regeneration in disturbed areas,
- Shrub planting to screening and to provide spatial definition,
- Groundcover planting to medians, planters and areas requiring clear views,
- Reed and sedge planting to swales and watercourses,
- Irrigated grass to informal usable space and recreation areas,

The proposed mix of native species and exotic cultural plantings in feature locations will provide a variation of character and define feature points. In general POS planting shall be composed of 75% native vegetation.

The selection and placement of species shall consider adjacent elements so as to limit future maintenance and public health and safety issues. It will promote the survival and health of the existing vegetation while also provide ongoing social and visual benefits. Items of consideration may include;

- Proximity to traffic sightlines to ensure suitable view corridors,
- Proximity and alignment to underground services to ensure no adverse impact,
- Seasonal influence of shade on adjacent facilities and areas,
- Passive solar benefits influencing adjacent built form and residential dwellings,
- Provision of seasonal visual colour,
- Provision of a seasonal food source to local fauna,
- Plant selection based on suitability to local climate, soils, rainfall and temperatures,
- Selection based on reduced maintenance, trimming, pruning, fertilising and watering
- Develop a species palette with subtle variations through the development to tie in with identifiable communities.
- Buffer screening will be provided to residential or sensitive areas where required
- Fringing vegetation to the surrounding areas is to be retained and protected.



Street trees

Street trees are a desirable design element to increase shade and amenity. The selection and placement of street trees shall vary dependant of the road hierarchy. It is proposed that along major roads, street trees will form a strong visual avenue, and not impede traffic flow, safety or sightlines.

In residential streets, the roads may vary in character from precinct to precinct; however they are characterised as smaller scale pedestrian friendly environments. Therefore street trees will be of a smaller scale, and take advantage of passive solar principles allowing summer shade and winter sun. As the road reserve widths may vary to allow for the retention of existing vegetation and the interconnection of the linear park network, it may be possible to allow for clustering or grouping of trees in the road reserve. This will be reviewed at the detailed design phase.

Water Wise Planting

It is intended that local species shall be used where suitable to maximise local habitat advantage and minimise water dependence. Soil amendments will be used in order to reduce leaching and increase soil moisture holding capacity. All garden beds will be mulched to reduce water lose through evaporation.

2.8. RETAINED VEGETATION

A primary goal in the Landscape Strategy is the protection of existing vegetation. The retention of existing vegetation in defined locations caters for existing habitat, preserves natural assets and provides visual relief against the broader development area.

Vegetation Type and Quality

Whilst some of the vegetation on site has suffered through the effect of the various past land uses and management, the areas of remnant vegetation offer positive outcomes if the development can be engineered to protect these areas. The majority of remnant vegetation is aligned with the Ki-It Monger Brook or is in the form of occasional isolated individual trees in a cleared pastoral setting.

The retention of vegetation shall be maximised through minor realignment of road reserves, carriageways and lot boundaries, through the creation of tree islands in between carriageways or grade separated carriageways.

Retention and Protection

The retention and protection of defined existing trees shall occur during construction, following building works and in conjunction with maintenance. Retention and protection strategies shall include;

- Temporary fencing and signage to all retained areas and individual specimen trees
- Ripping or compaction within 5m of the drip line of existing trees to be prohibited.
- In order to restrict the spread of exotic weeds the construction of clearly defined and easily maintained boundaries between retained vegetation and ornamental landscape may include such methods as increased depth to mowing kerbs, footpaths, roads, bollards and permanent fencing.
- All works shall comply with the recommendations of the Fire Management Plan.

2.9. ENTRY TREATMENTS

The entry points as defined on the Landscape Masterplan should express the design character of the development in respect to the local context. Any signage shall be clearly legible, reflect the project's design style and comply with the local authority's signage policy.

Where appropriate, street trees and entry features will be used to promote the significant nature of these entry precincts by creating landmarks, forming strong avenues and framing views to distant feature elements. Feature planting is preferable in order to create a landmark and assist in the providing a hierarchy and legibility through the streetscape network. Landscape design options shall be tailored to meet all necessary civil design standards while expressing the character of the precinct.

2.10. DRAINAGE/STORMWATER

The development aims to utilise water sensitive urban design principles covering the following:

- Stormwater detention in POS areas to minimise downstream flows following major storm events
- Bio retention swales to collect stormwater runoff.
- Dedicated first flush areas to capture sand and silt from development areas
- Reed and fringing vegetation to swales to provide a nutrient stripping function

It is important that proposed swales/basins provide for multiple uses including recreation, storm water management and creation of natural habitat.

2.11. DRAINAGE TREATMENTS ADJACENT TO POS

All stormwater from the development will be directed into a system of drainage swales and bio-retention basins constructed along the edges of the POS and within the road reserve. These devices will be sized to treat the flows from the 1 in 1 yr event in accordance with the principles of the Department of Water, Stormwater Management Manual for Western Australia. Storm events in excess of these will be directed into outlet basins located within the POS area.



2.12. IRRIGATION STRATEGY

In general terms the project is committed to undertaking water sensitive urban design with minimal impact on existing groundwater and the preservation of water quality. The project is also committed to minimising the volume of water used for irrigation. The following principles are held.

- Minimise the extent of irrigation and the volume of water consumed
- Minimise the extent of irrigated turf
- Minimise the extent of long term irrigation usage to planted beds
- Use of hydrozoning
- Use of xeriscaping where practical.
- Utilise water harvesting techniques where practical.

Irrigation shall aim to incorporate elements of subsurface, drip and trickle water application methods. Water application shall be based on seasonal need and be constructed of reliable, readily available and cost effective fittings, infrastructure and materials. Hydrozoning principles shall be incorporated at the detailed design stage.

All irrigation shall be installed to the local authority's standard specifications and industry best practice. Maintenance minimisation processes will apply in all circumstances. Controllers shall be keyed and accessed in accordance with the local authority's standards. Irrigation shall be designed to incorporate stations that can be terminated as agreed upon planting establishment and maintenance handover to the Council in accordance with relevant policies.

Further investigation is required to ascertain the presence of a suitable groundwater source prior to the documentation of a detailed groundwater usage and irrigation strategy. The presence and volume of suitable groundwater for irrigation will influence the design of the irrigation system and the operating and storage system proposed.

A number of dams are currently located on the site which, subject to a full investigation of groundwater levels and flows may provide an opportunity to act as storage. A detailed irrigation strategy will be prepared and submitted to the City of Swan as part of the detailed landscape and irrigation approvals.



2.13. SITE FURNITURE

The provision of street furniture demonstrates detailed consideration of human use and comfort. The inclusion of quality street furniture elements reinforces the intended design character, develops a sense of community and ownership among residents and encourages outdoor use.

The location of street furniture elements should closely correspond with more intensive areas of human use, gathering and recreation. Basic functional requirements shall typically include;

- Local availability for quick and cost effective replacement or parts as may be required,
- Cost effectiveness of installation, ongoing replacement and maintenance,
- Robust design to minimise the effects of vandalism or weathering,
- Robust appropriate fixing methods to prevent theft but allow maintenance,
- Colour being defined but neutral where possible to enable the maximum chance of matching with other site elements,
- Galvanised and powder coated finishes to maximise lifespan.

Elements shall provide a visually recognisable, clear and useful function. The types of street furniture envisaged include;

- Picnic settings & seating (formal and informal)
- Shade structures
- BBQs
- Rubbish bins
- Bollards
- Cycle racks
- Drinking fountains
- Boardwalks
- Conservation fencing
- Interpretive signage

2.14. PUBLIC ART

The selection and installation of appropriate public art creates interest, social discussion and promotes a sense of community and ownership to public spaces. Public art can provide historic, social, cultural and environmental comment and act as a reference to define a local area and community values.

It is intended that public art be distributed at either high profile points or community gathering spaces to ensure its value in place making is maximised. Locations should include vista and axis views from roads or pedestrian paths, inclusion into playgrounds or placement adjacent picnic locations. Individual lighting may be desirable in some instances to provide additional importance and focus to specific pieces.

2.15. MAINTENANCE MINIMISATION

In conjunction with the detail design of public open space and verge areas to be ultimately vested and controlled by the Council, a maintenance minimisation review and asset management plan shall be undertaken by the developer to assist in assessing and reducing the likely future maintenance costs. This process may typically include;

- review of all materials to ensure fitness for purpose and lifespan requirement,
- review of the area of planting vs turf areas,
- review of plant and turf species and their specific growth habits and requirements,
- monitoring of groundwater quality and levels,
- review of irrigation materials and standards,
- implementation of sustainability and water wise principles to enable the reduction of ongoing costs through removal of some short term landscape establishment assets,
- review of all structural design to ensure fitness for purpose and lifespan.

3. IMPLEMENTATION

3.1. APPROVALS

As part of an ongoing process, after the Local Structure Plan has been endorsed by the Shire and the sub division approvals received, each POS landscape and irrigation design will be submitted as a detailed documentation package to the Shire for review and approval.

The landscape design will incorporate recreation and environmental requirements, while focusing on maintenance minimisation principles and techniques.

The developer is committed to working with the City of Swan to deliver long term outcomes in this process to reflect best practice throughout the development.

3.2. PRACTICAL COMPLETION

Upon reaching Practical Completion of the landscape and irrigation works, a meeting shall be arranged and attended by the consulting landscape architect and the relevant council officers to inspect the completed landscape works. Following this inspection the Developer's representative shall issue to council the following:

- A list of items requiring completion
- As-constructed landscape and irrigation drawings
- Details including capital costs of all physical assets for inclusion in the Councils asset register

Following Practical Completion the Developer shall organise to:

- Carry out any remedial works noted during the Practical Completion inspection without delay
- Undertake maintenance of the POS as agreed with council.

3.3. LANDSCAPE MAINTENANCE RESPONSIBILITY

The developer funded and managed landscape and irrigation maintenance period of two years will apply to all public open space areas following completion of landscape construction works.

The maintenance period commences on the date of Practical Completion. Typically the first year is an establishment period, followed by a year of landscape maintenance.

After the two year period the POS landscape and irrigation maintenance will be handed over to the Local Government Authority to control, fund and manage.

3.4. SCHEDULED HANDOVER

Three months prior to the expiration of the maintenance period (from practical completion), the Developer shall contact the relevant Council officer to initiate the handover process, which will commence with an inspection of the POS.

At the handover inspection, the Developer shall provide to the Officer:

- Details of the areas maintained
- As-constructed irrigation drawings to include changes made to the system during the maintenance period
- Warranties, manuals and logbooks.

Following handover inspection and prior to the handover date, the Developer shall:

- Rectify all defects noted during the handover inspection and others that may emerge before the handover date
- The Council shall provide written confirmation that Council accepts responsibility for maintenance and liability for the location involved.

4. APPENDIX A LANDSCAPE MASTERPLAN



LEGEND

Site Boundary

POS

Indicative 1:1 ARI Drainage

Existing Dam

Existing Vegetation



Neighbourhood POS/Recreation nodes (high order)



Neighbourhood POS/Recreation nodes (low order)



Entry Statements



Green Streets



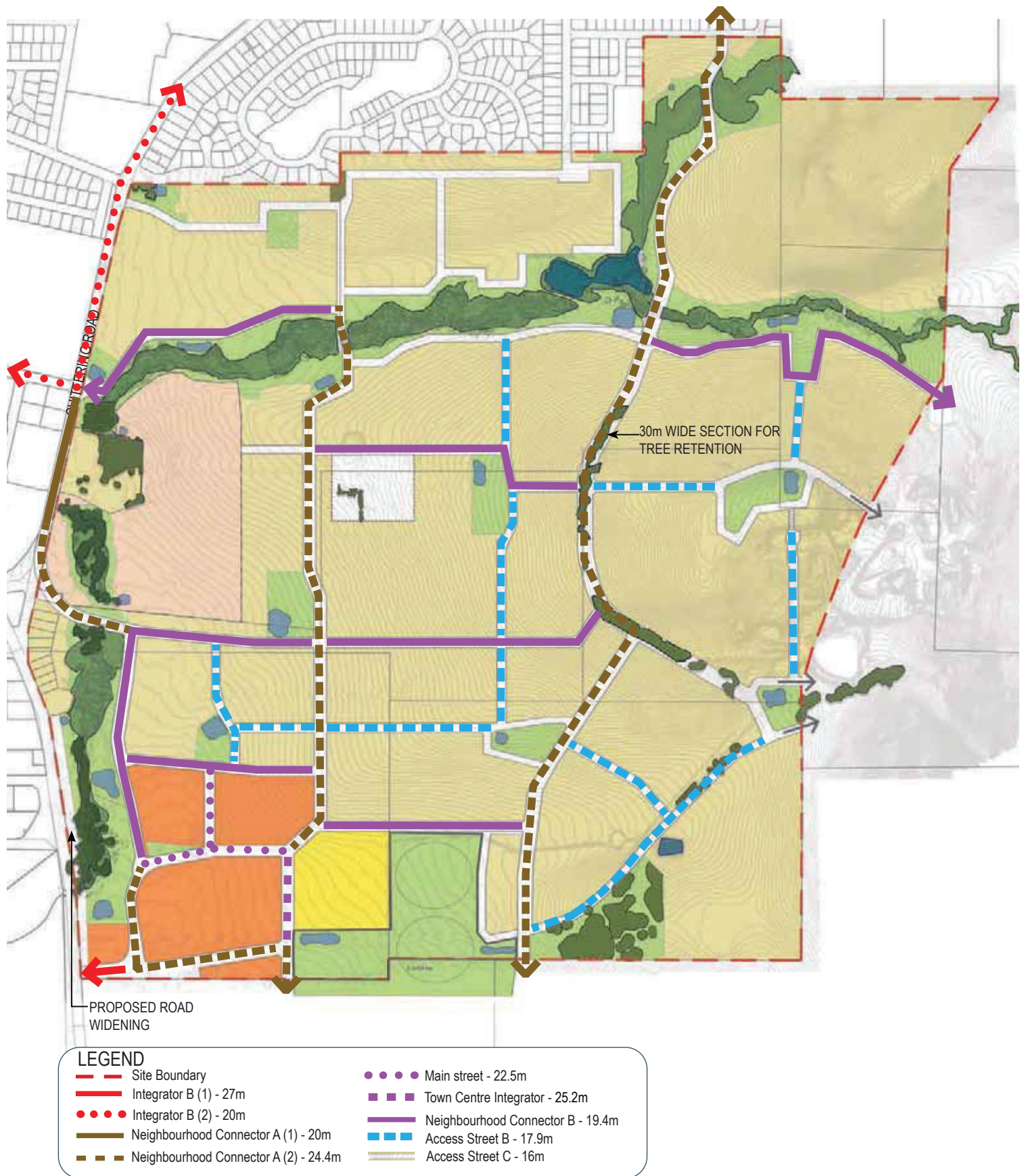
Town Centre

400m Ped Shed

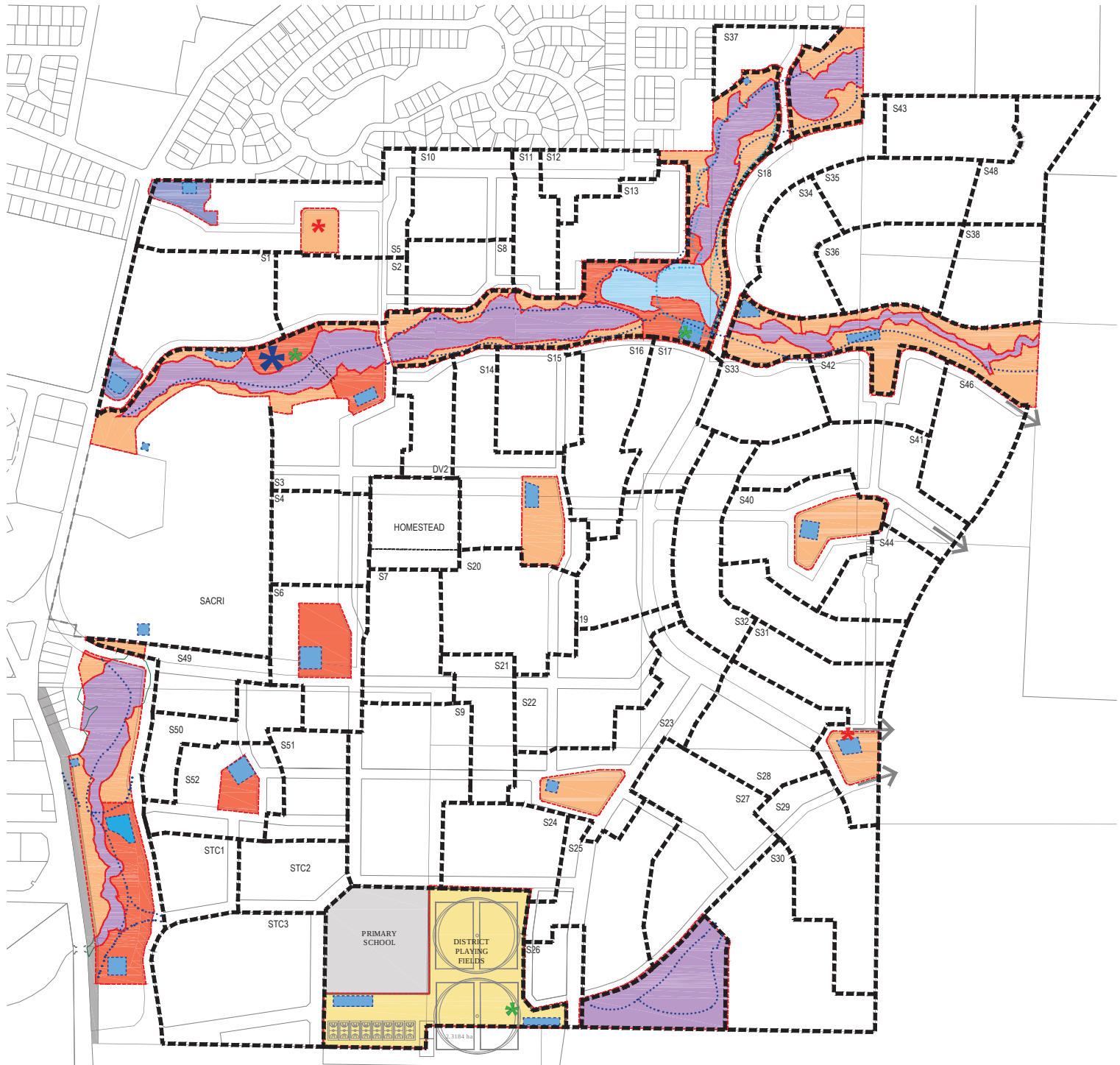
800m Ped Shed



6. APPENDIX C STREET HIERARCHY



7. APPENDIX D FACILITIES PLAN



LEGEND

--- Landscape Zone Boundary
 --- Landscape Stage Boundary

□ District Open Space
 □ Neighbourhood Open Space (High order amenity)

□ Local and / or Linear Open Space
 □ Small Open Space
 □ Ki-it Monger Brook and Conservation Areas
 □ Dam

* No Formal Play Facilities
 * Toilet Facilities
 * District POS
 ... Running Track
 ... Walking Track
 □ Indicative 1:1 ARI Drainage

NOTE: VERGE AND MEDIAN LANDSCAPE ZONES HAVE NOT BEEN DISPLAYED ON THIS DIAGRAM.

NOTE: A NETWORK OF TRAILS/PATHS FOR WALKING AND CASUAL CYCLING TO CONNECT ALL POS/CONSERVATION AREAS

8. POS STRATEGY - GREEN STREETS

BRIEF DESCRIPTION

- Retention of existing vegetation and creation of new landscape within a widened Road Reserve
- Creation of a 'Green Street' - a widened road reserve to create a sense of space and connectivity throughout the estate. This promotes legibility via creation of a landmark and establishes a hierarchy within the streets.
- Opportunity for stormwater and bio-filtration within widened road reserves
- Passive recreation opportunities
- Habitat corridors
- Opens view to hills



9. POS STRATEGY - NEIGHBOURHOOD PARKS

BRIEF DESCRIPTION

Located throughout the development, the Neighbourhood POS provides residents with open space in close proximity to their dwellings. The parks have areas of turf for passive play and informal kick about area with nodes of seating and shelter either provided by trees or built structure. A path network through and around the POS allows footpath connection to surrounding streets and other POS. Drainage will be incorporated within these areas.

SIZE (Excluding Verges)

POS 1: 3,023 sq.m	POS 6: 11,104 sq.m
POS 2: 4,679 sq.m	POS 7: 5,218 sq.m
POS 3: 4,508 sq.m	POS 8: 7,366 sq.m
POS 4: 10,767 sq.m	POS 9: 6,256 sq.m
POS 5: 10,187 sq.m	

FUNCTIONS

- Native, water wise planting. Deciduous used when and where appropriate
- Maximise shade trees with emphasis on native species
- Limited picnic facilities
- Internal path network
- Path network connecting into the broader path network
- Drainage
- Passive solar
- Historical and cultural character
- Landmark and feature planting

ENVIRONMENTAL CONSIDERATIONS

- Waterwise native planting
- Planting design to be zoned according to irrigation requirement, with full irrigation requirements to the informal turf playing area
- Source local materials where possible
- Consider the long term maintenance requirements for all materials



10. POS STRATEGY - DISTRICT POS/PLAYING FIELDS

BRIEF DESCRIPTION

- Landmark/destination for residents and community groups
- Opportunity to co-locate facilities (i.e. playing fields, junior ovals and hardcourts for future school and community)
- Provide shared amenities (i.e. shelters, BBQ areas, play and exercise nodes)
- Distinct active/passive zones amongst activities and age groups
- Promote accessibility and usage by community
- Pedestrian and cycle path along perimeter to connect into broader path network
- Playing fields with capacity for organised sporting and large scale community events
- Potential for grandstand for viewing
- Allow for drainage and stormwater flows
- Allowance for access and carparking provisions

SIZE (Excluding Verges) = 63,374 sq.m



FUNCTIONS

- Service diverse range of passive and active recreational activities
- Open area for informal/formal sports and events
- Predominantly irrigated turf for sporting fields
- Maximise shade trees
- Play elements for all ages
- Drainage
- Connection/Colocation with education facilities

ENVIRONMENTAL CONSIDERATIONS

- Planting design to be zoned according to irrigation requirement, with full irrigation requirements to the formal turf sporting fields
- Consider stormflows and drainage requirements
- Source local materials where possible
- Consider the long term maintenance requirements for all materials



11. POS STRATEGY - CONSERVATION AREA

BRIEF DESCRIPTION

- Conservation and protection of the site

SIZE (Excluding Verges) = 30,776 sq.m

FUNCTIONS

- Conservation
- Drainage

ENVIRONMENTAL CONSIDERATIONS

- No irrigation
- Re-vegetation of native plant communities to degraded areas. Location to be determined in detail design
- Removal of weed species



12. POS STRATEGY - KI-IT MONGER BROOK

BRIEF DESCRIPTION

- Primary POS/link with development
- Existing vegetation along brook alignment to be retained
- Revegetate and rehabilitate
- Promote accessibility and usage by community
- Pedestrian and cycle paths along top of bank interconnecting with recreational nodes along linear route/network.
- Play spaces/boardwalks/interpretive/signage/educational opportunities
- Allow for drainage and stormwater flows

SIZE (Excluding Verges) = 297,608 sq.m



FUNCTIONS

- Turf - informal kick-about, play spaces and picnic areas
- Native waterwise vegetation
- Maximise shade trees
- Picnic facilities for family/friend gatherings
- Play elements for all ages
- Path network connecting into broader path network
- Drainage
- Ecological function
- Habitat
- Education
- Connection

ENVIRONMENTAL CONSIDERATIONS

- Waterwise native planting
- Planting design to be zoned according to irrigation requirement, with full irrigation requirements to the informal turf playing areas
- Source local materials where possible
- Consider the long term maintenance requirements for all materials
- Consider stormflows and drainage requirements
- Rehabilitation/revegetation
- Respect geomorphology of existing and historic creekline



13. PROPOSED PLANT PALETTE

13.1 KI-IT MONGER BROOK AND LIVING STREAM REVEGETATION

Inundated - Bank Edge	
Shrubs/Sedges/Herbs/Groundcovers	
Species Name	Common Name
<i>Baumea articulata</i>	Jointed Twig Rush
<i>Baumea juncea</i>	Bare Twig Rush
<i>Baumea vaginalis</i>	Sheath Twig Rush
<i>Bolboschoenus caldwellii</i>	Marsh Club Rush
<i>Gahnia trifida</i>	Coast Saw Sedge
<i>Juncus subsecundus</i>	Finger Rush
<i>Juncus pallidus</i>	Pale Rush
<i>Lepidosperma longitudinale</i>	Pithy Sword Sedge
<i>Leptocarpus laxus</i>	
<i>Lepyrodia glauca</i>	
<i>Meeboldina coangustata</i>	
<i>Pericalymma elipticum</i>	Swamp Teatree
Trees	
<i>Melaleuca raphiophylla</i>	Swamp Paperbark
Lower Slope - Bank Edge	
Shrubs/Sedges/Herbs/Groundcovers	
Species Name	Common Name
<i>Anigozanthus bicolour</i>	Little Kangaroo Paw
<i>Baumea articulata</i>	Jointed Twig Rush
<i>Baumea juncea</i>	Bare Twig Rush
<i>Baumea vaginalis</i>	Sheath Twig Rush
<i>Bolboschoenus caldwellii</i>	Marsh Club Rush
<i>Gahnia trifida</i>	Coast Saw Sedge
<i>Hypocalymma angustifolium</i>	White Myrtle
<i>Juncus subsecundus</i>	Finger Rush
<i>Juncus pallidus</i>	Pale Rush
<i>Lepidosperma longitudinale</i>	Pithy Sword Sedge
<i>Leptocarpus laxus</i>	
<i>Lepyrodia glauca</i>	
<i>Meeboldina coangustata</i>	
<i>Pericalymma elipticum</i>	Swamp Teatree
<i>Regelia ciliata</i>	
<i>Scholtzia involucreta</i>	Spiked Scholtzia
Trees	
<i>Melaleuca preissiana</i>	Moonah
<i>Melaleuca raphiophylla</i>	Swamp Paperbark
<i>Taxandria linearifolia</i>	

Mid Slope - Bank Edge	
Shrubs/Sedges/Herbs/Groundcovers	
Species Name	Common Name
<i>Anigozanthus bicolour</i>	Little Kangaroo Paw
<i>Astartea scoparia</i>	
<i>Dasypogon bromefolius</i>	Pineapple Bush
<i>Kunzea glabrescens</i>	
<i>Hypocalymma angustifolium</i>	White Myrtle
<i>Leucopogon tenuis</i>	
<i>Melaleuca incana</i>	Grey Honeymyrtle
<i>Melaleuca thymoides</i>	
<i>Regelia ciliata</i>	
<i>Scholtzia involucrata</i>	Spiked Scholtzia
Trees	
<i>Eucalyptus rudis</i>	Flooded Gum
<i>Melaleuca preissiana</i>	Moonah
<i>Taxandria linearifolia</i>	
Upper Slope - Foreshore	
Shrubs/Sedges/Herbs/Groundcovers	
Species Name	Common Name
<i>Astartea scoparia</i>	
<i>Kunzea glabrescens</i>	
<i>Leucopogon tenuis</i>	
<i>Melaleuca incana</i>	Grey Honeymyrtle
<i>Melaleuca thymoides</i>	
Trees	
<i>Corymbia calophylla</i>	Marri
<i>Eucalyptus lane-poolei</i>	Salmon White Gum
<i>Eucalyptus marginata</i>	Jarra
<i>Eucalyptus wandoo</i>	Wandoo
<i>Melaleuca preissiana</i>	Moonah
<i>Taxandria linearifolia</i>	
<i>Xanthorrhoea preissii</i>	Grass Tree
Dryland Revegetation	
Shrubs/Sedges/Herbs/Groundcovers	
Species Name	Common Name
<i>Acacia divergens</i>	
<i>Acacia pulchella</i>	Prickly Moses
<i>Acacia saligna</i>	Orange Wattle
<i>Allocasuarina humilis</i>	Dwarf Sheoak
<i>Anigozanthos manglesii</i>	Mangles Kangaroo Paw
<i>Conostylis aculeata</i>	Prickly Conostylis
<i>Dampiera linearis</i>	Common Dampiera
<i>Dianella revoluta</i>	Dianella
<i>Dryandra nivea</i>	Honeypot Dryandra
<i>Ficinia nodosa</i>	Knotted Club Rush
<i>Grevillea pilulifera</i>	Woolly Flowered Grevillea
<i>Hakea ceratophylla</i>	Norned Leaf Hakea
<i>Hakea lissocarpha</i>	Honey Bush
<i>Hakea prostrata</i>	Harsh Hakea
<i>Hakea stenocarpa</i>	Narrow Fruited Hakea
<i>Hakea trifurcata</i>	Two Leaf Hakea

<i>Hypocalymma angustifolium</i>	White Myrtle
<i>Hypocalymma robustum</i>	Swan River Myrtle
<i>Kunzea micrantha</i>	
<i>Melaleuca laterifolia</i>	Gorada
<i>Patersonia occidentalis</i>	Purple Flag
<i>Eremophila glabra</i>	Tar Bush
<i>Grevillea crithmifolia</i>	
Trees	
<i>Allocasuarina fraseriana</i>	Sheoak
<i>Corymbia calophylla</i>	Marri
<i>Eucalyptus marginata</i>	Jarra
<i>Eucalyptus rudis</i>	Flooded Gum
<i>Eucalyptus wandoo</i>	Wandoo
<i>Nuytsia floribunda</i>	Christmas Tree

13.2 PARKLAND PLANTING (POS AREAS/BOULEVARDS)

Shrubs/Sedges/Herbs/Groundcovers	
Species Name	Common Name
<i>Acacia cognata</i> 'Limelight'	Limelight
<i>Acacia cognata</i>	
<i>Adenanthos sericea</i>	Albany Woolly Bush
<i>Agonis flexuosa</i> 'Nana'	
<i>Anigozanthus</i> ssp.	Kangaroo Paw
<i>Carex comans</i>	
<i>Dianella</i> ssp.	Dianella
<i>Dryandra nivea</i>	Honeypot Dryandra
<i>Eremophila</i> 'Carramar Grey'	
<i>Ficinia nodosa</i>	Knotted Club Rush
<i>Grevillea crithmifolia</i>	
<i>Grevillea obtusifolia</i> 'Gin Gin Gem'	Gin Gin Gem
<i>Grevillea</i> 'Golden Lyre'	Golden Lyre
<i>Grevillea</i> 'Lollypops'	Lollypops
<i>Grevillea thelemanniana</i>	Spidernet Grevillea
<i>Lomandra</i> ssp	Lomandra
<i>Pattersonia occidentalis</i>	Purple Flag
<i>Olearia axillaris</i>	Coastal Daisy Bush
<i>Phormium tenax</i> 'Purpurea'	Phormium
<i>Westringia fruticosa</i>	Coastal Rosemary
Trees	
<i>Agonis flexuosa</i>	Native Peppermint
<i>Brachychiton acerifolius</i>	Illawarra Flame Tree
<i>Corymbia calophylla</i>	Marri
<i>Corymbia maculata</i>	Spotted Gum
<i>Erythrina indica</i>	Coral Tree
<i>Eucalyptus marginata</i>	Jarra
<i>Fraxinus raywoodii</i>	Claret Ash
<i>Liquidambar styraciflua</i>	Liquidambar
<i>Platanus acerifolia</i>	London Plane Tree
<i>Xanthorrhoea preissii</i>	Grass Tree

13.3 DRAINAGE BASIN PLANTING (POS AREAS / LINEAR PARKS)

Inundated - Bank Edge	
Shrubs/Sedges/Herbs/Groundcovers	
Species Name	Common Name
<i>Baumea articulata</i>	Jointed Twig Rush
<i>Baumea juncea</i>	Bare Twig Rush
<i>Baumea vaginalis</i>	Sheath Twig Rush
<i>Bolboschoenus caldwellii</i>	Marsh Club Rush
<i>Gahnia trifida</i>	Coast Saw Sedge
<i>Juncus kraussii</i>	Sea Rush
<i>Juncus subsecundus</i>	Finger Rush
<i>Juncus pallidus</i>	Pale Rush
Trees	
Species Name	Common Name
<i>Casuarina obesa</i>	Swamp Sheoak
<i>Melaleuca raphiophylla</i>	Swamp Paperbark
Lower Slope - Bank Edge	
Shrubs/Sedges/Herbs/Groundcovers	
Species Name	Common Name
<i>Anigozanthus bicolour</i>	Little Kangaroo Paw
<i>Baumea articulata</i>	Jointed Twig Rush
<i>Baumea juncea</i>	Bare Twig Rush
<i>Baumea vaginalis</i>	Sheath Twig Rush
<i>Bolboschoenus caldwellii</i>	Marsh Club Rush
<i>Gahnia trifida</i>	Coast Saw Sedge
<i>Hypocalymma angustifolium</i>	White Myrtle
<i>Juncus kraussii</i>	Sea Rush
<i>Juncus subsecundus</i>	Finger Rush
<i>Juncus pallidus</i>	Pale Rush
Trees	
<i>Casuarina obesa</i>	Swamp Sheoak
<i>Melaleuca raphiophylla</i>	Swamp Paperbark
<i>Eucalyptus rudis</i>	Flooded Gum
Mid Slope - Bank Edge	
Shrubs/Sedges/Herbs/Groundcovers	
Species Name	Common Name
<i>Anigozanthus bicolour</i>	Little Kangaroo Paw
<i>Dampiera linearis</i>	Common Dampier
<i>Ficinia nodosa</i>	Knotted Club Rush
<i>Hypocalymma angustifolium</i>	White Myrtle
<i>Lomandra longifolia</i>	Lomandra
Trees	
<i>Eucalyptus rudis</i>	Flooded Gum
<i>Melaleuca preissiana</i>	Moonah

Upper Slope - Foreshore	
Shrubs/Sedges/Herbs/Groundcovers	
Species Name	Common Name
<i>Anigozanthus bicolour</i>	Little Kangaroo Paw
<i>Dampiera linearis</i>	Common Dampier
<i>Ficinia nodosa</i>	Knotted Club Rush
<i>Hypocalymma angustifolium</i>	White Myrtle
<i>Lomandra longifolia</i>	Lomandra
Trees	
<i>Corymbia calophylla</i>	Marri
<i>Euclayptus lane-poolei</i>	Salmon White Gum
<i>Eucalyptus marginata</i>	Jarrah
<i>Eucalyptus rudis</i>	Flooded Gum
<i>Melaleuca preissiana</i>	Moonah

13.4 STREETScape PLANTING

Shrubs/Sedges/Herbs/Groundcovers	
Species Name	Common Name
<i>Acacia cognata</i> 'Limelight'	Limelight
<i>Agonis flexuosa</i> 'Nana'	
<i>Anigozanthus ssp.</i>	Kangaroo Paw
<i>Carex comans</i>	
<i>Dianella ssp.</i>	Dianella
<i>Eremophila</i> 'Carramar Grey'	
<i>Ficinia nodosa</i>	Knotted Club Rush
<i>Grevillea crithmifolia</i>	
<i>Grevillea obtusifolia</i> 'Gin Gin Gem'	Gin Gin Gem
<i>Grevillea thelemanniana</i>	Spider Net Grevillea
<i>Lomandra ssp</i>	Lomandra
<i>Olearia axillaris</i>	Coastal Daisy Bush
<i>Phormium tenax</i> 'Purpurea'	Phormium
<i>Westringia fruticosa</i>	Coastal Rosemary
Trees	
<i>Agonis flexuosa</i>	Native Peppermint Tree
<i>Brachychiton acerifolius</i>	Illawarra Flame Tree
<i>Callistemon</i> 'Kings Park Special'	
<i>Corymbia calophylla</i>	Marri
<i>Corymbia maculata</i>	Spotted Gum
<i>Erythrina indica</i>	Coral Tree
<i>Eucalyptus marginata</i>	Jarrah
<i>Fraxinus raywoodii</i>	Claret Ash
<i>Liquidambar styraciflua</i>	Liquidambar
<i>Platanus acerifolia</i>	London Plane Tree
<i>Ulmus parvifolia</i>	Chinese Elm

13.5 TREE SPECIES SELECTION

NATIVE SPECIES



Agonis flexuosa
Willow Myrtle



Allocasuarina fraseriana



Callistemon 'Kings Park Special'



Casuarina obesa
Samp Sheoak



Corymbia calodora
Merrill



Eucalyptus laneway
White



Eucalyptus arida
rr



Eucalyptus rubra
looe



Eucalyptus oblonga
ri ly r



Eucalyptus anthonii
Wite



Melaleuca reissiana
Mo o



Melaleuca raietiana
w er r



Nuytsia floribunda
W ri t ree



Pandanus linearifolius



Pandanus roosei
r tree

EXOTIC SPECIES



Jacaranda mimosifolia
Flowering tree



Pinus pinaster
Pine



Quercus robur
Oak



Jacaranda mimosifolia
Flowering tree



Jacaranda mimosifolia



Jacaranda mimosifolia
r



Liquidambar styraciflua
Sweet



Platanus acerifolia
London Plane Tree



Platanus acerifolia
Tree

Appendix 7

Engineering Services Report

(JDSI)

Submission to Okeland Communities

SERVICING REPORT Bullsbrook Landholdings Revised Bullsbrook Central Structure Plan



JDS15920

Aug 2021

INTEGRITY

We are open, honest, and consistent in our principles and conduct, so we're able to build trusted relationships with our clients and partners.

RESPECT

We treat everyone with respect and dignity and develop relationships founded on understanding and trust.

ACCOUNTABILITY

We always assume responsibility for our actions and make decisions in line with our economic, social, and ethical obligations.

EXCELLENCE

We pursue excellence in everything we do, challenging ourselves to look beyond the obvious and ensure ongoing improvement.

This page has been intentionally left blank.



Table of Contents

1	Introduction.....	3
2	The Study Area	4
2.1	Topography.....	4
2.2	Ground Conditions	4
3	Wastewater.....	6
4	Water Supply.....	7
5	Power Supply	8
6	Gas Supply	9
7	Telecommunications	10
8	Roads and Traffic	11
8.1	Existing Traffic Conditions.....	11
8.2	Road and Intersection Improvements	11
9	Drainage	13
10	Disclaimer.....	14

1 Introduction

The Bullsbrook Landholdings (the development) is located approximately 40km north east of the Perth CBD. The site is located between the existing RAAF Pearce Airbase and the Darling Scarp, delineated by Great Northern Highway and Chittering Road to the west and Taylor Road to the east.

Okeland owns approximately 269 hectares with a planned total development yield of 2500+ residential lots.

This report has been prepared by JDSi Consulting Engineers to assist Okeland Communities with the Revised Bullsbrook Central – Local Structure Plan. It summarises the results of a review of the civil engineering issues which have influenced the form of the concept plan and which are related to the future servicing of the residential development of the concept plan area.

The key objectives of this report are to highlight:

- ▶ Existing infrastructure assets.
- ▶ Advise on infrastructure requirements for the planned development.
- ▶ Demonstrate the development can be serviced in the short to medium term.
- ▶ Advise on the implementation of key infrastructure requirements.
- ▶ Existing road networks and planned road networks are capable of supporting residential development in the short to medium term.

It is proposed the site will be developed for residential and Town Centre purposes with the specific aim of delivering an estate that achieves housing density targets aligned with the WAPC strategic directions for the region, as outlined in the “Sub Regional Structure Plan” documents. This includes the provision of residential, transitional and residential rural lifestyle lots in conjunction with primary schools, commercial retail centres and district recreation facilities.

This report has been based on the civil engineering aspects of urban land uses. The report covers the engineering infrastructure requirements to service the proposed development. The engineering review has covered earthworks, roads, stormwater drainage and utility services with a particular emphasis on outlining how all major utility services will be available once the rezoning of the landholding has been completed. This report will outline completed studies or studies currently underway and show that utility services are not an impediment on the development.

The investigations and preparation of the report are largely based on preliminary advice from the various service authorities. The information is current as of August 2021 and is subject to change as development proceeds in the Perth north east corridor resulting in the extension of service infrastructure and the creation of new capacity.

2 The Study Area

The development Study Area has a total land area of approximately 254.6 hectares. This site is located to the east of Great Northern Highway and south of the existing Bullsbrook townsite.

The Study Area is predominantly cleared open pasture with confined areas of trees and vegetation. The KI-IT Brook flows from the east/Darling Scarp through the west side of the landholding and under the Great Northern Highway via a bridge.

2.1 Topography

The land is located at the foothills of the Darling Scarp and is generally steep in nature with contours ranging from RL45 to the west to RL110 to the east. The RL110 is along the boundary adjacent to the neighbouring land holdings.

2.2 Ground Conditions

The following is a summary of the investigative reporting provided by Galt Geotechnical Consultants and is an overview of the likely soil types that will be encountered and proposed remedial measures;

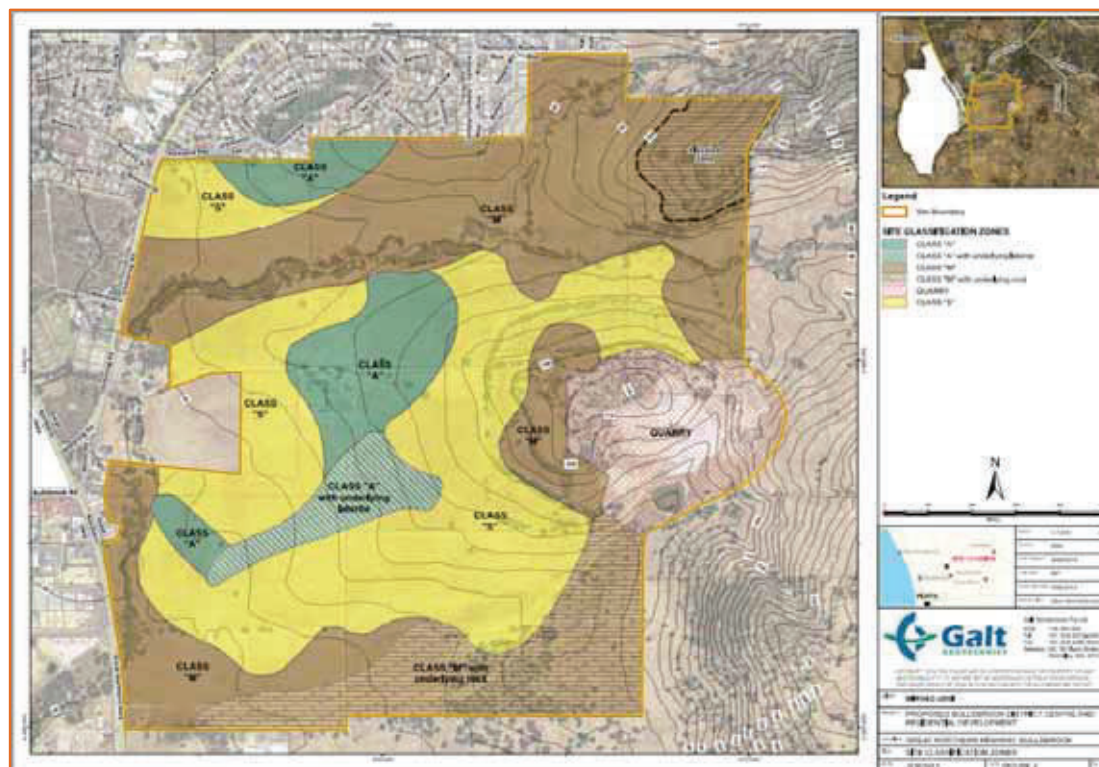
The Muchea sheet of the 1:50,000 scale Environmental Geology series of maps shows that the site is underlain by a variety of soil and rock types. The western part comprises mainly soil deposits while the eastern part of underlain by shallow rock and rock outcrop. The following notes are relevant:

1. Generally, soils over the western portion of the site are sandy overlaying clay/sandy clay. Test trenches were excavated to depths of 2.5m, typically with 0.5 to 1.0m of sand/gravelly sand cover.
2. Generally, soils over the eastern portion of the site are clays/clayey sand overlaying rock (siltstone/gravel/gneiss). Test trenches were refused at depths of 1.1 to 2.0m.
3. The soils are generally moderate to high reactive clay/clays soils with high percentage fines and low permeability.
4. The site is predominantly classed as M and S with some existing class A in the northern portion of the site.
5. The general remediation suggested is:
 - ▶ Strip 100mm topsoil and grub, remove deleterious material.
 - ▶ All excavated sand shall be reused as inert structural fill. The underlying clayey sand can be used for bulk fill (non structural) only.
 - ▶ Proof roll and lay inert clean structural fill with less than 5% fines at depths relevant to required classifications (>1.8m fill for class A, 1-1.8m fill for class S).
6. For areas where subgrade has >0.5m inert structural fill a CBR of 12 can be adopted for pavement design.
7. Drainage can be managed via infiltration only where clean sandy fill is present to a depth of 1.2m.

We would recommend that an allowance is made to fill the class M areas of the site by either 0.7m or 1.5m respectively to achieve class S or A classifications in accordance AS2870-2011 "Residential Slabs and Footings". This is based on the conservative assumption there is an average of 300mm of sandy fill overlaying the site. Ultimately this will have to be confirmed by intrusive geotechnical investigations.

Furthermore, detailed geotechnical work will be required at the time of land subdivision to confirm the assumptions and resulting building site classifications.

Refer to Galt Geotechnics drawing J1301013 002 R Rev1 (05 October 2015) for Preliminary Site Classification.





3 Wastewater

The Water Corporation advised JDSi that the development is located within the current scheme planning and a connection to gravity sewer has been provisioned for. The following provides a summary of the current advice.

The existing Bullsbrook wastewater treatment plant (WWTP) currently only caters for the existing urban zoned land within the Bullsbrook area and is currently close to full capacity. The Water Corporation is monitoring flows to the WWTP.

The Water Corporation has recently advised that the WWTP will be converted into a major transfer station with the additional flows created by the landholdings being rezoned to be pumped from Bullsbrook to Ellenbrook via a major transfer pipeline. The Water Corporation has advised that this project should be completed by mid 2023.

The land which is the subject of this report will require a pump station which is currently being designed, to be located within the south west corner of the site, adjacent to the future town centre. At a recent meeting with the Water Corporation they confirmed this pump station is on their capital works program. JDSi has received the information pack from the Water Corporation and has begun the scoping report design of this pump station. It is anticipated this pump station will be commissioned by FY22 at the latest. JDSi can confirm that servicing the landholdings via gravity sewer is possible and is not an impediment to development.



4 Water Supply

The Water Corporation has advised JDSi that the development is located within the current scheme planning and a connection to water reticulation has been provisioned for under an upgrade of the existing infrastructure located within Great Northern Highway (GNH). The following provides a summary of the advice.

The WC have recently completed the planning study for the delivery of additional water services to the Bullsbrook area. This included supply to the residential area on the eastern side of Great Northern Highway and Chittering Road including the proposed development site. WC advised that supply to the project area would be via a new DN300 distribution main between Great Northern Highway and Hurd Road installed to the west of the site along Chittering Road.

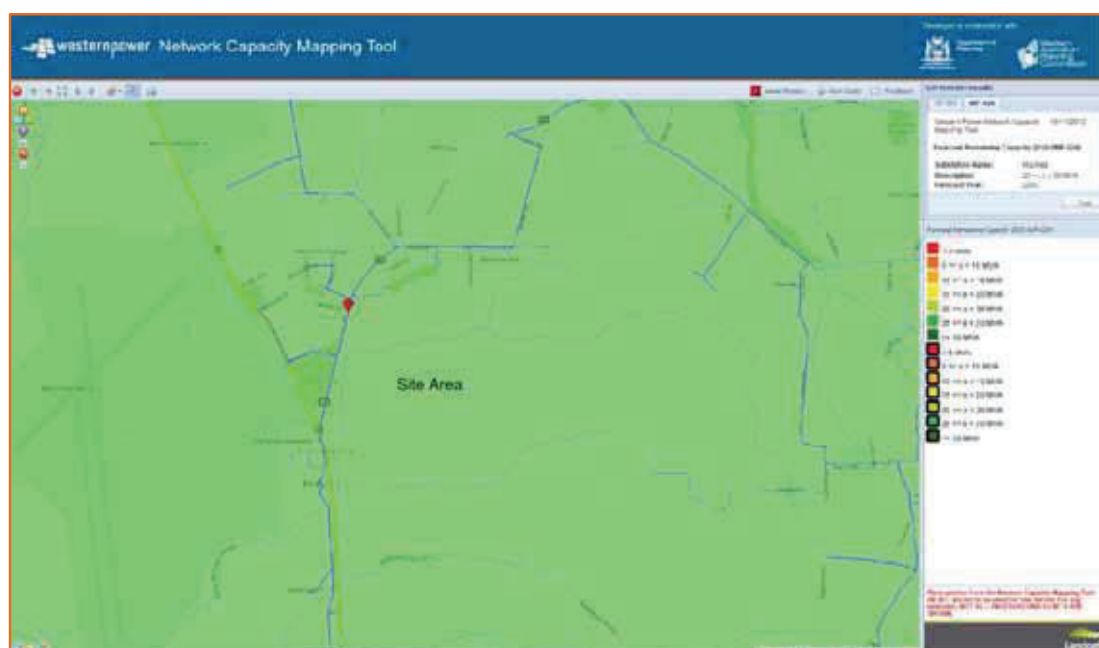
Provision of the new distribution main would include the installation of a new high level tank with 2km of DN300 inlet mains and associated pump station to convey the water from the existing Bullsbrook tank to a new tank and 2km of DN350 outlet mains to distribute the water back down to Chittering Road. JDSi can confirm that servicing the landholdings for water reticulation is possible and is not an impediment to development.

5 Power Supply

The Distribution network in this area currently provides power supply to mostly large rural lots. These lots are serviced by an existing three phase 22kV high voltage aerial network with small, lightly loaded pole top transformers. These feeders emanate from the Muchea substation. The development site is located approximately 20km south east of the Muchea 132kV / 22kV zone substation.

It will be a requirement that all existing aerial distribution lines are converted to underground cables within and bordering this development. Western Power's Network Capacity Mapping Tool indicates that there is enough capacity to feed the estimated ultimate 2500+ lots. JDSi can advise that a feasibility study was recently undertaken that indicates the remaining capacity on the existing 22kV feeder adjacent to the development was approximately 4MVA. Beyond the initial supply, reinforcement of the upstream 22kV feeder line, and voltage regulator may also be required. The development will also require a number of transformers, switchgear units and associated low voltage cable and pillar infrastructure to service the lots.

An extract below from Western Power Network Capacity Mapping Tool indicates that the forecast 2030 capacity for the area will be between 20 to 30 MVA.





6 Gas Supply

The Bullsbrook area currently has no reticulated gas network. Reticulated gas is not considered to be an essential service and as such is not required as a condition of subdivision. It is usual practice to install gas reticulation network for the subdivision within a common civil trench at no cost to the developer. If there is an extension required to connect to the nearest high pressure gas main the developer will be required to pay for the trenching to the gas main as a headworks cost.

The nearest high pressure mains are located some 13km away to the south in Ellenbrook and has recently been incorporated within ATCO's capital works programme. The timing for the gas main extension will coincide with the construction of Stock Road.

It is recommended consideration be given to the option of the developer funding the installation of a "dormant" internal gas network to the subdivision vested with ATCO Gas that could be connected into ATCO mains at some point in the future. ATCO have agreed in principle to assess such a proposal and ensure the design meets with ATCO standards.

JDSi recently contacted ATCO to obtain updated information. ATCO has advised that they have received construction costs of the new main from Ellenbrook to Bullsbrook and are confirming timing of portions of the main to begin construction in early 2022.



7 Telecommunications

JDSi has approached the national broadband installation initiative, NBN Co. to determine if the development site is located within the NBN rollout footprint. NBN Co. has advised that the development can be serviced from their existing infrastructure in the vicinity of the site. They have advised that they already have permanent equipment in the Bullsbrook exchange as well as a live network as part of the Bullsbrook Landing development.

As the development is close to the Bullsbrook exchange, NBN Co. has confirmed that there is no requirement for backhaul charges for the development.

The NBN standard process will apply to this development and therefore an application from the developer will be required prior to NBN Co commencing feasibility assessment process to provide early planning information and costing of any backhaul link.

After NBN connectivity for the development has been established at the boundary of the development, connections of subdivision lots to the network will thereafter be managed stage by stage. NBN deployment contribution fees of \$600 per premises for Single Dwelling Unit lots and \$400 per premises for Multi Dwelling Unit lots will apply.

8 Roads and Traffic

This site is located between the existing RAAF Pearce Airbase and the Darling Scarp, delineated by Great Northern Highway (GNH) and Chittering Road to the west and Taylor Road to the east. The site has excellent access to road transport infrastructure.

Chittering Road is the main connector to the local road network. It has direct access to the primary distributor for the area, the Great Northern Highway, and also acts as a district bypass providing northward connections to the regional suburbs of Western Australia between Bullsbrook and Chittering before reconnecting to GNH at Lake Chittering.

The Great Northern Highway provides the southwards road connection to the Perth Metropolitan Area. It also provides the northwards connection to the rest of Western Australia.

The Tonkin Highway extension / Perth Darwin National Highway (PDNH) has recently been completed and is the new long term transport route between the Perth Metropolitan Area and Northwest of Western Australia. This new road has reduced traffic loads on the Great Northern Highway. The new highway is located approximately 3.5km to the west of the development site.

The traffic movement patterns for the Bullsbrook area have changed substantially due to the construction of the new highway with most heavy vehicle traffic moving to PDNH from GNH. This change has reduced the movements of heavy vehicles adjacent to the development site, will promote improved traffic conditions for local vehicles and enhance the attraction of the development as the new residential townsite for Bullsbrook.

8.1 Existing Traffic Conditions

The site is bounded on two sides by existing roads, namely:

1. The Great Northern Highway lies on the western side of the development site and this road is classified as a primary distributor under the Perth metropolitan road hierarchy and is the national highway linking Perth and Darwin. The road is currently constructed as a two lane undivided paved highway with various passing lanes and turning pockets associated with intersections. The existing intersections are treated as intersections with low volume local roads.
2. Chittering Road lies on the western side of the development site and this road is classified as a district distributor B under the Perth metropolitan road hierarchy. The road is currently constructed as a two lane undivided paved road with various turning pockets associated with intersections. The existing intersections are treated as intersections with low volume local roads.

8.2 Road and Intersection Improvements

The existing roads will require improvements and upgrades which can be progressively completed to match the rate of development. As the development will be staged, the increase in traffic volumes on the GNH and Chittering Road can be managed. This will be achieved by implementing reduced speed zones, provision of controlled accesses along the frontage of the development with the GNH & Chittering Road. This will be achieved by complementing the existing GNH Access Strategy for the connections to GNH and will involve joint liaison with MRWA, the Client and relevant stakeholders.



The internal roads are proposed to be to the City of Swan's standards and are proposed to have 6.0m pavements in 16.0m road reserve for urban access roads, increasing to a 7m pavement within a 23m road reserve for Neighbourhood Connector type roads. Intersections, sweeps/corners, and roundabouts will be designed for vehicle turning movements defined in AUSTRROADS design guidelines.

The subdivision roads within the development area will need to be constructed in accordance with the IPWEA Subdivision Guidelines and read in conjunction with the City of Swan's subdivisional "Guidelines and Standards". All internal roads are owned and maintained by the City of Swan.

9 Drainage

Urban Water Management (UWM) is now a key part of any development process incorporating principles of integrating water and land use planning, considering all water sources in water planning, integrating water use and natural water processes and a total catchment integration of natural resource use and management (Ref. Stormwater Management Manual for Western Australia, DOW, April 2004 the State Water Strategy 2003 and the State Water Plan 2007).

Stormwater drainage management is a major component of an overall UWM strategy for which achievement of the principals of the plan may be facilitated through the application of Water Sensitive Urban Design (WSUD) techniques during planning, design and construction of urban development projects. Objectives of WSUD include but are not limited to the following:

- ▶ Detention of stormwater rather than rapid conveyance to maintain pre development flows for quantity management;
- ▶ Use of vegetation for filtering purposes and nutrient stripping for quality management;
- ▶ Use of stormwater to conserve potable water; and
- ▶ Water efficient landscaping.

Currently the main drainage system for the site consists of an existing creek (KI-IT Brook) that runs through the centre of the site and collects and distributes sheet flows from the Darling Scarp. The creek grades from east to west and contains a natural dam towards the centre providing detention and retardation of flows. At the western boundary of the site the creek changes direction and traverses in a north to south direction through a series of existing culverts of varying size beneath the Sacri Church land before being conveyed beneath GNH into the RAAF Pearce Airbase site.

Some of the proposed strategies that will be implemented on the site are:

- ▶ Managing runoff via a piped and pit system within road reserves with outfall into bioretention swales incorporated into POS areas adjacent the existing creek and wetlands/ponds.
- ▶ Lot runoff will be managed via onsite infiltration where it is possible to achieve 1.2m depth of clean permeable sandy soils.
- ▶ Bio retention swales will provide storage and infiltration for the 1 year 1 hour runoff volumes, with overflow into the creek for conveyance into the existing drainage system.
- ▶ Rehabilitation of the KI-IT Creek, including existing floodways / weirs, with upgrading as necessary.
- ▶ Given the natural groundwater level is some distance below existing ground level it is not expected management of a controlled ground water via subsoil drainage will be required.
- ▶ In development areas adjacent to the existing creek with perceived perched water table it is recommended at least 1.2m separation is achieved to finished earthwork levels.



10 Disclaimer

JDSi have undertaken this assessment based on limited information and subsequently assumptions have been made which, if incorrect, have potential to change costs. Major cost implications exist through factors which cannot be assured at this time including upgrading and provision of utility services, WAPC conditions of development, Local Authority Scheme Requirements, ground conditions, timing of adjacent developments, etc.

While JDSi has taken all care in the preparation of the likely development requirements and has noted key assumptions, JDSi accepts no responsibility for the accuracy of this report and provides it only as an indicative summary of engineering requirements.

If any further information is required or should you wish to clarify any issue, please contact our office.

