Common Name	Scientific Name	Habitat and Ecology (OEH Species Profile and /or EPBC SPRAT Profile)	TSC Act Status	EPBC Act Status	OEH Threatened Species Search	DSEWPaC Protected Matters Search	Potential to occur
		Nests on the ground amongst tall vegetation, such as grasses, tussocks or reeds. The nest consists of a scrape in the ground, lined with grasses and leaves. Breeding is often in response to local conditions; generally occurs from September to December. Forages nocturnally on mud-flats and in shallow water. Feeds on worms, molluscs, insects and some plant-matter.				occur within Area	
Pale-headed Snake	*Hoplocephalus bitorquatus*	Found mainly in dry eucalypt forests and woodlands, cypress woodland and occasionally in rainforest or moist eucalypt forest. Favours streamside areas, particularly in drier habitats. Shelter during the day between loose bark and tree-trunks, or in hollow trunks and limbs of dead trees. The main prey is tree frogs although lizards and small mammals are also taken.	Vulnerable		Predicted		Unlikely. Suitable habitat for this species does not occur in the Subject Site.
Pink-tailed Legless Lizard	Aprasia parapulchella	The Pink-tailed Worm Lizard is only known from the Central and Southern Tablelands, and the South Western Slopes. There is a concentration of populations in the Canberra/Queanbeyan Region. Other populations have been recorded near Cooma, Yass, Bathurst, Albury and West Wyalong. This species is also found in the Australian Capital Territory. Inhabits sloping, open woodland areas with predominantly native grassy groundlayers, particularly those dominated by Kangaroo Grass (Themeda australis). Sites are typically well-drained, with rocky outcrops or scattered, partially-buried rocks. Commonly found beneath small, partially-embedded rocks and appear to spend considerable time in burrows below these rocks; the burrows have been constructed by and are often still inhabited by small black ants and termites. Feeds on the larvae and eggs of the ants with which it shares its burrows. It is thought that this species lays two eggs inside the ant nests during summer; the young first appear in March.	Vulnerable	Vulnerable	Not identified in Central West Sub CMAs Pilliga or Talbragar Valley		No. However previously recorded near Dubbo. Suitable habitat for this species in the Central West CMA is known to occur on trachyte soils where small flat basalt rocks litter the surface.
Painted Snipe	Rostratula benghalensis (sensu lato)	Prefers fringes of swamps, dams and nearby marshy areas where there is a cover of grasses, lignum, low scrub or open timber.	Endangered	Endangered		Species or species habitat may occur within area	No

Common Name	Scientific Name	Habitat and Ecology (OEH Species Profile and /or EPBC SPRAT Profile)	TSC Act Status	EPBC Act Status	OEH Threatened Species Search	DSEWPaC Protected Matters Search	Potential to occur
Philotheca ericifolia	*Philotheca ericifolia*	Known only from the upper Hunter Valley and Pilliga to Peak Hill districts of NSW. The records are scattered over a range of over 400 kilometres between West Wyalong and the Pilliga Scrub. Site localities include Pilliga East State Forest, Goonoo State Forest, Hervey Range, Wingen Maid Nature Reserve, Toongi, Denman, Rylstone district and Kandos Weir. Grows chiefly in dry sclerophyll forest and heath on damp sandy flats and gullies. It has been collected from a variety of habitats including heath, open woodland, dry sandy creek beds, and rocky ridge and cliff tops. Associated species include Melaleuca uncinata, Eucalyptus crebra, E. rossii, E. punctata, Corymbia trachyphloia, Acacia triptera, A. burrowii, Beyeria viscosa, Philotheca australis, Leucopogon muticus and Calytrix tetragona. Flowering time is in the spring. Fruits are produced from November to December. Noted as being a “moisture-loving plant”, with plants common on the sides of a particular spur of the Hervey Ranges where soakage from the high background provides sufficient moisture for the plants. Also recorded growing in a recently burnt site (wildfire) and within a regeneration zone resulting from clearing. Populations comprise from 3-12 adult plants to approx. 200 plants (mostly seedlings in one population). Also described as uncommon, scattered, common, locally occasional and locally frequent. Populations in Pilliga State Forest consist of hundreds or thousands of individuals. A very large population occurs in Lincoln State Forest near Gilgandra.		Vulnerable (Commonwealth listed only)			No. Not identified in searches however known to have once occurred near Dubbo.
Pine Donkey Orchid	*Diuris tricolor*	The Pine Donkey Orchid grows in sclerophyll forest among grass, often with native Cypress Pine (*Callitris spp.*). It is found in sandy soils, either on flats or small rises. Also recorded from a red earth soil in a Bimble Box community in western NSW. Usually recorded as common and locally frequent in populations, however only one or two plants have also been observed at sites. The species has been noted as growing in large colonies. Disturbance regimes are not known, although the species is usually recorded from disturbed habitats. Associated species include *Callitris glaucophylla, Eucalyptus populnea, Eucalyptus intertexta*, Ironbark and *Acacia* shrubland.	Vulnerable		Known		Likely. Recorded in similar grassland in proximity to the Subject Site

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		The understorey is often grassy with herbaceous plants such as *Bulbine* species. Flowers from September to November or generally spring. The species is a tuberous, deciduous terrestrial orchid and the flowers have a pleasant, light sweet scent.					
Powerful Owl	Ninox connivens	Territorial pairs respond strongly to recordings of Barking Owl calls from up to 6 km away, though humans rarely hear this response farther than 1.5 km. Because disturbance reduces the pair's foraging time, and can pull the female off her eggs even on cold nights, recordings should not be broadcast unnecessarily nor during the nesting season. Inhabits woodland and open forest, including fragmented remnants and partly cleared farmland. Is flexible in its habitat use and hunting can extend in to closed forest and more open areas. Sometimes able to successfully breed along timbered watercourses in heavily cleared habitats (e.g. western NSW) due to the higher density of prey on these fertile soils. Roost in shaded portions of tree canopies, including tall midstorey trees with dense foliage such as Acacia and Casuarina species. During nesting season, the male perches in a nearby tree overlooking the hollow entrance. Preferentially hunts small arboreal mammals such as Squirrel Gliders and Ringtail Possums, but when loss of tree hollows decreases these prey populations it becomes more reliant on birds, invertebrates and terrestrial mammals such as rodents and rabbits. Can catch bats and moths on the wing, but typically hunts by sallying from a tall perch. Requires very large permanent territories in most habitats due to sparse prey densities. Monogamous pairs hunt over as much as 6000 hectares, with 2000 hectares being more typical in NSW habitats. Two or three eggs are laid in hollows of large, old trees. Living eucalypts are preferred though dead trees are also used. Nest sites are used repeatedly over years by a pair, but they may switch sites if disturbed by predators (e.g. goannas). Nesting occurs during mid-winter and spring. Female incubates for 5 weeks, roosts outside the hollow when chicks are 4 weeks old, then fledging starts two weeks later. Young are dependent for several months	Vulnerable		Predicted		Unlikely. Suitable habitat for this species does not occur in the Subject Site.
Regent Honeyeater	*Anthochaera phrygia*	The Regent Honeyeater is a flagship threatened woodland bird whose conservation will benefit a large suite of other threatened and declining woodland fauna. The species inhabits dry open forest and woodland, particularly Box-Ironbark woodland, and	Critically Endangered	Endangered	Known	Species or species habitat may	Likely. Over-wintering feeding resources. Breeding habitat

Common Name	Scientific Name	Habitat and Ecology (OEH Species Profile and /or EPBC SPRAT Profile)	TSC Act Status	EPBC Act Status	OEH Threatened Species Search	DSEWPaC Protected Matters Search	Potential to occur
		riparian forests of River Sheoak. Regent Honeyeaters inhabit woodlands that support a significantly high abundance and species richness of bird species. These woodlands have significantly large numbers of mature trees, high canopy cover and abundance of mistletoes. Every few years non-breeding flocks are seen foraging in flowering coastal Swamp Mahogany and Spotted Gum forests, particularly on the central coast and occasionally on the upper north coast. Birds are occasionally seen on the south coast. In the last 10 years Regent Honeyeaters have been recorded in urban areas around Albury where woodlands tree species such as Mugga Ironbark and Yellow Box were planted 20 years ago. The Regent Honeyeater is a generalist forager, which mainly feeds on the nectar from a wide range of eucalypts and mistletoes. Key eucalypt species include Mugga Ironbark, Yellow Box, Blakely's Red Gum, White Box and Swamp Mahogany. Also utilises: *E. microcarpa, E. punctata, E. polyanthemos, E. mollucana, Corymbia robusta, E. crebra, E. caleyi, Corymbia maculata,* E.mckieana, E. macrorhyncha, E. laevopinea, and Angophora floribunda. Nectar and fruit from the mistletoes A. miquelii, A. pendula, A. cambagei are also eaten during the breeding season. When nectar is scarce lerp and honeydew comprise a large proportion of the diet. Insects make up about 15% of the total diet and are important components of the diet of nestlings. A shrubby understorey is an important source of insects and nesting material.				occur within Area	does not occur in the Subject Site
Ruff	Philomachus pugnax	The Ruff is a rare but regular visitor to Australia, being recorded in all States and Territories. In Australia the Ruff is found on generally fresh, brackish of saline wetlands with exposed mudflats at the edges. It is found in terrestrial wetlands including lakes, swamps, pools, lagoons, tidal rivers, swampy fields and flood lands. They are occasionally seen on sheltered coasts, in harbours, estuaries, seashores and are known to visit sewage farms and salt works. They are sometimes found on wetlands surrounded by dense vegetation including grass, sedges, saltmarsh and reeds. They have been observed on sand spits and other sandy habitats including shingles. The Ruff forages on exposed mudflats, in shallow water and occasionally on dry mud. They have been observed foraging in dry waterside plants and in swampy areas next to aeration tanks in sewage farms. They prefer to roost amongst shorter vegetation (Higgins & Davies 1996).		Marine Migratory			No. Previously recorded in the Dubbo LGA. No suitable habitat for this species exists in the Subject Site
Rainbow Bee-eater	Merops ornatus	The Rainbow Bee-eater occurs mainly in open forests and woodlands, shrublands, and in various cleared or semi-cleared habitats, including farmland and areas of human habitation (Higgins 1999).		Migratory JAMBA		Species or species habitat may	Potential. Suitable breeding habitat (deep sandy banks near

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		It usually occurs in open, cleared or lightly-timbered areas that are often, but not always, located in close proximity to permanent water (Badman 1979; Boekel 1976; Fry 1984; Roberts 1979; Storr 1984a, 1984b, 1985a). It also occurs in inland and coastal sand dune systems, and in mangroves in northern Australia, and has been recorded in various other habitat types including heathland, sedgeland, vine forest and vine thicket, and on beaches (Higgins 1999). The Rainbow Bee-eater occurs in open woodlands and shrublands, including mallee, and in open forests that are usually dominated by eucalypts. It also occurs in grasslands (Gibson 1986; Jones 1986; Leach 1988; Longmore 1978; McEvey & Middleton 1968; Saunders & Ingram 1995; Woinarski et al. 1988, 1989) and, especially in arid or semi-arid areas, in riparian, floodplain or wetland vegetation assemblages (Badman 1989; Gee et al. 1996; Gibson 1986; Gibson & Cole 1988; Henle 1989; Longmore 1978; Storr 1977; Woinarski et al. 1988).				occur within area	waterways) for this species does not occur in the Subject Site. Potential to hunt in the Subject Site, however more likely to occur near rivers and flowing creeks.
Red-tailed Tropicbird	Phaethon rubricauda	Marine Breeds in coastal cliffs and under bushes in tropical Australia. Nests on cliffs of the northern hills and southern mountains on the main island at Lord Howe Island.	Vulnerable				No
Scarlet Robin	*Petroica boodang*	The Scarlet Robin lives in dry eucalypt forests and woodlands. The understorey is usually open and grassy with few scattered shrubs. This species lives in both mature and regrowth vegetation. It occasionally occurs in mallee or wet forest communities, or in wetlands and tea-tree swamps. Scarlet Robin habitat usually contains abundant logs and fallen timber: these are important components of its habitat. The Scarlet Robin breeds on ridges, hills and foothills of the western slopes, the Great Dividing Range and eastern coastal regions; this species is occasionally found up to 1000 meters in altitude. The Scarlet Robin is primarily a resident in forests and woodlands, but some adults and young birds disperse to more open habitats after breeding. In autumn and winter many Scarlet Robins live in open grassy woodlands, and grasslands or grazed paddocks with scattered trees. Birds forage from low perches, fence-posts or on the ground, from where they pounce on small insects and other invertebrates which are taken from the ground, or off tree trunks and logs; they sometimes forage in the shrub or canopy layer.	Vulnerable		Predicted		Potential.

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		Scarlet Robin pairs defend a breeding territory and mainly breed between the months of July and January; they may raise two or three broods in each season. This species' nest is an open cup made of plant fibres and cobwebs and is built in the fork of tree usually more than 2 meters above the ground; nests are often found in a dead branch in a live tree, or in a dead tree or shrub. In autumn and winter, the Scarlet Robin joins mixed flocks of other small insectivorous birds which forage through dry forests and woodlands.					
Satin Flycatcher	*Myiagra cyanoleuca*	Satin Flycatchers inhabit heavily vegetated gullies in eucalypt-dominated forests and taller woodlands, and on migration, occur in coastal forests, woodlands, mangroves and drier woodlands and open forests (Blakers et al. 1984; Emison et al. 1987; Officer 1969). Satin Flycatchers mainly inhabit eucalypt forests, often near wetlands or watercourses. They generally occur in moister, taller forests than the Leaden Flycatcher, Myiagra rebecula, often occurring in gullies		Listed		Species or species habitat may occur in the Subject Site	Potential
Rufous Fantail	*Rhipidura rufifrons*	The Rufous Fantail occurs in coastal and near coastal districts of northern and eastern Australia (Lindsey 1992). Rhipidura rufifrons rufifrons has breeding populations occurring from about the South Australia-Victoria border, through south and central Victoria, on and east of the Great Divide in New South Wales (NSW), and north to about the NSW-Queensland border; and R. r. intermedia has breeding populations occurring on and east of the Great Divide, from about the NSW-Queensland border, north to the Cairns-Atherton region, Queensland (Higgins et al. 2006). Both subspecies winter farther north from Cape York Peninsula in Queensland to Torres Strait and southern Papua New Guinea. The two subspecies intergrade in a zone between the Queensland-NSW border ranges and the Clarence-Orara rivers in NSW (Scodde & Mason 1999).		Listed		Species or species habitat known to occur within area	Potential
Sharp-tailed Sandpiper	*Calidris acuminata*	The Sharp-tailed Sandpiper spends the non-breeding season in Australia with small numbers occurring regularly in New Zealand. Most of the population migrates to Australia, mostly to the south-east and are widespread in both inland and coastal locations and in both freshwater and saline habitats. Many inland records are of birds on passage (Cramp 1985; Higgins & Davies 1996).		Marine Migratory			Unlikely.
Silky Swainson-pea	*Swainsona sericea*	Silky Swainson-pea has been recorded from the Northern Tablelands to the Southern Tablelands and further inland on the slopes and plains. There is one isolated record from the far north-west of NSW. Its stronghold is on the Monaro. Also found in South Australia, Victoria and Queensland.	Vulnerable		Known		Unlikely.

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		Found in Natural Temperate Grassland and Snow Gum Eucalyptus pauciflora Woodland on the Monaro. Found in Box-Gum Woodland in the Southern Tablelands and South West Slopes. Sometimes found in association with cypress-pines Callitris spp. Habitat on plains unknown. Regenerates from seed after fire.					
Silver Perch	Bidyanus bidyanus	Silver Perch were once widespread and abundant throughout most of the Murray-Darling river system. They have now declined to low numbers or disappeared from most of their former range. Only one remaining secure and self-sustaining population occurs in NSW in the central Murray River downstream of Yarrawonga weir, as well as several anabranches and tributaries	Vulnerable (FM Act)				No. Habitat suitable for this species will not be impacted.
Sloane's Froglet	*Crinia sloanei*	It is typically associated with periodically inundated areas in grassland, woodland and disturbed habitats.	Vulnerable		Predicted		Unlikely
Speckled Warbler	*Pyrrholaemus saggitatus*	The Speckled Warbler lives in a wide range of *Eucalyptus* dominated communities that have a grassy understorey, often on rocky ridges or in gullies. Typical habitat would include scattered native tussock grasses, a sparse shrub layer, some eucalypt regrowth and an open canopy. Large, relatively undisturbed remnants are required for the species to persist in an area. The diet consists of seeds and insects, with most foraging taking place on the ground around tussocks and under bushes and trees. Pairs are sedentary and occupy a breeding territory of about ten hectares, with a slightly larger home-range when not breeding. The rounded, domed, roughly built nest of dry grass and strips of bark is located in a slight hollow in the ground or the base of a low dense plant, often among fallen branches and other litter. A side entrance allows the bird to walk directly inside. A clutch of 3-4 eggs is laid, between August and January, and both parents feed the nestlings. The eggs are a glossy red-brown, giving rise to the unusual folk names ‘Blood Tit’ and ‘Chocolate bird’. Some cooperative breeding occurs. The species may act as host to the Black-eared Cuckoo. Speckled Warblers often join mixed species feeding flocks in winter, with other species such as Yellow-rumped, Buff-rumped, Brown and Striated Thornbill.	Vulnerable		Known		Yes. Known to occur in similar habitat in the Central West.

Common Name	Scientific Name	Habitat and Ecology (OEH Species Profile and /or EPBC SPRAT Profile)	TSC Act Status	EPBC Act Status	OEH Threatened Species Search	DSEWPaC Protected Matters Search	Potential to occur
Spotted Harrier	*Circus assimilis*	Occurs in grassy open woodland including acacia and mallee remnants, inland riparian woodland, and grassland and shrub steppe. It is found most commonly in native grassland, but also occurs in agricultural land, foraging over open habitats including edges of inland wetlands. Builds a stick nest in a tree and lays eggs in spring (or sometimes autumn), with young remaining in the nest for several months. Preys on terrestrial mammals (egg bandicoots, bettongs, and rodents), birds and reptile, occasionally insects and rarely carrion.	Vulnerable		Known		Potential to have hunting ground in the Subject Site.
Spotted-tailed Quoll	*Dasyurus maculatus*	Use ‘latrine sites’, often on flat rocks among boulder fields and rocky cliff-faces; these may be visited by a number of individuals; latrine sites can be recognised by the accumulation of the sometimes characteristic ‘twisty-shaped’ faeces deposited by animals. Recorded across a range of habitat types, including rainforest, open forest, woodland, coastal heath and inland riparian forest, from the sub-alpine zone to the coastline. Individual animals use hollow-bearing trees, fallen logs, small caves, rock crevices, boulder fields and rocky-cliff faces as den sites. Mostly nocturnal, although will hunt during the day; spends most of the time on the ground, although also an excellent climber and may raid possum and glider dens and prey on roosting birds. Consumes a variety of prey, including gliders, possums, small wallabies, rats, birds, bandicoots, rabbits and insects; also eats carrion and takes domestic fowl. Females occupy home ranges up to about 750 hectares and males up to 3500 hectares; usually traverse their ranges along densely vegetated creek lines. Average litter size is five; both sexes mature at about one year of age.	Vulnerable	Endangered	Known		Potential. Habitat may occur in the Subject Site however the lack of timber and ground debris probably excludes this species.
Scant Pomaderris	*Pomaderris queenslandica*	Widely scattered but not common in north-east NSW and in Queensland. It is only known from a few locations on the New England Tablelands and North West Slopes, including near Torrington and Coolatai, and also from several locations on the NSW north coast. Found in moist eucalypt forest or sheltered woodlands with a shrubby understorey, and occasionally along creeks.	Endangered		Known		Potential to occur in the Subject Site. Known to occur in Goonoo SCA.
Square-tailed Kite	*Lophoictinia isura*	Found in a variety of timbered habitats including dry woodlands and open forests. Shows a particular preference for timbered watercourses.	Vulnerable		Known		Potential to have hunting territory within the Subject Site.

Common Name	Scientific Name	Habitat and Ecology (OEH Species Profile and /or EPBC SPRAT Profile)	TSC Act Status	EPBC Act Status	OEH Threatened Species Search	DSEWPaC Protected Matters Search	Potential to occur
		In arid north-western NSW, has been observed in stony country with a ground cover of chenopods and grasses, open acacia scrub and patches of low open eucalypt woodland. Is a specialist hunter of passerines, especially honeyeaters, and most particularly nestlings, and insects in the tree canopy, picking most prey items from the outer foliage? Appears to occupy large hunting ranges of more than 100kilometer2. Breeding is from July to February, with nest sites generally located along or near watercourses, in a fork or on large horizontal limbs.					
Squirrel Glider	*Petaurus norfolcensis*	Inhabits mature or old growth Box, Box-Ironbark woodlands and River Red Gum forest west of the Great Dividing Range and Blackbutt-Bloodwood forest with heath understorey in coastal areas. Prefers mixed species stands with a shrub or Acacia midstorey. Live in family groups of a single adult male one or more adult females and offspring. Require abundant tree hollows for refuge and nest sites. Diet varies seasonally and consists of Acacia gum, eucalypt sap, nectar, honeydew and manna, with invertebrates and pollen providing protein.	Vulnerable		Predicted		Unlikely to occur in the Subject Site.
Stripe-faced Dunnart	*Sminthopsis macroura*	Native dry grasslands and low dry shrublands, often along drainage lines. During periods of hot weather they shelter in cracks in the soil, in grass tussocks or under rocks and logs.	Vulnerable		Predicted		Unlikely. The lack of understorey, woody debris precludes this species from occurring in the Subject Site
Superb Parrot	*Polytelis swainsonii*	Inhabit Box-Gum, Box-Cypress-pine and Boree Woodlands and River Red Gum Forest. In the Riverina the birds nest in the hollows of large trees (dead or alive) mainly in tall riparian River Red Gum Forest or Woodland. On the South West Slopes nest trees can be in open Box-Gum Woodland or isolated paddock trees. Species known to be used are Blakely's Red Gum, Yellow Box, Apple Box and Red Box. Nest in small colonies, often with more than one nest in a single tree. Breed between September and January. May forage up to 10 kilometres from nesting sites, primarily in grassy box woodland.	Vulnerable	Vulnerable	Known	Species or species habitat likely to occur within area	Likely

Common Name	Scientific Name	Habitat and Ecology (OEH Species Profile and /or EPBC SPRAT Profile)	TSC Act Status	EPBC Act Status	OEH Threatened Species Search	DSEWPaC Protected Matters Search	Potential to occur
		Feed in trees and understorey shrubs and on the ground and their diet consists mainly of grass seeds and herbaceous plants. Also eaten are fruits, berries, nectar, buds, flowers, insects and grain.					
Swift Parrot	*Lathamus discolor*	Migrates to the Australian south-east mainland between March and October. On the mainland they occur in areas where eucalypts are flowering profusely or where there are abundant lerp (from sap-sucking bugs) infestations. Favoured feed trees include winter flowering species such as Swamp Mahogany *Eucalyptus robusta*, Spotted Gum *Corymbia maculata*, Red Bloodwood *C. gummifera*, Mugga Ironbark *E. sideroxylon*, and White Box *E. albens*. Commonly used lerp infested trees include Inland Grey Box *E. microcarpa*, Grey Box *E. moluccana* and Blackbutt *E. pilularis*. Return to some foraging sites on a cyclic basis depending on food availability. Following winter they return to Tasmania where they breed from September to January, nesting in old trees with hollows and feeding in forests dominated by Tasmanian Blue Gum *Eucalyptus globulus*.	Endangered	Endangered	Known	Species or species habitat likely to occur within Area	Potential to occur. Feeding resources may occur in the Subject Site, however Breeding habitat is in Tasmania
Turquoise Parrot	*Neophema pulchella*	Lives on the edges of eucalypt woodland adjoining clearings, timbered ridges and creeks in farmland. Usually seen in pairs or small, possibly family, groups and have also been reported in flocks of up to thirty individuals. Prefers to feed in the shade of a tree and spends most of the day on the ground searching for the seeds or grasses and herbaceous plants, or browsing on vegetable matter. Forages quietly and may be quite tolerant of disturbance. However, if flushed it will fly to a nearby tree and then return to the ground to browse as soon as the danger has passed. Nests in tree hollows, logs or posts, from August to December. It lays four or five white, rounded eggs on a nest of decayed wood dust.	Vulnerable		Known		Potential to occur on the edge of the forested portions of the Subject Site adjoining grassy areas. Breeding habitat does not occur in the Subject Site.
Trout Cod	Maccullochella macquariensis	The Trout Cod is endemic to the southern Murray-Darling river system, including the Murrumbidgee and Murray Rivers, and the Macquarie River in central NSW. The species was once widespread and abundant in these areas but has undergone dramatic declines in its distribution and abundance over the past century. The last known reproducing population of Trout Cod is confined to the Murray River below Yarrawonga downstream to Tocumwal.	Endangered FM Act	Endangered		Species or species habitat may occur within area	No

Common Name	Scientific Name	Habitat and Ecology (OEH Species Profile and /or EPBC SPRAT Profile)	TSC Act Status	EPBC Act Status	OEH Threatened Species Search	DSEWPaC Protected Matters Search	Potential to occur
Varied Sittella	Daphoenositta chrysoptera	Inhabits eucalypt forests and woodlands, especially those containing rough-barked species and mature smooth-barked gums with dead branches, mallee and Acacia woodland. Feeds on arthropods gleaned from crevices in rough or decorticating bark, dead branches, standing dead trees and small branches and twigs in the tree canopy. Builds a cup-shaped nest of plant fibres and cobwebs in an upright tree fork high in the living tree canopy, and often re-uses the same fork or tree in successive years. Generation length is estimated to be 5 years.	Vulnerable		Known		Likely.
White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland		Characterised by the presence or prior occurrence of White Box, Yellow Box and/or Blakely's Red Gum. The trees may occur as pure stands, mixtures of the three species or in mixtures with other trees, including wattles. Commonly co-occurring eucalypts include Apple Box (*E. bridgesiana*), Red Box (*E. polyanthemos*), Candlebark (*E. rubida*), Snow Gum (*E. pauciflora*), Argyle Apple (*E. cinerea*), Brittle Gum (*E. mannifera*), Red Stringybark (*E. macrorhyncha*), Grey Box (*E. microcarpa*), Cabbage Gum (*E. amplifolia*) and others. The understorey in intact sites is characterised by native grasses and a high diversity of herbs; the most commonly encountered include Kangaroo Grass (*Themeda australis*) Poa Tussock (*Poa sieberiana*), wallaby grasses (*Austrodanthonia spp.*), spear-grasses (*Austrostipa spp.*), Common Everlasting (*Chrysocephalum apiculatum*), Scrambled Eggs (*Goodenia pinnatifida*), Small St John's Wort (*Hypericum gramineum*), Narrow-leafed New Holland Daisy (*Vittadinia muelleri*) and blue-bells (*Wahlenbergia spp.*). Shrubs are generally sparse or absent, though they may be locally common. Remnants generally occur on fertile lower parts of the landscape where resources such as water and nutrients are abundant. Sites with particular characteristics, including varying age classes in the trees, patches of regrowth, old trees with hollows and fallen timber on the ground are very important as wildlife habitat. Sites in the lowest parts of the landscape often support very large trees which have leafy crowns and reliable nectar flows - sites important for insectivorous and nectar feeding birds. Sites that retain only a grassy groundlayer and with few or no trees remaining are important for rehabilitation, and to rebuild connections between sites of better quality. Remnants support many species of threatened fauna and flora.	EEC	Critically Endangered	Known	Community likely to occur within area	Yes. Known to on areas of higher ground in the Dubbo area.

Common Name	Scientific Name	Habitat and Ecology (OEH Species Profile and /or EPBC SPRAT Profile)	TSC Act Status	EPBC Act Status	OEH Threatened Species Search	DSEWPaC Protected Matters Search	Potential to occur
		Retention of remnants is important as they contribute to productive farming systems (stock shelter, seed sources, sustainable grazing and water-table and salinity control). The fauna of remnants (insectivorous birds, bats, etc.) can contribute to insect control on grazing properties. Some of the component species (e.g. wattles, she-oaks, native legumes) fix nitrogen that is made available to other species in the community, while fallen timber and leaves recycle their nutrients. Disturbed remnants are considered to form part of the community, including where the vegetation would respond to assisted natural regeneration.					
White-fronted Chat	Epthianura albifrons	Regularly observed in the saltmarsh of Newington Nature Reserve (with occasional sightings from other parts of Sydney Olympic Park and in grassland on the northern bank of the Parramatta River). Current estimates suggest this population consists of 8 individuals. Regularly observed in the saltmarsh and on the sandy shoreline of a small island of Towra Point Nature Reserve. This population is estimated to comprise 19-50 individuals. The Newington and Towra Point populations are thought to be disjunct from each other (and from the nearest populations outside Sydney Metropolitan CMA). Gregarious species, usually found foraging on bare or grassy ground in wetland areas, singly or in pairs. They are insectivorous, feeding mainly on flies and beetles caught from or close to the ground. Have been observed breeding from late July through to early March, with 'open-cup' nests built in low vegetation. Nests in the Sydney region have also been seen in low isolated mangroves. Nests are usually built about 23 cm above the ground (but have been found up to 2.5 metres above the ground). Two to three eggs are laid in each clutch, and the complete nesting cycle from nest-building to independent young is approximately 50 days. Birds can breed at one year of age and are estimated to live for five years.	Endangered population		Known		No. Suitable habitat for this species does not occur in the Subject Site.
White-bellied Sea-Eagle	Haliaeetus leucogaster	The White-bellied Sea-Eagle is distributed along the coastline (including offshore islands) of mainland Australia and Tasmania. It also extends inland along some of the larger waterways, especially in eastern Australia. The inland limits of the species are most restricted in south-central and south-western Australia, where it is confined to a narrow band along the coast (Barrett et al. 2003; Bilney & Emison 1983; Blakers et al. 1984; Marchant & Higgins 1993). Recent analysis indicates that the distribution of the sea-		Listed		Species or species habitat likely to occur within area	Unlikely. Suitable habitat for this species does not occur in the Subject Site.

Common Name	Scientific Name	Habitat and Ecology (OEH Species Profile and /or EPBC SPRAT Profile)	TSC Act Status	EPBC Act Status	OEH Threatened Species Search	DSEWPaC Protected Matters Search	Potential to occur
		eagle may shift in response to climatic conditions, with an apparent decreased occupancy of inland sites (and increased occupancy of coastal sites) during drought conditions (Shephard et al. 2005a). Breeding has been recorded from only a relatively small area of the total distribution. Breeding records are patchily distributed, mainly along the coastline, and especially the eastern coast, extending from Queensland to Victoria, and to Tasmania. Breeding has also been recorded at some sites further inland, e.g. around the Murray, Murrumbidgee and Lachlan Rivers in northern Victoria and south-west NSW, and at other large drainage systems and water storages (Marchant & Higgins 1993). Although known breeding sites are widely dispersed, the species could potentially breed throughout much of its range (Birds Australia 2006c, pers. comm.).					
White-throated Needletail	Hirundapus caudacutus	The White-throated Needletail is widespread in eastern and south-eastern Australia (Barrett et al. 2003; Blakers et al. 1984; Higgins 1999). In eastern Australia, it is recorded in all coastal regions of Queensland and NSW, extending inland to the western slopes of the Great Divide and occasionally onto the adjacent inland plains. Further south on the mainland, it is widespread in Victoria, though more so on and south of the Great Divide, and there are few records in western Victoria outside the Grampians and the South West. The species occurs in adjacent areas of south-eastern South Australia, where it extends west to the Yorke Peninsula and the Mount Lofty Ranges. It is widespread in Tasmania (Barrett et al. 2003; Blakers et al. 1984; Higgins 1999). White-throated Needletails only occur as vagrants in the Northern Territory (recorded in the Top End, including around Darwin, Katherine and Mataranka and Tennant Creek; and further south around Alice Springs) and in Western Australia (at disparate sites from the Mitchell Plateau in the Kimberley, south to the Nullarbor Plain and Augusta in the South West, and west to Barrow Island, the Houman Abrolhos and the Swan River Plain) (Barrett et al. 2003; Blakers et al. 1984; Brooker et al. 1979; Sedgwick 1978; Slater 1964; Storr 1987; Storr et al. 1986; Wheeler 1959). The species is also a vagrant to various outlying islands, including Norfolk, Lord Howe, Macquarie, Christmas and Cocos-Keeling Islands (Barrand 2005; Green 1989; McAllan et al. 2004; Schodde et al. 1983; Stokes et al. 1984; Warham 1961a).		Listed			Potential.
Yellow-bellied Sheathtail-bat	*Saccolaimus flaviventris*	Roosts singly or in groups of up to six, in tree hollows and buildings; in treeless areas they are known to utilise mammal burrows. When foraging for insects, flies high and fast over the forest canopy, but lower in more open country.	Vulnerable		Known		Potential.

Common Name	Scientific Name	Habitat and Ecology (OEH Species Profile and /or EPBC SPRAT Profile)	TSC Act Status	EPBC Act Status	OEH Threatened Species Search	DSEWPaC Protected Matters Search	Potential to occur
		Forages in most habitats across its very wide range, with and without trees; appears to defend an aerial territory. Breeding has been recorded from December to mid-March, when a single young is born. Seasonal movements are unknown; there is speculation about a migration to southern Australia in late summer and autumn.					
	Commersonia procumbens	Grows in sandy sites, often along roadsides. Recorded in *Eucalyptus dealbata* and *Eucalyptus sideroxylon* communities, *Melaleuca uncinata* scrub, under mallee eucalypts with a *Calytrix tetragona* understorey, and in a recently burnt Ironbark and *Callitris* area. Also in *Eucalyptus fibrosa* subsp. *nubila, Eucalyptus dealbata, Eucalyptus albens* and *Callitris glaucophylla* woodlands north of Dubbo. Other associated species include Acacia triptera, Callitris endlicheri, Eucalyptus melliodora, Allocasuarina diminuta, Philotheca salsolifolia, Xanthorrhoea species, Exocarpus cupressiformis, Leptospermum parvifolium and Kunzea parvifolia. Fruiting period is summer to autumn. Flowers from August to December. Appears to produce seed which persists for some time in the seed bank. Large numbers of seedlings have been observed germinating after fire at sites where the species was not apparent above ground before the fires. Clusters of individuals may be clonal. The species is often found as a pioneer species of disturbed habitats. It has been recorded colonising disturbed areas such as roadsides, the edges of quarries and gravel stockpiles and a recently cleared easement under power lines. Has been recorded in populations of 50+ individuals of various ages, 28 plants on the western side of the road and 58 plants on the sunnier eastern side. Populations may comprise a single cohort of individuals, or have a multi-aged structure where some individuals appear to be old with thickened runners.	Vulnerable	Vulnerable	Known	Species or species habitat likely to occur within area	Unlikely. Suitable soil for this species does not occur in the Subject Site. Known to occur along the Golden Highway on red sandy ridges.
	Tylophora linearis	Grows in dry scrub and open forest. Recorded from low-altitude sedimentary flats in dry woodlands of Eucalyptus fibrosa, Eucalyptus sideroxylon, Eucalyptus albens, Callitris endlicheri, Callitris glaucophylla and Allocasuarina luehmannii. Also grows in association with Acacia hakeoides, Acacia lineata, Melaleuca uncinata, Myoporum species and Casuarina species. Flowers in spring, with flowers recorded in November or May with fruiting probably 2 to 3 months later.	Vulnerable	Endangered	Known	Species or species habitat may occur within area	Potential. Disturbance most likely precludes this species from occurring in the Subject Site. Known to occur in Goonoo SCA.

Common Name	Scientific Name	Habitat and Ecology (OEH Species Profile and /or EPBC SPRAT Profile)	TSC Act Status	EPBC Act Status	OEH Threatened Species Search	DSEWPaC Protected Matters Search	Potential to occur
		Very low number of confirmed populations and has been recorded in very low abundances.					

Key to Table

BB Score: Braun Banquet Score
L: Lower stratum
U: Upper Stratum
M: Middle stratum

Braun Banquet Score	Cover
0	Absent from quadrant
0.1	Represented by a solitary item (<5% cover)
0.5	Represented by a few (<5) items (<5% cover)
1	Represented by >5 items (<5% cover)
2	Represented by many (>5) items (5-25% cover)
3	Represented by many (>5) items (25 - 50% cover)
4	Represented by many (>5) items (50-75% cover)
5	Represented by many (>5) items (75-100% cover)

Common Name	*Scientific Name*	Stratum (weed)	Stratum (Native)	*Weed*	Plot 1	Plot 2	Plot 3	Plot 4
Cat Head	*Emex australis*	Lower			0.5	0.5	0.1	
Scarlet/ Blue Pimpernal	*Anagallis arvensis* *	Lower		*	0.5			
Broomrape	*Orobanche minor* *	Lower		*		1	0.5	
Cape Weed	*Arctotheca calendula* *	Lower		*				
Khaki Weed	*Alteranthera pungens*	Lower		*	0.1	0.1		
Nodding Thistle	*Carduus nutans subsp. nutans*	Lower		*#				
Saffron Thistle	*Carthamus lanatus* *	Lower		*		0.5	0.5	
Maltese Cockspur	*Centaurea melitensis**	Lower		*	0.1	2		
Spear Thistle	*Cirsium vulgare* *	Lower		*	0.1	0.5		
Flax-leaf Fleabane	*Conyza bonariensis*	Lower		*	1	1		
Lucerne	*Medicago sativa* *	Lower			2	3	3	
	Hedypnois rhagadioloides ssp. cretica *	Lower		*				
Flatweed	*Hypochaeris glabra* *	Lower		*	1	1	1	
Flatweed hairy	*Hypochaeris radicata**	Lower		*				
Hawkweed	*Leotodon taraxacoides**	Lower		*				
Varigated Thistle	*Silybum marianum* *	Lower		*				
	Sisymbrium erysimoides	Lower		*				
Scourweed	*Sisyrinchium sp. A sensu*	Lower		*				
Prickley Cow Thistle	*Sonchus asper*	Lower		*				
Common Sow Thistle	*Sonchus oleraceus*	Lower		*				
Stagger Weed	*Stachys arvensis*	Lower		*				
Skeleton Weed	*Chondrilla juncea*	Lower		*	1	1	1	
	Amsinckia intermedia	Lower		*				
Paterson's Curse	*Echium plantagineum* *	Lower		*	1	1	1	
Vipers Bugloss	*Echium vulgare**	Lower		*				
Potato Weed	*Heliotropium europaeum**	Lower		*		0.5		
Turnip	*Brassica rapa subsp. sylvestris**	Lower		*			1	
Brassica	*Brassica tournefortii* *	Lower		*	1	1		
Shepherd's Purse	*Capsella bursa-pastoris**	Lower		*	2	2	1	
Argentine Peppercress	*Lepidium africanum**	Lower		*				
Peppercress	*Lepidium bonariense**	Lower		*		0.5	1	
	Silene gallica var. gallica *	Lower		*				
	Stellaria media *	Lower		*				
Proliferous Pink	*Petrorhagia nanteuilii*	Lower		*	0.5	0.5	1	
Paddy Melon	*Cucumis myriocarpus subsp. leptodermis*	Lower		*				
Haresfoot clover	*Trifolium arvense* *	Lower		*	3	3	3	

Common Name	Scientific Name	Stratum (weed)	Stratum (Native)	*Weed*	Plot 1	Plot 2	Plot 3	Plot 4
	Trifolium campestre *	Lower		*				
	Trifolium dubium *	Lower		*				
White Clover	*Trifolium repens* *	Lower		*	0.5	0.5	2	
	Trifolium subterraneum *	Lower		*				
	*Medicago arabica**	Lower		*		0.5		
	Medicago minima *	Lower		*				
	*Geranium spp.**	Lower		*	0.5	0.5		
	Juncus bufonius *	Lower		*				
	Lamium amplexicaule *	Lower		*				
White Horehound	*Marrubium vulgare**	Lower		*	0.1	0.1	0.5	
Pennyroyal	*Mentha pulegium**	Lower		*				
Vervain	*Salvia verbenaca**	Lower		*				
Spiked Malvastrum	*Malvastrum americanum*	Lower		*				
Oxalis	*Oxalis corniculata**	Lower		*	1	1		
Blackberry Nightshade	*Solanum nigram*	Lower		*	0.5			
Small Nettle	*Urtica urens**	Lower		*	0.5			
Purpletop	*Verbena bonariensis**	Lower		*	0.5			
Nagoora Burr	*Xanthium pungens**	Lower		*#				
Tall Fleabane	*Conzya alibida*	Lower			1	1	1	
Mexican Poppy	*Argemone ochroleuca**	Lower		*				
African Lovegrass	*Eragrostis curvula*	Lower		*	0.5		0.5	
Great Brome	*Bromus diandrus*	Lower (Grass)		*	0.5	0.5		
Praire Grass	*Bromus cartharticus**	Lower (Grass)		*	2	1	1	
Soft Brome	*Bromus molliformis* *	Lower (Grass)		*	2	2		
Small Quaker Grass	*Briza minor**	Lower (Grass)		*				
Quaker Grass	*Briza major**	Lower (Grass)		*				
Stinkgrass	*Eragrostis cilianensis**	Lower (Grass)		*	0.5	0.5	1	
Barley Grass	*Hordeum leporinum* *	Lower (Grass)		*	2	1	2	
Oats	*Avena fatua**	Lower (Grass)		*	3	3	3	
Golden Top	*Lamarckia aurea* *	Lower (Grass)		*				
Perennial Rye	*Lolium perennens*	Lower (Grass)		*	1	1	2	
Wimera Ryegrass	*Lolium rigidum**	Lower (Grass)		*				
Squirrel Tail Fescue	*Vulpia bromoides* *	Lower (Grass)		*				
Rhodes Grass	*Chloris virgata*	Lower (Grass)		*	1	1		
	Vulpia myuros *	Lower (Grass)		*				
Pepper-leaved Senna				*	0.5			
Prickley Pear	*Opuntia stricta**	Mid		*#				

Common Name	Scientific Name	Stratum (weed)	Stratum (Native)	*Weed*	Plot 1	Plot 2	Plot 3	Plot 4
African Boxthorn	*Lycium ferocissimum**	Mid		*#	0.1			
Pepper Tree		Upper			33	31	21	
Native Carrot	*Daucus glochidiatus*		Lower					
Guinea flower	*Hibbertia sp.*		Lower					
Slender Dock	*Rumex brownii*		Lower		2	1		
	Pomax umbellata		Lower					
Hairy Joyweed	*Alternanthera nana*		Lower		1			
Twining Fringe Lily	*Thysanotus patersonii*		Lower				1	
Common Fringe Lily	*Thysanotus tuberosus*		Lower					
	Dichopogon fimbriatus		Lower					
	Bulbine bulbosa		Lower					
Leek Lily	*Bulbine semibarbata*		Lower		1			
	Asteraceae sp.		Lower					
Purple Burr-daisy	*Calotis cuneifolia*		Lower		1			
Showy Burr-daisy	*Calotis cymbacantha*		Lower					
Yellow Burr-daisy	*Calotis lappulacea*		Lower					
Bogan Flea	*Calotis hispidula*		Lower		1			
	Cassinia arcuata		Lower					
	Cassinia arculeata		Lower					
	Cassinia leavis		Lower					
Common Sneezeweed	*Centipeda cunninghamii*		Lower					
	Chrysocephalum apiculatum		Lower					
Bears Ear	*Cymbonotus preissianus*		Lower					
	Cynoglossum australe		Lower					
Small Orange Sunray	*Hyalosperma semisterile*		Lower					
	Hydrocotyle laxiflora		Lower					
Yam Daisy	*Microseris lanceolata*		Lower					
Sunray	*Rhodanthe diffusa ssp. leucactina*		Lower					
Fuzzweed /New Holland Daisy			Lower		1			
Tall Grounsel	*Senecio quadridentatus*		Lower					
Common Sunray	*Triptilodiscus pygmaeus*		Lower					
	Vittadinia cervicularis var. cervicularis		Lower					
	Vittadinia cuneata var. cuneata		Lower					
	Vittadinia cuneata var. hirsute		Lower					
Golden Everlasting	*Xerochrysum bracteata*		Lower					

Common Name	*Scientific Name*	Stratum (weed)	Stratum (Native)	*Weed*	Plot 1	Plot 2	Plot 3	Plot 4
Sticky Everlasting	*Xerochrysum viscosa*		Lower					
	Cynoglossum suaveolens		Lower					
	Brassica nigra		Lower					
	Lepdiium sp.		Lower					
	Wahlenbergia communis		Lower		2			
	Wahlenbergia gracilis		Lower					
	Wahlenbergia stricta ssp stricta		Lower					
Mouse-ear Chickweed	*Cerastium glomeratum*		Lower					
Pig Weed								
	Centrolepis strigosa subsp. strigosa		Lower					
Early nancy	*Wurmbea dioica*		Lower					
Kidney Weed	*Dichondra repens*		Lower		1			
Dense Stonecrop	*Crassula colorata*		Lower					
Australian Stonecrop	*Crassula sieberiana*		Lower					
Sundew	*Drosera peltata*		Lower					
Caustic Weed	*Euphorbia drummondii*		Lower		1			
Slender Tick-trefoil	*Desmodium varians*		Lower					
Kneed Swainson-pea	*Swainsona reticulata*		Lower					
Leafy Stenophylla	*Templetonia stenophylla*		Lower					
Woolly Clover	*Trifolium tomentosum*		Lower					
Twining Glycine	*Glycine clandestina*		Lower		1	1		
	Glycine latifolia		Lower					
	Glycine tabacina		Lower					
	Glycine tomentosa / canescens		Lower					
Burr Medic	*Medicago polymorpha*		Lower					
Narrow-leaved Fumitory	*Fumaria densiflora*		Lower					
Blue Crowfoot	*Erodium crinitum*		Lower		1	1	0.5	
	Geranium homeanum		Lower		1			
	Geranium retorsum		Lower					
	Geranium solanderi var. solanderi		Lower					
Native Storksbill	*Pelagonium australe*		Lower					
	Goodenia hederacea ssp. hederacea		Lower					
	Gonocarpus elatus [Hill Raspwort]		Lower					
Toothed Raspwort	*Halogaris odontocarpa*		Lower					

Common Name	Scientific Name	Stratum (weed)	Stratum (Native)	*Weed*	Plot 1	Plot 2	Plot 3	Plot 4
Tiny Star	*Hypoxis glabella var. glabella*		Lower			1		
Austral Bugle	*Ajuga australis*		Lower					
Native Pennyroyal	*Mentha satureioides*		Lower					
	Linum marginale		Lower					
Rock Isotome	*Isotoma axillaris*		Lower					
	Lomandra filiformis ssp. coriacea		Lower					
Spiky-headed Matt Rush	*Lomandra longifolia*		Lower					
Many-flowered matt Rush	*Lomandra multiflora subsp. Multiflora*		Lower					
Small-flowered mallow	*Malva parvifolia*		Lower					
	Sida corrugata		Lower					
Winter Apple	*Eremophila debilis*		Lower					
Pink Fingers	*Caladenia carnea*		Lower					
Tiger Orchid	*Diuris sulphurea*		Lower					
	Microtis unifolia		Lower					
	Pterostylis bicolor		Lower					
Midget Greenhood	*Pterostylis mutica*		Lower					
Dwarf Greenhood	*Pterostylis nana*		Lower					
Autumn Greenhood	*Pterostylis revoluta*		Lower					
	Oxalis perennans		Lower					
	Oxalis radicosa		Lower					
	Dianella revoluta subsp.		Lower					
Small Sago Weed	*Plantago turrifera*		Lower					
Rock Fern	*Cheilanthes austrotenuifolia*		Lower					
Mulga Fern	*Cheilanthes sieberi*		Lower					
Narrawa Burr	*Solanum cinereum*		Lower					
Slender violet-bush	*Hybanthus monopetalus*		Lower					
Purple Wiregrass	*Aristida jerichoensis*		Lower (grass)		1			
	Aristida ramosa		Lower (grass)					
Wallaby Grass	*Austrodanthonia erianthia*		Lower (grass)					
Common Wallaby Grass	*Austrodanthonia caespitosa*		Lower (grass)		1			
	Austrodanthonia sp.		Lower (grass)					
Wallaby Grass	*Austrodanthonia bipartita*		Lower (grass)					
Dense Foxtail Grass	*Austrostipa densiflora*		Lower (grass)					
Rough Spear Grass	*Austrostipa scabra subs scabra*		Lower (grass)		2	1	1	
	Austrostipa ramosa		Lower (grass)					
Spear Grass	*Austrostipa sp.*		Lower (grass)		1			
Slender Bamboo Grass	*Austrostipa verticillata*		Lower (grass)					

Common Name	*Scientific Name*	Stratum (weed)	Stratum (Native)	*Weed*	Plot 1	Plot 2	Plot 3	Plot 4
Plains Grass	*Austrostipa*		Lower (grass)		1	1	2	
Red-Leg Grass	*Bothriochloa macra*		Lower (grass)		1	2	1	
Short Chloris	*Chloris truncata*		Lower (grass)					
Tall Chloris	*Chloris ventricosa*		Lower (grass)					
	Cynodon dactylon		Lower (grass)					
Queensland Bluegrass	*Dichanthium serecium*		Lower (grass)					
	Dichelachne micrantha		Lower (grass)					
Cotton Panic	*Digitaria brownii*		Lower (grass)		1			
	Digitaria sp.		Lower (grass)					
Awnless barnyard Grass	*Echinochloa colona*		Lower (grass)					
Common Wheatgrass	*Elymus scaber*		Lower (grass)					
Slender bottlewashers	*Ennaepogon gracilis*		Lower (grass)					
Curly Windmill Grass	*Enteropogon acicularis*		Lower (grass)		2		1	
Brown Lovegrass	*Eragrostis brownii*		Lower (grass)					
Purple Love Grass	*Eragrostis lacunaria*		Lower (grass)					
Hairy Panic	*Panicum effusum*		Lower (grass)		1	1		
	Poa sieberiana		Lower (grass)					
Western Rat's Tail Grass	*Sporobolus crebra*		Lower (grass)				1	
	Thyridolepis mitchelliana		Lower (grass)					
Five-minute Grass	*Tripogon loliformis*		Lower (grass)					
	Cyperus sp.		Lower (sedge)					
	Carex inversa		Lower (sedge)					
Tall sedge	*Carex appressa*		Lower (sedge)					
Rough Sas Sedge	*Gahnia aspera*		Lower (sedge)					
Common Bog Rush	*Shoenus apogon*		Lower (sedge)					
	Juncas arcutus		Lower (sedge)					
	Juncas arculeata		Lower (sedge)					
	Juncus aridicola		Lower (sedge)					
	Juncas sp.		Lower (sedge)					
			Lower (sedge)					
Water Ribbons			Lower (sedge)					
Bull Rush	*Typha*		Lower (sedge)		3			
Hill Oak	*Allocasuarina verticillata*		Mid					
Climbing Saltbush	*Einadia hastata*		Mid					
Creeping Saltbush	*Einadia nutans subs. Nutans*		Mid					
	Enchylaena tomentosa		Mid					
Eastern Cotton Bush	*Maireana microphylla.*		Mid		1			
Galvanised Burr			Mid					

Common Name	Scientific Name	Stratum (weed)	Stratum (Native)	*Weed*	Plot 1	Plot 2	Plot 3	Plot 4
	Acacia cheelii		Mid					
	Acacia deanei subsp. deanei		Mid					
Western Golden Wattle	*Acacia decora*		Mid					
Currawang	*Acacia doratoloxyn*		Mid					
	Acacia implexa ?		Mid					
Boree	*Acacia vestita*		Mid					
	Acacia lineata		Mid					
Mudgee Wattle	*Acacia spectabilis*		Mid					
Sword-leaf Wattle	*Acacia gladiformis*		Mid					
	Mirbelia pungens		Mid					
Small-leaf Bush-pea	*Pultenaea foliolosa*		Mid					
	Pultenaea microphylla		Mid					
Senna	*Senna artemisioides subsp. zygophylla*		Mid					
Silver cassia	*Senna artemisioides*		Mid					
Butterbush	*Pittosporum angustifolium*		Mid					
Hooked Needlewood	*Hakea tephrosperma*		Mid					
	Dodonaea boroniifolia		Mid					
Hopbush	*Dodonaea sp.*		Mid					
Narrow-leafed hopbush	*Dodonaea viscosa subsp. augustissim*		Mid					
	Dodonaea viscosa subsp. cuneata		Mid					
Cherry Ballart	*Exocarpos cupressiformis*		Mid					
White Cypress Pine	*Callitris endlicheri*		Upper		1			
Black Cypress Pine	*Callitris glaucophylla*		Upper					
White Box	*Eucalyptus albens*		Upper					
Fuzzy Box	*Eucalyptus conica*		Upper		1			
Tumbledown Red Gum	*Eucalyptus dealbata*		Upper					
Dwyer's Red Gum	*Eucalyptus Dwyeri*		Upper					
Yellow Box	*Eucalyptus melliodora*		Upper		1			
Rough barked Apple	*Angophora floribunda*		Upper		1			
Inland Grey Box	*Eucalyptus microcarpa*		Upper		1			
Kurrajong			Upper					
TOTAL Species / Plot					*28*	*8*	*7*	
Total species	72							
Native Plant Species (NPS)	31				28	8	7	0

Common Name	*Scientific Name*	Stratum (weed)	Stratum (Native)	*Weed*	Plot 1	Plot 2	Plot 3	Plot 4
No. weeds	41				32	30	20	0
% NPS	43.06							
% Weeds	56.94							

Family	Class	Scientific Name	Common Name	Legal Status	Subject Site	Native	Non-native
Mammalia	Carnivora	Vulpes vulpes	Red Fox		**x**		x
Amphibia	Myobatrachidae	Crinia signifera	Common Eastern Froglet	P	x	x	
Amphibia	Myobatrachidae	Limnodynastes peroni	Striped Marsh Frog	P	x	x	
Reptilia	Scincidae	Menetia greyii	Dwarf Skink	P	x	x	
Reptilia	Scincidae	Morethia boulengeri	South-eastern Morethia Skink	P	x	x	
Aves	Motacillidae	Anthus australis	Australasian Pipit	P	x	x	
Aves	Artamidae	Gymnorhina tibicen	Australian Magpie	P	x	x	
Aves	Corvidae	Corvus coronoides	Australian Raven	P	x	x	
Aves	Anatidae	Tadorna tadornoides	Australian Shelduck	P	x	x	
Aves	Campephagidae	Coracina novaehollandiae	Black-faced Cuckoo-shrike	P	x	x	
Aves	Anatidae	Anas castanea	Chestnut Teal	P	x	x	
Aves	Sturnidae	Sturnus vulgaris	Common Starling	P	x	x	
Aves	Cacatuidae	Eolophus roseicapilla	Galah	P	x	x	
Aves	Anatidae	Anas gracilis	Grey Teal	P	x		x
Aves	Passeridae	Passer domesticus	House Sparrow		x	x	
Aves	Monarchidae	Grallina cyanoleuca	Magpie-lark	P	x	x	
Aves	Charadriidae	Vanellus miles	Masked Lapwing	P	x	x	
Aves	Sturnidae	Aplornis metallica	Metallic Starling		x		x
Aves	Falconidae	Falco cenchroides	Nankeen Kestrel	P	x	x	
Aves	Anatidae	Anas superciliosa	Pacific Black Duck	P	x	x	
Aves	Artamidae	Cracticus nigrogularis	Pied Butcherbird	P	x	x	
Aves	Threskiornithidae	Threskiornis spinicollis	Straw-necked Ibis	P	x	x	
Aves	Cacatuidae	Cacatua galerita	Sulphur-crested Cockatoo	P	x	x	
Aves	Ptilonorhynchidae	Amblyornis newtonianus	Superb Fairy-wren	P	x	x	
Aves	Ardeidae	Egretta novaehollandiae	White-faced Heron	P	x	x	
Aves	Rhipiduridae	Rhipidura leucophrys	Willie Wagtail	P	x	x	

APPENDIX 5: ASSESSMENTS OF SIGNIFICANCE

7-PART TEST CRITERIA

7-Part Test Criteria	Fuzzy Box Woodland White Box Woodland Inland Grey Box Woodland	Barking Owl	Black Falcon Grey Falcon Little Eagle Spotted Harrier Square-tailed Kite	Aquatic Ecological Community in the Natural Drainage System of the Lowland Catchment of the Darling River (NSW FM Act).
a) in the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction.	Not relevant.	Local population: Barking Owls occur in the Dubbo area, with breeding habitat known to occur in large hollow bearing trees adjacent to watercourses. As no impact will occur to suitable riparian large hollow bearing trees known to be used for breeding, the proposal is unlikely to disrupt a local population of Barking Owls.	Local population: These species of bird of prey are known to occur in the Dubbo area. Due to the mobile nature of these species, hunting grounds in cleared (semi-suburban) and riparian habitat cannot be considered critical to the survival of this species, as similar habitat along the riparian zone is abundant in the locality (Macquarie River). It is likely that these birds of prey may hunt on open ground associated with the floodplain. Vehicle movement and noise associated with the Proposal may impact birds hunting, however the short nature of this noise is unlikely to disrupt a viable local population of the species such that they are placed at a risk of extinction Breeding sites for these birds of prey are likely to occur in tall trees associated with riparian environments outside the Subject Site near the Macquarie or Talbragar River. No likely breeding trees would be removed. Furthermore, no breeding sites have been	Not relevant

7-Part Test Criteria	Fuzzy Box Woodland White Box Woodland Inland Grey Box Woodland	Barking Owl	Black Falcon Grey Falcon Little Eagle Spotted Harrier Square-tailed Kite	Aquatic Ecological Community in the Natural Drainage System of the Lowland Catchment of the Darling River (NSW FM Act).
			previously recorded by the species in the Subject Site. Habitat critical to the survival of these species \is unlikely to occur in the Subject Site given the less disturbed habitats are available in the locality. Thus a viable local population of the species is unlikely to be placed at risk of extinction.	
b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.	Not relevant.	Not relevant	Not relevant	Not relevant
c) in the case of an endangered ecological community or CE ecological community, whether the action proposed: (i) is likely to have an adverse effect on the extent of the ecological community such that its occurrence is likely to be placed at risk of extinction, or	The Proposal would not place this EEC at risk of local extinction.	Not relevant	Not relevant	Eulomogo Creek drains into the Macquarie River that forms part of the listing for this aquatic EEC. The EEC will not become locally extinct as the works will only affect small areas of its extent.

7-Part Test Criteria	Fuzzy Box Woodland White Box Woodland Inland Grey Box Woodland	Barking Owl	Black Falcon Grey Falcon Little Eagle Spotted Harrier Square-tailed Kite	Aquatic Ecological Community in the Natural Drainage System of the Lowland Catchment of the Darling River (NSW FM Act).
(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,				
d) in relation to habitat of a threatened species, population or ecological community: (i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and (ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and (iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.	The Subject Site has already had habitat removed, fragmented and now exists in a derived grassland state.	Any component of habitat/resource is considered important. The Subject Site contains likely hunting grounds for the Barking Owl. It is unlikely that the Proposal would isolate and decrease the availability of quality habitat to the extent that the species is likely to decline. It is unlikely that the action will adversely affect habitat critical to the survival of the species.	Any component of habitat / resource is considered important. The Subject Site contains likely hunting grounds and potential breeding resources. Due to grassy habitat within the Subject Site, no roost or breeding sites will be impacted. It is unlikely that the Proposal would isolate and decrease the availability of quality habitat to the extent that the species is likely to decline. It is unlikely that the action will adversely affect habitat critical to the survival of the species	The EEC extends beyond the Subject Site and is in a degraded state. Recovery of this EEC will occur once the works have completed.
e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).	Critical habitat does not occur in the locality.	Critical habitat has not been declared for this species and at present there are no habitats listed as critical in the locality.	Critical habitat has not been declared for these species and at present there are no habitats listed as critical in the locality.	Critical habitat does not occur in the locality.

7-Part Test Criteria	Fuzzy Box Woodland White Box Woodland Inland Grey Box Woodland	Barking Owl	Black Falcon Grey Falcon Little Eagle Spotted Harrier Square-tailed Kite	Aquatic Ecological Community in the Natural Drainage System of the Lowland Catchment of the Darling River (NSW FM Act).
f) whether the actions proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.	There are no recovery or threat abatement plans for this EEC.	Two recovery plans relevant to this species exist: Draft Recovery Plan for the Barking Owl Recovery Plan for the Large Forest Owls Seven large hollow bearing trees suitable as a breeding site will be removed, however as noted its location next to a busy road make it highly unlikely to be used. Impact will occur in the short term to likely hunting territory.	There are no recovery or threat abatement plans for these species. Vegetation removal contributes to the threats facing this species. However habitat restoration and rehabilitation is consistent with the recovery plans for these species.	There is no recovery plan for this EEC.
g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.	KTPs such as clearing of native vegetation, will be exacerbated by the Proposal. Predation by the European red fox (*Vulpes vulpes*) and Predation by the feral cat (*Felis catus*), have or are currently occurring with Subject Site.	As per left hand column	As per left hand column	The alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands has been listed as a KTP in Schedule 3 of the TSC Act. Even though the creek flow will not be altered in the long-term, construction works in the vicinity of the creek may impact its viability in the short term. Degradation of native riparian vegetation along NSW waterways has been listed as a KTP in Schedule 6 of the FM Act. The clearing of riparian vegetation and machinery access to the riparian zone increases erosion and siltation, and may impact habitat including reproductive sites for species in this aquatic ecological community. This clearing is however minimal.

7-Part Test Criteria	Fuzzy Box Woodland White Box Woodland Inland Grey Box Woodland	Barking Owl	Black Falcon Grey Falcon Little Eagle Spotted Harrier Square-tailed Kite	Aquatic Ecological Community in the Natural Drainage System of the Lowland Catchment of the Darling River (NSW FM Act).
				The clearing of native vegetation has been listed as a KTP in Schedule 3 of the TSC Act
Conclusion	The Proposal is not likely to significantly impact a locally occurring population of this EEC such that it is placed at risk of local extinction. A SIS is not warranted. It would however be appropriate to offset the loss of vegetation following recommendations in this report.	A local population being placed at risk of extinction is unlikely due to the large amount of surrounding analogous habitat adjoining the Subject Site. A Species Impact Statement is not required	A local population being placed at risk of extinction is unlikely due to the large amount of surrounding analogous habitat adjoining the Subject Site. A Species Impact Statement is not required.	Recommendations in this report will ensure a high level of soil and sediment controls are implemented. A SIS is not required.

DoE Assessments of Significance - migratory species

Criteria: An action is likely to have a significant impact on a migratory species if there is a real chance or possibility that it will:	White-throated Needletail, Fork-tailed Swift, Rainbow Bee-eater, Cattle Egret, Great Egret.
substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species	All species are predicted to have occasional habitat in the Subject Site. **Fork-tailed Swift (Apus pacificus) and White-throated Needletail (Hirundapus caudacutus)** The White-throated Needletail and Fork-tailed Swift are aerial species for which the Subject Site will not represent 'important habitat' and no impacts are expected due to the ability of this species to forage over a wide variety of land use, including human infrastructure and large water bodies and wetland areas in Dubbo. **Great Egret (Ardea alba) and Cattle Egret (Bubulcus ibis)** These species are predicted to occur, within or nearby to the Subject Site during periods of inundation. Furthermore the Cattle Egret is predicted to occur during the non-breeding period when cattle are stocked. There is no record of either in the Subject Site. Any such impacts involving habitat would be minor and may be mitigated by the habitat creation and enhancement activities noted above for other wetland species. The proposed action would have minimal effects on any local population of these species. **Rainbow Bee-eater Merops ornatus** The Macquarie River is a known place for congregation of flocks and is core breeding habitat for the species. The Rainbow Bee-eater is most often found in open forests, woodlands and shrublands, and cleared areas, usually near water. It will use disturbed sites with sandy soils such as river banks, quarries, cuttings and mines or exposed sites on cleared flats to build its nesting tunnels. Providing that recommendations in this report are followed there will be no impact to individual birds or a long term decrease in the population.
result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species, or	The local area has a history of clearing and habitat modification, which has benefited a number of feral and invasive flora and fauna species. The proponent proposes to ensure the spread of weeds and feral fauna is not enhanced by the project that will contribute to the overall enhancement of habitat for all species.
seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.	It is unlikely that the Proposal would interfere with an ecologically significant proportion of any of these species. It is unlikely that these species would be significantly impacted by the Project. Referral to the DoE is not required.

DENOTES R2 - LOW DENSITY RESIDENTIAL LAND ZONE

DENOTES RE1 - PUBLIC RECREATION

DENOTES R5 - LARGE LOT RESIDENTIAL

NOTES:

1. INFORMATION SHOWN IS FOR DEVELOPMENT APPLICATION PURPOSES ONLY
2. AREAS AND DIMENSIONS ARE SUBJECT TO SURVEY

SCALE 1:3000(A1)

SCALE 1:6000(A3)

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No	DATE	DRAFTING CHECK	APPROVED BY	DETAILS
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B	15/08/16	JE	MT	LOT LAYOUT AMENDED
C	20/12/16	JE	MT	LOT LAYOUT AMENDED
D	02/02/17	JE	MT	LOT LAYOUT AMENDED

PROJECT
SOUTHLAKES ESTATE (HILLVIEW)

FILE REFERENCE

APPROVAL AUTHORITY
DUBBO REGIONAL COUNCIL

CLIENT
MAAS GROUP PROPERTIES No.2 PTY LTD

DRAWING
EXISTING ZONING PLAN

PROJECT NUMBER: 114135 DRAWING NUMBER: 19D_TP01 REV: D

SOURCE: INTERNAL

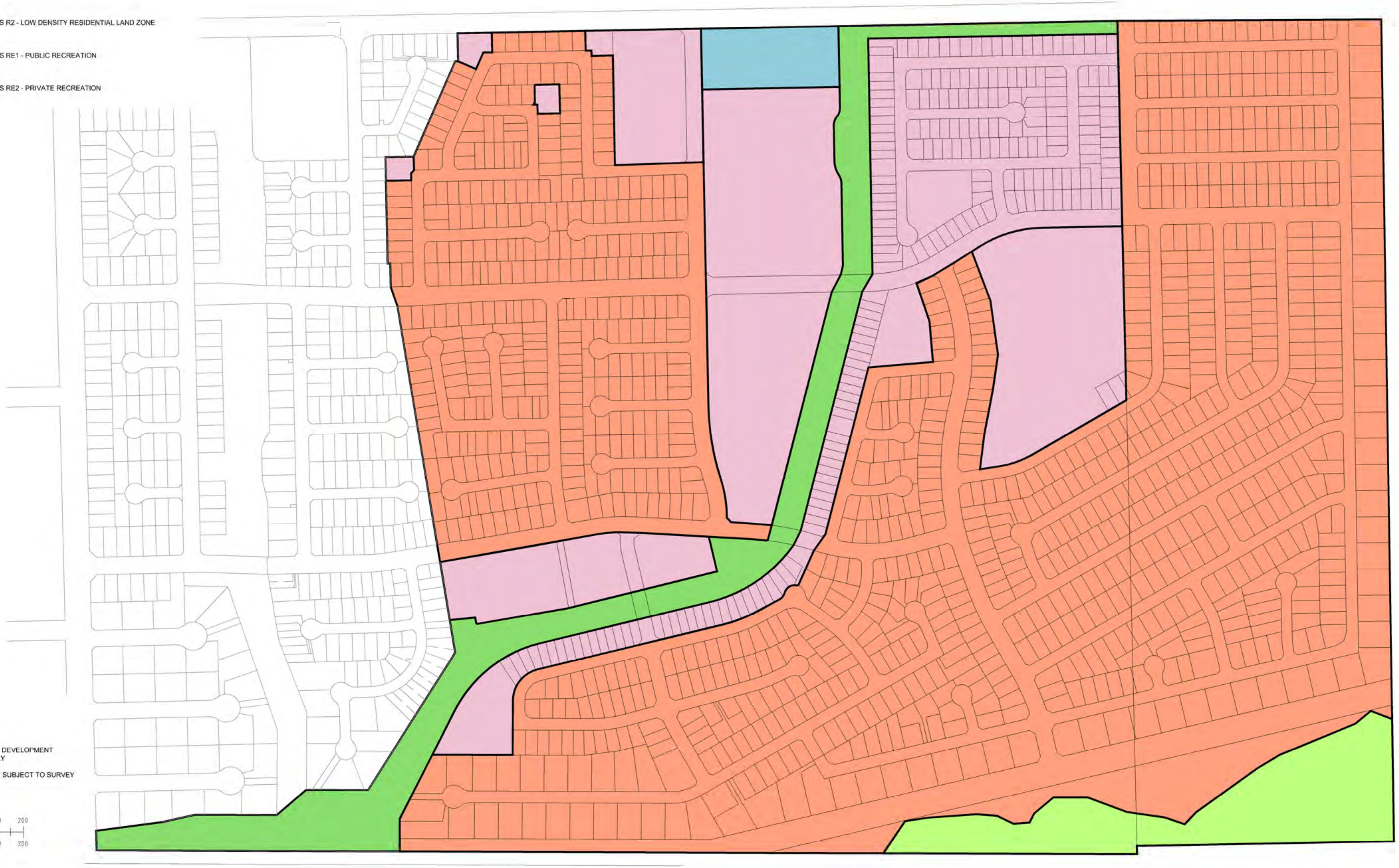
DENOTES B1 - NEIGHBOURHOOD CENTRE

DENOTES R1 - GENERAL RESIDENTIAL LAND ZONE

DENOTES R2 - LOW DENSITY RESIDENTIAL LAND ZONE

DENOTES RE1 - PUBLIC RECREATION

DENOTES RE2 - PRIVATE RECREATION



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SCALE 1:3000(A1)

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SCALE 1:6000(A3)

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D	02/02/17	JE	MT	LOT LAYOUT AMENDED

PROJECT: SOUTHLAKES ESTATE (HILLVIEW)

FILE REFERENCE: 114135_19D_TP02.dwg

APPROVAL AUTHORITY: DUBBO REGIONAL COUNCIL

CLIENT: MAAS GROUP PROPERTIES No.2 PTY LTD

DRAWING: PROPOSED ZONING PLAN

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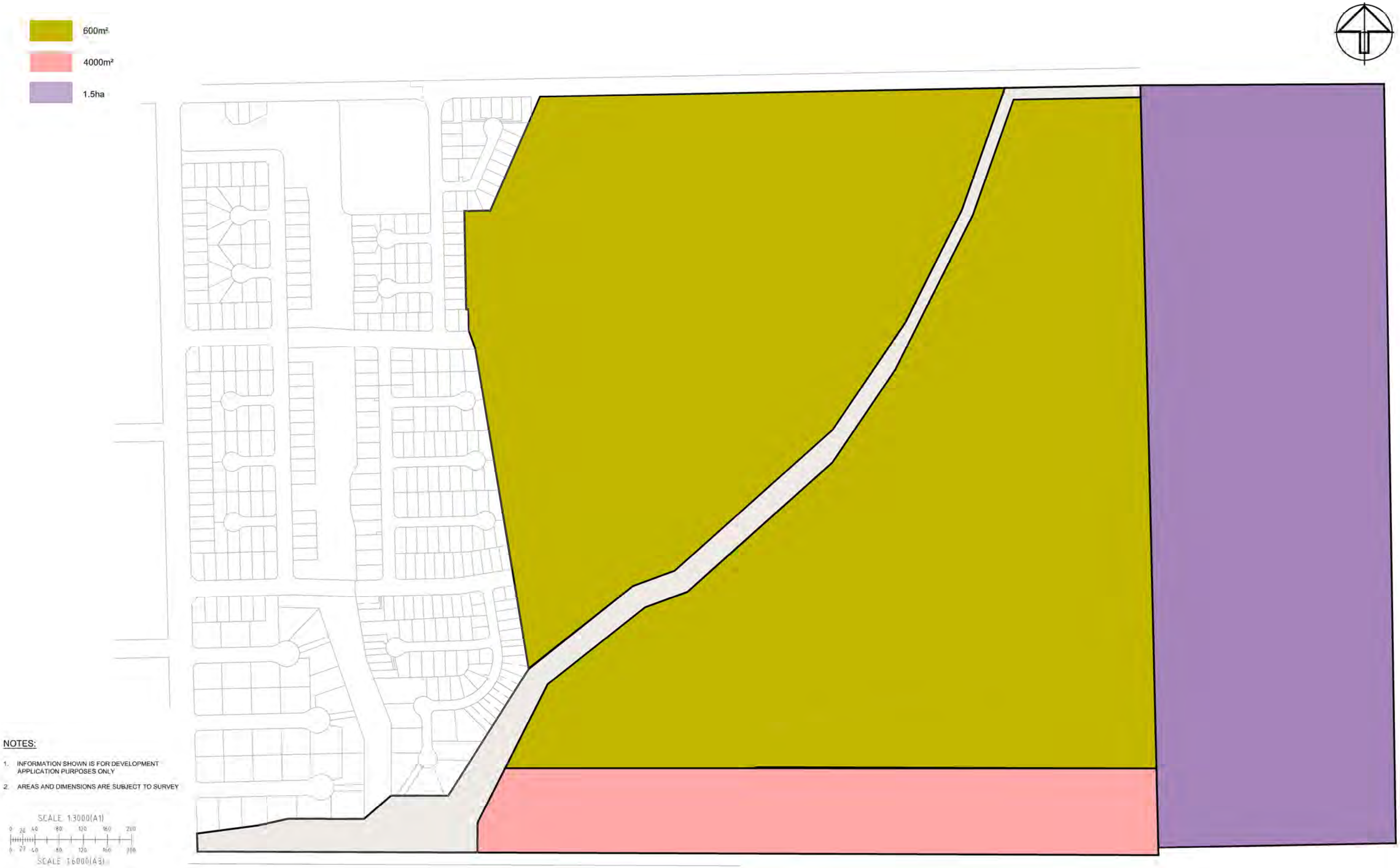
SOURCE: INTERNAL



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PROJECT: SOUTHLAKES ESTATE (HILLVIEW)

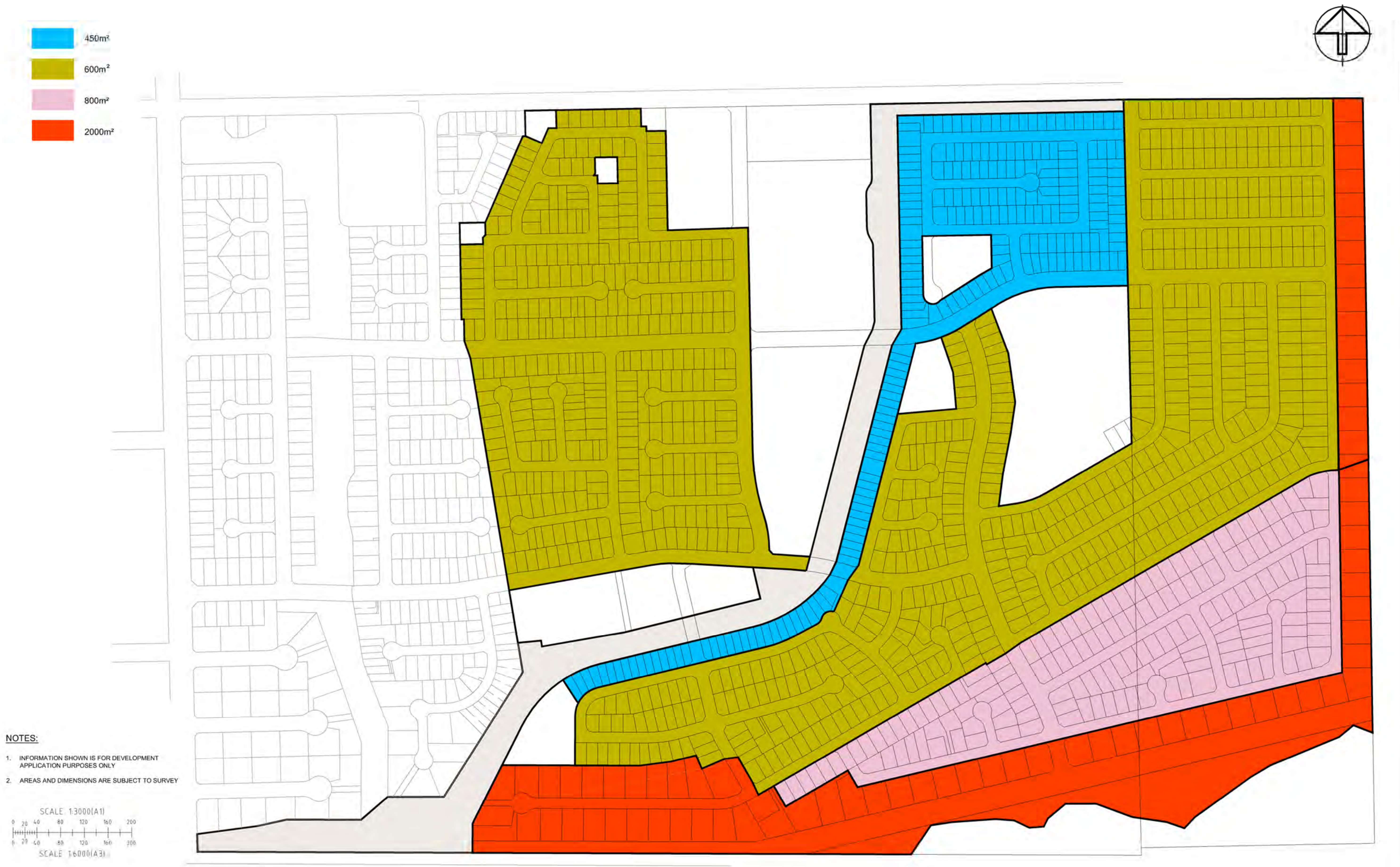
APPROVAL AUTHORITY: DUBBO REGIONAL COUNCIL

CLIENT: MAAS GROUP PROPERTIES No.2 PTY LTD

DRAWING: EXISTING LOT SIZE MAP

PROJECT NUMBER: 114135 DRAWING NUMBER: 19D_TP03 REV: D

SOURCE: INTERNAL



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D	02/02/17	JE	MT	LOT LAYOUT AMENDED

PROJECT

SOUTHLAKES ESTATE
(HILLVIEW)

FILE REFERENCE: 114135_19D_TP04.dwg

APPROVAL AUTHORITY

DUBBO REGIONAL COUNCIL

CLIENT

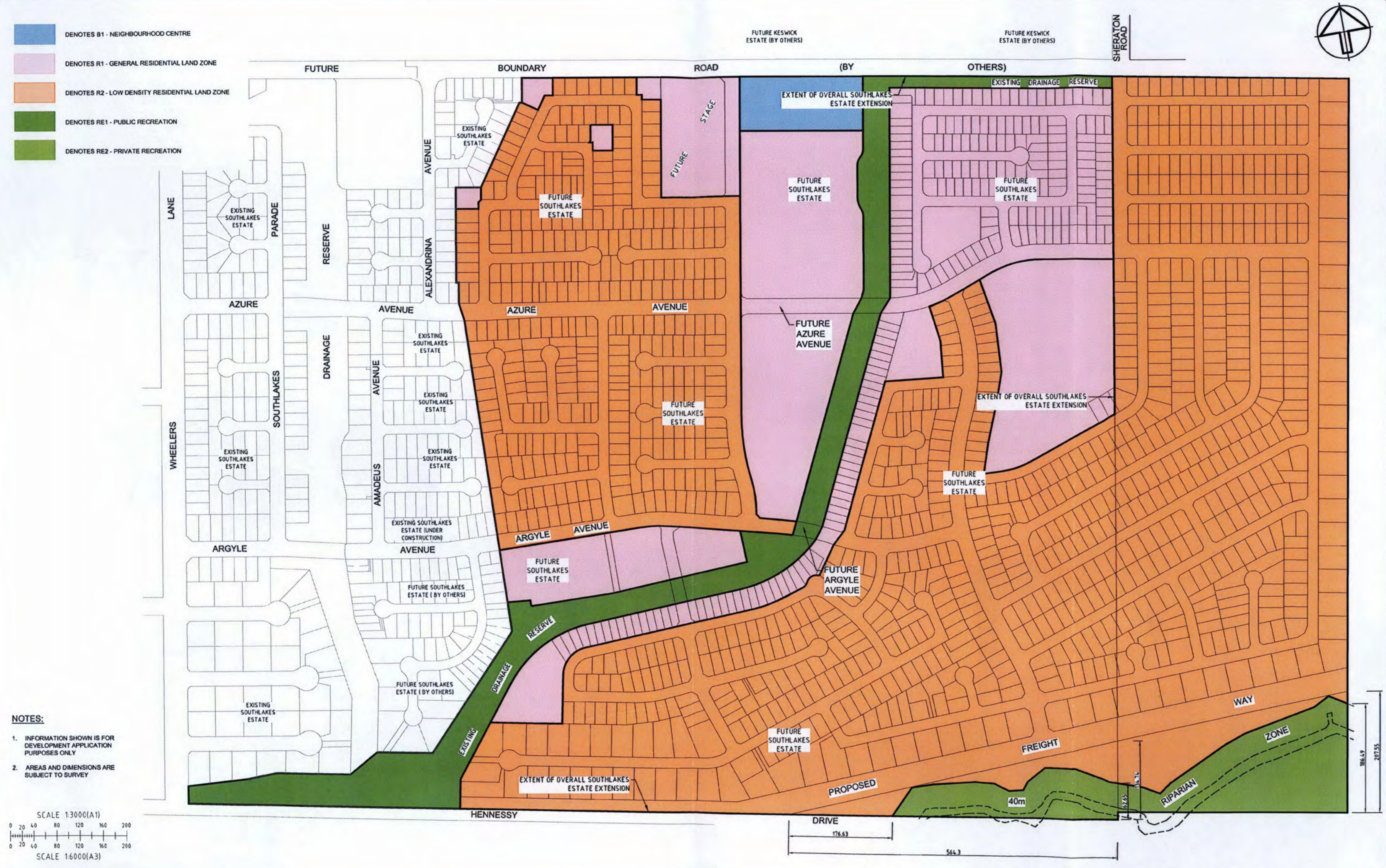
MAAS GROUP
PROPERTIES No.2
PTY LTD

DRAWING

PROPOSED LOT SIZE MAP

PROJECT NUMBER: 114135 DRAWING NUMBER: 19D_TP04 REV: D

SOURCE: INTERNAL



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A	02/02/17	JE	MT	ISSUED TO CLIENT

PROJECT: SOUTHLAKES ESTATE (HILLVIEW)

FILE REFERENCE: 114135_39A_TP01-TP02.dwg

APPROVAL AUTHORITY: DUBBO REGIONAL COUNCIL

CLIENT: MAAS GROUP PROPERTIES No.2 PTY LTD

DRAWING: OVERALL ZONING PLAN

PROJECT NUMBER: 114135 | DRAWING NUMBER: 39A_TP02 | REV: A

SOURCE: INTERNAL

Inspection Report

DUBBO REGIONAL COUNCIL

APPLICATION NO:	11-2017-70 Part 1 - AU17/188
INSPECTION DATE:	8 March 2017
RESPONSIBLE OFFICER:	WAB
SPECIFY STRUCTURE:	Dwelling
ADDRESS:	Lot: 1922 DP: 1216563 - 12 Tolmer Terrace DUBBO PN: 26472
OWNER:	Brett Harvey Constructions Pty Ltd
CONTACT PERSON:	Zac — Ring/text contact with outcome **Yes** □ **No** □
CONTACT PHONE NO:	0413 145 824

SPECIAL INSTRUCTIONS: **At 11:30am if possible**

TYPE OF INSPECTION:

Footings, Piers, Trenches (IFOO)	□	Internal Sanitary Drainage (IISD)	X
Sub Floor Frame (ISUB)	□	External Sanitary Drainage (IESD)	□
Slab (ISLB)	□	**Draw Drainage Diagram** **Yes** □	**No** □
Wet-Area Waterproofing (IWET)	□	Date requested: / / Date drawn: / /	
Stormwater Connection (ISTW)	□	Water Plumbing H/C (IWPL)	□
Frame and Water Plumbing H/C (IFW)	□	Plumbing and Drainage Final (IPLF)	□
Frame (IFRM)	□	Internal Drainage Septic (IIDS)	□
Pool Steel (IPST)	□	External Drainage Septic (IEDS)	□
Pool Fencing (IPFC)	□	Septic (ISEP)	□
Compliance (ICOM)	□	Other (IOTH) (ie stackwork)	□
Final (IFIN)	□		

Issue certificates: **Yes** □ **No** □ Compliance (ICOM) □ Interim OCC □
Fire Service (IFSP) □ Final OC (IOCC) □ Re-inspection □

Have you identified any major hazards/no-go areas onsite? Yes ☐ No ☐	***Is PPE required before entry? Yes ☐ No ☐***
Do you have the correct PPE? Yes ☐ No ☐	***Is it safe to proceed onto the site? Yes ☐ No ☐***

PCA sign erected? Yes ☐ No ☐ NA ☐	**Onsite toilet? Yes ☐ No ☐ NA ☐**	**Conditions checked? Yes ☐ No ☐ NA ☐**
Sed. control present? Yes ☐ No ☐ NA ☐	**Any missed Critical Stage Inspections? Yes ☐ No ☐ NA ☐**	
Plumber's name:	**Principal contractor's name:**	

INSPECTION NOTES:

PTO ☐

INSPECTION RESULTS: SATISFACTORY ❑	**UNSATISFACTORY** ❑	**Not Ready/Cancelled** ❑

Reinspection required? Yes ☐ No ☐ - Reinspection to be rebooked? Yes ☐ No ☐

Sticker left onsite? Yes ☐ No ☐ Tradesman contacted directly? Yes ☐ No ☐

INSPECTED BY:	(Print Full Name)	Accreditation No:	BPB A1 A2 A3 A4
Signature:		Date:	

ENTERED BY: TAF	DATE: 7 March 2017	UPDATED BY:	DATE:

APPLICATION NO:	11-2017-70 Part 1 (AU17/188)
INSPECTION NOTES – Cont:	

REINSPECTION RESULTS: SATISFACTORY ❑	**UNSATISFACTORY ❑**
Reinspection required? Yes ☐ No ☐ - Reinspection to be rebooked? Yes ☐ No ☐	
Sticker left onsite? Yes ☐ No ☐	Tradesman contacted directly: Yes ☐ No ☐

INSPECTED BY:	(Print Full Name)	Accreditation No:	BPB A1 A2 A3 A4
Signature:		Date:	

ENTERED BY:	DATE:	UPDATED BY:		DATE:	

Cardno
Shaping the Future

Our Ref: 59915164-L02:BCP/bcp
Contact: Dr Brett C. Phillips

27th March 2017

Cardno (NSW/ACT) Pty Ltd
ABN 95 001 145 035

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International: +61 2 9496 7700

Web: www.cardno.com.au

The Manager,
Maas Group Properties
PO Box 332
DUBBO NSW 2830

Attention: Mr Steven Guy

Dear Steven,

FURTHER FLOODING INFORMATION FOR LOT 399 DP 1199356 (HILLVIEW) IN DUBBO

In response to your recent request, we are pleased to provide the following flooding advice for Lot 399 DP 1199356 (Hillview) in Dubbo.

1. BACKGROUND

1.1 Location

The location of Lot 399 DP 1199356 (Hillview) in Dubbo is indicated in **Figure 1**. The property is located adjacent to the downstream reach of the Eulomogo Creek.

1.2 Keswick Drainage Review

In 2010 the Keswick Drainage Review prepared by Cardno Willing updated the feasibility study reported by Willing & Partners in 1995. The Willing & Partners report investigated the trunk drainage and water quality requirements that would allow development in the Keswick area to proceed in an orderly fashion. Since 1995 residential development has become established with imminent plans for further development. The establishment of two schools and commercial development has also occurred.

The investigations have been completed in two parts.

The first part involved reviewing the hydrology of the area and re-estimating the peak flow rate and volume of runoff. This required the conceptual location and sizing of flood retarding basins, and connecting trunk drainage channels with the aim of reducing the estimated future runoff from the developed catchment to no more than undeveloped catchment, and in the location where drainage works have already been constructed, no more than the 1995 estimates of peak flow.

Notwithstanding these objectives the lower part of Eulomogo Creek is in a degraded condition and is continuing to experience severe erosion of the bed and banks. A related study of the lower part of Eulomogo Creek [Cardno, 2010] identified that a significant factor contributing to bank instability is the increase in the peak flow rate and volume of runoff during small frequent events, typically having an average recurrence interval up to 5 years. Therefore practical opportunities to include measures to reduce the impact of the small frequent storms were included in the drainage strategy including the use of multi-staged outlets to selected retarding basins.

The second part of the study considered water quality issues and identified, at a conceptual level the type and size of facilities required to achieve runoff water quality consistent with current NSW guidelines for total phosphorus, total nitrogen, and suspended solids. In some instances the water quality facilities have been integrated with the flood retardation basins.

1.3 Firgrove Estate Flooding Assessments

Assessments of rainfall, runoff and flooding in the Firgrove Estate and the upper Eulomogo Creek catchment have been ongoing since 2012.

In a Discussion Paper dated 20 January 2012, various tasks that were undertaken at the time to investigate rainfall, runoff and flooding in Firgrove Estate were described. These included:

- Assembly of an **xprafts** model of the Eulomogo Creek catchment upstream of the Railway Line based on model parameters that have been adopted elsewhere in Dubbo;
- Input 100 yr ARI design storm bursts for a range of durations and estimate the critical duration 100 yr ARI peak flow;
- Compare the 100 yr ARI peak flow with an alternate estimate and if appropriate adjust the model parameters to achieve broad agreement;
- Estimation of runoff during the storms of 18 November 2000 and 3-4 December 2010;
- Creation of a local 1D/2D **xpswmm2D** model of the reach of Eulomogo Creek and Firgrove Estate. Upstream boundary conditions are flows generated by the **xprafts** model of the Eulomogo Creek catchment while the downstream boundary condition is based on normal flow conditions.
- Running of the model to assess the flood extents and the magnitude of any flow down the flood runner during November 2000 and/or 3-4 December 2010 (if possible) and during a 100 yr ARI event.

It was concluded from these assessments that:

- The frequency of the November 2000 and December 2010 floods inferred from the peak flows estimated using the initial loss / continuing loss model are close to the estimated frequency of the storm bursts except for the synthetic December 2010 storm where the severity of the peak flow is far greater than the severity of the (synthetic) rainfall;
- The frequency of the November 2000 and December 2010 floods inferred from the peak flows estimated using the ARBM loss model are comparable to the estimated frequency of the storm bursts;
- The Eastern NSW procedure appears to underestimate the design flows at Toorale Rd in comparison with the observed flooding and the estimated frequency of the storm bursts.

The peak flows for the November 2000 and December 2010 events estimated by the hydrological model using the two loss models are also plotted in **Figure 2** in order to infer the severity of these events from the relevant flood frequency curves.

A 2D floodplain model was assembled and was run to estimate the flood extents, depths and velocities in the November 2000, December 2010 and the 100 yr ARI events for both initial loss / continuing loss and ARBM models. It was concluded from a comparison of the observed and predicted flood levels for the December 2010 flood that:

- The synthetic December 2010 storm gave flood levels far closer to the observed levels than the Dubbo Airport storm adjusted to match the daily reading at the Geurie PO;
- The level of agreement for the IL/CL loss model and the ARBM model (with 40% soil saturation) with the observed levels was good considering the method used to create the synthetic December 2010 storm

The 100 yr ARI flood levels were also estimated using both loss models. In the case of the ARBM model an initial condition of 65% soil saturation was adopted when assessing the design floods to account for antecedent rainfall prior to the design storm burst.

It was concluded that while the IL/CL and ARBM loss models gave comparable estimates of the peak flows in design floods that ARBM loss model gave flood severities for the historical floods were in better agreement with the assessed rainfall severity than the IL/CL model.

1.4 Australian Rainfall & Runoff

The most commonly encountered hydrological problem associated with estimating flood flows is that of estimating the flood flow of a given Annual Exceedance Probability (AEP) at a location where the historical monitored information is inadequate for frequency analysis. These locations are referred to as ungauged catchments. Numerous alternative techniques have been developed historically in the different regions of Australia to provide the necessary design flow predictions in ungauged catchments. The current diversity of approaches has resulted in predicted flows varying significantly at the interfaces between regions. It was recognised that there was a need to develop generic techniques that can be applied across the whole country, to test these techniques, and to develop appropriate guidance in their usage.

The aim of Stage 2 of Project 5 was to test the suitability of alternative national approaches to the estimation of design peak flow predictions for ungauged catchments

Stage 2 developed a firm basis for recommendations on the methods for regional flood frequency estimation (RFFE) included in the revised ARR Chapter (4th edition).

The application of empirical scale correction factors with these regional flood prediction equations has most recently been presented as a case study for eastern Australia by Zaman et al (2013)[1]. These procedures supersede the current Eastern NSW procedure.

A trial application of this procedure is presented in **Figure 2**. It lends great support to the previous modelling results and suggests that it may be appropriate to re-visit the ARBM initial moisture condition to lower the design peak flows to broadly match the RFFE values.

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[1] Zaman, M. A., Haddad, K. & Rahman, A. 2013, "Application of empirical scale correction factors with regional flood prediction equations: A case study for eastern Australia", *Australian Journal of Water Resources*, Vol. 16, No. 2, pp. 141-150, http://dx.doi.org/10.7158/W12-008.2013.16.2

2. OBJECTIVE

The objective of the assessment is to provide information on the impact of the proposed development layout on Lot 399 DP 1199356 (Hillview) in relation to flooding in a 100 yr ARI event.

3. BENCHMARK CONDITIONS

3.1 Local 1D/2D Floodplain Model

In order to estimate 100 yr ARI flood levels in the lower reach of Eulomogo Creek a local 1D/2D model was assembled of the Eulomogo Creek floodplain and a reach of the Macquarie River in June 2015.

The hydraulic study area is identified in **Figure 3.**

The adopted grid size was 2 m x 2 m in the area of detailed interest (Hillview) and was 5 m x 5 m elsewhere on the floodplain (refer **Figure 3**).

Figure 4 shows the study area and roughness zones adopted in the TUFLOW model.

Inflows were generated using an updated **xprafts** model of the Eulomogo Creek catchment in combination with post-development flows at Hennessy Drive. The updated **xprafts** model was run and it was determined that the 6 hour storm was critical in the lower reach of Eulomogo Creek. The Keswick catchment model was also re-run to estimated inflows under the 6 hour storm burst.

The runoff from the Eulomogo Creek and Keswick catchments under a 6 hour storm was combined with the adopted 100 yr ARI hydrograph in the Macquarie River. The significant difference in size of the Macquarie River catchment upstream of Dubbo and the Eulomogo Creek and Keswick Creek catchments is expected to lead to significant differences in the timing of runoff from these catchments. As indicated in **Figure 7** runoff from the Eulomogo Creek and Keswick Creek catchments would peak far earlier than the more slowly rising flood in the Macquarie River.

The 1D/2D model included the proposed Hennessy Drive Basin. The downstream boundary based on the flood levels in Macquarie River.

The model was run over a 60 hour period to ensure that the interaction of peak flooding in the Macquarie River with Eulomogo Creek was assessed.

3.2 Results

The 100 yr ARI flood was assessed under benchmark conditions. The estimated 100 yr ARI flood levels and flood extents in the study area and in the vicinity of Hillview are given **Figures 5** and **6** respectively. The calculated flood levels at two reference locations (identified in Figure 3) are plotted in **Figure 7**. The peak 100 yr ARI flood level at these two locations are:

Location P1	264.56 m AHD
Location P2	266.20 m AHD

It was concluded that flooding in a 100 yr ARI event in the vicinity of Hillview is just beyond the influence of the Macquarie River and is governed by runoff from the Eulomogo Creek catchment.

The estimated 100 yr ARI flood depths in the study area and in the vicinity of Hillview are given **Figures 8** and **9** respectively.

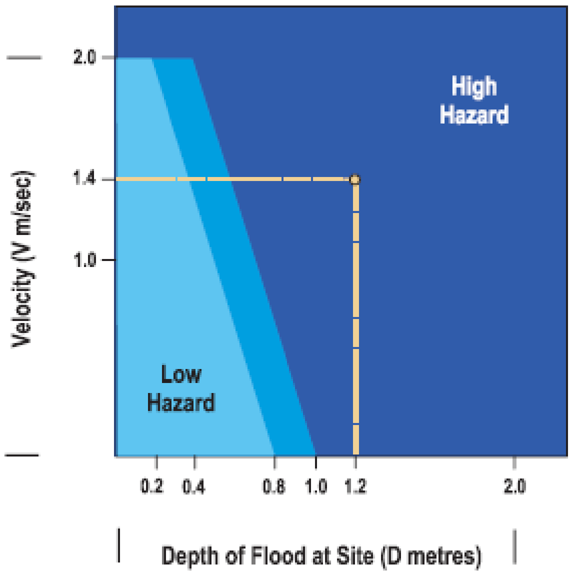
The estimated 100 yr ARI flood velocities in the study area and in the vicinity of Hillview are given **Figures 10** and **11** respectively

When considering pedestrian and vehicular stability, three velocity x depth criteria were identified as follows:

Velocity x Depth	Comment
≤ 0.4 m^2/s	This is typically adopted by Councils as a limit of stability for pedestrians
0.4 – 0.6 m^2/s	Unsafe for pedestrians but safe for vehicles if overland flood depths do not exceed around 0.3 m
> 0.6 m^2/s	This is typically adopted by Councils as a limit of stability for vehicles

The estimated 100 yr ARI velocity x depth in the study area and in the vicinity of Hillview are given **Figures 12** and **13** respectively.

Experience from studies of floods throughout NSW and elsewhere has allowed authorities to develop methods of assessing the hazard to life and property on floodplains. This experience has been used in developing the NSW Floodplain Development Manual to provide guidelines for managing this hazard. These guidelines are shown schematically below.



Provisional Hazard Categories (after Figure L2, NSW Government, 2005)

To use the diagram, it is necessary to know the average depth and velocity of floodwaters at a given location. If the product of depth and velocity exceeds a critical value (as shown below), the flood flow will create a **high hazard** to life and property. There will probably be danger to persons caught in the floodwaters, and possible structural damage. Evacuation of persons would be difficult.

By contrast, in **low hazard** areas people and their possessions can be evacuated safely by trucks. Between the two categories a transition zone is defined in which the degree of hazard is dependent on site conditions and the nature of the proposed development.

This calculation leads to a provisional hazard rating. The provisional hazard rating may be modified by consideration of effective flood warning times, the rate of rise of floodwaters, duration of flooding and ease or otherwise of evacuation in times of flood. The estimated 100 yr ARI provisional flood hazard in the study area and in the vicinity of Hillview are given **Figures 14** and **15** respectively.

4. FUTURE CONDITIONS

The floodplian model of Eulomogo Creek which was assembled previously in June 2015 was modified to represent the proposed landform adjacent to Eulomogo Creek given in **Figure 16** and to run the model to assess the flood impacts. The proposed lot layout is overlaid the 100 yr ARI flood extent under Existing Conditions in **Figure 17**. It is noted from **Figure 17** that in the vicinity of Eulomogo Creek the proposed road would need to be formed by filling. It was assumed that this fill would be contained by a vertical wall along the boundary of the road reserve.

While it is noted that the creek line plotted in **Figure 16** broadly aligns with the alignment of Eulomogo Creek (as disclosed by ALS data) it is noted that the creek alignment appears to deviate north of the plotted alignment in the vicinity of lot boundary at the western end of the section of Eulomogo Creek located within the property.

The 100 yr ARI flood level contours, depths, velocities, velocity x depth and hazards under Future Conditions are plotted in **Figures 18 – 22** respectively.

5. FLOOD IMPACT ASSESSMENT

The impacts of the proposed landform adjacent to Eulomogo Creek on 100 yr ARI flood levels are plotted in **Figure 23**.

It is noted from **Figure 23** that the proposed filling locally increases 100 yr ARI flood levels. The majority of the impact is located within Hillview Estate but the impacts do extend onto the adjoining property. These impacts on the adjoining property are considered to be minor given the current rural use.

A zone of reduced 100 yr ARI flood levels located in the vicinity of lot boundary at the western end of the section of Eulomogo Creek indicates that the proposed filling is partially blocking flood flows that occur under Existing Conditions. This is consistent with the creek alignment which appears to deviate north of the plotted alignment in the vicinity of lot boundary at the western end of the section of Eulomogo Creek located within the property.

An impact is also disclosed on the eastern boundary of the property. This is due to a local drainage line through the property being filled within the property. No attempt was made to locally redirect these flows to reduce the impact. This would need to be considered when designing the land form.

We would be pleased to further discuss our findings with you upon your request.

Yours faithfully

……………………………

Dr Brett C. Phillips
Director, Water Engineering
for **Cardno**

Figure 1 Location of Lot 399 DP 1199356 (Hillview) (Source: Geolyse)

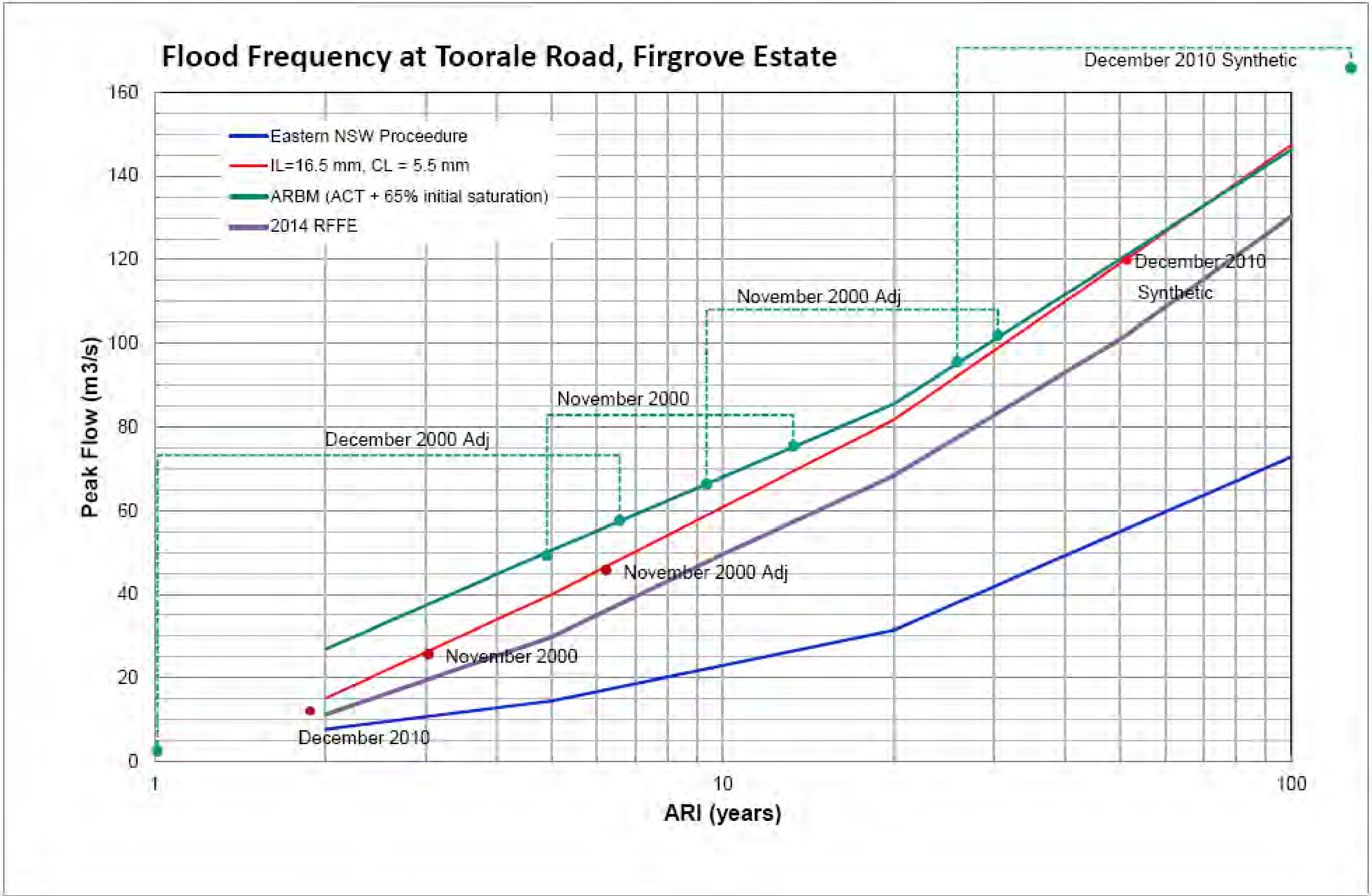


Figure 2 Flood Frequency Curves at Toorale Road, Firgrove Estate

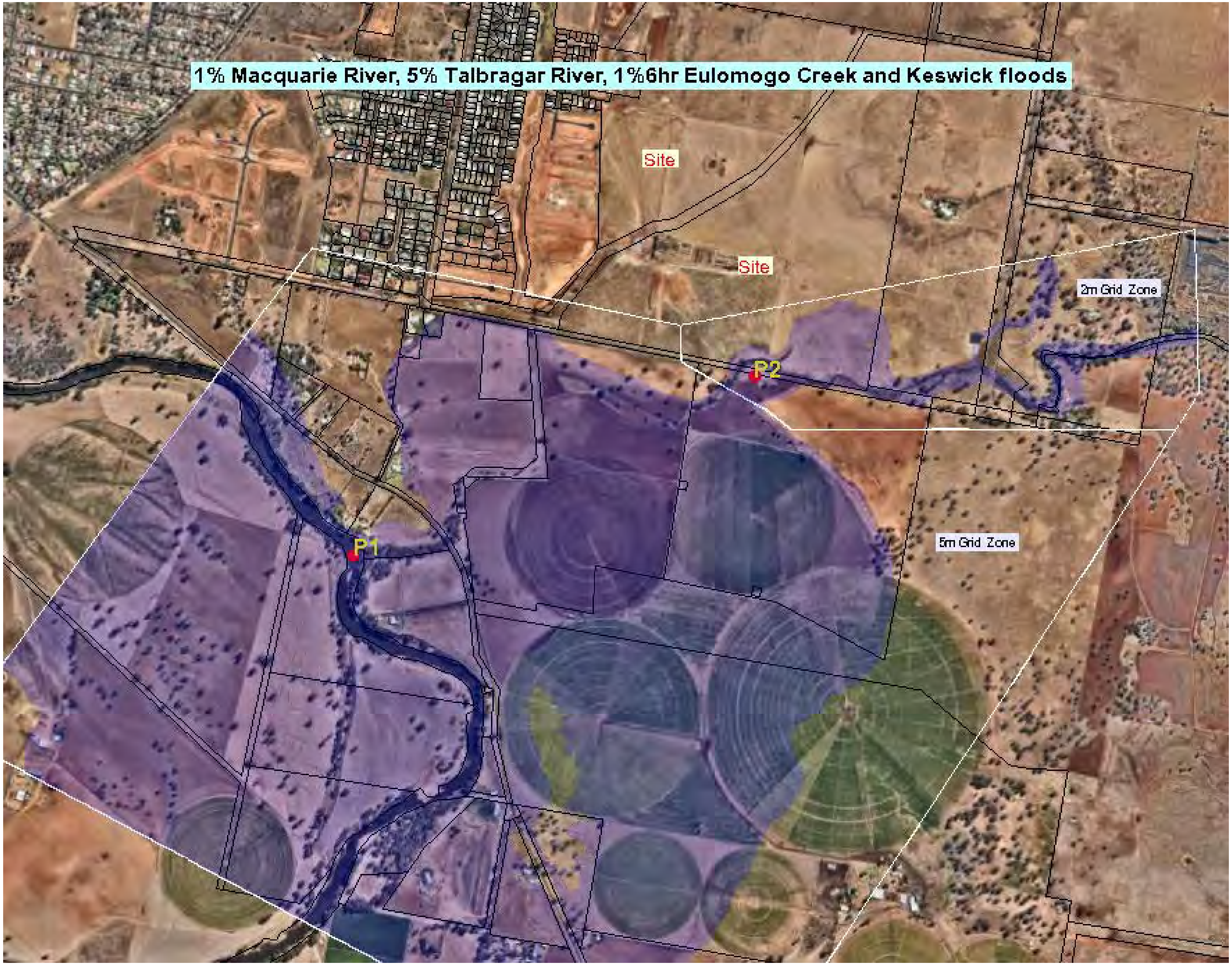


Figure 3 Lower Reach of Eulomogo Creek and Model Extents

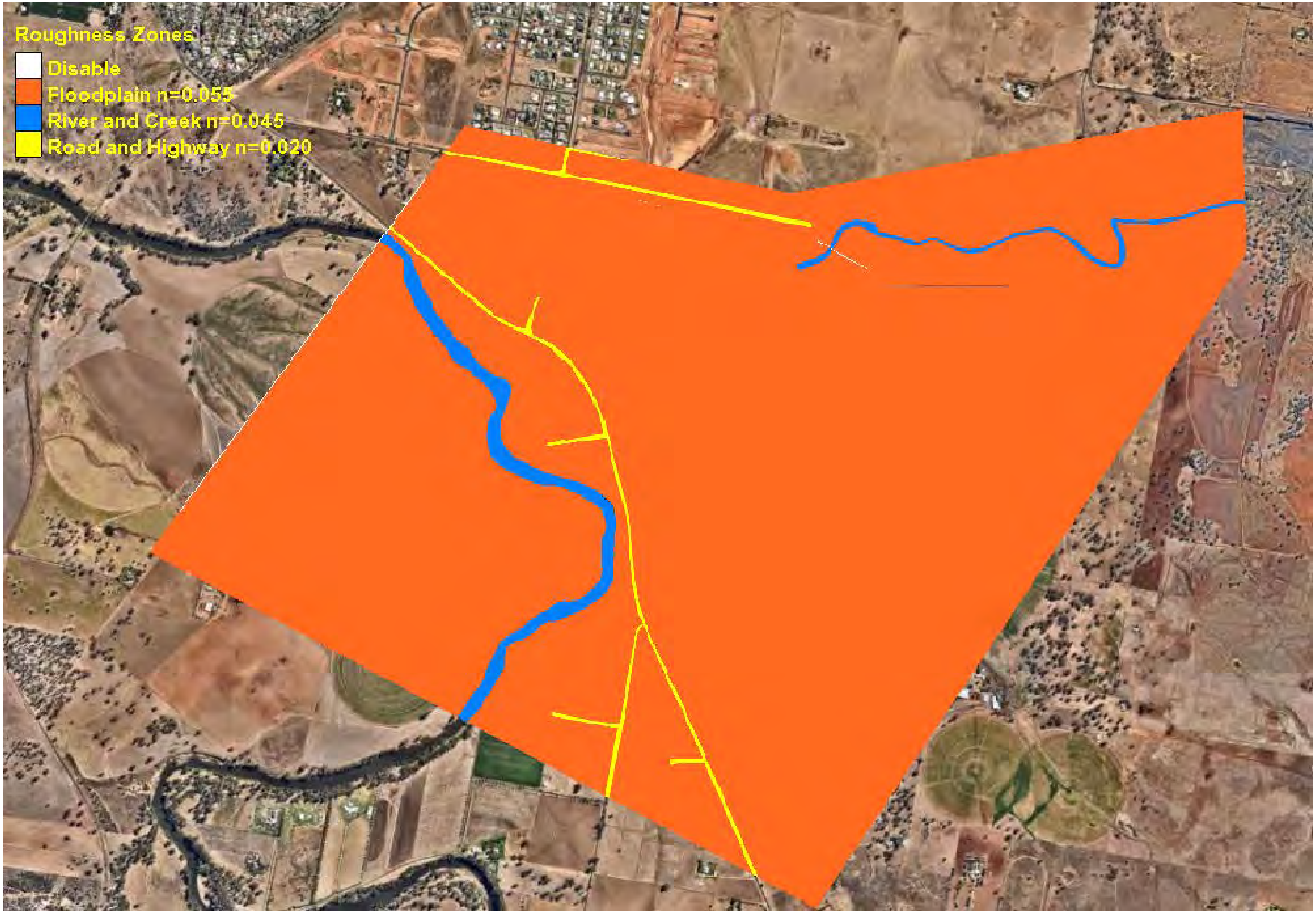


Figure 4 Adopted Existing Conditions Roughness Zones

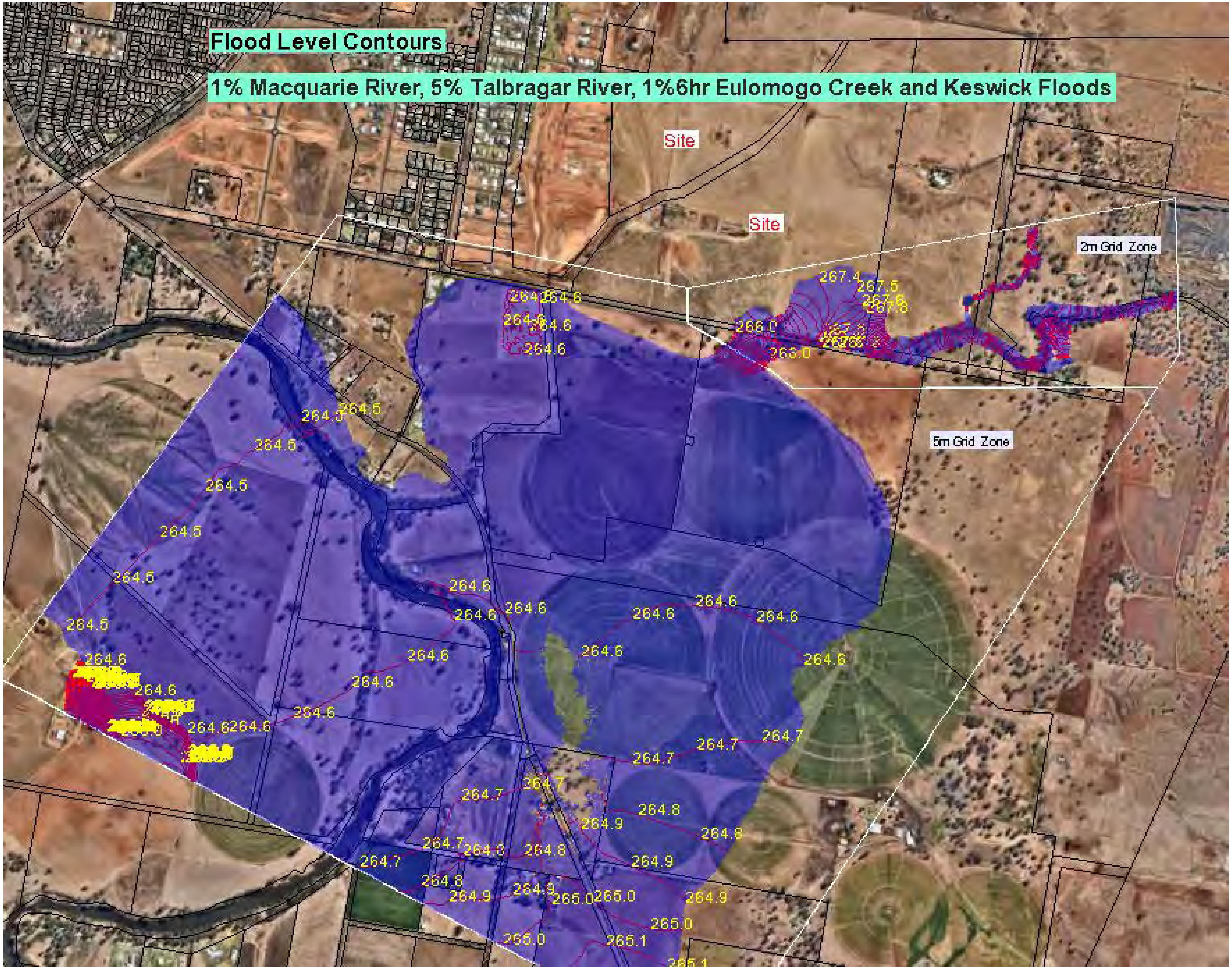


Figure 5 100 yr ARI Flood Levels Depths

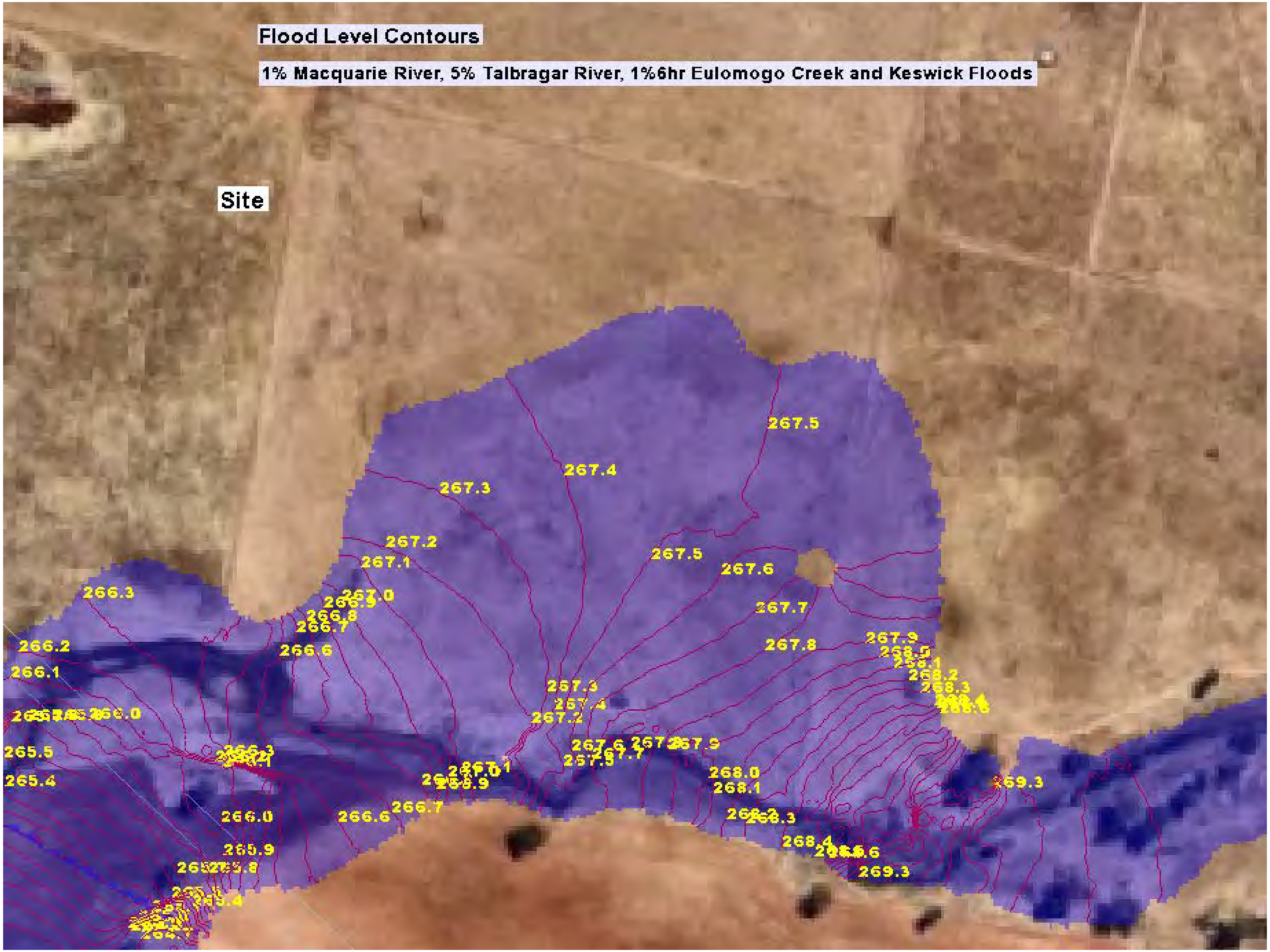


Figure 6 Zoomed 100 yr ARI Flood Levels – Hillview

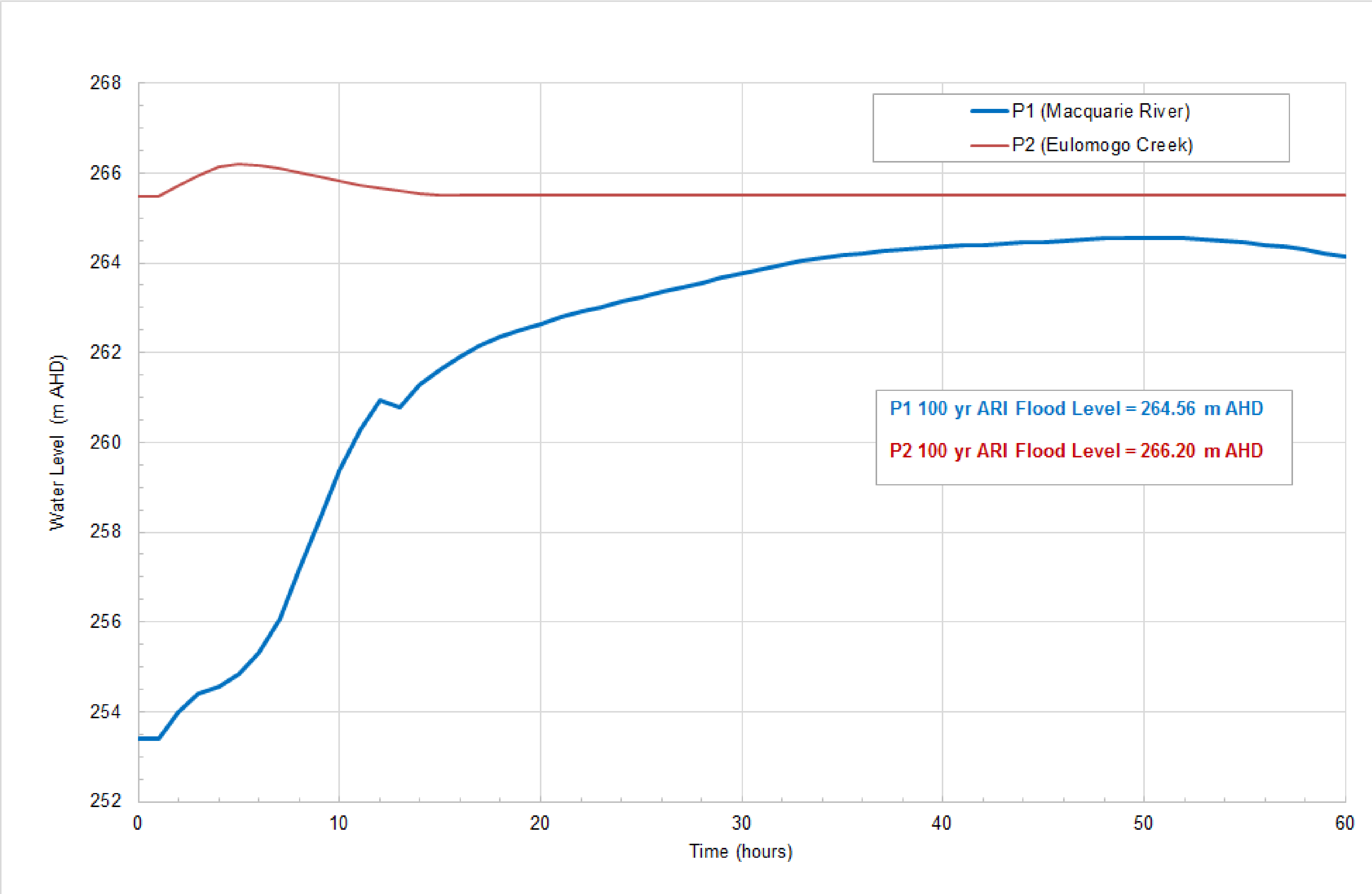


Figure 7 100 yr ARI Flood Levels at Reference Locations

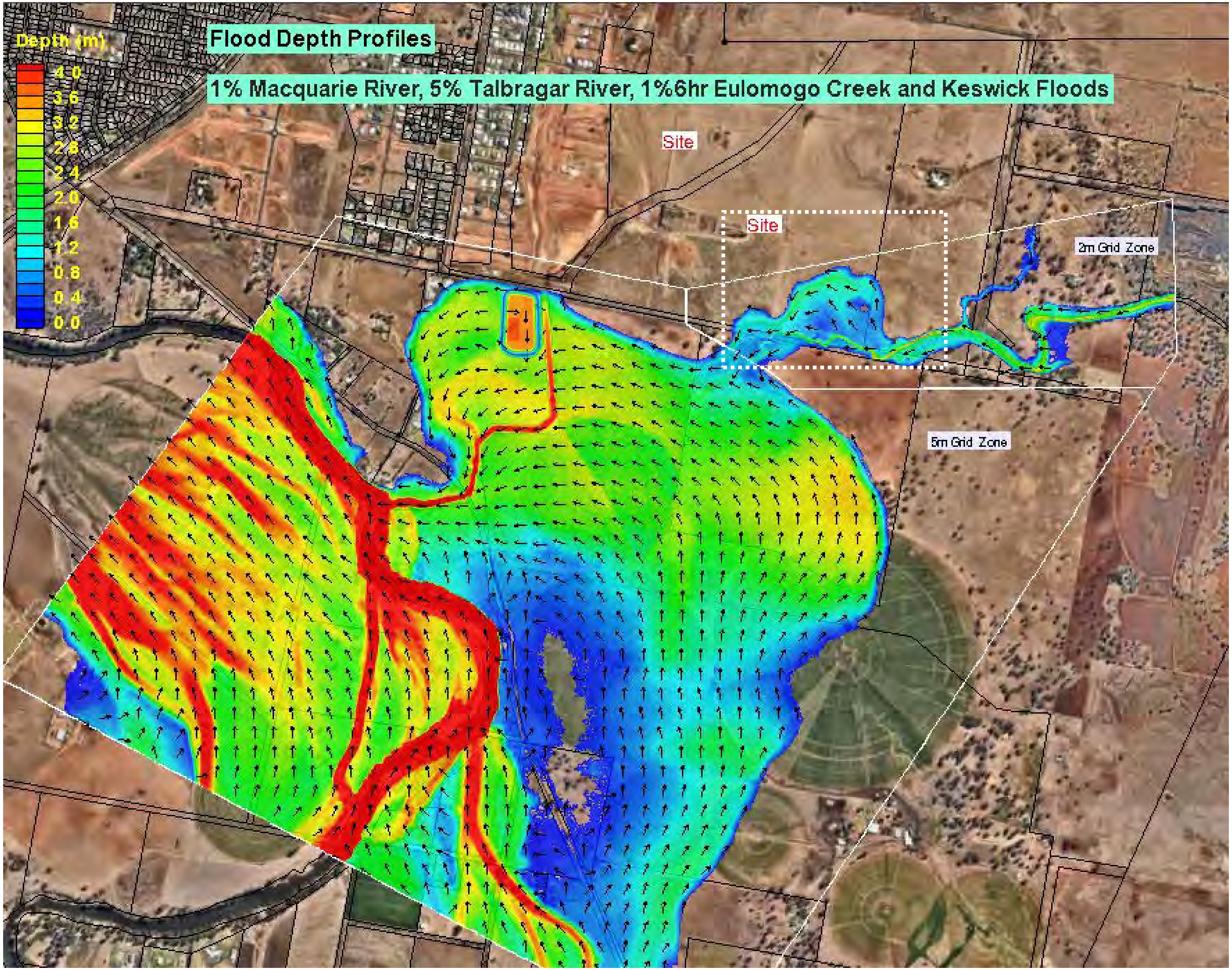


Figure 8 100 yr ARI Flood Depths

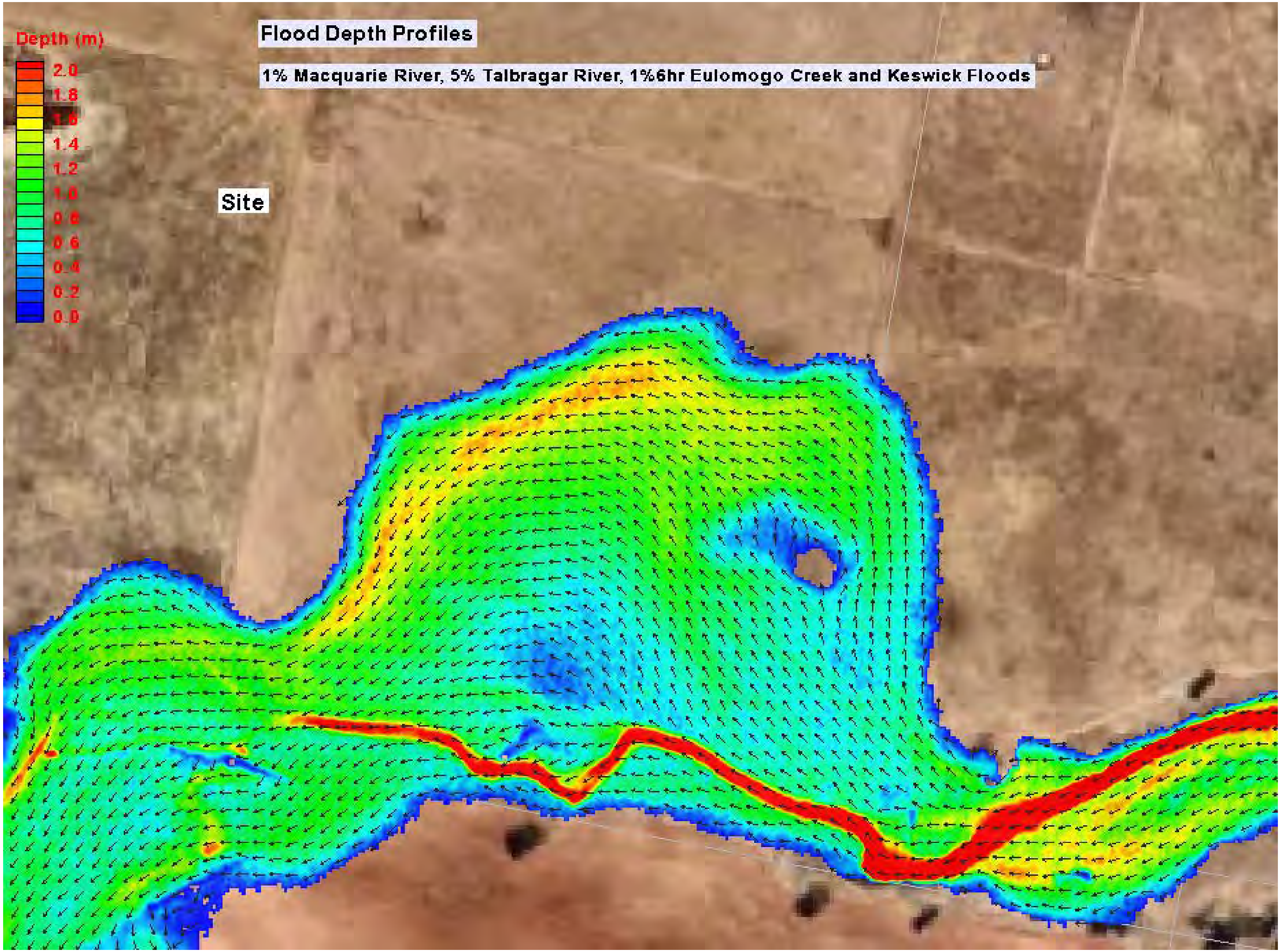


Figure 9 Zoomed 100 yr ARI Flood Depths - Hillview

Figure 10 100 yr ARI Flood Velocities

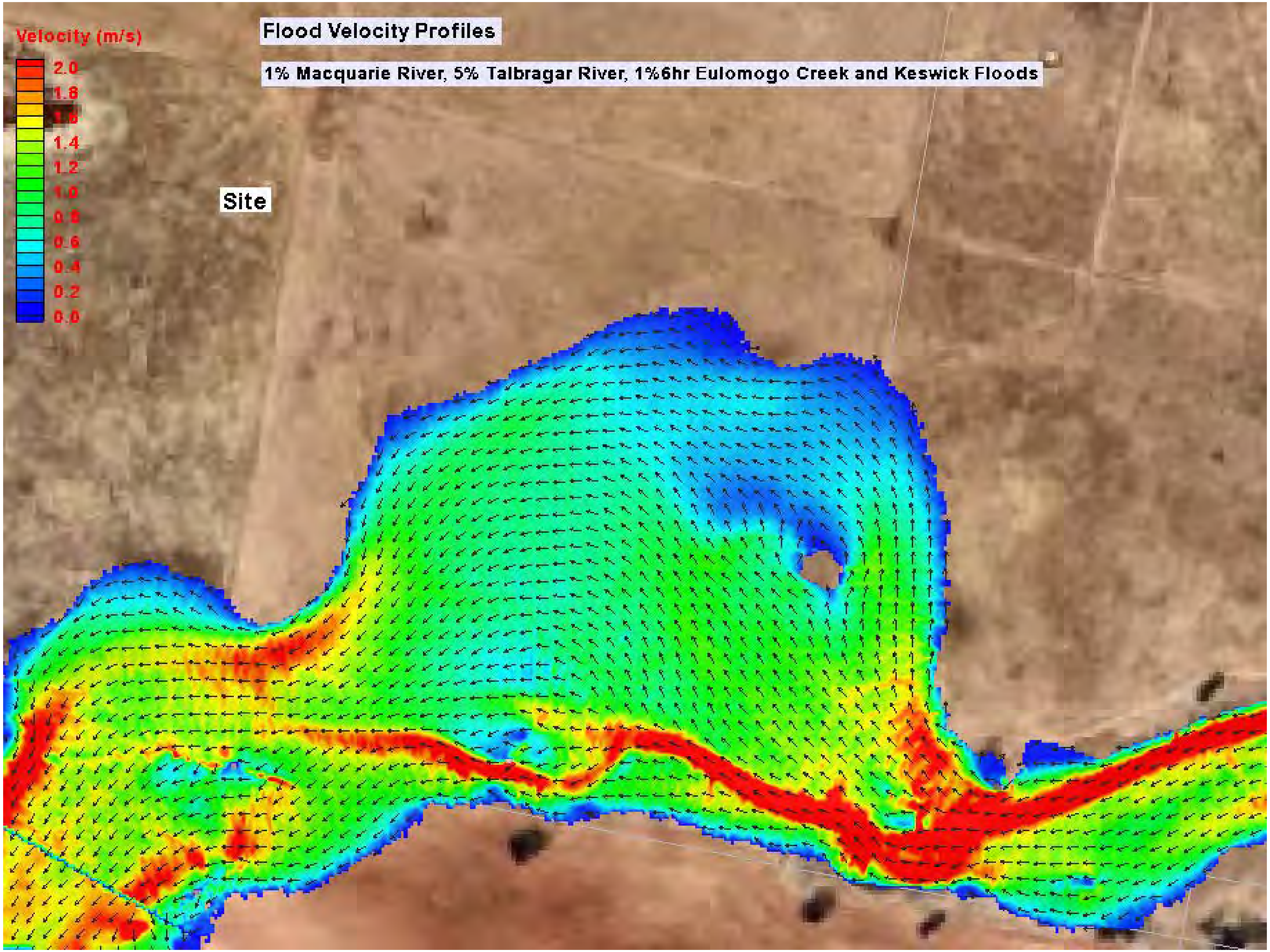


Figure 11 Zoomed 100 yr ARI Flood Velocities - Hillview

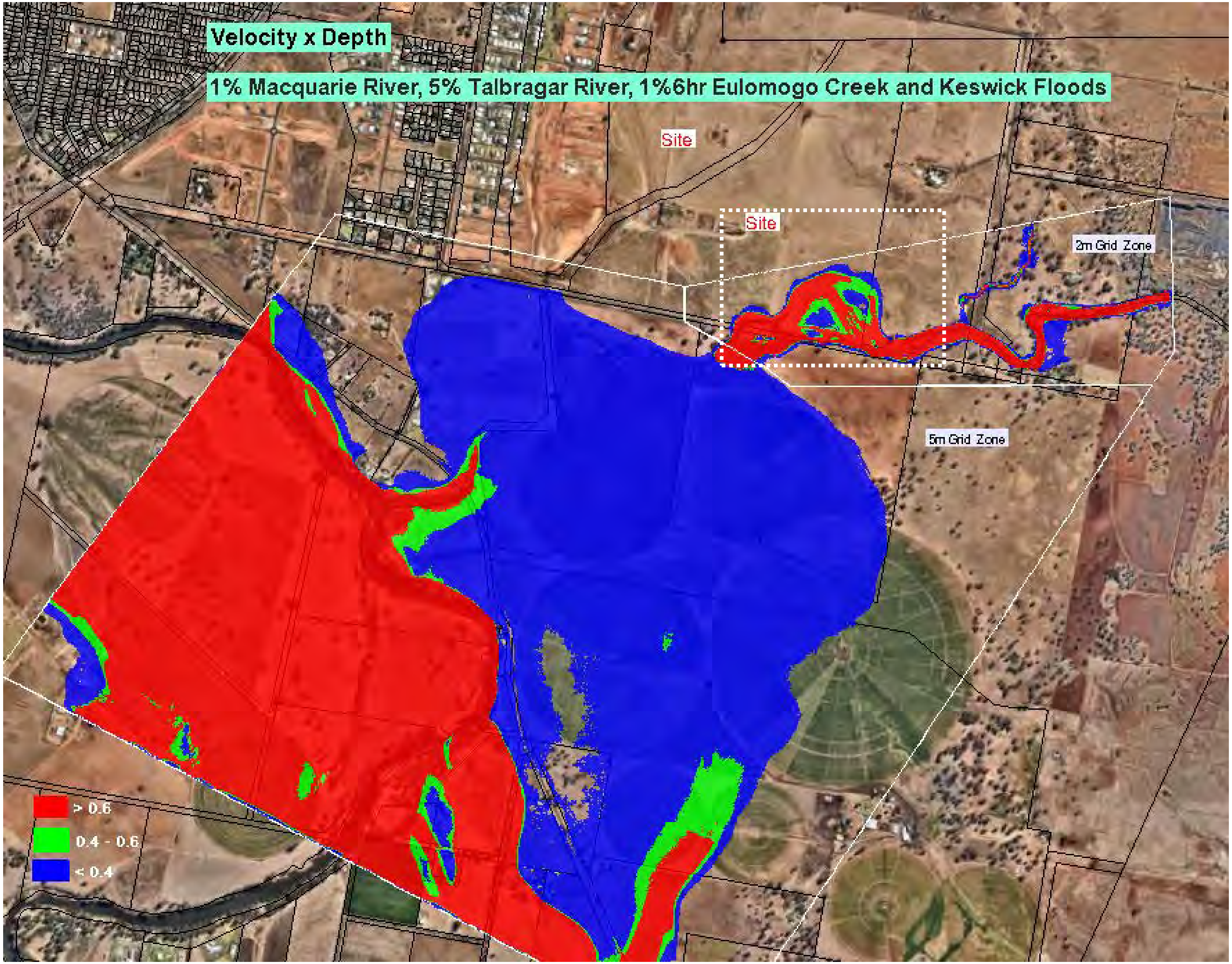


Figure 12 100 yr ARI Flood Velocity x Depth

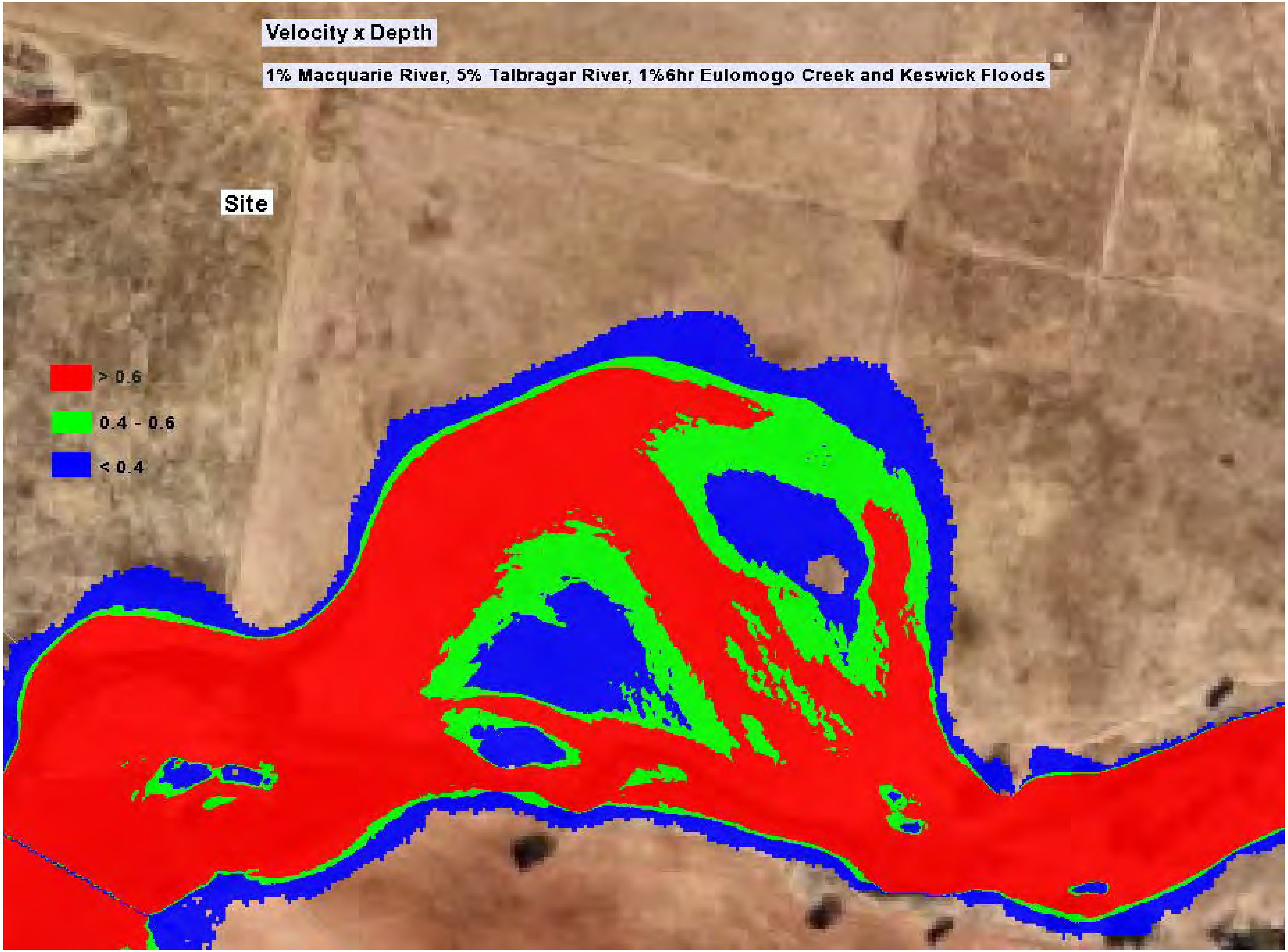


Figure 13 Zoomed 100 yr ARI Flood Velocity x Depth - Hillview

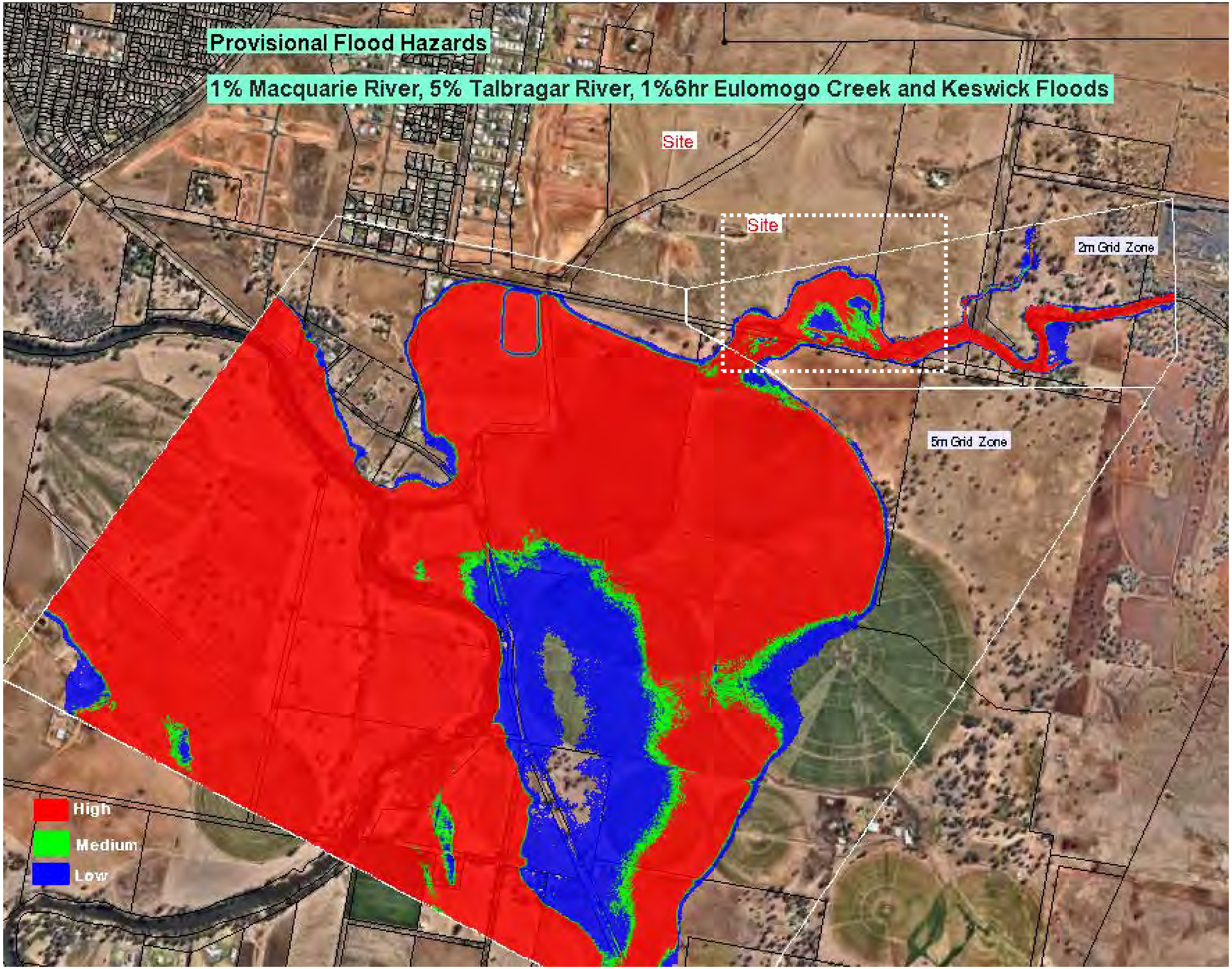


Figure 14 100 yr ARI Flood Hazards

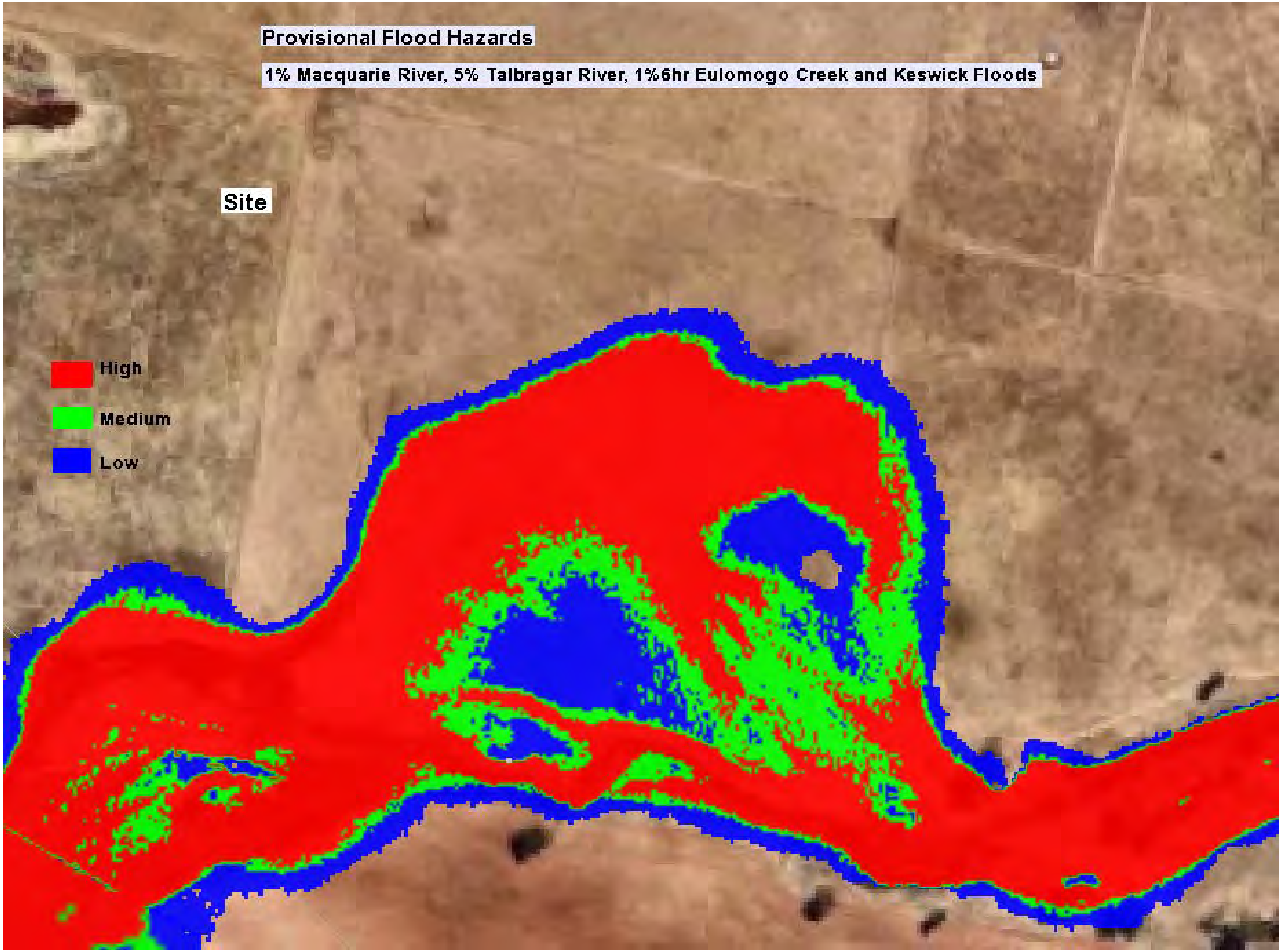


Figure 15 Zoomed 100 yr ARI Flood Hazards - Hillview

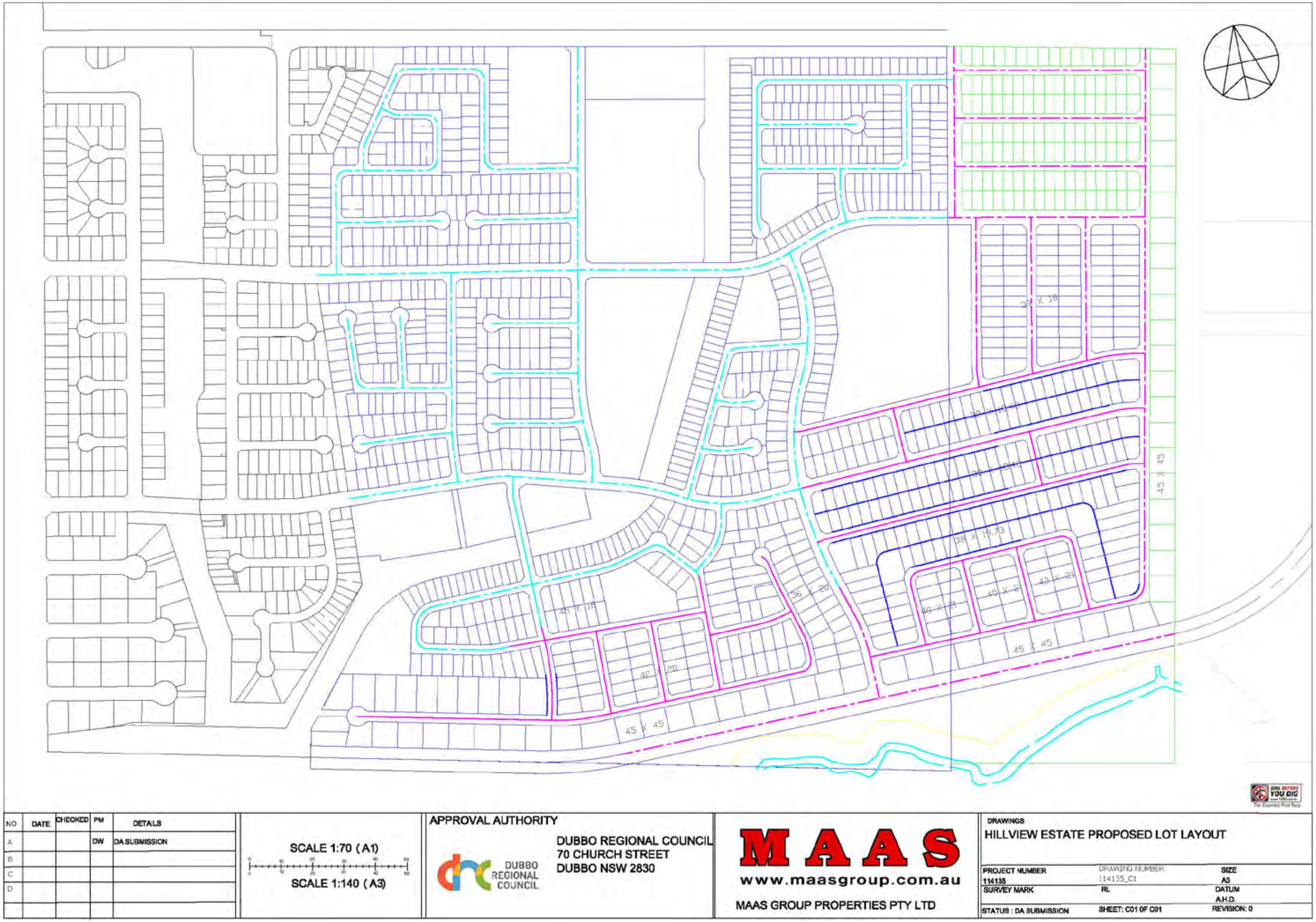


Figure 16 Proposed Lot Layout for Hillview Estate

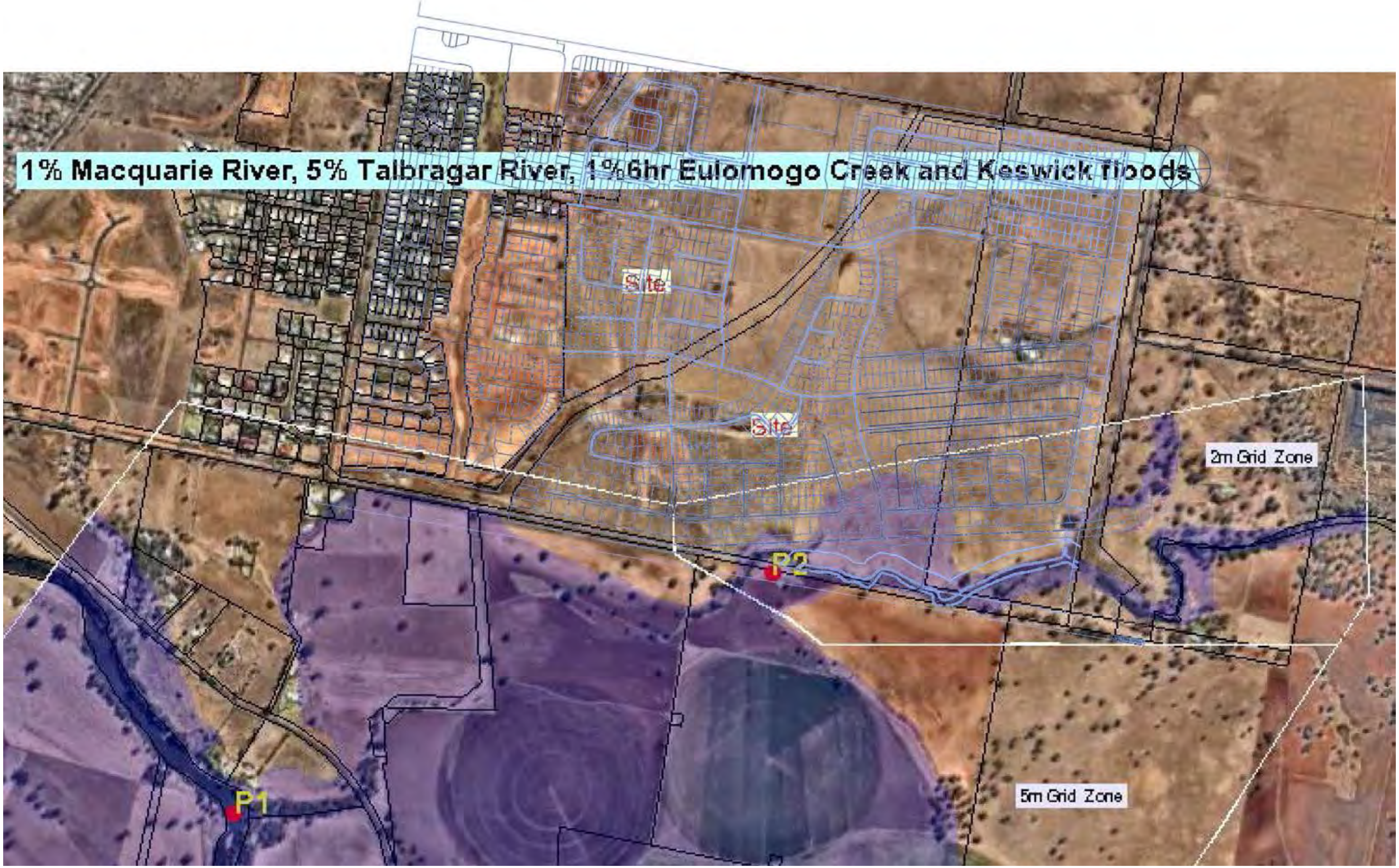


Figure 17 Proposed Development Layout overlaid on 100 yr ARI Flood Extent

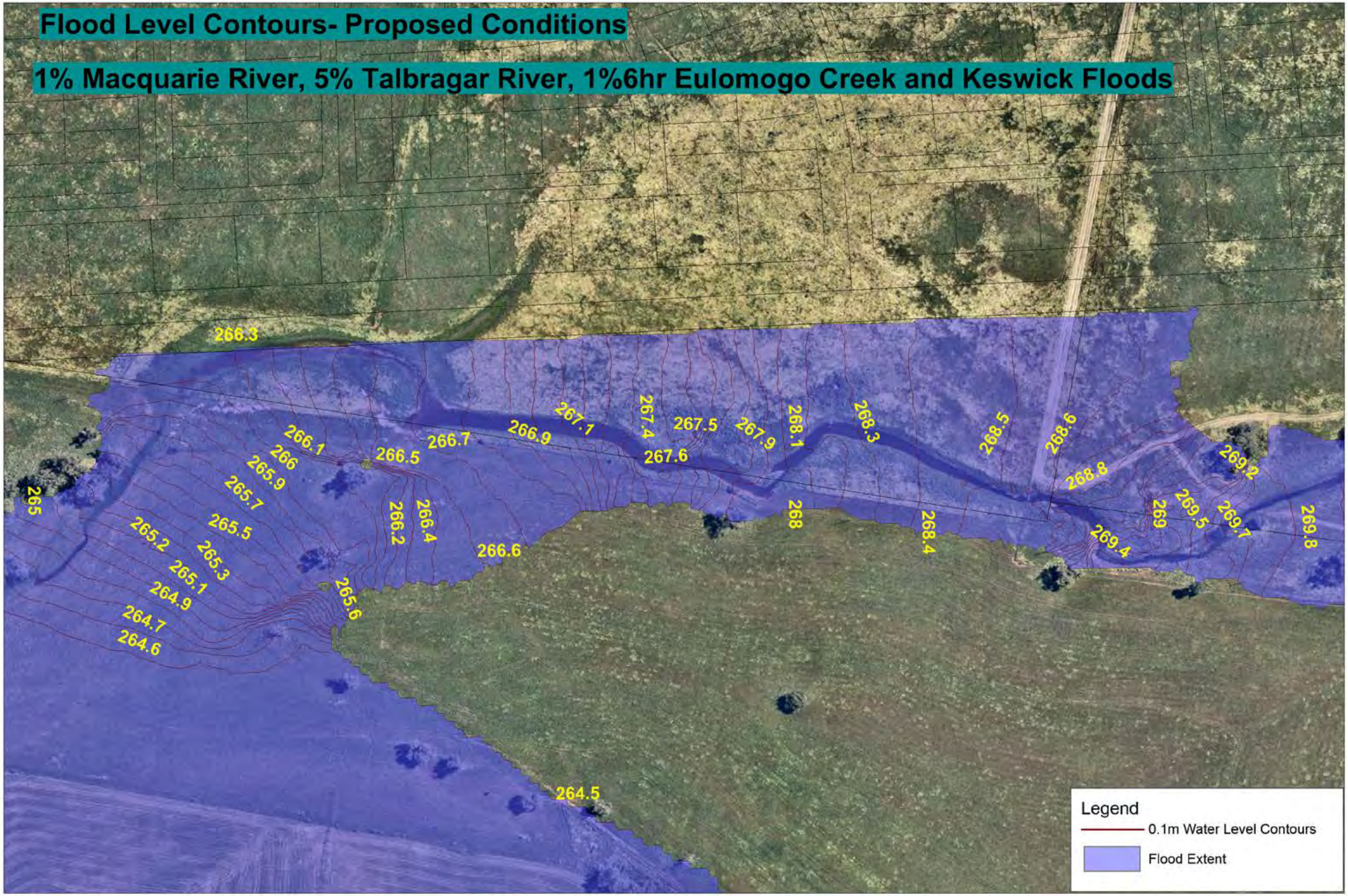


Figure 18 100 yr ARI Flood Levels – Hillview – Post-Development Conditions

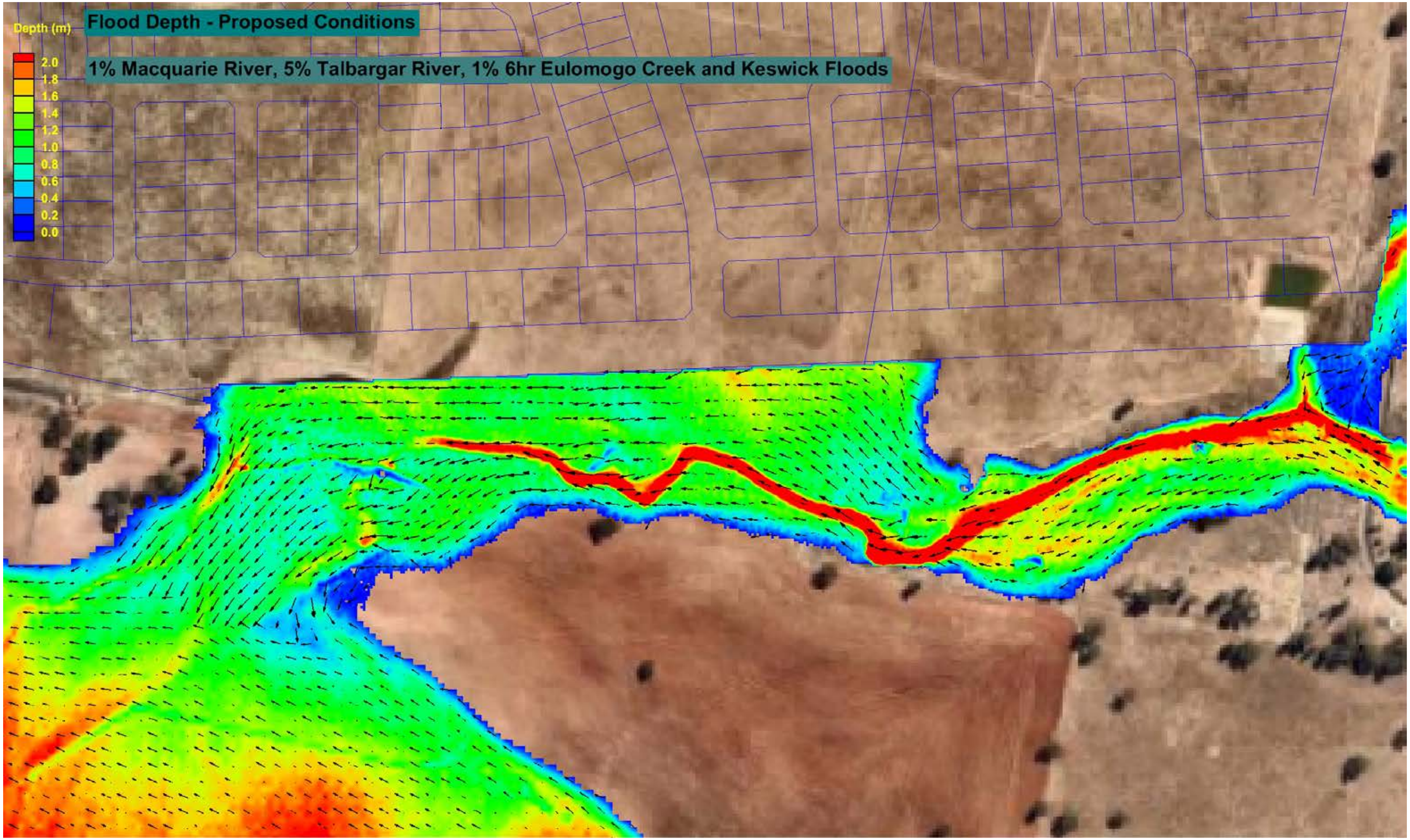


Figure 19 100 yr ARI Flood Depths – Hillview – Post-Development Conditions

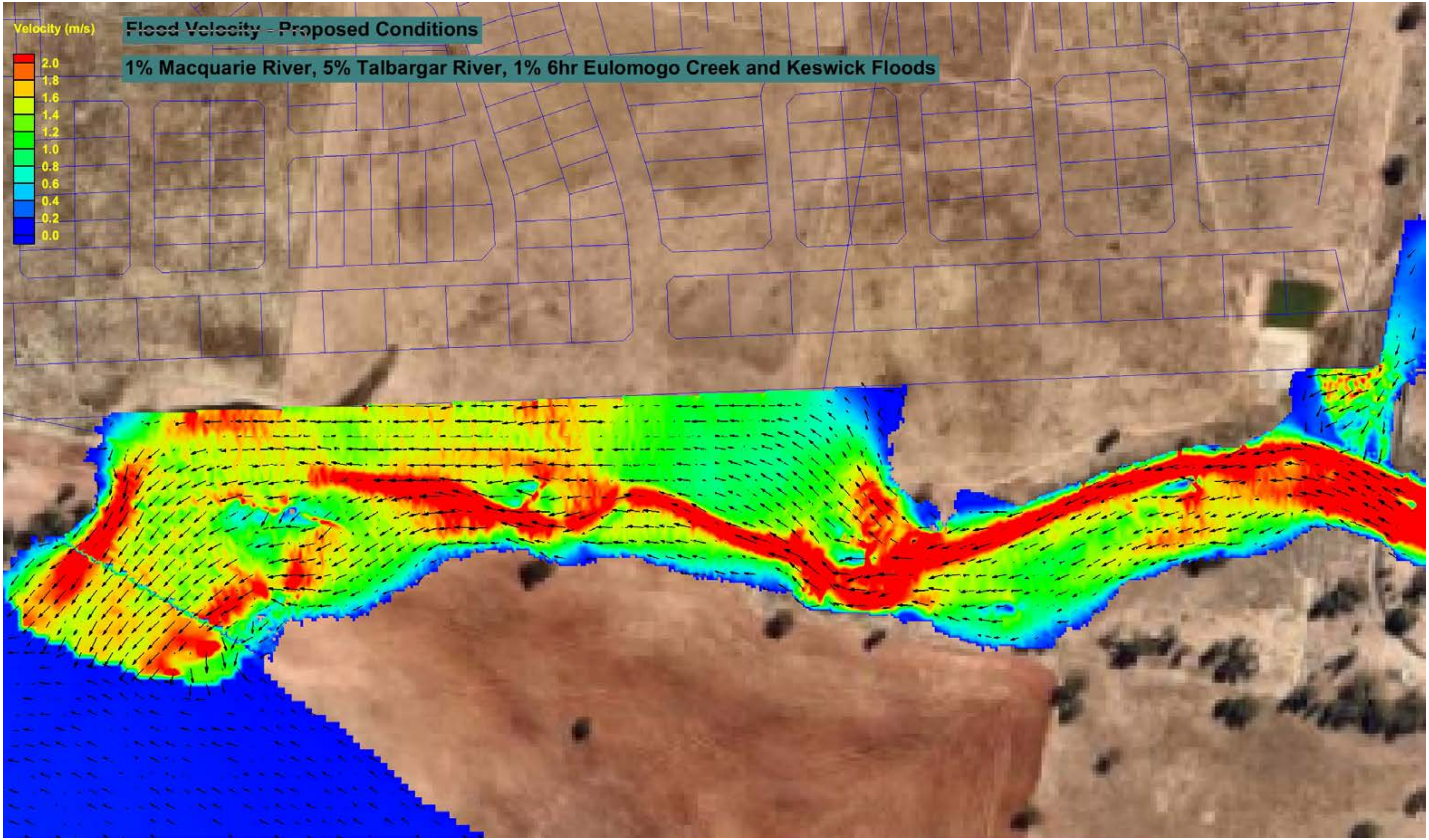


Figure 20 100 yr ARI Flood Velocities – Hillview – Post-Development Conditions

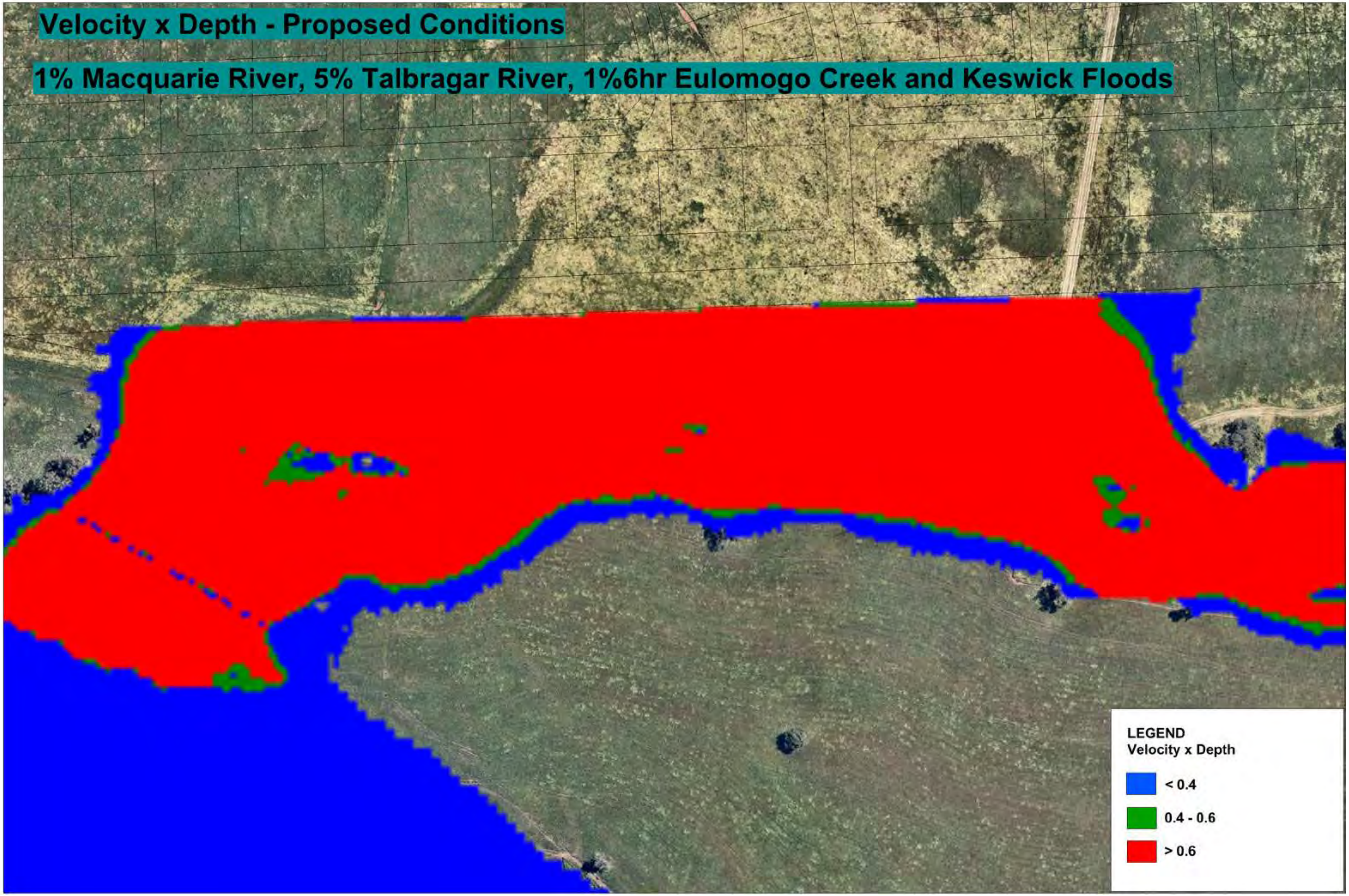


Figure 21 100 yr ARI Flood Velocity x Depth – Hillview – Post-Development Conditions

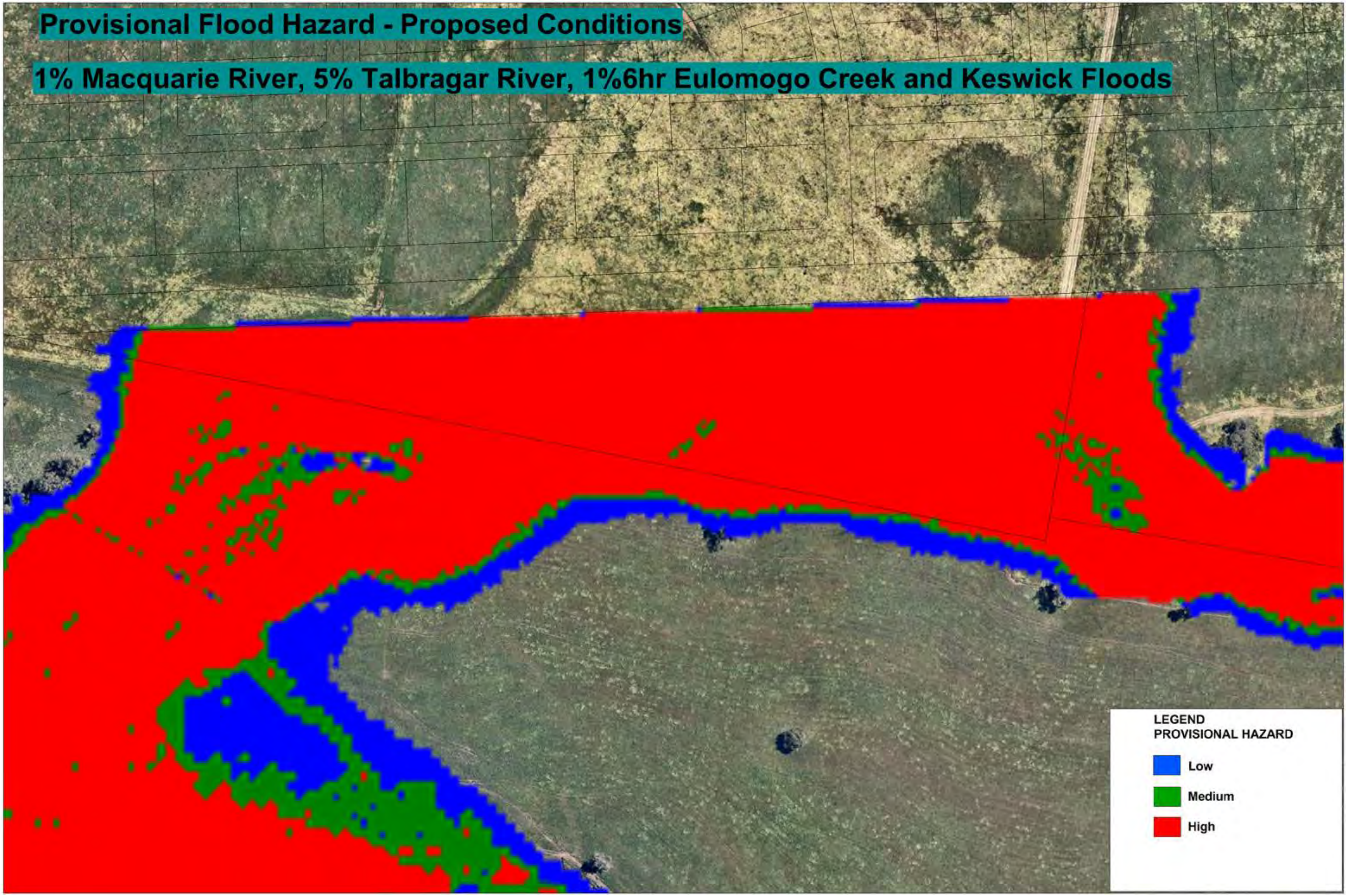


Figure 22 100 yr ARI Flood Hazards – Hillview – Post-Development Conditions

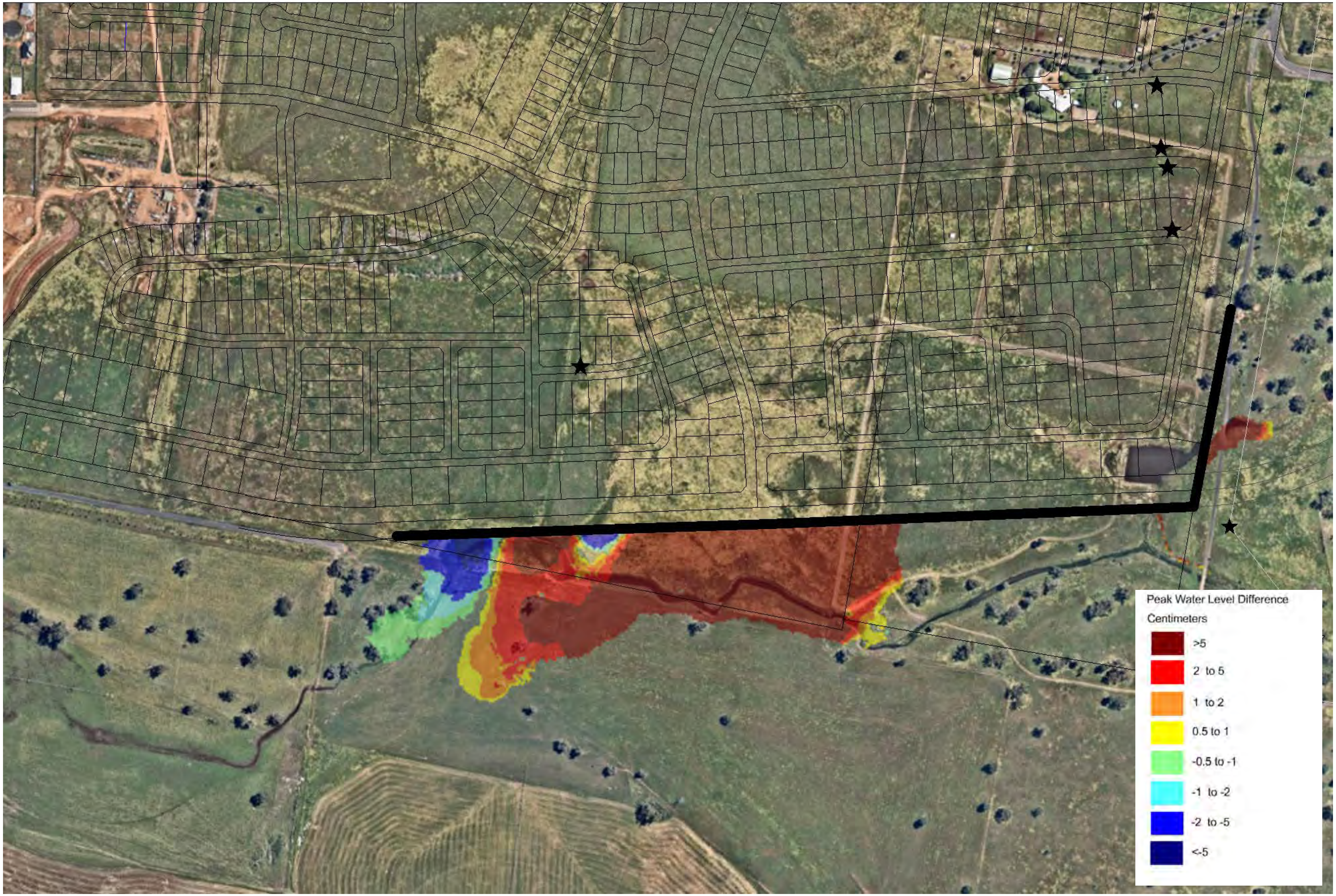
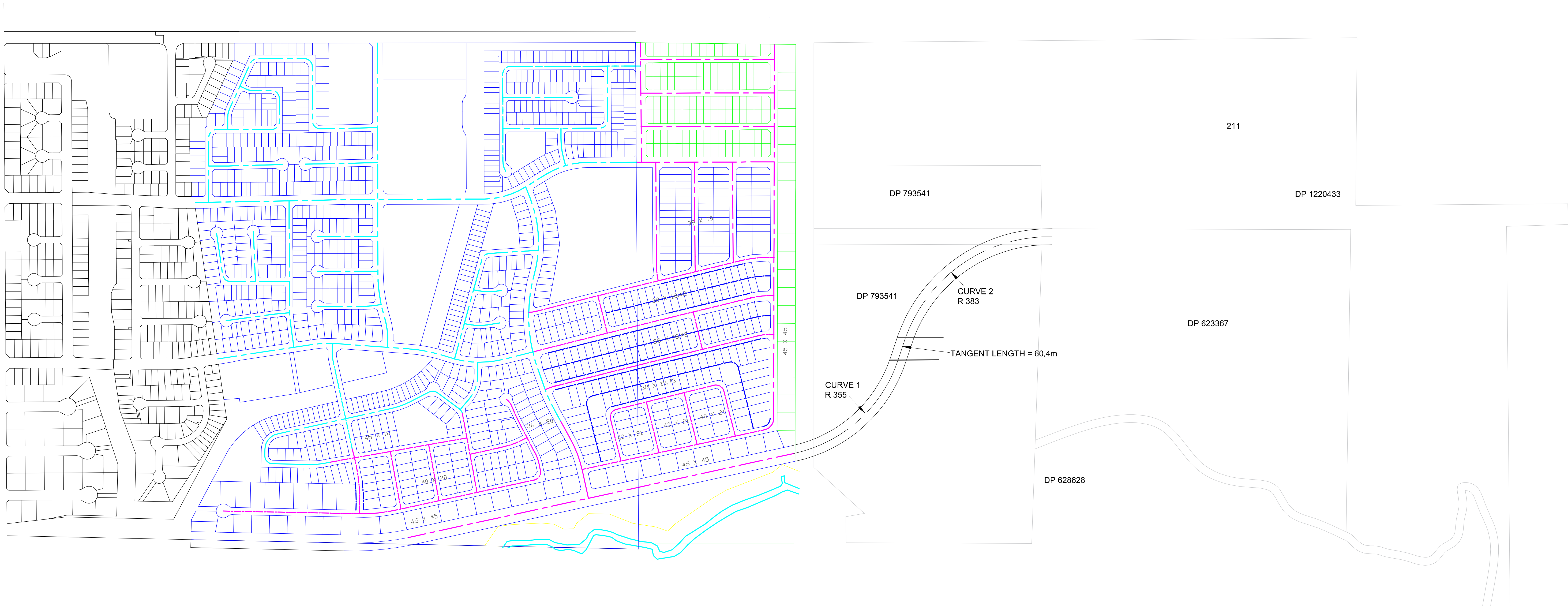


Figure 23 100 yr ARI Flood Level Differences – Hillview – Post-Development Conditions minus Existing Conditions



NOTE :

- AUSTROADS GUIDE TO ROAD DESIGN PART 3 : GEOMETRIC DESIGN HAS BEEN FOLLOWED FOR RADIUS OF CURVES, TANGENT LENGTH,SUPERELEVATION AND SIDE FRICTION .
- THE RADIUS OF CURVE HAS BEEN CROSS-CHECKED WITH FIGURE 7.9, PAGE 172 OF AUSTROADS 2016.
- ACCORDONG TO TABLE 7.6 ,PAGE 167 OF AUSTROADS GUIDE TO ROAD DESIGN, MINIMUM RADIUS OF CURVE FOR URBAN ROADS IS 354m WHEN SUPERELEVATION IS 5% AND DESIGN SPEED IS 90km/hr.
- MAXIMUM SUPERELEVATION , e_{max}= 5% (AS PER TABLE 7.6 , AUSTROADS 2016) HAS BEEN CONSIDERED.
- OPERATING SPEED =90 km/hr (AS PER TABLE 7.6 AUSTROADS 2016) HAS BEEN CONSIDERED.
- f_{max} HAS BEEN TAKEN FROM TABLE 7.5, PAGE 167 AUSTROADS 2016.
- EQUATION 5, PAGE 157 AUSTROADS 2016 HAS BEEN USED FOR CALCULATION.
- SECTION 7.5.3 OF AUSTROADS HAS BEEN CONSIDERED FOR TANGENT LENGH.
- AS PER FIGURE 7.3, PAGE 160 0F AUSTROADS , MINIMUM TANGENT LENGTH BETWEEN TWO REVERSE CURVE IS 54m WHEN VEHICLE TRAVELING AT 90km/hr.
- ACCORDING TO SECTION 7.5.3 OF AUSTROADS , REVERSE TRANSITION CURVE CONNECTED WITH TANGENT HAS BEEN CONSIDERED.

DIAL BEFORE YOU DIG
The Essential First Step

NO	DATE	CHECKED	PM	DETAILS
A			DW	PLANNING PROPOSAL
B				
C				
D				

SCALE 1:125 (A1)

SCALE 1:250 (A3)

APPROVAL AUTHORITY

DUBBO REGIONAL COUNCIL
70 CHURCH STREET
DUBBO NSW 2830

MAAS
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MAAS GROUP PROPERTIES PTY LTD

DRAWINGS
PROPOSED FREIGHT WAY ALIGNMENT

PROJECT NUMBER	DRAWING NUMBER	SIZE
114135	114135_C1	A3
SURVEY MARK	RL	DATUM A.H.D.
STATUS : P.P. SUBMISSION	SHEET: C01 0F C01	REVISION: 0

NOTES:

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Fax. (02) 6884 1470

No	DATE	DRAFTING CHECK	APPROVED BY	DETAILS
A	27/07/16	JE	MT	ISSUED TO CLIENT
B	15/08/16	JE	MT	LOT LAYOUT AMENDED
C	20/12/16	JE	MT	LOT LAYOUT AMENDED
D	02/02/17	JE	MT	LOT LAYOUT AMENDED

PROJECT: SOUTHLAKES ESTATE (HILLVIEW)

FILE REFERENCE: 114135_19D_TP01.dwg

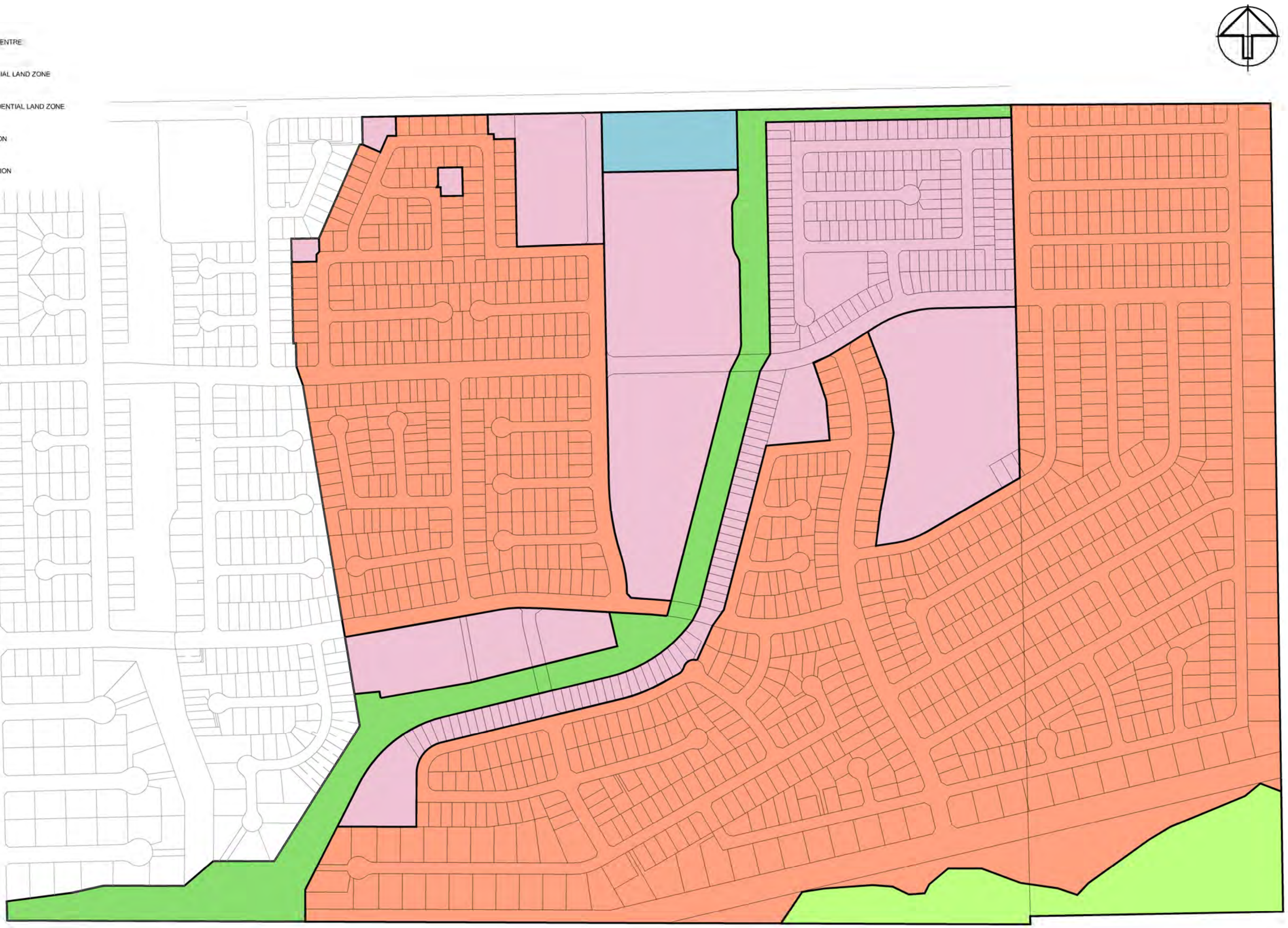
APPROVAL AUTHORITY: DUBBO REGIONAL COUNCIL

CLIENT: MAAS GROUP PROPERTIES No.2 PTY LTD

DRAWING: EXISTING ZONING PLAN

PROJECT NUMBER: 114135 | DRAWING NUMBER: 19D_TP01 | REV: D

SOURCE: INTERNAL



DENOTES B1 - NEIGHBOURHOOD CENTRE

DENOTES R1 - GENERAL RESIDENTIAL LAND ZONE

DENOTES R2 - LOW DENSITY RESIDENTIAL LAND ZONE

DENOTES RE1 - PUBLIC RECREATION

DENOTES RE2 - PRIVATE RECREATION

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SCALE 1:3000(A1)

SCALE 1:6000(A3)

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C	20/12/16	JE	MT	LOT LAYOUT AMENDED
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PROJECT: SOUTHLAKES ESTATE (HILLVIEW)

FILE REFERENCE: 114135_19D_TP02.dwg

APPROVAL AUTHORITY: DUBBO REGIONAL COUNCIL

CLIENT: MAAS GROUP PROPERTIES No.2 PTY LTD

DRAWING: PROPOSED ZONING PLAN

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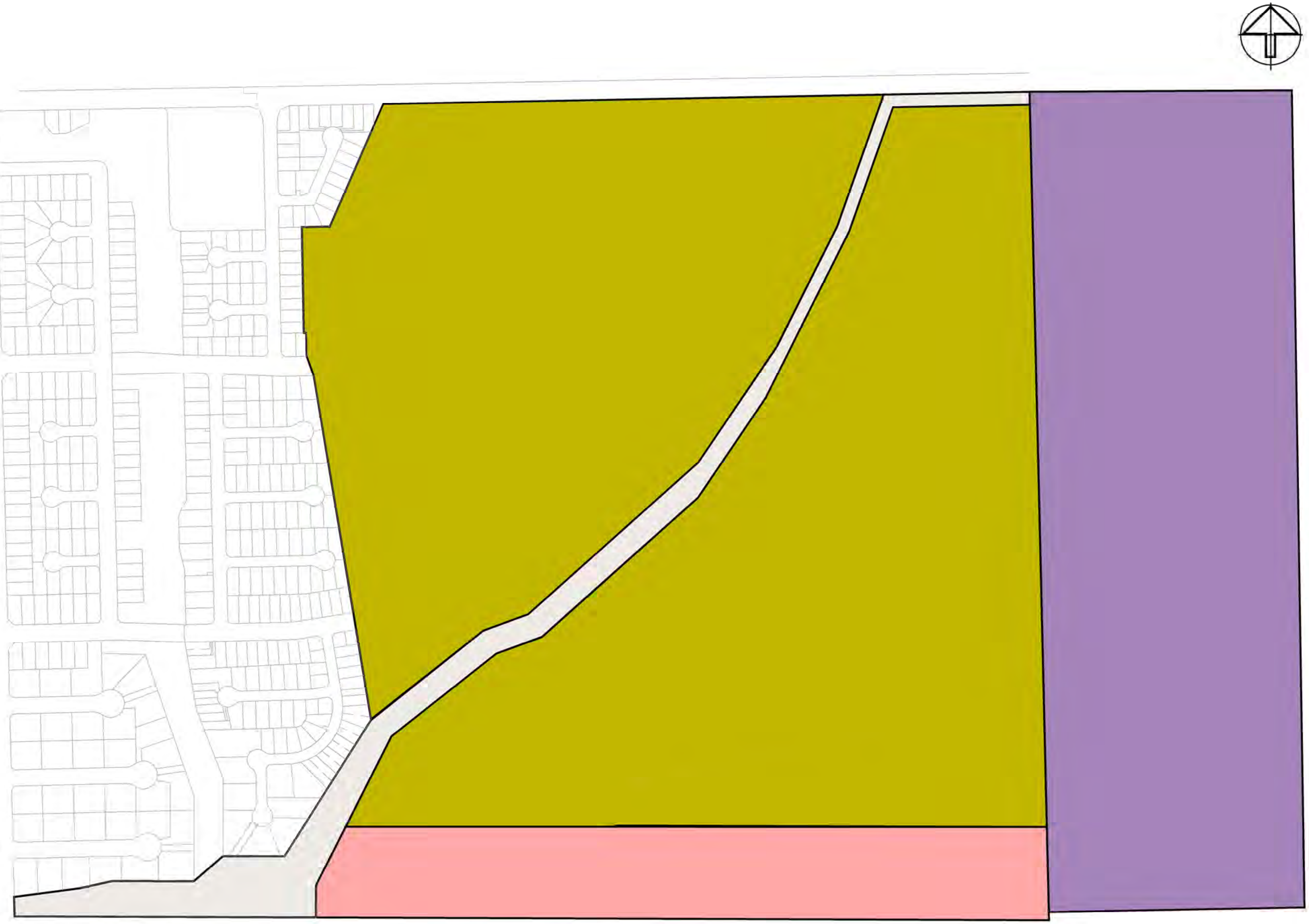
SOURCE: INTERNAL



(olive)	600m²
(pink)	4000m²
(purple)	1.5ha

NOTES:

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SCALE 1:3000(A1)
SCALE 1:6000(A3)

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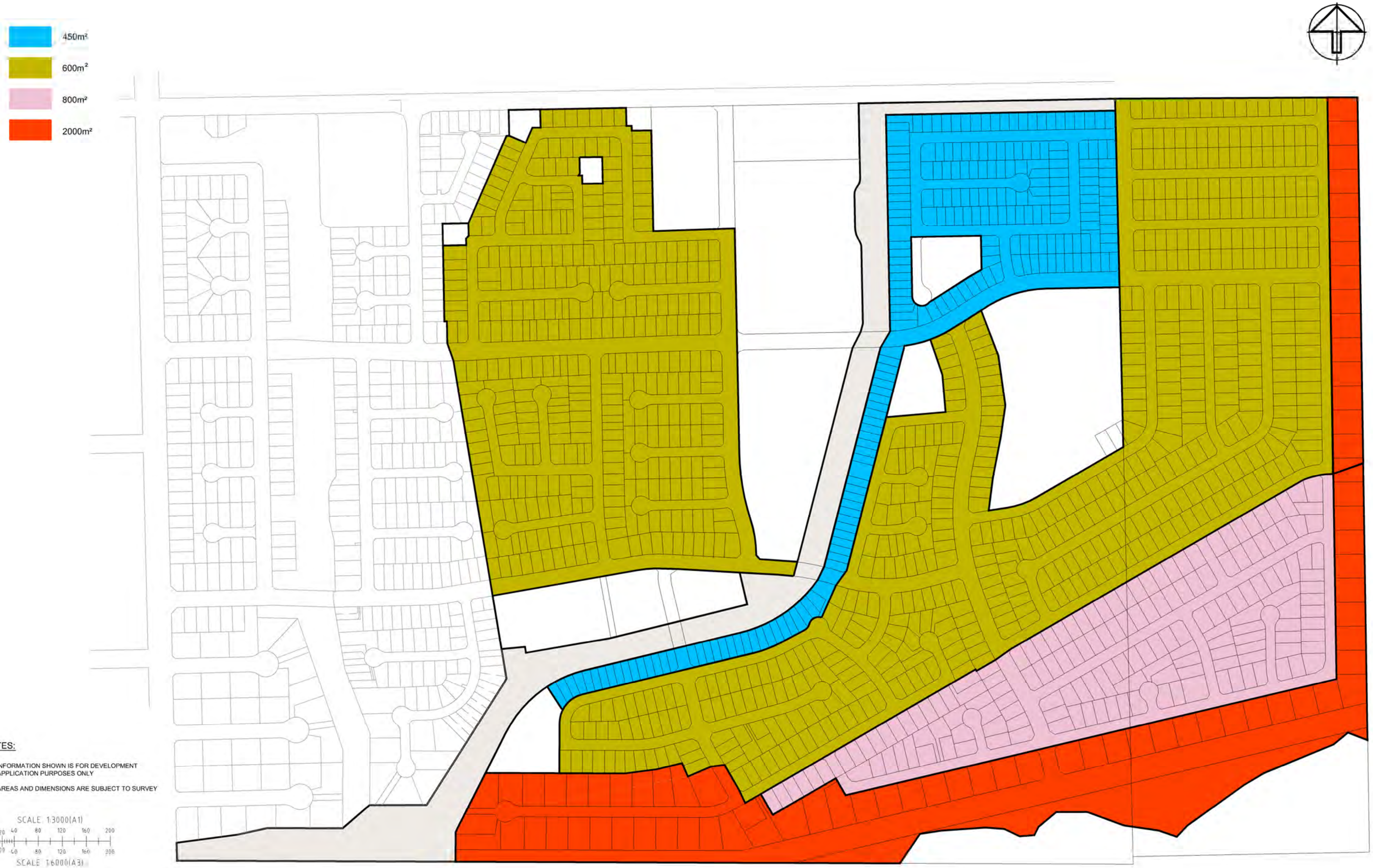
No	DATE	DRAFTING CHECK	APPROVED BY	DETAILS
A	27/07/16	JE	MT	ISSUED TO CLIENT
B	15/08/16	JE	MT	LOT LAYOUT AMENDED
C	20/12/16	JE	MT	LOT LAYOUT AMENDED
D	02/02/17	JE	MT	LOT LAYOUT AMENDED

PROJECT: SOUTHLAKES ESTATE (HILLVIEW)
FILE REFERENCE: 114135_19D_TP03.dwg

APPROVAL AUTHORITY: DUBBO REGIONAL COUNCIL

CLIENT: MAAS GROUP PROPERTIES No.2 PTY LTD

DRAWING: EXISTING LOT SIZE MAP
PROJECT NUMBER: 114135 DRAWING NUMBER: 19D_TP03 REV: D
SOURCE: INTERNAL



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No	DATE	DRAFTING CHECK	APPROVED BY	DETAILS
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B	15/08/16	JE	MT	LOT LAYOUT AMENDED
C	20/12/16	JE	MT	LOT LAYOUT AMENDED
D	02/02/17	JE	MT	LOT LAYOUT AMENDED

PROJECT: SOUTHLAKES ESTATE (HILLVIEW)

FILE REFERENCE: 114135_19D_TP04.dwg

APPROVAL AUTHORITY: DUBBO REGIONAL COUNCIL

CLIENT: MAAS GROUP PROPERTIES No.2 PTY LTD

DRAWING: PROPOSED LOT SIZE MAP

PROJECT NUMBER: 114135 DRAWING NUMBER: 19D_TP04 REV: D

SOURCE: INTERNAL

Preliminary contamination investigation

Lot 2 DP880413, 24R Sheraton Road, Dubbo NSW

Ref: R7891c1
Date: 10 March 2017

Envirowest Consulting *Pty Ltd* ABN 18 103 955 246
• 9 Cameron Place, PO Box 8158, Orange NSW 2800 • Tel (02) 6361 4954 •
• Fax (02) 6360 3960 • Email admin@envirowest.net.au • Web www.envirowest.net.au •

Environmental
Geotechnical
Asbestos
Services

Client:	Maas Group Properties Pty Ltd Lot 2 Jannali Road Dubbo NSW 2830
Assessor:	Ashleigh Pickering BSc Environmental Scientist
Checked by:	Leah Desborough BNatRes (Hons) Senior Environmental Scientist
Authorising Officer:	Greg Madafiglio PhD Senior Environmental Scientist
Interested authorities:	Dubbo City Council
Report number:	R7891c1
Date:	10 March 2017

Executive summary

Background

A residential subdivision is proposed for Lot 2 DP880413 Sheraton Road, Dubbo NSW. The site has an agricultural land-use history of grazing. An investigation of the site is required to determine the soil contamination status and suitability for residential and recreational land-use.

Objectives of the investigation

A preliminary site investigation was conducted in accordance with the contaminated land management planning guidelines State Environmental Planning Policy No. 55 (SEPP 55) to determine the soil contamination status of Lot 2 DP880413, 24R Sheraton Road, Dubbo NSW.

Investigation and conclusions

An inspection of the site was made on 10 and 11 January 2017. The site is located in a developing residential area on the south eastern fringes of Dubbo and has an area of approximately 50 hectares.

The site has an agricultural land-use history of grazing. Several structures were identified on the site including a dwelling, machinery shed, cattle yards and two above ground storage tanks. There is no evidence of orchards, mines, sheep dips, mixing sheds or contaminating industrial activities on the site from the review of site history or site walkover. The use of agricultural pesticides over the area in the past is expected to be low.

The contamination status of the site was assessed from a soil sampling and laboratory analysis program. One hundred and four discrete soil samples were collected over the paddock areas from the 0 to 100mm soil depth. The discrete samples were combined to form twenty six composite samples for analysis. The soil samples were analysed for arsenic, cadmium, chromium, copper, lead, nickel and zinc. Five discrete soil samples from within the paddocks were analysed for organochlorine pesticides (OCP). Seven discrete samples were collected from around the shed and historic cattle yards and were analysed for arsenic, cadmium, chromium, copper, lead, nickel, zinc, mercury, organochlorine pesticides (OCP), total recoverable hydrocarbons (TRH) (C6-C40), benzene, toluene, ethylbenzene, xylenes and naphthalene (BTEXN) and polycyclic aromatic hydrocarbons (PAH).

Two cottages were identified in aerial photographs (2006-2010) south of the machinery shed and had been removed at the time of the site inspection. The cottages were west of the dwelling. Asbestos containing fragments were identified in the area of the old cottages. Several small mounds containing soil, timber and bitumen were identified in this area. Asbestos containing fragments were excavated during investigations of the extent of asbestos impacted material. The asbestos fragments were generally spread across the surface with some buried up to 500mm in depth. The impacted area was approximately $600m^2$ in size. The impacted material was removed landfill licensed to accept asbestos waste. A visual clearance was undertaken following excavation and removal of asbestos impacted material. Four surface samples were collected across the area of the historic cottages and analysed for heavy metals, OCP, TRH, BTEXN and PAH. The levels of all metals, OCPs, TRH, BTEXN and PAH analysed in the cottage soil samples were not detected or at environmental background levels and below the residential and recreational land-use thresholds.

The levels of all metals and OCPs analysed in the machinery shed and yard area soil samples were not detected or at environmental background levels and below the residential and recreational land-use thresholds. One soil sample from near the diesel above ground storage tank contained levels of TRH (>C16-C34) above the health screening levels for residential land use. Two soil samples collected from within the area of above ground storage tanks were above the adopted ecological screening levels for TRH (>C16-C34) for residential land use. Further investigations into the depth of hydrocarbon impacted material identified the impacted material was contained within the top 100mm of soil. The impacted material was excavated and removed during the investigations to determine the depth. The area was less than $10m^2$ in size. Three additional discrete samples were collected from the base of excavations and TRH was reported as not detected in all three samples. Hydrocarbon impacted material was removed to a licensed landfill.

The soil sampling program did not detect elevated levels of the analysed metals or OCP within the paddock areas. The levels of all substances evaluated were below the EPA investigation threshold for residential land-use with access to soil.

Recommendations

The site is suitable for the proposed residential and recreational activities.

If additional asbestos fragments or other hazardous materials are encountered then the unexpected finds protocol (Appendix 5) should be implemented which would include ceasing works and the identified impacted asbestos material removed in accordance with SafeWork methods "How to safely remove asbestos" prior to site works commencing.

Contents

page

1. Introduction

A residential subdivision is proposed for Lot 2 DP880413 Sheraton Road, Dubbo NSW. The site has an agricultural land-use history of grazing. An investigation of the site is required to determine the soil contamination status and suitability for residential and recreational land-use.

A desktop study and a review of the available history were undertaken of the site. A walkover and site inspection for evidence of contamination from past activities was conducted on 10 and 11 January 2017. Soil samples were collected and analysed for metals, persistent pesticides and hydrocarbons.

2. Scope of work

Envirowest Consulting Pty Ltd was commissioned by Maas Group Properties Pty Ltd to undertake a preliminary contamination investigation, in accordance with the contaminated land management planning guidelines, from the *Contaminated Land Management Act 1997* and the *State Environmental Policy No. 55 (SEPP 55)*, of Lot 2 DP880413, 24R Sheraton Road, Dubbo NSW. The objective was to identify past potentially contaminating activities, identify potential contamination types, discuss the site condition, provide a preliminary assessment of site contamination and assess the need for further investigation or suitability for residential land-use.

3. Site identification

Address	24R Sheraton Road Dubbo NSW
Client	Maas Group Properties Pty Ltd
Deposited plans	Lot 2 DP880413
Locality map	Figure 1
Site plan	Figure 2
Photographs	Figure 5
Area	Approximately 50ha

4. Site history

4.1 Zoning

The site is zoned R5 Large Lot Residential under the Dubbo Local Environmental Plan (2011).

4.2 Land-use

The site is currently used for grazing of livestock and horses on improved pastures. The site is located in a developing residential area on the south eastern fringes of the city of Dubbo. A dwelling is located on the property and is currently occupied. A machinery shed is located west of the dwelling along with farm machinery identified inside.

4.3 Summary of council records

None expected

4.4 Sources of information

Site inspection 10 and 11 January 2017 by Leah Desborough and Ashleigh Pickering
NSW EPA records of public notices under the CLM Act 1997
Soil and geological maps
Historical aerial photographs
Dubbo LEP 2011

4.5 Chronological list of site uses

The 1986 topographic map developed off the 1980 aerial photograph does not indicate any buildings or infrastructure on the site. A drainage line is located in the south eastern section of the site.

Aerial photography of the site indicated few changes between 1965 to 2016.

Year	Visual observations on site	Surrounding area
1965	The land appears predominantly cleared with remnant trees remaining. No buildings or dwellings are visible on the site. A drainage line is present in the southern section of the site.	The surrounding land appears to be used for grazing of stock. Land to the west of the site appears to have been cultivated.
1980	The site appears to have been split into two paddocks. The site remains free of buildings and dwellings.	Some trees have been removed to the east of the site. No other changes are evident to the surrounding land.
1995	The site remains split into two paddocks. A dwelling is visible in the central area of the lot with farm sheds.	No changes are evident to the surrounding land
2006	A dwelling, farm sheds and two cottages are visible. The paddocks have been divided into approximately five paddocks. A dam is located on the eastern boundary of the site. An area of stockpiles and disturbed soil is visible to the east of the cottages.	Agricultural grazing land remains surrounding the site on all sides. A quarry is evident approximately 1km to the east of the site. An increase in residential development is visible to the west of the site.
2010	The eastern cottage has been removed with demolition material evident. All other buildings remain. The stockpiles and disturbed soil is still evident.	No changes are evident to the surrounding land
2012	The western cottage has been removed and no demolition material is visible. The paddocks have been further divided and horse husbandry structures are visible in each paddock. The large machinery shed to the west of the dwelling has been expanded. The stockpiles and disturbed material is no longer visible.	Continued residential development is visible to the west.
2016	The dam on the eastern boundary of the property has been expanded. No other changes are visible to the site.	The residential developments to the west are expanding further east towards to site. The predominant land use surrounding the site remains agricultural grazing.

No orchards, mines, sheep dips or contaminating industrial activities are known to have been located on the site from the site inspection and site history.

4.6 Buildings and infrastructure
A dwelling, garage and large machinery shed were located in the central area of the site at the time of site inspection. Farming machinery including a sprayer and quadbike were identified inside the machinery shed.

Two above ground storage tanks (AST) were located north west of the large machinery shed. One AST was identified as unleaded petrol (ULP) with approximately 1000L capacity and the other AST was identified as diesel with approximately 2000L capacity.

House footings were identified from the two previous cottages located on site. Horse shelters were identified in each paddock.

4.7 Contaminant sources
No known contaminants have been applied to the site. The historic agricultural land-use may have resulted in application of pesticides.

The machinery shed is suspected to have been used for the storage of machinery and chemicals. Contamination may have occurred from leaking chemical and fuel storage containers.

The cottages may have been constructed using asbestos containing materials.

4.8 Contaminants of concern
Based on historical activities and site inspection the contaminants of concern are:

4.8.1 Paddocks
- Heavy metals (arsenic, cadmium, chromium, copper, nickel, lead, zinc)
- Organochlorine pesticides (OCP)

4.8.2 Machinery shed and yards
- Heavy metals (arsenic, cadmium, chromium, copper, nickel, lead, zinc, mercury)
- OCP
- Total Recoverable Hydrocarbons (TRH C6-C40)
- Polycyclic Aromatic hydrocarbons

4.8.3 Former cottage site
- Heavy metals (arsenic, cadmium, chromium, copper, nickel, lead, zinc, mercury)
- OCP
- Asbestos

4.9 Relevant complaint history
Nil

4.10 Contaminated site register
The investigation area is not listed on the NSW EPA register of contaminated sites.

4.11 Previous investigations
No previous investigations are known to have been undertaken on the site.

4.12 Neighbouring land-use

North – Rural
South – Rural
East – Rural with quarry beyond
West – Rural with residential development beyond

Historical and present neighbouring land-uses not expected to impact of the site.

4.13 Integrity assessment

The site history was obtained from a site inspection and history review. The information is consistent with the current site condition and to the best of the assessor's knowledge is accurate.

5. Site condition and environment

5.1 Surface cover

Surface cover on the site consisted of improved pasture including paspalum, lucerne, wild oats and wild sage and weed species include Paterson's curse, cat head, clover, saffron thistle and khaki weed. The site has been predominately cleared of native tree species. Eucalypts and cyprus pines occur within the south eastern section of the site.

5.2 Topography

The site is a mid-slope with a gentle inclination of less than 5% and a predominant southerly aspect. The site has several raised outcrops with scattered rocks located in the north eastern section of the site. The site drops off in the south eastern corner of the site to Eulomogo Creek. Eulomogo Creek traverses the southern section of the site.

5.3 Soils and geology

The site is within the Bunglegumbie and Wongarbon Soil Landscape (Murphy *et al.* 1998). Soil in the Bunglegumbie landscape consists of red-brown earths comprises dark brown sandy loam topsoil with bleached silty loam to reddish brown medium clay subsoil. Red earths comprise dark reddish brown loamy sands over a reddish brown fine sandy clay loam. The soil has a moderate fertility and generally low erodibility.

Soil in the Wongarbon Soil Landscape (Muphy et al. 1998) consists of Euchrozems and red and brown crack clays. The soil has a moderate to high fertility and a moderate to high erodibility

The site is underlain by Ballimore formation which comprises quartz sandstone, lithic sandstone, conglomerate, ferruginous sandstone, siltstone and undifferentiated olivine basalt and dolerite (Murphy *et al.* 1998).

5.4 Water

5.4.1 Surface water

The Eulomogo Creek traverses the southern section of the site. The drainage line empties into the Macquarie River approximately 2km west of the site. One dam has been formed within the site and fed by the natural slope of the site.

Surface water over the remainder of the site predominantly flows south and into the Eulomogo Creek.

5.4.2 Groundwater

Eight bores have been constructed across the site to depths from 29m to 149m. One bore is licensed for stock supplies and had water bearing zones from 57m in consolidated sandstone. No details are provided for the other bores and it is expected they did not intercept groundwater and were not cased.

5.5 Evidence of contamination checklist

Site layout showing industrial processes	None present
Sewer and service plans	None known
Manufacturing processes	None known
Underground tanks	None known
Product spills and loss history	Pesticide mixing or storage of chemicals may have occurred in the machinery shed. Small amounts of diesel and ULP may have been spilled during refuelling on site.
Discharges to land, water and air	None known
Disposal locations, presence of drums, wastes and fill materials	Two small mounds of soil were identified near the location of the previous cottages. The mounds of soil contained rock, soil, timber and bitumen. Asbestos cement fragments were identified to the west of the mounds within the historical cottages location.
Soil staining	Nil
Visible signs of plant stress, bare areas	Nil
Odours	Nil
Ruins	Footings of the former cottage
Other	Nil

6. Conceptual site model

Potential contamination sources, exposure pathways and receptors are presented below.

Contamination source	Potential exposure pathways	Receptors
Hydrocarbon spills Pesticides ACM fragments	Direct contact (ingestion and absorption) Wind blown	*On-site* Residential Site workers Terrestrial environment *Off-site* Residential Rural

7. Data quality objectives (DQO)

7.1 State the problem

A change of land-use is proposed from rural to low density residential including recreational areas. The property has historically been used for grazing stock on improved pastures and associated machinery is expected to have been used. A dwelling is located in the central section of the site. The site requires investigation to ensure suitability for the proposed land-use.

7.2 Identify the decision

The land-use proposed is low density residential and the levels of contaminants should be less than the thresholds listed in Section 10. The decision problem is, do the levels of potential contaminants exceed the assessment criteria listed in Section 10.

7.3 Identify the inputs decision

Investigations of the paddocks, the machinery shed and yards and the old cottage area is required to identify any potential contaminants from historical land use.

7.4 Define the boundaries of the study

The investigation area is Lot 2 DP880413, 24R Sheraton Road, Dubbo NSW.

7.5 Develop a decision rule

The initial guidelines for soil were the health investigation levels for residential and recreational land-use (NEPC 1999).

If soil contamination was identified then the contaminant source and extent of contamination was determined.

7.6 Specify acceptable limits on the decision errors.

The 95% upper confidence limit of average levels of samples collected are less than the threshold levels.

7.7 Optimize the design for obtaining data

Soil samples were collected from the paddocks on an approximate 70m and combined to form composite samples. Discrete soil samples were collected from the machinery area in potential hot spot areas. Analytes to be evaluated include heavy metals, OCP, TRH (C6-C40), BTEXN and PAH. Discrete soil samples were collected from the old cottage area and the AST area following additional investigations.

8. Sampling analysis plan and sampling methodology

8.1 Sampling strategy

The main land-use was identified as grazing on agricultural paddocks with associated machinery use.

8.1.1 Sampling design

8.1.1.1 Paddocks

A systematic sampling pattern was adopted to assess the probable location of contamination in the paddocks. Uniform management practices are expected to have occurred on the site. The site has been historically managed as part of a single unit and is expected to have been treated similarly.

8.1.1.2 Machinery shed and yards

A judgmental sampling pattern was adopted to assess the probably location of contamination in the machinery shed and yards area. Potential hotspot locations were identified in the machinery shed and yards area and discrete samples were taken. Discrete soil samples were collected following additional investigations to determine the extent of hydrocarbon impacted material.

8.1.1.3 Old cottages area

A systematic sampling pattern was adopted to assess the probable location of contamination within the old cottages area.

8.1.2 Sampling locations

8.1.2.1 Paddocks

Discrete soil samples were collected from the site on an approximate 70m grid pattern across the paddocks. Four discrete samples were combined to form a composite soil sample. A total of 104 discrete soil samples were collected and combined to form 26 composite samples for analysis. The sampling locations are described in Figure 2.

A visual inspection of the site for asbestos was undertaken.

8.1.2.2 Machinery shed and yard area

Seven discrete soil samples were collected from the machinery shed and yard area. Three additional samples were collected from the above ground storage area to confirm the hydrocarbon impacted materials had been removed.

The sampling locations are described in Figure 2.

8.1.2.3 Old cottages area

Four discrete soil samples were collected from the old cottages area on an approximate 15m grid pattern. The sampling locations are described in Figure 2.

A visual inspection of the old cottage area for asbestos was undertaken following excavation of asbestos impacted material.

8.1.3 Sampling density

8.1.3.1 Paddocks

The sampling density can detect a potential hot spot with a radius of 41m at a 95% level of confidence. Uniform management practices have been undertaken on the site and the soil sampling and laboratory analysis is considered indicative of the site as a whole. The sampling frequency is less than the minimum recommended by EPA (1995) but justified due to the uniform management of the site.

The surface was visually inspected for asbestos. One cement sheeting sample was submitted for analysis from an area to the east of the cottages.

8.1.3.2 Machinery shed and yard area

Potential hot spot areas were identified within the machinery shed and yard area. The sampling frequency is considered adequate for the area.

8.1.3.3 Old cottages area

The sampling density can detect a potential hot spot with a radius of 8.8m at a 95% level of confidence. Uniform management practices have been undertaken on the site and the soil sampling and laboratory analysis is considered indicative of the site as a whole. The sampling frequency is less than the minimum recommended by EPA (1995) but justified due to the uniform management of the area.

8.1.4 Sampling depth

Any heavy metals or persistent pesticides present are generally immobile and expected to be contained in the 0-100mm soil layer which was the target sampling depth as soil disturbance has not occurred.

The investigation area was also visually inspected for asbestos.

8.2 Analytes

8.2.1 Paddocks

The paddock composite soil samples were evaluated for OCP, arsenic, cadmium, chromium, copper, lead, nickel and zinc as these were identified as the contaminants of concern possibly present as a result of previous activities.

One sample of cement sheeting fragment was analysed for asbestos identification.

8.2.2 Machinery shed and yard area

The machinery and yard discrete soil samples were evaluated for OCP, arsenic, cadmium, chromium, copper, lead, nickel, zinc, mercury, TRH, BTEXN and PAH as these were identified as the contaminants of concern possibly present as a result of previous activities (Table 1). Additional samples were analysed for TRH (C6-C40) as these were identified as the contaminants present.

8.2.3 Old cottages area

The old cottage area discrete soil samples were evaluated for arsenic, cadmium, chromium, copper, lead, nickel, zinc and OCP as these were identified as the contaminants of concern possibly present as a result of previous activities (Table 1).

8.3 Sampling methods

Soil samples were taken using a stainless steel soil push corer. Soil was taken at each individual sampling location below the vegetated and detrital layer.

The soil was transferred to a stainless steel bucket, mixed and transferred to a solvent rinsed glass jar with a Teflon lid. Combining 4 discrete samples made a composite sample for chemical analysis. Discrete soil samples were transferred directly to a solvent rinsed glass jar with a Teflon lid.

Tools were decontaminated between sampling locations to prevent cross contamination by: brushing to remove caked or encrusted material, washing in detergent and tap water, rinsing in an organic solvent, rinsing with clean tap water and allowing to air dry or using a clean towel.

A visual inspection was undertaken to determine the presence of asbestos across the site. One fragment of cement sheeting was submitted for analysis.

Table 1. Schedule of samples and analyses

Sample ID	Discrete sample ID (Figure 2)	Location	Depth	Analysis undertaken
SR1	11, 12, 13, 14	Paddock	0-100mm	Arsenic (As), cadmium (Cd), chromium (Cr), copper (Cu), lead (Pb), nickel (Ni), zinc (Zn)
SR2	21, 22, 23, 24	Paddock	0-100mm	As, Cd, Cr, Cu, Pb, Ni, Zn
SR3	31, 32, 33, 34	Paddock	0-100mm	As, Cd, Cr, Cu, Pb, Ni, Zn
SR4	41, 42, 43, 44	Paddock	0-100mm	As, Cd, Cr, Cu, Pb, Ni, Zn
SR5	51, 52, 53, 54	Paddock	0-100mm	As, Cd, Cr, Cu, Pb, Ni, Zn
SR6	61, 62, 63, 64	Paddock	0-100mm	As, Cd, Cr, Cu, Pb, Ni, Zn
SR7	71, 72, 73, 74	Paddock	0-100mm	As, Cd, Cr, Cu, Pb, Ni, Zn
SR8	81, 82, 83, 84	Paddock	0-100mm	As, Cd, Cr, Cu, Pb, Ni, Zn
SR9	91, 92, 93, 94	Paddock	0-100mm	As, Cd, Cr, Cu, Pb, Ni, Zn
SR10	101, 102, 103, 104	Paddock	0-100mm	As, Cd, Cr, Cu, Pb, Ni, Zn
SR11	111, 112, 113, 114	Paddock	0-100mm	As, Cd, Cr, Cu, Pb, Ni, Zn
SR12	121, 122, 123, 124	Paddock	0-100mm	As, Cd, Cr, Cu, Pb, Ni, Zn
SR13	131, 132, 133, 134	Paddock	0-100mm	As, Cd, Cr, Cu, Pb, Ni, Zn
SR14	141, 142, 143, 144	Paddock	0-100mm	As, Cd, Cr, Cu, Pb, Ni, Zn
SR15	151, 152, 153, 154	Paddock	0-100mm	As, Cd, Cr, Cu, Pb, Ni, Zn
SR16	161, 162, 163, 164	Paddock	0-100mm	As, Cd, Cr, Cu, Pb, Ni, Zn
SR17	171, 172, 173, 174	Paddock	0-100mm	As, Cd, Cr, Cu, Pb, Ni, Zn
SR18	181, 182, 183, 184	Paddock	0-100mm	As, Cd, Cr, Cu, Pb, Ni, Zn
SR19	191, 192, 193, 194	Paddock	0-100mm	As, Cd, Cr, Cu, Pb, Ni, Zn
SR20	201, 202, 203, 204	Paddock	0-100mm	As, Cd, Cr, Cu, Pb, Ni, Zn
SR21	211, 212, 213, 214	Paddock	0-100mm	As, Cd, Cr, Cu, Pb, Ni, Zn
SR22	221, 222, 223, 224	Paddock	0-100mm	As, Cd, Cr, Cu, Pb, Ni, Zn
SR23	231, 232, 233, 234	Paddock	0-100mm	As, Cd, Cr, Cu, Pb, Ni, Zn
SR24	241, 242, 243, 244	Paddock	0-100mm	As, Cd, Cr, Cu, Pb, Ni, Zn
SR25	251, 252, 253, 254	Paddock	0-100mm	As, Cd, Cr, Cu, Pb, Ni, Zn
SR26	261, 262, 263, 264	Paddock	0-100mm	As, Cd, Cr, Cu, Pb, Ni, Zn
SR27	SR27	Cattle yard	0-100mm	OCP, As, Cd, Cr, Cu, Pb, Ni, Zn, Total Recoverable Hydrocarbons (C6-C40) (TRH), Polycyclic Aromatic Hydrocarbon (PAH), Benzene, Toluene, Ethylbenzene, Xylenes, Naphthalene (BTEXN)
SR28	SR28	ULP AST	0-100mm	OCP, As, Cd, Cr, Cu, Pb, Ni, Zn, Mercury (Hg), TRH , PAH, BTEXN
SR29	SR29	Diesel AST	0-100mm	OCP, As, Cd, Cr, Cu, Pb, Ni, Zn, Hg, TRH, PAH, BTEXN
SR30	SR30	Behind machinery shed	0-100mm	OCP, As, Cd, Cr, Cu, Pb, Ni, Zn, Hg, TRH, PAH, BTEXN
SR31	SR31	Behind machinery shed	0-100mm	OCP, As, Cd, Cr, Cu, Pb, Ni, Zn, Hg, TRH, PAH, BTEXN
SR32	SR32	Inside machinery shed	0-100mm	OCP, As, Cd, Cr, Cu, Pb, Ni, Zn, Hg, TRH, PAH, BTEXN

Table 1 cont. Schedule of samples and analyses

Sample ID	Discrete sample ID	Location	Depth	Analysis undertaken
SR33	SR33	Inside machinery shed	0-100mm	OCP, As, Cd, Cr, Cu, Pb, Ni, Zn, Hg, TRH, PAH, BTEXN
SR73	SR73	Paddock	0-100mm	OCP
SR91	SR91	Paddock	0-100mm	OCP
SR113	SR113	Paddock	0-100mm	OCP
SR184	SR184	Paddock	0-100mm	OCP
SR224	SR224	Paddock	0-100mm	OCP
SR201	SR201	Old cottage area	0-100mm	OCP, As, Cd, Cr, Cu, Pb, Ni, Zn, Hg
SR202	SR202	Old cottage area	0-100mm	OCP, As, Cd, Cr, Cu, Pb, Ni, Zn, Hg
SR203	SR20	Old cottage area	0-100mm	OCP, As, Cd, Cr, Cu, Pb, Ni, Zn, Hg
SR204	SR204	Old cottage area	0-100mm	OCP, As, Cd, Cr, Cu, Pb, Ni, Zn, Hg
SRV301	SRV301	AST area	0-100mm	TRH
SRV302	SRV302	AST area	0-100mm	TRH
SRV303	SRV303	AST area	0-100mm	TRH

9. Quality assurance and quality control

9.1 Sampling design

The sampling program is intended to provide data as to the presence and levels of contaminants.

Discrete soil samples were collected on a systematic pattern across the paddocks on an approximate grid pattern of 70 metres. This sampling density will enable the detection of an area with an elevated concentration on a radius of 41 metres with a 95% confidence level. Five discrete soil samples were analysed from within the paddocks for OCP.

Seven discrete samples were collected from the machinery shed and yard area. The samples were taken in potential hotspot areas and the frequency is considered adequate.

The number of sampling locations is less than the recommended density in the EPA sampling guidelines but justified due to the uniform management practices on the site. No “hot spots” smaller than the sampled grid are expected over the site.

One cement sheeting fragment from the surface of the old cottage area was collected and submitted for asbestos identification.

9.2 Field

The collection of samples was undertaken in accordance with accepted standard protocols (NEPC 1999). Composite sampling was undertaken to reduce the cost of chemical analysis. Combining equal amounts from four discrete samples created the composite samples. A composite sample represents the average concentration of the sub-sample.

The rules for composite sampling were observed (EPA 1995). All composite samples were analysed for arsenic, cadmium, chromium, copper, lead, nickel and zinc.

Sampling equipment was decontaminated between each sampling event. The appropriate storage conditions and duration were observed between sampling and analysis. A chain of custody form accompanied the samples to the laboratory (Appendix 2).

A single sampler was used to collect the samples using standard methods. Soil collected was a fresh sample from a hand shovel. After collection the samples were immediately placed in new glass sampling jars and placed in a cooler.

Two duplicate samples were collected. No field blank, rinsate, trip blank or matrix spikes were submitted for analysis. Some samples from all batches did not contain contaminants which confirm the absence of cross contamination during transport and storage. A field sampling log is presented in Appendix 3.

9.3 Laboratory

9.3.1 Soil

Chemical analysis was conducted by SGS Laboratories, Alexandria, which is NATA accredited for the tests undertaken. The laboratories have quality assurance and quality control programs in place, which include internal replication and analysis of spike samples and recoveries.

Method blanks, matrix duplicates and laboratory control samples were within acceptance criteria. The quality assurance and quality control report is presented together with the laboratory report as Appendix 2.

9.3.2 Asbestos cement sheeting

Asbestos identification was undertaken at Greencap, South Australia, which is NATA accredited for the test undertaken.

9.4 Data evaluation

The laboratory quality control report indicates the data variability is within acceptable industry limits. The data is considered representative and usable for the purposes of the investigation. Data quality indicators are presented in Appendix 1.

10. Assessment criteria

10.1 Soil

The proposed land use is low density and large lot residential. The laboratory results were assessed against the proposed land-use of residential (*HIL A*) and recreational (*HIL C*). The health-based investigation levels of contaminants in the soil for residential and recreational sites, for the substances for which criteria are available, are listed in Table 2, as recommended in the NEPC (1999).

The NEPC (1999) also provides health screening levels (HSL) for hydrocarbons in soil. The HSLs have been developed to be protective of human health for soil types, depths below surface and apply to exposure to hydrocarbons through the predominant vapour exposure pathway. The appropriate HSL for the site is listed in Table 2. TRH>16 have physical properties which make the TRH fractions non-volatiles and therefore these TRH fractions are not applicable for vapour intrusion.

Ecological investigation levels (EIL) have been developed for the protection of terrestrial ecosystems for selected metals and organic substances in the soil in the guideline (NEPC 1999). Ecological screening levels (ESL) assess the risk to terrestrial ecosystems from petroleum hydrocarbons in the soil. The EILs and ESLs consider the properties of the soil and contaminants and the capacity of the local ecosystem to accommodate increases in contaminant levels.

EILs vary with land-use and apply to contaminants up to 2m depth below the surface. The EILs for residential and recreational land-use are listed in Table 2.

ESLs are dependent on land-use, soil types and are applicable to contaminants up to 2m below the surface. The appropriate ESL for the site is residential in fine soil as listed in Table 2.

Management limits have been developed to assess petroleum hydrocarbons following evaluation of human health and ecological risks (NEPC 1999). Management limits are applicable as screening levels after consideration of relevant ESLs and HSLs. The appropriate management limit for the site is listed in Table 3.

The investigation threshold was adjusted to enable the detection of an individual location being diluted in the composting process (EPA 1995). For composite sampling, the analyte result was divided against the number of discrete samples making up the composite. This is based on a worst-case scenario in which one sample has a high concentration whilst other discrete samples have zero concentration. This is a conservative approach.

Chromium is analysed as total chromium which is the sum of chromium (III) and chromium (VI). Chromium (VI) is a potential contaminant from industrial processes including ferrochrome production, electroplating, pigment production and tanning (WHO 1998) and is not expected to occur in agricultural sites. Chromium (VI) is reduced to chromium (III) when it comes into contact with organic matter in biota, soil and water. No threshold has been set for total chromium on agricultural sites as it is ubiquitous in the environment and is almost always present in the trivalent state (WHO 1998). Chromium (III) is poorly absorbed by any route therefore toxicity of chromium is mainly attributable to chromium (VI) (ATSDR 2013).

10.2 Asbestos

One pieces of cement sheeting was sent to Greencap for asbestos identification by Polarised Light Microscopy including Dispersion Staining (AS4964-2004). The requirement for the soil surface to be free of asbestos is applicable.

Table 2. Soil assessment criteria metals and OCPs (mg/kg)

Analyte	Residential land-use with access to soil threshold (NEPC 1999)		Public open space- HIL C Recreational (NEPC 1999)		EIL – Urban residential and public open space	
	Discrete Samples (mg/kg)	Composite Samples (mg/kg)	Discrete Samples (mg/kg)	Composite Samples (mg/kg)	Discrete Samples (mg/kg)	Composite Samples (mg/kg)
Arsenic	100	25	300	75	100	25
Cadmium	20	5	90	22.5	-	-
Chromium (total)	-*	-*	-*	-*	-	-
Copper	6,000	1,500	17,000	4,250	-	-
Lead	300	75	600	150	1100	275
Nickel	400	100	1,200	300	170	42.5
Zinc	7,400	1,850	30,000	7,500	-	-
Mercury	40	10	80	20	-	-
OCP	-	-	-	-	180	45
DD's	240	60	-	-		

* Not applicable due to low human toxicity of Cr(III) and non-industrial site

Table 2. Soil assessment criteria hydrocarbons (mg/kg)

Analyte	HSL Residential / clay soil				HSL Recreational / clay soil				ESL Residential/ recreational-fine soil	Management limits for TRH in soil – residential/ recreational
	0m to <1m	1m to <2m	2m to <4m	>4m	0m to <1m	1m to <2m	2m to <4m	>4m		
TRH (C6-C10) (F1)	50	90	150	290	NL	NL	NL	NL	180	800
TRH (>C10-C16) (F2)	280	NL	NL	NL	NL	NL	NL	NL	120	1,000
TRH (>C16-C34)	NA	NA	NA	NA	NL	NL	NL	NL	1,300	3,500
TRH (>C34-C40)	NA	NA	NA	NA	NL	NL	NL	NL	5,600	10,000
Benzene	0.7	1	2	3	NL	NL	NL	NL	65	-
Toluene	480	NL	NL	NL	NL	NL	NL	NL	105	-
Ethylbenzene	NL	NL	NL	NL	NL	NL	NL	NL	125	-
Xylenes	110	310	NL	NL	NL	NL	NL	NL	45	-
Naphthalene	5	NL	NL	NL	NL	NL	NL	NL	-	-
Benzo(a)pyrene	-	-	-	-	-	-	-	-	0.7	-

HSL – health screening level, ESL – ecological screening level, NL – non limiting, NA – not applicable

11. Results and discussion

11.1 Paddocks

Surface cover on the site consisted of improved pasture including native and introduced pasture species with weeds. The site has been predominately cleared of native tree species. Pasture species include paspalum, lucerne, wild oats, wild sage. The weed species include Paterson's curse, cat head, clover, saffron thistle, couch grass, and khaki weed. Eucalypts and Cyprus pines occur within the south eastern section of the site.

The levels of all metals and OCPs analysed in the paddock soil samples (Table 4) were not detected or at environmental background levels and below the residential and recreational land-use thresholds (NEPC 1999).

11.2 Machinery shed and yard area

A machinery shed and yard area was located in the central section of the site. The area has been used to store machinery and refuelling from above ground storage tanks. Cattle yards were also located within this area.

The levels of all metals and OCPs analysed in the machinery shed and yard area soil samples (Table 5) were not detected or at environmental background levels and below the residential and recreational land-use thresholds (NEPC 1999).

One sample (SR29) contained levels of TRH (>C10-C16) above the health screening levels for residential and recreational land use. Two samples (SR28 and SR29) were above the adopted ecological screening levels for residential and recreational land in fine soil. The levels of all other hydrocarbons analysed in the machinery and yard area soil samples (Table 6) were below the residential and recreational land-use thresholds (NEPC 1999). Additional investigations were undertaken to determine the extent hydrocarbon impacted material. Approximately 1.3m^3 of hydrocarbon impacted material was removed from the AST area (6m x 2m x 0.1m). No hydrocarbon material remained following the investigations to determine the extent of the hydrocarbon impacted material. Disposal dockets of the hydrocarbon impacted material are provided in Appendix 4.

10.3 Old cottage area

Small mounds containing soil, timber and bitumen were located to the east of the historical cottages.

Asbestos containing fragments were identified on the soil surface in the area of the historical cottages. The asbestos containing fragments were assessed as being in poor condition with moderate accessibility. Small fragments less than 7mm were observed therefore classing the fragments as friable asbestos. The risk rating of exposure has been assessed as moderate to high.

Additional investigations were undertaken to determine the depth and extent of asbestos impacted material. The asbestos fragments were generally spread across the surface with some buried up to 500mm in depth. The impacted area was approximately 600m^2 in size. The asbestos impacted material was removed during the additional investigations. Disposal dockets are provided in Appendix 4.

Table 4. Analytical results and threshold concentrations (mg/kg)

Sample ID	Sample type	Location	Arsenic	Cadmium	Chromium (total)	Copper	Lead	Nickel	Zinc	OCP
SR1	Composite	Paddock	ND	ND	19	7	5	10	14	-
SR2	Composite	Paddock	ND	ND	18	6	6	9	18	-
SR3	Composite	Paddock	ND	ND	20	6	5	9	13	-
SR4	Composite	Paddock	ND	ND	11	4	4	5	10	-
SR5	Composite	Paddock	ND	ND	18	7	6	8	13	-
SR6	Composite	Paddock	ND	ND	19	8	6	10	15	-
SR7	Composite	Paddock	ND	ND	11	5	5	5	12	-
SR8	Composite	Paddock	ND	ND	23	7	6	10	14	-
SR9	Composite	Paddock	ND	ND	36	7	8	14	22	-
SR10	Composite	Paddock	ND	ND	10	3	4	3	6	-
SR11	Composite	Paddock	ND	ND	9	4	5	4	7	-
SR12	Composite	Paddock	ND	ND	11	5	5	7	9	-
SR13	Composite	Paddock	ND	ND	16	7	6	11	14	-
SR14	Composite	Paddock	ND	ND	58	18	9	41	45	-
SR15	Composite	Paddock	ND	ND	50	17	9	34	31	-
SR16	Composite	Paddock	ND	ND	41	14	8	25	23	-
SR17	Composite	Paddock	ND	ND	36	13	11	20	21	-
SR18	Composite	Paddock	ND	ND	36	12	8	17	22	-
SR19	Composite	Paddock	ND	ND	24	11	8	16	24	-
SR20	Composite	Paddock	ND	ND	27	11	7	16	22	-
SR21	Composite	Paddock	ND	ND	41	13	7	24	25	-
SR22	Composite	Paddock	ND	0.3	65	18	9	42	35	-
SR23	Composite	Paddock	ND	0.4	59	20	9	52	41	-
SR24	Composite	Paddock	ND	0.4	63	20	9	50	40	-
SR25	Composite	Paddock	ND	ND	40	15	9	32	29	-
SR26	Composite	Paddock	ND	0.4	67	10	10	52	59	-
SR73	Discrete	Paddock	-	-	-	-	-	-	-	ND
SR91	Discrete	Paddock	-	-	-	-	-	-	-	ND
SR113	Discrete	Paddock	-	-	-	-	-	-	-	ND
SR184	Discrete	Paddock	-	-	-	-	-	-	-	ND
SR224	Discrete	Paddock	-	-	-	-	-	-	-	ND
SR201	Discrete	Old cottage area	3	0.4	47	21	17	42	55	ND
SR202	Discrete	Old cottage area	3	0.4	51	22	19	38	80	ND
SR203	Discrete	Old cottage area	3	0.4	60	20	13	49	23	ND
SR204	Discrete	Old cottage area	3	0.4	52	15	16	31	48	ND
Health Investigation Levels – Residential land-use threshold (NEPC 1999)										
Discrete			*100*	*20*	*-**	*6,000*	*300*	*400*	*7,400*	-
Composite			*25*	*5*	*-**	*1,500*	*75*	*100*	*1,850*	-
Health Investigation Levels – Recreational land-use threshold (NEPC 1999)										
Discrete			*300*	*90*	*-**	*17,000*	*600*	1,200	*30,000*	-
Composite			*75*	*21.5*	*-**	*4,250*	*150*	300	*7,500*	-
Ecological Investigation Levels – Urban residential and public open space (NEPC 1999)										
Discrete			*100*	-	-	-	*1100*	170	-	*180*
Composite			*25*	-	-	-	*275*	42.5	-	*45*

ND = not detected at the detection limit, * Not applicable due to low human toxicity of Cr(III) and non-industrial site

Table 5. Analytical results and threshold concentrations (mg/kg)

Sample ID	Sample type	Location	Arsenic	Cadmium	Chromium (total)	Copper	Lead	Nickel	Zinc	OCP DD's
SR27	Discrete	Cattle yard	ND	0.4	58	23	11	62	64	ND
SR28	Discrete	ULP AST	ND	0.3	50	19	10	40	58	ND
SR29	Discrete	Diesel AST	ND	0.4	63	26	8	83	50	ND
SR30	Discrete	Behind machinery shed	ND	0.3	64	22	9	48	49	ND
SR31	Discrete	Behind machinery shed	ND	ND	49	21	10	41	58	ND
SR32	Discrete	Inside machinery shed	ND	0.3	53	22	10	50	40	ND
SR33	Discrete	Inside machinery shed	ND	0.3	59	22	10	48	44	ND
Health Investigation Levels – Residential land-use threshold (NEPC 1999)										
			100	*20*	*-**	*6,000*	*300*	*400*	*7,400*	*3,600*
Health Investigation Levels – Recreational land-use threshold (NEPC 1999)										
			300	*90*	*-**	*300*	*17,000*	*600*	*1,200*	*-*
Ecological Investigation Levels – Urban residential and public open space (NEPC 1999)										
			100	*-*	*-*	*-*	*1,100*	*170*	*-*	*180*

ND = not detected at the detection limit, * Not applicable due to low human toxicity of Cr(III) and non-industrial site

Table 6. Analytical results and threshold concentrations for hydrocarbons (mg/kg)

Sample id.	Sample type	Location	TRH (C6-C10)	TRH (>C10-C16)	TRH (>C16-C34)	TRH (>C34-C40)	Benzene	Toluene	Ethylbenzene	Xylenes	Naphthalene
SR27	Discrete	Cattle yard	ND	ND	ND	ND	ND	ND	ND	ND	ND
SR28	Discrete	ULP AST	ND	ND	930	ND	ND	ND	ND	ND	ND
SR29	Discrete	Diesel AST	ND	450	3,100	ND	ND	ND	ND	ND	ND
SR30	Discrete	Behind machinery shed	ND	ND	ND	ND	ND	ND	ND	ND	ND
SR31	Discrete	Behind machinery shed	ND	ND	ND	ND	ND	ND	ND	ND	ND
SR32	Discrete	Inside machinery shed	ND	ND	170	ND	ND	ND	ND	ND	ND
SR33	Discrete	Inside machinery shed	ND	ND	ND	ND	ND	ND	ND	ND	ND
SRV301	Discrete	AST area	ND	ND	130	ND	-	-	-	-	-
SRV302	Discrete	AST area	ND	26	210	ND	-	-	-	-	-
SRV303	Discrete	AST area	ND	53	540	ND	-	-	-	-	-
HSL A– Residential/recreational clay soil		0m to <1m	*50*	*280*	*NA*	*NA*	*0.7*	*480*	*NL*	*110*	*NL*
EIL – residential/recreational			-	-	-	-	-	-	-	-	*170*
ESL – residential/ recreational / fine soil			*180*	*120*	*1,300*	*5,600*	*65*	*105*	*125*	*45*	-
Management limits for TRH fractions in soil / residential/recreational			*800*	*1,000*	*5,000*	*10,000*	-	-	-	-	-

ND = not detected at the detection limit

12. Site characterisation

12.1 Environmental contamination

No soil contamination remained on site.

12.2 Chemical degradation production

No soil contamination remained on site.

12.3 Exposed population

No soil contamination remained on site.

13. Conclusions and recommendations

13.1 Summary

An inspection of the site was made on 10 and 11 January 2017. The site is located in a developing residential area on the south eastern fringes of Dubbo and has an area of approximately 50ha.

The site has an agricultural land-use history of grazing. Several buildings were identified on the site including a dwelling, machinery shed, cattle yards and two above ground storage tanks. There is no evidence of orchards, mines, sheep dips, mixing sheds or contaminating industrial activities on the site from the review of site history or site walkover. The use of agricultural pesticides over the area in the past is expected to be low.

The contamination status of the site was assessed from a soil sampling and laboratory analysis program. One hundred and four discrete soil samples were collected over the paddock areas from the 0 to 100mm soil depth. The discrete samples were combined to form twenty six composite samples for analysis. The soil samples were analysed for arsenic, cadmium, chromium, copper, lead, nickel and zinc. Five discrete soil samples from within the paddocks were analysed for organochlorine pesticides (OCP). Seven discrete samples were collected from around the shed and historic cattle yards and were analysed for arsenic, cadmium, chromium, copper, lead, nickel, zinc, mercury, organochlorine pesticides (OCP), total recoverable hydrocarbons (TRH) (C6-C40), benzene, toluene, ethylbenzene, xylenes and naphthalene (BTEXN) and polycyclic aromatic hydrocarbons (PAH).

Two cottages were identified in aerial photographs (2006-2010) south of the machinery shed and had been removed at the time of the site inspection. The cottages were located west of the dwelling. Asbestos containing fragments were identified in the area of the old cottages. Several small mounds containing soil, timber and bitumen were identified in this area. Asbestos containing fragments were excavated during investigations of the extent of asbestos impacted material. The asbestos fragments were generally spread across the surface with some buried up to 500mm in depth. The impacted area was approximately 600m^2 in size. The impacted material was removed landfill licensed to accept asbestos waste. A visual clearance was undertaken following excavation and removal of asbestos impacted material. Four surface samples were collected across the area of the historic cottages and analysed for heavy metals, OCP, TRH, BTEXN and PAH. The levels of all metals, OCPs, TRH, BTEXN and PAH analysed in the cottage soil samples were not detected or at environmental background levels and below the residential and recreational land-use thresholds.

The levels of all metals and OCPs analysed in the machinery shed and yard area soil samples were not detected or at environmental background levels and below the residential and recreational land-use thresholds. One soil sample from near the diesel above ground storage tank contained levels of TRH (>C16-C34) above the health screening levels for residential land use. Two soil samples collected from within the area of above ground storage tanks were above the adopted ecological screening levels for TRH (>C16-C34) for residential land use. Further investigations into the depth of hydrocarbon impacted material identified the impacted material was contained within the top 100mm of soil. The impacted material was excavated and removed during the investigations to determine the depth. The area was less than 10m^2 in size. Three additional discrete samples were collected from the base of excavations and TRH was reported as not detected in all three samples. Hydrocarbon impacted material was removed to a licensed landfill.

The soil sampling program did not detect elevated levels of the analysed metals or OCP within the paddock areas. The levels of all substances evaluated were below the EPA investigation threshold for residential land-use with access to soil.

13.2 Assumptions in reaching the conclusions

It is assumed the sampling sites are representative of the site. An accurate history has been obtained and typical past farming practices were adopted.

13.3 Extent of uncertainties

The analytical data relate only to the locations sampled. Soil conditions can vary both laterally and vertically and it cannot be excluded that unidentified contaminants may be present. The sampling density was designed to detect a ‘hot spot’ in the field area within a radius of approximately 41 metres and with a 95% level of confidence.

13.4 Suitability for proposed use of the site

The site requires additional investigations in the area of the old cottages. A remediation action plan is required for the hydrocarbon and asbestos impacted material.

13.5 Limitations and constraints on the use of the site

The assessed areas are suitable for the proposed land use of residential and recreational. Additional investigations are required in the area of the old cottages.

13.6 Recommendation for further work

The site is suitable for the proposed residential activities.

If additional asbestos fragments or other hazardous materials are encountered then the unexpected finds protocol (Appendix 5) should be followed which would include ceasing works and the identified impacted asbestos material removed in accordance with SafeWork methods “How to safely remove asbestos” prior to site works commencing.

14. Report limitations and intellectual property

This report has been prepared for the use of the client to achieve the objectives given the clients requirements. The level of confidence of the conclusion reached is governed by the scope of the investigation and the availability and quality of existing data. Where limitations or uncertainties are known, they are identified in the report. No liability can be accepted for failure to identify conditions or issues which arise in the future and which could not reasonably have been predicted using the scope of the investigation and the information obtained.

The investigation identifies the actual subsurface conditions only at those points where samples are taken, when they are taken. Data derived through sampling and subsequent laboratory testing is interpreted by geologists, engineers or scientists who then render an opinion about overall subsurface conditions, the nature and extent of the contamination, it's likely impact on the proposed development and appropriate remediation measures. Actual conditions may differ from those inferred to exist, because no professional, no matter how well qualified, and no sub-surface exploration program, no matter how comprehensive, can reveal what is hidden by earth, rock or time. The actual interface between materials may be far more gradual or abrupt than a report indicates. Actual conditions in areas not sampled may differ from predictions. It is thus important to understand the limitations of the investigation and recognise that we are not responsible for these limitations.

This report, including data contained and its findings and conclusions, remains the intellectual property of Envirowest Consulting Pty Ltd. A licence to use the report for the specific purpose identified is granted for the persons identified in that section after full payment for the services involved in preparation of the report. This report should not be used by persons or for purposes other than those stated and should not be reproduced without the permission of Envirowest Consulting Pty Ltd.

15. References

DEC (2006) *Contaminated Sites: Guidelines for the NSW Site Auditors Scheme* (NSW Department of Environment and Conservation, Chatswood)

Environment Protection Authority (1995) *Contaminated sites: Sampling Design Guidelines* (NSW Environment Protection Authority, Chatswood)

Murphy BW and Lawrie, JW (1990) *Soil Landscapes of the Dubbo 1:250,000 Sheet* (Soil Conservation Service of NSW, Sydney)

NEPC (1999 revised 2013) *National Environment Protection (Assessment of Site Contamination) Measure 1999* (National Environment Protection Council Service Corporation, Adelaide)

Figures

Figure 1: Locality map		
Lot 2 DP880413, 24R Sheraton Road, Dubbo NSW		
	Envirowest Consulting Pty Ltd	
Job: R7891c	Drawn by: AP	Date: 31/01/2017

Approximate Scale 1: 6,000

0 60 120 240m

Legend

⊗ Sampling location

Lot boundary

Dam

Fence

Figure 2: Site plan		
Lot 2 DP880413, 24R Sheraton Road, Dubbo NSW		
	Envirowest Consulting Pty Ltd	
Job: R7891c	Drawn by: AP	Date: 31/01/2017

North

Legend

⊗ Sampling location

Lot boundary

Fence

Slope

Approximate Scale 1: 6,000

0 60 120 240m

Figure 3: Sampling locations		
Lot 2 DP880413, 24R Sheraton Road, Dubbo NSW		
	Envirowest Consulting Pty Ltd	
Job: R7891c	Drawn by: AP	Date: 31/01/2017

Legend

⊗ Sampling location

—·— Fence

Approximate Scale 1: 1,500

0 15 30 60m

Figure 4: Sampling locations in machinery shed and yard		
Lot 2 DP880413, 24R Sheraton Road, Dubbo NSW		
	Envirowest Consulting Pty Ltd	
Job: R7891c	Drawn by: AP	Date: 31/01/2017

Legend

⊗ Sampling location

— · — Fence

Figure 5: Sampling locations in old cottage and AST area	
Lot 2 DP880413, 24R Sheraton Road, Dubbo NSW	
	Envirowest Consulting Pty Ltd
Job: R7891c	Drawn by: AP / Date: 31/01/2017

Figure 6. Photographs of the site

Looking west across paddocks

Looking south west across paddocks

Looking south across paddocks

Cottage area requiring following investigations

AST area

AST area

Appendices

Appendix 1. Sample analysis, quality assurance and quality control (QAQC) report
Appendix 2. Soil analysis results –
    SGS report number SE160957 and chain of custody form
    Greencap report number 21782 and chain of custody form
Appendix 3. Field sampling log

Appendix 1. Sample analysis, quality assurance and quality control (QAQC) report

1. Data quality indicators (DQI) requirements

1.1 Completeness

A measure of the amount of usable data for a data collection activity. Greater than 95% of the data must be reliable based on the quality objectives. Where greater than two quality objectives have less reliability than the acceptance criterion the data may be considered with uncertainty.

1.1.1 Field

Consideration	Requirement
Locations and depths to be sampled	Described in the sampling plan. The acceptance criterion is 95% data retrieved compared with proposed. Acceptance criterion is 100% in crucial areas.
SOP appropriate and compiled	Described in the sampling plan.
Experienced sampler	Sampler or supervisor
Documentation correct	Sampling log and chain of custody completed

1.1.2 Laboratory

Consideration	Requirement
Samples analysed	Number according to sampling and quality plan
Analytes	Number according to sampling and quality plan
Methods	EPA or other recognised methods with suitable PQL
Sample documentation	Complete including chain of custody and sample description
Sample holding times	Metals 6 months, OCP, PAH, TPH, PCB 14 days

1.2 Comparability

The confidence that data may be considered to be equivalent for each sampling and analytical event. The data must show little or no inconsistencies with results and field observations.

1.2.1 Field

Consideration	Requirement
SOP	Same sampling procedures to be used
Experienced sampler	Sampler or supervisor
Climatic conditions	Described as may influence results
Samples collected	Sample medium, size, preparation, storage, transport

1.2.2 Laboratory

Consideration	Requirement
Analytical methods	Same methods, approved methods
PQL	Same
Same laboratory	Justify if different
Same units	Justify if different

1.3 Representativeness

The confidence (expressed qualitatively) that data are representative of each media present on the site.

1.3.1 Field

Consideration	Requirement
Appropriate media sampled	Sampled according to sampling and quality plan or in accordance with the EPA (1995) sampling guidelines.
All media identified	Sampling media identified in the sampling and quality plan. Where surface water bodies on the site sampled.

1.3.2 Laboratory

Consideration	Requirement
Samples analysed	Blanks

1.4 Precision

A quantitative measure of the variability (or reproduced of the data). Is measured by standard deviation or relative percent difference (RPD). A RPD analysis is calculated and compared to the practical quantitation limit (PQL) or absolute difference AD.

- Levels greater than 10 times the PQL the RPD is 50%
- Levels between 5 and 10 times the PQL the RPD is 75%
- Levels between 2 and 5 times the PQL the RPD is 100%
- Levels less than 2 times the PQL, the AD is less than 2.5 times the PQL

Data not conforming to the acceptance criterion will be examined for determination of suitability for the purpose of site characterisation.

1.4.1 Field

Consideration	Requirement
Field duplicates	Frequency of 5%, results to be within RPD or discussion required indicate the appropriateness of SOP

1.4.2 Laboratory

Consideration	Requirement
Laboratory and inter lab duplicates	Frequency of 5%, results to be within RPD or discussion required. Inter laboratory duplicates will be one sample per batch.
Field duplicates	Frequency of 5%, results to be within RPD or discussion required
Laboratory prepared volatile trip spikes	One per sampling batch, results to be within RPD or discussion required

1.5 Accuracy

A quantitative measure of the closeness of the reported data to the true value.

1.5.1 Field

Consideration	Requirement
SOP	Complied
Inter laboratory duplicates	Frequency of 5%. Analysis criterion 60% RPD for levels greater than 10 times the PQL 85% RPD for levels between 5 to 10 times the PQL 100% RPD at levels between 2 to 5 times the PQL Absolute difference, 3.5 times the PQL where levels are, 2 times PQL

1.5.2 Laboratory

Recovery data (surrogates, laboratory control samples and matrix spikes) data subject to the following control limits:

- 60 to 140% acceptable data
- 20-60% discussion required, may be considered acceptable
- 10-20% data should considered as estimates
- 10% data should be rejected

Consideration	Requirement
Field blanks	Frequency of 5%, <5 times the PQL, PQL may be adjusted
Rinsate blanks	Frequency of 5%, <5 times the PQL, PQL may be adjusted
Method blanks	Frequency of 5%, <5 times the PQL, PQL may be adjusted
Matrix spikes	Frequency of 5%, results to be within +/-40% or discussion required
Matrix duplicates	Sample injected with a known concentration of contaminants with tested. Frequency of 5%, results to be within +/-40% or discussion required
Surrogate spikes	QC monitoring spikes to be added to samples at the extraction process in the laboratory where applicable. Surrogates are closely related to the organic target analyte and not normally found in the natural environment. Frequency of 5%, results to be within +/-40% or discussion required
Laboratory control samples	Externally prepared reference material containing representative analytes under investigation. These will be undertaken at one per batch. It is to be within +/-40% or discussion required
Laboratory prepared spikes	Frequency of 5%, results to be within +/-40% or discussion required

2. Laboratory analysis summary

One analysis batch was undertaken over the preliminary investigation program. Samples were collected on 22 and 23 April 2015. A total of thirty four samples were submitted for analytical testing. The samples were collected in the field by an environmental scientist from Envirowest Consulting Pty Ltd, placed into laboratory prepared receptacles as recommended in NEPC (1999). The samples preservation and storage was undertaken using standard industry practices (NEPC 1999). A chain of custody form accompanied transport of the samples to the laboratory.

The samples were analysed at the laboratories of SGS, Alexandria, NSW which is National Association of Testing Authorities (NATA) accredited for the tests undertaken. The analyses undertaken, number of samples tested and methods are presented in the following tables:

Laboratory analysis schedule

Sample id. (sampling location)	Number of samples	Duplicate	Analyses	Date collected	Substrate	Laboratory report
SR1, SR2, SR3, SR4, SR5, SR6, SR7, SR8, SR9, SR10, SR11, SR12, SR13, SR14, SR15, SR16, SR17, SR18, SR19, SR20, SR21, SR22, SR23, SR24, SR25, SR26, SR27	27	2	As, Cd, Cr (total), Cu, Pb, Ni, Zn	11/01/2017	Soil	SE160957
SR28, SR29, SR30, SR31, SR32, SR33	2	0	As, Cd, Cr, Pb, Ni, Zn, OCP, TRH (C6-C40), BTEXN, PAH	11/01/2017 12/01/2017	Soil	SE160957
SR73, SR91, SR113, SR184, , SR224	5	0	OCP	11/01/2017	Soil	SE160957
SR201, SR202, SR203, SR204	4	0	As, Cd, Cr (total), Cu, Pb, Ni, Zn, OCP	22/02/2017	Soil	SE162373
SRV301, SRV302, SRV303	3	0	TRH (C6-C40)	22/02/2017	Soil	SE162373A

Analytical methods

Analyte	Extraction	Laboratory methods
Metals	USEPA 200.2 Mod	APHA USEPA SW846-6010
Chromium (III)	-	APHA 3500 CR-A&B & 3120 and USEPA SW846-3060A
Chromium (VI)	USEPA SW846-3060A	USEPA SW846-3060A
Mercury	USEPA 200.2 Mod	APHA 3112
TRH(C6-C9)	USPEA SW846-5030A	USPEA SW 846-8260B
TRH(C10-C36), PAH	Tumbler extraction of solids	USEPA SW 846-8270B
PCB	Tumbler extraction of solids	USEPA SW 846-8270B
OC Pesticides	Tumbler extraction of solids	USEPA SW 846-8270B
BTEX	Tumbler extraction of solids	USEPA SW 846-8260B

3. Field quality assurance and quality control

Two intra laboratory duplicate samples were collected for the investigation. The frequency was slightly less than the recommended frequency of 5%. Table A5.1 outlines the samples collected and differences in replicate analyses. Relative differences were deemed to pass if they were within the acceptance limits of +/- 40% for replicate analyses or less than 5 times the detection limit.

Field duplicate frequency

Sample id.	Number of samples	Duplicate	Frequency (%)	Date collected	Substrate	Laboratory report
SR1, SR2, SR3, SR4, SR5, SR6, SR7, SR8, SR9, SR10, SR11, SR12, SR13, SR14, SR15, SR16, SR17, SR18, SR19, SR20, SR21, SR22, SR23, SR24, SR25, SR26, SR27, SR28, SR29, SR30, SR31, SR32, SR33, SR73, SR91, SR113	36	2	5.5	11/01/2017 12/01/2017	Soil	SE160957
SR201, SR202, SR203, SR204	4	0	0	22/02/2017	Soil	SE162373
SRV301, SRV302, SRV303	3	0	0	22/02/2017	Soil	SE162373A

Table A5.1. Relative differences for intra laboratory duplicates

	SR2, SRA		SR10, SRB	
	Relative difference (%)	Pass/Fail	Relative difference (%)	Pass/Fail
Arsenic	NA	-	NA	-
Cadmium	NA	-	NA	-
Chromium	15	Pass	0	Pass
Copper	0	Pass	0	Pass
Lead	18	Pass	0	Pass
Nickel	0	Pass	0	Pass
Zinc	6	Pass	18	Pass

NA – relative difference unable to be calculated as results are less than laboratory detection limit

No trip blanks or spikes were submitted for analysis. This is not considered to create significant uncertainty in the analysis results because of the following rationale:

- The fieldwork was completed within a short time period and consistent methods were used for soil sampling.
- Soil samples were placed in insulated cooled containers after sampling to ensure preservation during transport and storage.
- The samples were placed in single use jars using clean sampling tools and disposable gloves from material not in contact with other samples. This reduces the likelihood of cross contamination.
- Samples in the analysis batch contain analytes below the level of detection. It is considered unlikely that contamination has occurred as a result of transport and handling.

4. Laboratory quality assurance and quality control

Sample holding times are recommended in NEPC (1999). The time between collection and extraction for all samples was less than the criteria listed below:

Analyte	Maximum holding time
Metals, cyanide	6 months
OCP, TPH, PCB, BTEX, PAH	14 days

The laboratory interpretative reports are presented with individual laboratory report. Assessment is made of holding time, frequency of control samples and quality control samples. No significant outliers exist for the sampling batches. The laboratory report also contains a detailed description of preparation methods and analytical methods.

The results, quality report, interpretative report and chain of custody are presented in the attached appendices. The quality report contains the laboratory duplicates, spikes, laboratory control samples, blanks and where appropriate matrix spike recovery (surrogate).

5. Data quality indicators (DQI) analysis

5.1 Completeness

A measure of the amount of usable data for a data collection activity (total to be greater than 95%).

The data set was found to be complete based on the scope of work. No critical areas of contamination were omitted from the data set.

5.1.1 Field

Consideration	Accepted	Comment
Locations to be sampled	Yes	In accordance with sampling methodology, described in the report. Sampling locations described in figures.
Depth to be sampled	Yes	In accordance with sampling methodology
SOP appropriate and compiled	Yes	In accordance with sampling methodology Sampled with stainless steel spade into lab prepared containers, decontamination between samples, latex gloves worn by sampler
Experienced sampler	Yes	Same soil sampler, environmental scientist

Documentation correct	Yes	Sampling log completed Chain of custody completed

5.1.2 Laboratory

Consideration	Accepted	Comment
Samples analysed	Yes	All critical samples analysed in accordance with chain of custody and analysis plan
Analytes	Yes	All analytes in accordance with chain of custody and analysis plan
Methods	Yes	Analysed in NATA accredited laboratory with recognised methods and suitable PQL
Sample documentation	Yes	Completed including chain of custody and sample results and quality results report for each batch
Sample holding times	Yes	Metals less than 6 months. OCP, TPH, PCB, BTEX less than 14 days

5.2 Comparability

The confidence that data may be considered to be equivalent for each sampling and analytical event.

The data sets were found to be acceptable.

5.2.1 Field

Consideration	Accepted	Comment
SOP	Yes	Same sampling procedures used and sampled on one date
Experienced sampler	Yes	Experienced scientist
Climatic conditions	Yes	Described in field sampling log
Samples collected	Yes	Suitable size, storage and transport

5.2.2 Laboratory

Consideration	Accepted	Comment
Analytical methods	Yes	Same methods all samples, in accordance with NEPC(1999) or USEPA
PQL	Yes	Suitable for analytes
Same laboratory	Yes	ALS Environmental is NATA accredited for the test
Same units	Yes	-

5.3 Representativeness

The confidence (expressed qualitatively) that data are representative of each media present on the site.

The data sets were found to be acceptable.

5.3.1 Field

Consideration	Accepted	Comment
Appropriate media sampled	Yes	Sampled according to sampling and quality plan
All media identified	Yes	Soil Sampling media identified in the sampling and quality plan

5.3.2 Laboratory

Consideration	Accepted	Comment
Samples analysed	Yes	Undertaken in NATA accredited laboratory. No blanks analysed. Samples in the analysis batch contain analytes below the level of detection. It is considered unlikely that contamination has occurred as a result of transport and handling.

5.4 Precision

A quantitative measure of the variability (or reproduced of the data).
The data sets were found to be acceptable.

5.4.1 Field

Consideration	Accepted	Comment
SOP	Yes	Complied
Field duplicates	Yes	Collected.

5.4.2 Laboratory

Consideration	Accepted	Comment
Laboratory and inter lab duplicates	Yes	Frequency of 5%, results to be within +/-40% or discussion required
Field duplicates	Yes	Frequency of 5%, results to be within +/-40% or discussion required
Laboratory prepared volatile trip spikes	NA	Not collected due to the preliminary nature of the investigation

5.5 Accuracy

A quantitative measure of the closeness of the reported data to the true value.

The data sets were found to be acceptable.

5.5.1 Field

Consideration	Accepted	Comment
SOP	Yes	Complied
Field blanks	NA	Frequency of 5%, <5 times the PQL, PQL may be adjusted
Rinsate blanks	NA	Frequency of 5%, <5 times the PQL, PQL may be adjusted

5.5.2 Laboratory

Consideration	Accepted	Comment
Method blanks	Yes	Frequency of 5%, <5 times the PQL, PQL may be adjusted
Matrix spikes	Yes	Frequency of 5%, results to be within +/-40% or discussion required.
Matrix duplicates	Yes	Frequency of 5%, results to be within +/-40% or discussion required
Surrogate spikes	Yes	Frequency of 5%, results to be within +/-40% or discussion required
Laboratory control samples	Yes	Frequency of 5%, results to be within +/-40% or discussion required
Laboratory prepared spikes	Yes	Frequency of 5%, results to be within +/-40% or discussion required

No trip blanks, field spikes or sample rinsates were submitted for analysis. This is not considered to create significant uncertainty in the analysis results because of the following rationale:

- The fieldwork methods used for soil sampling were consistent throughout the project with all in situ samples collected from material which had not been subject to exposure.
- The fieldwork was completed within a short time period and consistent methods were used for soil sampling.
- Soil samples were placed in insulated cooled containers as quickly as possible, with the containers filled to minimize headspace. The sample containers were sealed immediately after the sample was collected and chilled in an esky containing ice.
- The samples were stored in a refrigerator and transported with ice bricks to ensure preservation during transport and storage.
- The samples were placed in single use jars using clean sampling tools and disposable gloves from material not in contact with other samples. This reduces the likelihood of cross contamination.
- Samples in the analysis batches contained analytes below the level of detection. It is considered unlikely that contamination has occurred as a result of transport and handling.

6. Conclusion

All media appropriate to the objectives of this investigation have been adequately analysed and no area of significant uncertainty exist. It is concluded the data is usable for the purposes of the investigation.

Appendix 2. Soil analysis results – SGS report number SE160957 and chain of custody form
– SGS report number SE162373 and chain of custody form
– SGS report number SE162373A and chain of custody form
– Greencap report number 21782 and chain of custody form

ANALYTICAL REPORT

Accreditation No. 2562

CLIENT DETAILS

Contact	Ashleigh Pickering
Client	ENVIROWEST CONSULTING PTY LIMITED
Address	PO BOX 8158 ORANGE NSW 2800
Telephone	61 2 63614954
Facsimile	(Not specified)
Email	ashleigh@envirowest.net.au
Project	**7891**
Order Number	(Not specified)
Samples	42

LABORATORY DETAILS

Manager	Huong Crawford
Laboratory	SGS Alexandria Environmental
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SGS Reference	**SE160957 R0**
Date Received	17/1/2017
Date Reported	24/1/2017

COMMENTS

Accredited for compliance with ISO/IEC 17025. NATA accredited laboratory 2562(4354).

SIGNATORIES

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VOC's in Soil [AN433] Tested: 19/1/2017

PARAMETER	UOM	LOR	SR27 SOIL - 11/1/2017 SE160957.027	SR28 SOIL - 11/1/2017 SE160957.028	SR29 SOIL - 11/1/2017 SE160957.029	SR30 SOIL - 11/1/2017 SE160957.030	SR31 SOIL - 11/1/2017 SE160957.031
Benzene	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Toluene	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Ethylbenzene	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
m/p-xylene	mg/kg	0.2	<0.2	<0.2	<0.2	<0.2	<0.2
o-xylene	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Total Xylenes*	mg/kg	0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Total BTEX	mg/kg	0.6	<0.6	<0.6	<0.6	<0.6	<0.6
Naphthalene	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1

PARAMETER	UOM	LOR	SR32 SOIL - 12/1/2017 SE160957.032	SR33 SOIL - 12/1/2017 SE160957.033
Benzene	mg/kg	0.1	<0.1	<0.1
Toluene	mg/kg	0.1	<0.1	<0.1
Ethylbenzene	mg/kg	0.1	<0.1	<0.1
m/p-xylene	mg/kg	0.2	<0.2	<0.2
o-xylene	mg/kg	0.1	<0.1	<0.1
Total Xylenes*	mg/kg	0.3	<0.3	<0.3
Total BTEX	mg/kg	0.6	<0.6	<0.6
Naphthalene	mg/kg	0.1	<0.1	<0.1

Volatile Petroleum Hydrocarbons in Soil [AN433] Tested: 19/1/2017

PARAMETER	UOM	LOR	SR27 SOIL - 11/1/2017 SE160957.027	SR28 SOIL - 11/1/2017 SE160957.028	SR29 SOIL - 11/1/2017 SE160957.029	SR30 SOIL - 11/1/2017 SE160957.030	SR31 SOIL - 11/1/2017 SE160957.031
TRH C6-C9	mg/kg	20	<20	<20	<20	<20	<20
Benzene (F0)	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
TRH C6-C10	mg/kg	25	<25	<25	<25	<25	<25
TRH C6-C10 minus BTEX (F1)	mg/kg	25	<25	<25	<25	<25	<25

PARAMETER	UOM	LOR	SR32 SOIL - 12/1/2017 SE160957.032	SR33 SOIL - 12/1/2017 SE160957.033
TRH C6-C9	mg/kg	20	<20	<20
Benzene (F0)	mg/kg	0.1	<0.1	<0.1
TRH C6-C10	mg/kg	25	<25	<25
TRH C6-C10 minus BTEX (F1)	mg/kg	25	<25	<25

TRH (Total Recoverable Hydrocarbons) in Soil [AN403] Tested: 18/1/2017

PARAMETER	UOM	LOR	SR27 SOIL - 11/1/2017 SE160957.027	SR28 SOIL - 11/1/2017 SE160957.028	SR29 SOIL - 11/1/2017 SE160957.029	SR30 SOIL - 11/1/2017 SE160957.030	SR31 SOIL - 11/1/2017 SE160957.031
TRH C10-C14	mg/kg	20	<20	<20	120	<20	<20
TRH C15-C28	mg/kg	45	<45	910	3400	<45	<45
TRH C29-C36	mg/kg	45	<45	52	<45	<45	<45
TRH C37-C40	mg/kg	100	<100	<100	<100	<100	<100
TRH >C10-C16 (F2)	mg/kg	25	<25	<25	450	<25	<25
TRH >C10-C16 (F2) - Naphthalene	mg/kg	25	<25	<25	450	<25	<25
TRH >C16-C34 (F3)	mg/kg	90	<90	930	3100	<90	<90
TRH >C34-C40 (F4)	mg/kg	120	<120	<120	<120	<120	<120
TRH C10-C36 Total	mg/kg	110	<110	960	3500	<110	<110
TRH C10-C40 Total	mg/kg	210	<210	960	3500	<210	<210

PARAMETER	UOM	LOR	SR32 SOIL - 12/1/2017 SE160957.032	SR33 SOIL - 12/1/2017 SE160957.033
TRH C10-C14	mg/kg	20	<20	<20
TRH C15-C28	mg/kg	45	140	<45
TRH C29-C36	mg/kg	45	51	<45
TRH C37-C40	mg/kg	100	<100	<100
TRH >C10-C16 (F2)	mg/kg	25	<25	<25
TRH >C10-C16 (F2) - Naphthalene	mg/kg	25	<25	<25
TRH >C16-C34 (F3)	mg/kg	90	170	<90
TRH >C34-C40 (F4)	mg/kg	120	<120	<120
TRH C10-C36 Total	mg/kg	110	190	<110
TRH C10-C40 Total	mg/kg	210	<210	<210

PAH (Polynuclear Aromatic Hydrocarbons) in Soil [AN420] Tested: 18/1/2017

PARAMETER	UOM	LOR	SR27 SOIL - 11/1/2017 SE160957.027	SR28 SOIL - 11/1/2017 SE160957.028	SR29 SOIL - 11/1/2017 SE160957.029	SR30 SOIL - 11/1/2017 SE160957.030	SR31 SOIL - 11/1/2017 SE160957.031
Naphthalene	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2-methylnaphthalene	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
1-methylnaphthalene	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Acenaphthylene	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Acenaphthene	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Fluorene	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Phenanthrene	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Anthracene	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Fluoranthene	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Pyrene	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Benzo(a)anthracene	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Chrysene	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Benzo(b&j)fluoranthene	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Benzo(k)fluoranthene	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Benzo(a)pyrene	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Indeno(1,2,3-cd)pyrene	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Dibenzo(ah)anthracene	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Benzo(ghi)perylene	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Carcinogenic PAHs, BaP TEQ <LOR=0	TEQ	0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Carcinogenic PAHs, BaP TEQ <LOR=LOR	TEQ (mg/kg)	0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Carcinogenic PAHs, BaP TEQ <LOR=LOR/2	TEQ (mg/kg)	0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Total PAH (18)	mg/kg	0.8	<0.8	<0.8	<0.8	<0.8	<0.8
Total PAH (NEPM/WHO 16)	mg/kg	0.8	<0.8	<0.8	<0.8	<0.8	<0.8

PARAMETER	UOM	LOR	SR32 SOIL - 12/1/2017 SE160957.032	SR33 SOIL - 12/1/2017 SE160957.033
Naphthalene	mg/kg	0.1	<0.1	<0.1
2-methylnaphthalene	mg/kg	0.1	<0.1	<0.1
1-methylnaphthalene	mg/kg	0.1	<0.1	<0.1
Acenaphthylene	mg/kg	0.1	<0.1	<0.1
Acenaphthene	mg/kg	0.1	<0.1	<0.1
Fluorene	mg/kg	0.1	<0.1	<0.1
Phenanthrene	mg/kg	0.1	<0.1	<0.1
Anthracene	mg/kg	0.1	<0.1	<0.1
Fluoranthene	mg/kg	0.1	<0.1	<0.1
Pyrene	mg/kg	0.1	<0.1	<0.1
Benzo(a)anthracene	mg/kg	0.1	<0.1	<0.1
Chrysene	mg/kg	0.1	<0.1	<0.1
Benzo(b&j)fluoranthene	mg/kg	0.1	<0.1	<0.1
Benzo(k)fluoranthene	mg/kg	0.1	<0.1	<0.1
Benzo(a)pyrene	mg/kg	0.1	<0.1	<0.1
Indeno(1,2,3-cd)pyrene	mg/kg	0.1	<0.1	<0.1
Dibenzo(ah)anthracene	mg/kg	0.1	<0.1	<0.1
Benzo(ghi)perylene	mg/kg	0.1	<0.1	<0.1
Carcinogenic PAHs, BaP TEQ <LOR=0	TEQ	0.2	<0.2	<0.2
Carcinogenic PAHs, BaP TEQ <LOR=LOR	TEQ (mg/kg)	0.3	<0.3	<0.3
Carcinogenic PAHs, BaP TEQ <LOR=LOR/2	TEQ (mg/kg)	0.2	<0.2	<0.2
Total PAH (18)	mg/kg	0.8	<0.8	<0.8
Total PAH (NEPM/WHO 16)	mg/kg	0.8	<0.8	<0.8

OC Pesticides in Soil [AN420] Tested: 18/1/2017

PARAMETER	UOM	LOR	SR27 SOIL - 11/1/2017 SE160957.027	SR28 SOIL - 11/1/2017 SE160957.028	SR29 SOIL - 11/1/2017 SE160957.029	SR30 SOIL - 11/1/2017 SE160957.030	SR31 SOIL - 11/1/2017 SE160957.031
Hexachlorobenzene (HCB)	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Alpha BHC	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Lindane	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Heptachlor	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Aldrin	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Beta BHC	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Delta BHC	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Heptachlor epoxide	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
o,p'-DDE	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Alpha Endosulfan	mg/kg	0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Gamma Chlordane	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Alpha Chlordane	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
trans-Nonachlor	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
p,p'-DDE	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Dieldrin	mg/kg	0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Endrin	mg/kg	0.2	<0.2	<0.2	<0.2	<0.2	<0.2
o,p'-DDD	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
o,p'-DDT	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Beta Endosulfan	mg/kg	0.2	<0.2	<0.2	<0.2	<0.2	<0.2
p,p'-DDD	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
p,p'-DDT	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Endosulfan sulphate	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Endrin Aldehyde	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Methoxychlor	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Endrin Ketone	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Isodrin	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Mirex	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1

OC Pesticides in Soil [AN420] Tested: 18/1/2017 (continued)

PARAMETER	UOM	LOR	SR32 SOIL - 12/1/2017 SE160957.032	SR33 SOIL - 12/1/2017 SE160957.033	SR73 SOIL - 11/1/2017 SE160957.034	SR91 SOIL - 11/1/2017 SE160957.035	SR113 SOIL - 11/1/2017 SE160957.036
Hexachlorobenzene (HCB)	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Alpha BHC	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Lindane	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Heptachlor	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Aldrin	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Beta BHC	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Delta BHC	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Heptachlor epoxide	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
o,p'-DDE	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Alpha Endosulfan	mg/kg	0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Gamma Chlordane	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Alpha Chlordane	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
trans-Nonachlor	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
p,p'-DDE	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Dieldrin	mg/kg	0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Endrin	mg/kg	0.2	<0.2	<0.2	<0.2	<0.2	<0.2
o,p'-DDD	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
o,p'-DDT	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Beta Endosulfan	mg/kg	0.2	<0.2	<0.2	<0.2	<0.2	<0.2
p,p'-DDD	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
p,p'-DDT	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Endosulfan sulphate	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Endrin Aldehyde	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Methoxychlor	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Endrin Ketone	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Isodrin	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Mirex	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1

OC Pesticides in Soil [AN420] Tested: 18/1/2017 (continued)

PARAMETER	UOM	LOR	SR184 SOIL - 11/1/2017 SE160957.037	SR224 SOIL - 11/1/2017 SE160957.038
Hexachlorobenzene (HCB)	mg/kg	0.1	<0.1	<0.1
Alpha BHC	mg/kg	0.1	<0.1	<0.1
Lindane	mg/kg	0.1	<0.1	<0.1
Heptachlor	mg/kg	0.1	<0.1	<0.1
Aldrin	mg/kg	0.1	<0.1	<0.1
Beta BHC	mg/kg	0.1	<0.1	<0.1
Delta BHC	mg/kg	0.1	<0.1	<0.1
Heptachlor epoxide	mg/kg	0.1	<0.1	<0.1
o,p'-DDE	mg/kg	0.1	<0.1	<0.1
Alpha Endosulfan	mg/kg	0.2	<0.2	<0.2
Gamma Chlordane	mg/kg	0.1	<0.1	<0.1
Alpha Chlordane	mg/kg	0.1	<0.1	<0.1
trans-Nonachlor	mg/kg	0.1	<0.1	<0.1
p,p'-DDE	mg/kg	0.1	<0.1	<0.1
Dieldrin	mg/kg	0.2	<0.2	<0.2
Endrin	mg/kg	0.2	<0.2	<0.2
o,p'-DDD	mg/kg	0.1	<0.1	<0.1
o,p'-DDT	mg/kg	0.1	<0.1	<0.1
Beta Endosulfan	mg/kg	0.2	<0.2	<0.2
p,p'-DDD	mg/kg	0.1	<0.1	<0.1
p,p'-DDT	mg/kg	0.1	<0.1	<0.1
Endosulfan sulphate	mg/kg	0.1	<0.1	<0.1
Endrin Aldehyde	mg/kg	0.1	<0.1	<0.1
Methoxychlor	mg/kg	0.1	<0.1	<0.1
Endrin Ketone	mg/kg	0.1	<0.1	<0.1
Isodrin	mg/kg	0.1	<0.1	<0.1
Mirex	mg/kg	0.1	<0.1	<0.1

Exchangeable Cations and Cation Exchange Capacity (CEC/ESP/SAR) [AN122] Tested: 23/1/2017

PARAMETER	UOM	LOR	BH16-100 SOIL - 11/1/2017 SE160957.041	BH16-1500 SOIL - 11/1/2017 SE160957.042
Exchangeable Sodium, Na	mg/kg	2	17	530
Exchangeable Sodium, Na	meq/100g	0.01	0.07	2.3
Exchangeable Sodium Percentage*	%	0.1	3.3	36.5

Soluble Anions (1:5) in Soil by Ion Chromatography [AN245] Tested: 19/1/2017

PARAMETER	UOM	LOR	BH16-100 SOIL - 11/1/2017 SE160957.041	BH16-1500 SOIL - 11/1/2017 SE160957.042
Chloride	mg/kg	0.25	7.6	50

Total Recoverable Metals in Soil/Waste Solids/Materials by ICPOES [AN040/AN320] Tested: 23/1/2017

PARAMETER	UOM	LOR	SR1 SOIL - 11/1/2017 SE160957.001	SR2 SOIL - 11/1/2017 SE160957.002	SR3 SOIL - 11/1/2017 SE160957.003	SR4 SOIL - 11/1/2017 SE160957.004	SR5 SOIL - 11/1/2017 SE160957.005
Arsenic, As	mg/kg	3	<3	<3	<3	<3	<3
Cadmium, Cd	mg/kg	0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Chromium, Cr	mg/kg	0.3	19	18	20	11	18
Copper, Cu	mg/kg	0.5	6.7	6.0	5.5	4.2	6.8
Lead, Pb	mg/kg	1	5	6	5	4	6
Nickel, Ni	mg/kg	0.5	9.8	8.5	8.5	5.1	7.6
Zinc, Zn	mg/kg	0.5	14	18	13	9.6	13
Calcium, Ca	mg/kg	5	-	-	-	-	-
Magnesium, Mg	mg/kg	5	-	-	-	-	-
Sodium, Na	mg/kg	5	-	-	-	-	-
Potassium, K	mg/kg	10	-	-	-	-	-

PARAMETER	UOM	LOR	SR6 SOIL - 11/1/2017 SE160957.006	SR7 SOIL - 11/1/2017 SE160957.007	SR8 SOIL - 11/1/2017 SE160957.008	SR9 SOIL - 11/1/2017 SE160957.009	SR10 SOIL - 11/1/2017 SE160957.010
Arsenic, As	mg/kg	3	<3	<3	<3	<3	<3
Cadmium, Cd	mg/kg	0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Chromium, Cr	mg/kg	0.3	19	11	23	36	9.9
Copper, Cu	mg/kg	0.5	7.5	5.1	7.3	7.1	3.2
Lead, Pb	mg/kg	1	6	5	6	8	4
Nickel, Ni	mg/kg	0.5	10	4.6	9.5	14	3.1
Zinc, Zn	mg/kg	0.5	15	12	14	22	6.2
Calcium, Ca	mg/kg	5	-	-	-	-	-
Magnesium, Mg	mg/kg	5	-	-	-	-	-
Sodium, Na	mg/kg	5	-	-	-	-	-
Potassium, K	mg/kg	10	-	-	-	-	-

PARAMETER	UOM	LOR	SR11 SOIL - 11/1/2017 SE160957.011	SR12 SOIL - 11/1/2017 SE160957.012	SR13 SOIL - 11/1/2017 SE160957.013	SR14 SOIL - 11/1/2017 SE160957.014	SR15 SOIL - 11/1/2017 SE160957.015
Arsenic, As	mg/kg	3	<3	<3	<3	<3	<3
Cadmium, Cd	mg/kg	0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Chromium, Cr	mg/kg	0.3	9.2	11	16	58	50
Copper, Cu	mg/kg	0.5	3.9	4.8	6.5	18	17
Lead, Pb	mg/kg	1	5	5	6	9	9
Nickel, Ni	mg/kg	0.5	4.4	7.0	11	41	34
Zinc, Zn	mg/kg	0.5	7.4	8.9	14	45	31
Calcium, Ca	mg/kg	5	-	-	-	-	-
Magnesium, Mg	mg/kg	5	-	-	-	-	-
Sodium, Na	mg/kg	5	-	-	-	-	-
Potassium, K	mg/kg	10	-	-	-	-	-

Total Recoverable Metals in Soil/Waste Solids/Materials by ICPOES [AN040/AN320] Tested: 23/1/2017 (continued)

PARAMETER	UOM	LOR	SR16 SOIL - 11/1/2017 SE160957.016	SR17 SOIL - 11/1/2017 SE160957.017	SR18 SOIL - 11/1/2017 SE160957.018	SR19 SOIL - 11/1/2017 SE160957.019	SR20 SOIL - 11/1/2017 SE160957.020
Arsenic, As	mg/kg	3	<3	<3	<3	<3	<3
Cadmium, Cd	mg/kg	0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Chromium, Cr	mg/kg	0.3	41	36	36	24	27
Copper, Cu	mg/kg	0.5	14	13	12	11	11
Lead, Pb	mg/kg	1	8	11	8	8	7
Nickel, Ni	mg/kg	0.5	25	20	17	16	16
Zinc, Zn	mg/kg	0.5	23	21	22	24	22
Calcium, Ca	mg/kg	5	-	-	-	-	-
Magnesium, Mg	mg/kg	5	-	-	-	-	-
Sodium, Na	mg/kg	5	-	-	-	-	-
Potassium, K	mg/kg	10	-	-	-	-	-

PARAMETER	UOM	LOR	SR21 SOIL - 11/1/2017 SE160957.021	SR22 SOIL - 11/1/2017 SE160957.022	SR23 SOIL - 11/1/2017 SE160957.023	SR24 SOIL - 11/1/2017 SE160957.024	SR25 SOIL - 11/1/2017 SE160957.025
Arsenic, As	mg/kg	3	<3	<3	<3	<3	<3
Cadmium, Cd	mg/kg	0.3	<0.3	0.3	0.4	0.4	<0.3
Chromium, Cr	mg/kg	0.3	41	65	59	63	40
Copper, Cu	mg/kg	0.5	13	18	20	20	15
Lead, Pb	mg/kg	1	7	9	9	9	9
Nickel, Ni	mg/kg	0.5	24	42	52	50	32
Zinc, Zn	mg/kg	0.5	25	35	41	40	29
Calcium, Ca	mg/kg	5	-	-	-	-	-
Magnesium, Mg	mg/kg	5	-	-	-	-	-
Sodium, Na	mg/kg	5	-	-	-	-	-
Potassium, K	mg/kg	10	-	-	-	-	-

PARAMETER	UOM	LOR	SR26 SOIL - 11/1/2017 SE160957.026	SR27 SOIL - 11/1/2017 SE160957.027	SR28 SOIL - 11/1/2017 SE160957.028	SR29 SOIL - 11/1/2017 SE160957.029	SR30 SOIL - 11/1/2017 SE160957.030
Arsenic, As	mg/kg	3	<3	<3	<3	<3	<3
Cadmium, Cd	mg/kg	0.3	0.4	0.4	0.3	0.4	0.3
Chromium, Cr	mg/kg	0.3	67	58	50	63	64
Copper, Cu	mg/kg	0.5	22	23	19	26	22
Lead, Pb	mg/kg	1	10	11	10	8	9
Nickel, Ni	mg/kg	0.5	52	62	40	83	48
Zinc, Zn	mg/kg	0.5	59	64	58	50	49
Calcium, Ca	mg/kg	5	-	-	-	-	-
Magnesium, Mg	mg/kg	5	-	-	-	-	-
Sodium, Na	mg/kg	5	-	-	-	-	-
Potassium, K	mg/kg	10	-	-	-	-	-

Total Recoverable Metals in Soil/Waste Solids/Materials by ICPOES [AN040/AN320] Tested: 23/1/2017 (continued)

PARAMETER	UOM	LOR	SR31 SOIL - 11/1/2017 SE160957.031	SR32 SOIL - 12/1/2017 SE160957.032	SR33 SOIL - 12/1/2017 SE160957.033	SRA SOIL - 11/1/2017 SE160957.039	SRB SOIL - 11/1/2017 SE160957.040
Arsenic, As	mg/kg	3	<3	<3	<3	<3	<3
Cadmium, Cd	mg/kg	0.3	<0.3	0.3	0.3	<0.3	<0.3
Chromium, Cr	mg/kg	0.3	49	53	59	21	9.7
Copper, Cu	mg/kg	0.5	21	22	22	6.0	3.4
Lead, Pb	mg/kg	1	10	10	10	5	4
Nickel, Ni	mg/kg	0.5	41	50	48	8.3	2.9
Zinc, Zn	mg/kg	0.5	58	40	44	17	5.1
Calcium, Ca	mg/kg	5	-	-	-	-	-
Magnesium, Mg	mg/kg	5	-	-	-	-	-
Sodium, Na	mg/kg	5	-	-	-	-	-
Potassium, K	mg/kg	10	-	-	-	-	-

PARAMETER	UOM	LOR	BH16-100 SOIL - 11/1/2017 SE160957.041	BH16-1500 SOIL - 11/1/2017 SE160957.042
Arsenic, As	mg/kg	3	-	-
Cadmium, Cd	mg/kg	0.3	-	-
Chromium, Cr	mg/kg	0.3	-	-
Copper, Cu	mg/kg	0.5	-	-
Lead, Pb	mg/kg	1	-	-
Nickel, Ni	mg/kg	0.5	-	-
Zinc, Zn	mg/kg	0.5	-	-
Calcium, Ca	mg/kg	5	180	230
Magnesium, Mg	mg/kg	5	190	590
Sodium, Na	mg/kg	5	22	450
Potassium, K	mg/kg	10	590	360

Mercury in Soil [AN312] Tested: 20/1/2017

PARAMETER	UOM	LOR	SR27 SOIL - 11/1/2017 SE160957.027	SR28 SOIL - 11/1/2017 SE160957.028	SR29 SOIL - 11/1/2017 SE160957.029	SR30 SOIL - 11/1/2017 SE160957.030	SR31 SOIL - 11/1/2017 SE160957.031
Mercury	mg/kg	0.05	<0.05	<0.05	<0.05	<0.05	<0.05

PARAMETER	UOM	LOR	SR32 SOIL - 12/1/2017 SE160957.032	SR33 SOIL - 12/1/2017 SE160957.033
Mercury	mg/kg	0.05	<0.05	<0.05

Moisture Content [AN002] Tested: 20/1/2017

			SR1	SR2	SR3	SR4	SR5
			SOIL	SOIL	SOIL	SOIL	SOIL
			-	-	-	-	-
			11/1/2017	11/1/2017	11/1/2017	11/1/2017	11/1/2017
PARAMETER	UOM	LOR	SE160957.001	SE160957.002	SE160957.003	SE160957.004	SE160957.005
% Moisture	%w/w	0.5	8.7	4.9	4.0	9.1	5.6

			SR6	SR7	SR8	SR9	SR10
			SOIL	SOIL	SOIL	SOIL	SOIL
			-	-	-	-	-
			11/1/2017	11/1/2017	11/1/2017	11/1/2017	11/1/2017
PARAMETER	UOM	LOR	SE160957.006	SE160957.007	SE160957.008	SE160957.009	SE160957.010
% Moisture	%w/w	0.5	7.7	3.5	6.5	3.5	2.0

			SR11	SR12	SR13	SR14	SR15
			SOIL	SOIL	SOIL	SOIL	SOIL
			-	-	-	-	-
			11/1/2017	11/1/2017	11/1/2017	11/1/2017	11/1/2017
PARAMETER	UOM	LOR	SE160957.011	SE160957.012	SE160957.013	SE160957.014	SE160957.015
% Moisture	%w/w	0.5	5.3	3.6	3.2	7.7	8.1

			SR16	SR17	SR18	SR19	SR20
			SOIL	SOIL	SOIL	SOIL	SOIL
			-	-	-	-	-
			11/1/2017	11/1/2017	11/1/2017	11/1/2017	11/1/2017
PARAMETER	UOM	LOR	SE160957.016	SE160957.017	SE160957.018	SE160957.019	SE160957.020
% Moisture	%w/w	0.5	7.1	8.3	6.7	6.3	6.2

			SR21	SR22	SR23	SR24	SR25
			SOIL	SOIL	SOIL	SOIL	SOIL
			-	-	-	-	-
			11/1/2017	11/1/2017	11/1/2017	11/1/2017	11/1/2017
PARAMETER	UOM	LOR	SE160957.021	SE160957.022	SE160957.023	SE160957.024	SE160957.025
% Moisture	%w/w	0.5	5.8	12	7.4	6.4	4.8

			SR26	SR27	SR28	SR29	SR30
			SOIL	SOIL	SOIL	SOIL	SOIL
			-	-	-	-	-
			11/1/2017	11/1/2017	11/1/2017	11/1/2017	11/1/2017
PARAMETER	UOM	LOR	SE160957.026	SE160957.027	SE160957.028	SE160957.029	SE160957.030
% Moisture	%w/w	0.5	8.5	6.3	6.3	4.8	5.7

			SR31	SR32	SR33	SR73	SR91
			SOIL	SOIL	SOIL	SOIL	SOIL
			-	-	-	-	-
			11/1/2017	12/1/2017	12/1/2017	11/1/2017	11/1/2017
PARAMETER	UOM	LOR	SE160957.031	SE160957.032	SE160957.033	SE160957.034	SE160957.035
% Moisture	%w/w	0.5	4.3	5.3	5.7	1.3	5.5

Moisture Content [AN002] Tested: 20/1/2017 (continued)

PARAMETER	UOM	LOR	SR113 SOIL - 11/1/2017 SE160957.036	SR184 SOIL - 11/1/2017 SE160957.037	SR224 SOIL - 11/1/2017 SE160957.038	SRA SOIL - 11/1/2017 SE160957.039	SRB SOIL - 11/1/2017 SE160957.040
% Moisture	%w/w	0.5	2.2	7.9	7.6	5.2	2.2

PARAMETER	UOM	LOR	BH16-100 SOIL - 11/1/2017 SE160957.041	BH16-1500 SOIL - 11/1/2017 SE160957.042
% Moisture	%w/w	0.5	6.3	10

METHOD	METHODOLOGY SUMMARY
AN002	The test is carried out by drying (at either 40°C or 105°C) a known mass of sample in a weighed evaporating basin. After fully dry the sample is re-weighed. Samples such as sludge and sediment having high percentages of moisture will take some time in a drying oven for complete removal of water.
AN040/AN320	A portion of sample is digested with nitric acid to decompose organic matter and hydrochloric acid to complete the digestion of metals. The digest is then analysed by ICP OES with metals results reported on the dried sample basis. Based on USEPA method 200.8 and 6010C.
AN040	A portion of sample is digested with Nitric acid to decompose organic matter and Hydrochloric acid to complete the digestion of metals and then filtered for analysis by ASS or ICP as per USEPA Method 200.8.
AN122	Exchangeable Cations, CEC and ESP: Soil sample is extracted in 1M Ammonium Acetate at pH=7 (or 1M Ammonium Chloride at pH=7) with cations (Na, K, Ca & Mg) then determined by ICP OES/ICP MS and reported as Exchangeable Cations. For saline soils, these results can be corrected for water soluble cations and reported as Exchangeable cations in meq/100g or soil can be pre-treated (aqueous ethanol/aqueous glycerol) prior to extraction. Cation Exchange Capacity (CEC) is the sum of the exchangeable cations in meq/100g.
AN122	The Exchangeable Sodium Percentage (ESP) is calculated as the exchangeable sodium divided by the CEC (all in meq/100g) times 100. ESP can be used to categorise the sodicity of the soil as below: ESP < 6% non-sodic ESP 6-15% sodic ESP >15% strongly sodic Method is refernced to Rayment and Higginson, 1992, sections 15D3 and 15N1.-
AN245	Anions by Ion Chromatography: A water sample is injected into an eluent stream that passes through the ion chromatographic system where the anions of interest ie Br, Cl, NO2, NO3 and SO4 are separated on their relative affinities for the active sites on the column packing material. Changes to the conductivity and the UV-visible absorbance of the eluent enable identification and quantitation of the anions based on their retention time and peak height or area. APHA 4110 B
AN312	Mercury by Cold Vapour AAS in Soils: After digestion with nitric acid, hydrogen peroxide and hydrochloric acid, mercury ions are reduced by stannous chloride reagent in acidic solution to elemental mercury. This mercury vapour is purged by nitrogen into a cold cell in an atomic absorption spectrometer or mercury analyser. Quantification is made by comparing absorbances to those of the calibration standards. Reference APHA 3112/3500
AN403	Total Recoverable Hydrocarbons: Determination of Hydrocarbons by gas chromatography after a solvent extraction. Detection is by flame ionisation detector (FID) that produces an electronic signal in proportion to the combustible matter passing through it. Total Recoverable Hydrocarbons (TRH) are routinely reported as four alkane groupings based on the carbon chain length of the compounds: C6-C9, C10-C14, C15-C28 and C29-C36 and in recognition of the NEPM 1999 (2013), >C10-C16 (F2), >C16-C34 (F3) and >C34-C40 (F4). F2 is reported directly and also corrected by subtracting Naphthalene (from VOC method AN433) where available.
AN403	Additionally, the volatile C6-C9 fraction may be determined by a purge and trap technique and GC/MS because of the potential for volatiles loss. Total Petroleum Hydrocarbons (TPH) follows the same method of analysis after silica gel cleanup of the solvent extract. Aliphatic/Aromatic Speciation follows the same method of analysis after fractionation of the solvent extract over silica with differential polarity of the eluent solvents.
AN403	The GC/FID method is not well suited to the analysis of refined high boiling point materials (ie lubricating oils or greases) but is particularly suited for measuring diesel, kerosene and petrol if care to control volatility is taken. This method will detect naturally occurring hydrocarbons, lipids, animal fats, phenols and PAHs if they are present at sufficient levels, dependent on the use of specific cleanup/fractionation techniques. Reference USEPA 3510B, 8015B.
AN420	(SVOCs) including OC, OP, PCB, Herbicides, PAH, Phthalates and Speciated Phenols (etc) in soils, sediments and waters are determined by GCMS/ECD technique following appropriate solvent extraction process (Based on USEPA 3500C and 8270D).
AN420	SVOC Compounds: Semi-Volatile Organic Compounds (SVOCs) including OC, OP, PCB, Herbicides, PAH, Phthalates and Speciated Phenols in soils, sediments and waters are determined by GCMS/ECD technique following appropriate solvent extraction process (Based on USEPA 3500C and 8270D).
AN433	VOCs and C6-C9 Hydrocarbons by GC-MS P&T: VOC`s are volatile organic compounds. The sample is presented to a gas chromatograph via a purge and trap (P&T) concentrator and autosampler and is detected with a Mass Spectrometer (MSD). Solid samples are initially extracted with methanol whilst liquid samples are processed directly. References: USEPA 5030B, 8020A, 8260.

FOOTNOTES

*	NATA accreditation does not cover the performance of this service.	-	Not analysed.	UOM	Unit of Measure.
**	Indicative data, theoretical holding time exceeded.	NVL	Not validated.	LOR	Limit of Reporting.
		IS	Insufficient sample for analysis.	↑↓	Raised/lowered Limit of Reporting.
		LNR	Sample listed, but not received.		

Samples analysed as received.
Solid samples expressed on a dry weight basis.

Where "Total" analyte groups are reported (for example, Total PAHs, Total OC Pesticides) the total will be calculated as the sum of the individual analytes, with those analytes that are reported as <LOR being assumed to be zero. The summed (Total) limit of reporting is calculated by summing the individual analyte LORs and dividing by two. For example, where 16 individual analytes are being summed and each has an LOR of 0.1 mg/kg, the "Totals" LOR will be 1.6 / 2 (0.8 mg/kg). Where only 2 analytes are being summed, the " Total" LOR will be the sum of those two LORs.

Some totals may not appear to add up because the total is rounded after adding up the raw values.

If reported, measurement uncertainty follow the ± sign after the analytical result and is expressed as the expanded uncertainty calculated using a coverage factor of 2, providing a level of confidence of approximately 95%, unless stated otherwise in the comments section of this report.

Results reported for samples tested under test methods with codes starting with ARS-SOP, radionuclide or gross radioactivity concentrations are expressed in becquerel (Bq) per unit of mass or volume or per wipe as stated on the report. Becquerel is the SI unit for activity and equals one nuclear transformation per second.
Note that in terms of units of radioactivity:

a. 1 Bq is equivalent to 27 pCi
b. 37 MBq is equivalent to 1 mCi

For results reported for samples tested under test methods with codes starting with ARS-SOP, less than (<) values indicate the detection limit for each radionuclide or parameter for the measurement system used. The respective detection limits have been calculated in accordance with ISO 11929.

The QC criteria are subject to internal review according to the SGS QAQC plan and may be provided on request or alternatively can be found here : http://www.sgs.com.au/~/media/Local/Australia/Documents/Technical%20Documents/MP-AU-ENV-QU-022%20QA%20QC%20Plan.pdf

STATEMENT OF QA/QC PERFORMANCE

SE160957 R0

CLIENT DETAILS

Contact	Ashleigh Pickering
Client	ENVIROWEST CONSULTING PTY LIMITED
Address	PO BOX 8158 ORANGE NSW 2800
Telephone	61 2 63614954
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Email	ashleigh@envirowest.net.au
Project	**7891**
Order Number	(Not specified)
Samples	42

LABORATORY DETAILS

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SGS Reference	**SE160957 R0**
Date Received	17 Jan 2017
Date Reported	25 Jan 2017

COMMENTS

All the laboratory data for each environmental matrix was compared to SGS' stated Data Quality Objectives (DQO). Comments arising from the comparison were made and are reported below.

The data relating to sampling was taken from the Chain of Custody document and was supplied by the Client.
This QA/QC Statement must be read in conjunction with the referenced Analytical Report.
The Statement and the Analytical Report must not be reproduced except in full.

All Data Quality Objectives were met with the exception of the following:

Matrix Spike	Total Recoverable Metals in Soil/Waste Solids/Materials by ICPOES	1 item
	Total Recoverable Metals in Soil/Waste Solids/Materials by ICPOES	3 items

SAMPLE SUMMARY

Samples clearly labelled	Yes	Complete documentation received	Yes
Sample container provider	SGS	Sample cooling method	Ice Bricks
Samples received in correct containers	Yes	Sample counts by matrix	42 Soil
Date documentation received	17/1/2017	Type of documentation received	COC
Samples received in good order	Yes	Samples received without headspace	Yes
Sample temperature upon receipt	21.5°C	Sufficient sample for analysis	Yes
Turnaround time requested	Standard		

SGS holding time criteria are drawn from current regulations and are highly dependent on sample container preservation as specified in the SGS "Field Sampling Guide for Containers and Holding Time" (ref: GU-(AU)-ENV.001). Soil samples guidelines are derived from NEPM "Schedule B(3) Guideline on Laboratory Analysis of Potentially Contaminated Soils". Water sample guidelines are derived from "AS/NZS 5667.1 : 1998 Water Quality - sampling part 1" and APHA "Standard Methods for the Examination of Water and Wastewater" 21st edition 2005.

Extraction and analysis holding time due dates listed are calculated from the date sampled, although holding times may be extended after laboratory extraction for some analytes. The due dates are the suggested dates that samples may be held before extraction or analysis and still be considered valid.

Extraction and analysis dates are shown in **Green** when within suggested criteria or **Red** with an appended dagger symbol (†) when outside suggested criteria. If the sampled date is not supplied then compliance with criteria cannot be determined. If the received date is after one or both due dates then holding time will fail by default.

Exchangeable Cations and Cation Exchange Capacity (CEC/ESP/SAR)

Method: ME-(AU)-[ENV]AN122

Sample Name	Sample No.	QC Ref	Sampled	Received	Extraction Due	Extracted	Analysis Due	Analysed
BH16-100	SE160957.041	LB117341	11 Jan 2017	17 Jan 2017	08 Feb 2017	23 Jan 2017	08 Feb 2017	23 Jan 2017
BH16-1500	SE160957.042	LB117341	11 Jan 2017	17 Jan 2017	08 Feb 2017	23 Jan 2017	08 Feb 2017	23 Jan 2017

Mercury in Soil

Method: ME-(AU)-[ENV]AN312

Sample Name	Sample No.	QC Ref	Sampled	Received	Extraction Due	Extracted	Analysis Due	Analysed
SR27	SE160957.027	LB117281	11 Jan 2017	17 Jan 2017	08 Feb 2017	20 Jan 2017	08 Feb 2017	24 Jan 2017
SR28	SE160957.028	LB117281	11 Jan 2017	17 Jan 2017	08 Feb 2017	20 Jan 2017	08 Feb 2017	24 Jan 2017
SR29	SE160957.029	LB117281	11 Jan 2017	17 Jan 2017	08 Feb 2017	20 Jan 2017	08 Feb 2017	24 Jan 2017
SR30	SE160957.030	LB117281	11 Jan 2017	17 Jan 2017	08 Feb 2017	20 Jan 2017	08 Feb 2017	24 Jan 2017
SR31	SE160957.031	LB117281	11 Jan 2017	17 Jan 2017	08 Feb 2017	20 Jan 2017	08 Feb 2017	24 Jan 2017
SR32	SE160957.032	LB117281	12 Jan 2017	17 Jan 2017	09 Feb 2017	20 Jan 2017	09 Feb 2017	24 Jan 2017
SR33	SE160957.033	LB117281	12 Jan 2017	17 Jan 2017	09 Feb 2017	20 Jan 2017	09 Feb 2017	24 Jan 2017

Moisture Content

Method: ME-(AU)-[ENV]AN002

Sample Name	Sample No.	QC Ref	Sampled	Received	Extraction Due	Extracted	Analysis Due	Analysed
SR1	SE160957.001	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR2	SE160957.002	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR3	SE160957.003	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR4	SE160957.004	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR5	SE160957.005	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR6	SE160957.006	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR7	SE160957.007	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR8	SE160957.008	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR9	SE160957.009	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR10	SE160957.010	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR11	SE160957.011	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR12	SE160957.012	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR13	SE160957.013	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR14	SE160957.014	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR15	SE160957.015	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR16	SE160957.016	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR17	SE160957.017	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR18	SE160957.018	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR19	SE160957.019	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR20	SE160957.020	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR21	SE160957.021	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR22	SE160957.022	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR23	SE160957.023	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR24	SE160957.024	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR25	SE160957.025	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR26	SE160957.026	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR27	SE160957.027	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR28	SE160957.028	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR29	SE160957.029	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR30	SE160957.030	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR31	SE160957.031	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR32	SE160957.032	LB117208	12 Jan 2017	17 Jan 2017	26 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR33	SE160957.033	LB117208	12 Jan 2017	17 Jan 2017	26 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR73	SE160957.034	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR91	SE160957.035	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR113	SE160957.036	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR184	SE160957.037	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR224	SE160957.038	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SRA	SE160957.039	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SRB	SE160957.040	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
BH16-100	SE160957.041	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
BH16-1500	SE160957.042	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017

OC Pesticides in Soil

Method: ME-(AU)-[ENV]AN420

Sample Name	Sample No.	QC Ref

SGS holding time criteria are drawn from current regulations and are highly dependent on sample container preservation as specified in the SGS "Field Sampling Guide for Containers and Holding Time" (ref: GU-(AU)-ENV.001). Soil samples guidelines are derived from NEPM "Schedule B(3) Guideline on Laboratory Analysis of Potentially Contaminated Soils". Water sample guidelines are derived from "AS/NZS 5667.1 : 1998 Water Quality - sampling part 1" and APHA "Standard Methods for the Examination of Water and Wastewater" 21st edition 2005.

Extraction and analysis holding time due dates listed are calculated from the date sampled, although holding times may be extended after laboratory extraction for some analytes. The due dates are the suggested dates that samples may be held before extraction or analysis and still be considered valid.

Extraction and analysis dates are shown in **Green** when within suggested criteria or **Red** with an appended dagger symbol (†) when outside suggested criteria. If the sampled date is not supplied then compliance with criteria cannot be determined. If the received date is after one or both due dates then holding time will fail by default.

OC Pesticides in Soil (continued)

Method: ME-(AU)-[ENV]AN420

Sample Name	Sample No.	QC Ref	Sampled	Received	Extraction Due	Extracted	Analysis Due	Analysed
SR27	SE160957.027	LB117067	11 Jan 2017	17 Jan 2017	25 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017
SR28	SE160957.028	LB117067	11 Jan 2017	17 Jan 2017	25 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017
SR29	SE160957.029	LB117067	11 Jan 2017	17 Jan 2017	25 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017
SR30	SE160957.030	LB117067	11 Jan 2017	17 Jan 2017	25 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017
SR31	SE160957.031	LB117067	11 Jan 2017	17 Jan 2017	25 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017
SR32	SE160957.032	LB117067	12 Jan 2017	17 Jan 2017	26 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017
SR33	SE160957.033	LB117067	12 Jan 2017	17 Jan 2017	26 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017
SR73	SE160957.034	LB117067	11 Jan 2017	17 Jan 2017	25 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017
SR91	SE160957.035	LB117067	11 Jan 2017	17 Jan 2017	25 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017
SR113	SE160957.036	LB117067	11 Jan 2017	17 Jan 2017	25 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017
SR184	SE160957.037	LB117067	11 Jan 2017	17 Jan 2017	25 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017
SR224	SE160957.038	LB117067	11 Jan 2017	17 Jan 2017	25 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017

PAH (Polynuclear Aromatic Hydrocarbons) in Soil

Method: ME-(AU)-[ENV]AN420

Sample Name	Sample No.	QC Ref	Sampled	Received	Extraction Due	Extracted	Analysis Due	Analysed
SR27	SE160957.027	LB117067	11 Jan 2017	17 Jan 2017	25 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017
SR28	SE160957.028	LB117067	11 Jan 2017	17 Jan 2017	25 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017
SR29	SE160957.029	LB117067	11 Jan 2017	17 Jan 2017	25 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017
SR30	SE160957.030	LB117067	11 Jan 2017	17 Jan 2017	25 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017
SR31	SE160957.031	LB117067	11 Jan 2017	17 Jan 2017	25 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017
SR32	SE160957.032	LB117067	12 Jan 2017	17 Jan 2017	26 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017
SR33	SE160957.033	LB117067	12 Jan 2017	17 Jan 2017	26 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017
SR73	SE160957.034	LB117067	11 Jan 2017	17 Jan 2017	25 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017
SR91	SE160957.035	LB117067	11 Jan 2017	17 Jan 2017	25 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017
SR113	SE160957.036	LB117067	11 Jan 2017	17 Jan 2017	25 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017
SR184	SE160957.037	LB117067	11 Jan 2017	17 Jan 2017	25 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017
SR224	SE160957.038	LB117067	11 Jan 2017	17 Jan 2017	25 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017

Soluble Anions (1:5) in Soil by Ion Chromatography

Method: ME-(AU)-[ENV]AN245

Sample Name	Sample No.	QC Ref	Sampled	Received	Extraction Due	Extracted	Analysis Due	Analysed
BH16-100	SE160957.041	LB117119	11 Jan 2017	17 Jan 2017	18 Jan 2017	18 Jan 2017	15 Feb 2017	18 Jan 2017
BH16-1500	SE160957.042	LB117119	11 Jan 2017	17 Jan 2017	18 Jan 2017	18 Jan 2017	15 Feb 2017	18 Jan 2017

Total Recoverable Metals in Soil/Waste Solids/Materials by ICPOES

Method: ME-(AU)-[ENV]AN040/AN320

Sample Name	Sample No.	QC Ref	Sampled	Received	Extraction Due	Extracted	Analysis Due	Analysed
SR1	SE160957.001	LB117335	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017
SR2	SE160957.002	LB117335	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017
SR3	SE160957.003	LB117335	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017
SR4	SE160957.004	LB117335	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017
SR5	SE160957.005	LB117335	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017
SR6	SE160957.006	LB117335	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017
SR7	SE160957.007	LB117335	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017
SR8	SE160957.008	LB117335	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017
SR9	SE160957.009	LB117335	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017
SR10	SE160957.010	LB117335	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017
SR11	SE160957.011	LB117335	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017
SR12	SE160957.012	LB117335	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017
SR13	SE160957.013	LB117335	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017
SR14	SE160957.014	LB117335	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017
SR15	SE160957.015	LB117336	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017
SR16	SE160957.016	LB117336	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017
SR17	SE160957.017	LB117336	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017
SR18	SE160957.018	LB117336	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017
SR19	SE160957.019	LB117336	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017
SR20	SE160957.020	LB117336	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017
SR21	SE160957.021	LB117336	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017
SR22	SE160957.022	LB117336	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017
SR23	SE160957.023	LB117336	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017
SR24	SE160957.024	LB117336	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017
SR25	SE160957.025	LB117336	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017
SR26	SE160957.026	LB117336	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017

SGS holding time criteria are drawn from current regulations and are highly dependent on sample container preservation as specified in the SGS “Field Sampling Guide for Containers and Holding Time” (ref: GU-(AU)-ENV.001). Soil samples guidelines are derived from NEPM "Schedule B(3) Guideline on Laboratory Analysis of Potentially Contaminated Soils". Water sample guidelines are derived from "AS/NZS 5667.1 : 1998 Water Quality - sampling part 1" and APHA "Standard Methods for the Examination of Water and Wastewater" 21st edition 2005.

Extraction and analysis holding time due dates listed are calculated from the date sampled, although holding times may be extended after laboratory extraction for some analytes. The due dates are the suggested dates that samples may be held before extraction or analysis and still be considered valid.

Extraction and analysis dates are shown in **Green** when within suggested criteria or **Red** with an appended dagger symbol (†) when outside suggested criteria. If the sampled date is not supplied then compliance with criteria cannot be determined. If the received date is after one or both due dates then holding time will fail by default.

Total Recoverable Metals in Soil/Waste Solids/Materials by ICPOES (continued) — Method: ME-(AU)-[ENV]AN040/AN320

Sample Name	Sample No.	QC Ref	Sampled	Received	Extraction Due	Extracted	Analysis Due	Analysed
SR27	SE160957.027	LB117336	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017
SR28	SE160957.028	LB117336	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017
SR29	SE160957.029	LB117336	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017
SR30	SE160957.030	LB117336	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017
SR31	SE160957.031	LB117336	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017
SR32	SE160957.032	LB117336	12 Jan 2017	17 Jan 2017	11 Jul 2017	23 Jan 2017	11 Jul 2017	24 Jan 2017
SR33	SE160957.033	LB117336	12 Jan 2017	17 Jan 2017	11 Jul 2017	23 Jan 2017	11 Jul 2017	24 Jan 2017
SRA	SE160957.039	LB117337	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017
SRB	SE160957.040	LB117337	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017
BH16-100	SE160957.041	LB117337	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017
BH16-1500	SE160957.042	LB117337	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017

TRH (Total Recoverable Hydrocarbons) in Soil — Method: ME-(AU)-[ENV]AN403

Sample Name	Sample No.	QC Ref	Sampled	Received	Extraction Due	Extracted	Analysis Due	Analysed
SR27	SE160957.027	LB117067	11 Jan 2017	17 Jan 2017	25 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017
SR28	SE160957.028	LB117067	11 Jan 2017	17 Jan 2017	25 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017
SR29	SE160957.029	LB117067	11 Jan 2017	17 Jan 2017	25 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017
SR30	SE160957.030	LB117067	11 Jan 2017	17 Jan 2017	25 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017
SR31	SE160957.031	LB117067	11 Jan 2017	17 Jan 2017	25 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017
SR32	SE160957.032	LB117067	12 Jan 2017	17 Jan 2017	26 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017
SR33	SE160957.033	LB117067	12 Jan 2017	17 Jan 2017	26 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017
SR73	SE160957.034	LB117067	11 Jan 2017	17 Jan 2017	25 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017
SR91	SE160957.035	LB117067	11 Jan 2017	17 Jan 2017	25 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017
SR113	SE160957.036	LB117067	11 Jan 2017	17 Jan 2017	25 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017
SR184	SE160957.037	LB117067	11 Jan 2017	17 Jan 2017	25 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017
SR224	SE160957.038	LB117067	11 Jan 2017	17 Jan 2017	25 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017

VOC's in Soil — Method: ME-(AU)-[ENV]AN433

Sample Name	Sample No.	QC Ref	Sampled	Received	Extraction Due	Extracted	Analysis Due	Analysed
SR27	SE160957.027	LB117101	11 Jan 2017	17 Jan 2017	25 Jan 2017	19 Jan 2017	28 Feb 2017	24 Jan 2017
SR28	SE160957.028	LB117101	11 Jan 2017	17 Jan 2017	25 Jan 2017	19 Jan 2017	28 Feb 2017	24 Jan 2017
SR29	SE160957.029	LB117101	11 Jan 2017	17 Jan 2017	25 Jan 2017	19 Jan 2017	28 Feb 2017	24 Jan 2017
SR30	SE160957.030	LB117101	11 Jan 2017	17 Jan 2017	25 Jan 2017	19 Jan 2017	28 Feb 2017	24 Jan 2017
SR31	SE160957.031	LB117101	11 Jan 2017	17 Jan 2017	25 Jan 2017	19 Jan 2017	28 Feb 2017	24 Jan 2017
SR32	SE160957.032	LB117101	12 Jan 2017	17 Jan 2017	26 Jan 2017	19 Jan 2017	28 Feb 2017	24 Jan 2017
SR33	SE160957.033	LB117101	12 Jan 2017	17 Jan 2017	26 Jan 2017	19 Jan 2017	28 Feb 2017	24 Jan 2017

Volatile Petroleum Hydrocarbons in Soil — Method: ME-(AU)-[ENV]AN433

Sample Name	Sample No.	QC Ref	Sampled	Received	Extraction Due	Extracted	Analysis Due	Analysed
SR27	SE160957.027	LB117101	11 Jan 2017	17 Jan 2017	25 Jan 2017	19 Jan 2017	28 Feb 2017	24 Jan 2017
SR28	SE160957.028	LB117101	11 Jan 2017	17 Jan 2017	25 Jan 2017	19 Jan 2017	28 Feb 2017	24 Jan 2017
SR29	SE160957.029	LB117101	11 Jan 2017	17 Jan 2017	25 Jan 2017	19 Jan 2017	28 Feb 2017	24 Jan 2017
SR30	SE160957.030	LB117101	11 Jan 2017	17 Jan 2017	25 Jan 2017	19 Jan 2017	28 Feb 2017	24 Jan 2017
SR31	SE160957.031	LB117101	11 Jan 2017	17 Jan 2017	25 Jan 2017	19 Jan 2017	28 Feb 2017	24 Jan 2017
SR32	SE160957.032	LB117101	12 Jan 2017	17 Jan 2017	26 Jan 2017	19 Jan 2017	28 Feb 2017	24 Jan 2017
SR33	SE160957.033	LB117101	12 Jan 2017	17 Jan 2017	26 Jan 2017	19 Jan 2017	28 Feb 2017	24 Jan 2017

Surrogate results are evaluated against upper and lower limit criteria established in the SGS QA/QC plan (Ref: MP-(AU)-[ENV]QU-022). At least two of three routine level soil sample surrogate spike recoveries for BTEX/VOC are to be within 70-130% where control charts have not been developed and within the established control limits for charted surrogates. Matrix effects may void this as an acceptance criterion. Water sample surrogate spike recoveries are to be within 40-130%. The presence of emulsions, surfactants and particulates may void this as an acceptance criterion.

Result is shown in **Green** when within suggested criteria or **Red** with an appended reason identifer when outside suggested criteria. Refer to the footnotes section at the end of this report for failure reasons.

OC Pesticides in Soil

Method: ME-(AU)-[ENV]AN420

Parameter	Sample Name	Sample Number	Units	Criteria	Recovery %
Tetrachloro-m-xylene (TCMX) (Surrogate)	SR27	SE160957.027	%	60 - 130%	109
	SR28	SE160957.028	%	60 - 130%	115
	SR29	SE160957.029	%	60 - 130%	80
	SR30	SE160957.030	%	60 - 130%	109
	SR31	SE160957.031	%	60 - 130%	105
	SR32	SE160957.032	%	60 - 130%	100
	SR33	SE160957.033	%	60 - 130%	105
	SR73	SE160957.034	%	60 - 130%	105
	SR91	SE160957.035	%	60 - 130%	108
	SR113	SE160957.036	%	60 - 130%	107
	SR184	SE160957.037	%	60 - 130%	107
	SR224	SE160957.038	%	60 - 130%	109

PAH (Polynuclear Aromatic Hydrocarbons) in Soil

Method: ME-(AU)-[ENV]AN420

Parameter	Sample Name	Sample Number	Units	Criteria	Recovery %
2-fluorobiphenyl (Surrogate)	SR27	SE160957.027	%	70 - 130%	100
	SR28	SE160957.028	%	70 - 130%	78
	SR29	SE160957.029	%	70 - 130%	110
	SR30	SE160957.030	%	70 - 130%	78
	SR31	SE160957.031	%	70 - 130%	110
	SR32	SE160957.032	%	70 - 130%	80
	SR33	SE160957.033	%	70 - 130%	80
d14-p-terphenyl (Surrogate)	SR27	SE160957.027	%	70 - 130%	92
	SR28	SE160957.028	%	70 - 130%	86
	SR29	SE160957.029	%	70 - 130%	112
	SR30	SE160957.030	%	70 - 130%	78
	SR31	SE160957.031	%	70 - 130%	112
	SR32	SE160957.032	%	70 - 130%	76
	SR33	SE160957.033	%	70 - 130%	94
d5-nitrobenzene (Surrogate)	SR27	SE160957.027	%	70 - 130%	90
	SR28	SE160957.028	%	70 - 130%	74
	SR29	SE160957.029	%	70 - 130%	110
	SR30	SE160957.030	%	70 - 130%	84
	SR31	SE160957.031	%	70 - 130%	112
	SR32	SE160957.032	%	70 - 130%	80
	SR33	SE160957.033	%	70 - 130%	88

VOC's in Soil

Method: ME-(AU)-[ENV]AN433

Parameter	Sample Name	Sample Number	Units	Criteria	Recovery %
Bromofluorobenzene (Surrogate)	SR27	SE160957.027	%	60 - 130%	72
	SR28	SE160957.028	%	60 - 130%	71
	SR29	SE160957.029	%	60 - 130%	94
	SR30	SE160957.030	%	60 - 130%	75
	SR31	SE160957.031	%	60 - 130%	77
	SR32	SE160957.032	%	60 - 130%	71
	SR33	SE160957.033	%	60 - 130%	71
d4-1,2-dichloroethane (Surrogate)	SR27	SE160957.027	%	60 - 130%	110
	SR28	SE160957.028	%	60 - 130%	109
	SR29	SE160957.029	%	60 - 130%	104
	SR30	SE160957.030	%	60 - 130%	112
	SR31	SE160957.031	%	60 - 130%	109
	SR32	SE160957.032	%	60 - 130%	109
	SR33	SE160957.033	%	60 - 130%	112
d8-toluene (Surrogate)	SR27	SE160957.027	%	60 - 130%	79
	SR28	SE160957.028	%	60 - 130%	80
	SR29	SE160957.029	%	60 - 130%	75
	SR30	SE160957.030	%	60 - 130%	81
	SR31	SE160957.031	%	60 - 130%	78
	SR32	SE160957.032	%	60 - 130%	76
	SR33	SE160957.033	%	60 - 130%	79
Dibromofluoromethane (Surrogate)	SR27	SE160957.027	%	60 - 130%	96
	SR28	SE160957.028	%	60 - 130%	95

Surrogate results are evaluated against upper and lower limit criteria established in the SGS QA /QC plan (Ref: MP-(AU)-[ENV]QU-022). At least two of three routine level soil sample surrogate spike recoveries for BTEX/VOC are to be within 70-130% where control charts have not been developed and within the established control limits for charted surrogates. Matrix effects may void this as an acceptance criterion. Water sample surrogate spike recoveries are to be within 40-130%. The presence of emulsions, surfactants and particulates may void this as an acceptance criterion.

Result is shown in **Green** when within suggested criteria or **Red** with an appended reason identifer when outside suggested criteria. Refer to the footnotes section at the end of this report for failure reasons.

VOC's in Soil (continued)

Method: ME-(AU)-[ENV]AN433

Parameter	Sample Name	Sample Number	Units	Criteria	Recovery %
Dibromofluoromethane (Surrogate)	SR29	SE160957.029	%	60 - 130%	92
	SR30	SE160957.030	%	60 - 130%	98
	SR31	SE160957.031	%	60 - 130%	98
	SR32	SE160957.032	%	60 - 130%	98
	SR33	SE160957.033	%	60 - 130%	100

Volatile Petroleum Hydrocarbons in Soil

Method: ME-(AU)-[ENV]AN433

Parameter	Sample Name	Sample Number	Units	Criteria	Recovery %
Bromofluorobenzene (Surrogate)	SR27	SE160957.027	%	60 - 130%	72
	SR28	SE160957.028	%	60 - 130%	71
	SR29	SE160957.029	%	60 - 130%	94
	SR30	SE160957.030	%	60 - 130%	75
	SR31	SE160957.031	%	60 - 130%	77
	SR32	SE160957.032	%	60 - 130%	71
	SR33	SE160957.033	%	60 - 130%	71
d4-1,2-dichloroethane (Surrogate)	SR27	SE160957.027	%	60 - 130%	110
	SR28	SE160957.028	%	60 - 130%	109
	SR29	SE160957.029	%	60 - 130%	104
	SR30	SE160957.030	%	60 - 130%	112
	SR31	SE160957.031	%	60 - 130%	109
	SR32	SE160957.032	%	60 - 130%	109
	SR33	SE160957.033	%	60 - 130%	112
d8-toluene (Surrogate)	SR27	SE160957.027	%	60 - 130%	79
	SR28	SE160957.028	%	60 - 130%	80
	SR29	SE160957.029	%	60 - 130%	75
	SR30	SE160957.030	%	60 - 130%	81
	SR31	SE160957.031	%	60 - 130%	78
	SR32	SE160957.032	%	60 - 130%	76
	SR33	SE160957.033	%	60 - 130%	79
Dibromofluoromethane (Surrogate)	SR27	SE160957.027	%	60 - 130%	96
	SR28	SE160957.028	%	60 - 130%	95
	SR29	SE160957.029	%	60 - 130%	92
	SR30	SE160957.030	%	60 - 130%	98
	SR31	SE160957.031	%	60 - 130%	98
	SR32	SE160957.032	%	60 - 130%	98
	SR33	SE160957.033	%	60 - 130%	100

Blank results are evaluated against the limit of reporting (LOR), for the chosen method and its associated instrumentation, typically 2.5 times the statistically determined method detection limit (MDL).

Result is shown in **Green** when within suggested criteria or **Red** with an appended dagger symbol (†) when outside suggested criteria.

Exchangeable Cations and Cation Exchange Capacity (CEC/ESP/SAR)

Method: ME-(AU)-[ENV]AN122

Sample Number	Parameter	Units	LOR

Mercury in Soil

Method: ME-(AU)-[ENV]AN312

Sample Number		Parameter	Units	LOR	Result
LB117281.001		Mercury	mg/kg	0.05	<0.05

OC Pesticides in Soil

Method: ME-(AU)-[ENV]AN420

Sample Number		Parameter	Units	LOR	Result
LB117067.001		Hexachlorobenzene (HCB)	mg/kg	0.1	<0.1
		Alpha BHC	mg/kg	0.1	<0.1
		Lindane	mg/kg	0.1	<0.1
		Heptachlor	mg/kg	0.1	<0.1
		Aldrin	mg/kg	0.1	<0.1
		Beta BHC	mg/kg	0.1	<0.1
		Delta BHC	mg/kg	0.1	<0.1
		Heptachlor epoxide	mg/kg	0.1	<0.1
		Alpha Endosulfan	mg/kg	0.2	<0.2
		Gamma Chlordane	mg/kg	0.1	<0.1
		Alpha Chlordane	mg/kg	0.1	<0.1
		p,p'-DDE	mg/kg	0.1	<0.1
		Dieldrin	mg/kg	0.2	<0.2
		Endrin	mg/kg	0.2	<0.2
		Beta Endosulfan	mg/kg	0.2	<0.2
		p,p'-DDD	mg/kg	0.1	<0.1
		p,p'-DDT	mg/kg	0.1	<0.1
		Endosulfan sulphate	mg/kg	0.1	<0.1
		Endrin Aldehyde	mg/kg	0.1	<0.1
		Methoxychlor	mg/kg	0.1	<0.1
		Endrin Ketone	mg/kg	0.1	<0.1
		Isodrin	mg/kg	0.1	<0.1
		Mirex	mg/kg	0.1	<0.1
	Surrogates	Tetrachloro-m-xylene (TCMX) (Surrogate)	%	-	99

PAH (Polynuclear Aromatic Hydrocarbons) in Soil

Method: ME-(AU)-[ENV]AN420

Sample Number		Parameter	Units	LOR	Result
LB117067.001		Naphthalene	mg/kg	0.1	<0.1
		2-methylnaphthalene	mg/kg	0.1	<0.1
		1-methylnaphthalene	mg/kg	0.1	<0.1
		Acenaphthylene	mg/kg	0.1	<0.1
		Acenaphthene	mg/kg	0.1	<0.1
		Fluorene	mg/kg	0.1	<0.1
		Phenanthrene	mg/kg	0.1	<0.1
		Anthracene	mg/kg	0.1	<0.1
		Fluoranthene	mg/kg	0.1	<0.1
		Pyrene	mg/kg	0.1	<0.1
		Benzo(a)anthracene	mg/kg	0.1	<0.1
		Chrysene	mg/kg	0.1	<0.1
		Benzo(a)pyrene	mg/kg	0.1	<0.1
		Indeno(1,2,3-cd)pyrene	mg/kg	0.1	<0.1
		Dibenzo(ah)anthracene	mg/kg	0.1	<0.1
		Benzo(ghi)perylene	mg/kg	0.1	<0.1
		Total PAH (18)	mg/kg	0.8	<0.8
	Surrogates	d5-nitrobenzene (Surrogate)	%	-	82
		2-fluorobiphenyl (Surrogate)	%	-	84
		d14-p-terphenyl (Surrogate)	%	-	76

Soluble Anions (1:5) in Soil by Ion Chromatography

Method: ME-(AU)-[ENV]AN245

Sample Number	Parameter	Units	LOR

Blank results are evaluated against the limit of reporting (LOR), for the chosen method and its associated instrumentation, typically 2.5 times the statistically determined method detection limit (MDL).

Result is shown in **Green** when within suggested criteria or **Red** with an appended dagger symbol (†) when outside suggested criteria.

Soluble Anions (1:5) in Soil by Ion Chromatography (continued)

Method: ME-(AU)-[ENV]AN245

Sample Number	Parameter	Units	LOR	Result
LB117119.001	Chloride	mg/kg	0.25	<0.25

Total Recoverable Metals in Soil/Waste Solids/Materials by ICPOES

Method: ME-(AU)-[ENV]AN040/AN320

Sample Number	Parameter	Units	LOR	Result
LB117335.001	Arsenic, As	mg/kg	3	<3
	Cadmium, Cd	mg/kg	0.3	<0.3
	Chromium, Cr	mg/kg	0.3	<0.3
	Copper, Cu	mg/kg	0.5	<0.5
	Lead, Pb	mg/kg	1	<1
	Nickel, Ni	mg/kg	0.5	<0.5
	Zinc, Zn	mg/kg	0.5	<0.5
LB117336.001	Arsenic, As	mg/kg	3	<3
	Cadmium, Cd	mg/kg	0.3	<0.3
	Chromium, Cr	mg/kg	0.3	<0.3
	Copper, Cu	mg/kg	0.5	<0.5
	Lead, Pb	mg/kg	1	<1
	Nickel, Ni	mg/kg	0.5	<0.5
	Zinc, Zn	mg/kg	0.5	<0.5
LB117337.001	Arsenic, As	mg/kg	3	<3
	Cadmium, Cd	mg/kg	0.3	<0.3
	Chromium, Cr	mg/kg	0.3	<0.3
	Copper, Cu	mg/kg	0.5	<0.5
	Lead, Pb	mg/kg	1	<1
	Nickel, Ni	mg/kg	0.5	<0.5
	Zinc, Zn	mg/kg	0.5	<0.5
	Calcium, Ca	mg/kg	5	<5
	Magnesium, Mg	mg/kg	5	<5
	Sodium, Na	mg/kg	5	<5
	Potassium, K	mg/kg	10	<10

TRH (Total Recoverable Hydrocarbons) in Soil

Method: ME-(AU)-[ENV]AN403

Sample Number	Parameter	Units	LOR	Result
LB117067.001	TRH C10-C14	mg/kg	20	<20
	TRH C15-C28	mg/kg	45	<45
	TRH C29-C36	mg/kg	45	<45
	TRH C37-C40	mg/kg	100	<100
	TRH C10-C36 Total	mg/kg	110	<110

VOC's in Soil

Method: ME-(AU)-[ENV]AN433

Sample Number		Parameter	Units	LOR	Result
LB117101.001	Monocyclic Aromatic Hydrocarbons	Benzene	mg/kg	0.1	<0.1
		Toluene	mg/kg	0.1	<0.1
		Ethylbenzene	mg/kg	0.1	<0.1
		m/p-xylene	mg/kg	0.2	<0.2
		o-xylene	mg/kg	0.1	<0.1
	Polycyclic VOCs	Naphthalene	mg/kg	0.1	<0.1
	Surrogates	Dibromofluoromethane (Surrogate)	%	-	96
		d4-1,2-dichloroethane (Surrogate)	%	-	109
		d8-toluene (Surrogate)	%	-	75
		Bromofluorobenzene (Surrogate)	%	-	70
	Totals	Total BTEX	mg/kg	0.6	<0.6

Volatile Petroleum Hydrocarbons in Soil

Method: ME-(AU)-[ENV]AN433

Sample Number		Parameter	Units	LOR	Result
LB117101.001		TRH C6-C9	mg/kg	20	<20
	Surrogates	Dibromofluoromethane (Surrogate)	%	-	96
		d4-1,2-dichloroethane (Surrogate)	%	-	109
		d8-toluene (Surrogate)	%	-	75

Duplicates are calculated as Relative Percentage Difference (RPD) using the formula: RPD = | OriginalResult - ReplicateResult | x 100 / Mean

The RPD is evaluated against the Maximum Allowable Difference (MAD) criteria and can be graphically represented by a curve calculated from the Statistical Detection Limit (SDL) and Limiting Repeatability (LR) using the formula: MAD = 100 x SDL / Mean + LR

Where the Maximum Allowable Difference evaluates to a number larger than 200 it is displayed as 200.

RPD is shown in **Green** when within suggested criteria or **Red** with an appended reason identifer when outside suggested criteria. Refer to the footnotes section at the end of this report for failure reasons.

Mercury in Soil

Method: ME-(AU)-[ENV]AN312

Original	Duplicate		Parameter	Units	LOR	Original	Duplicate	Criteria %	RPD %
SE160957.031	LB117281.014		Mercury	mg/kg	0.05	<0.05	<0.05	200	0
SE160960.007	LB117281.024		Mercury	mg/kg	0.05	<0.05	<0.05	200	0

Moisture Content

Method: ME-(AU)-[ENV]AN002

Original	Duplicate		Parameter	Units	LOR	Original	Duplicate	Criteria %	RPD %
SE160956.011	LB117208.011		% Moisture	%w/w	0.5	<0.5	<0.5	200	0
SE160957.010	LB117208.022		% Moisture	%w/w	0.5	2.0	1.8	82	13
SE160957.020	LB117208.033		% Moisture	%w/w	0.5	6.2	6.6	46	7
SE160957.030	LB117208.044		% Moisture	%w/w	0.5	5.7	5.8	47	3
SE160957.040	LB117208.055		% Moisture	%w/w	0.5	2.2	1.8	80	22
SE160957.042	LB117208.058		% Moisture	%w/w	0.5	10	10	40	1

OC Pesticides in Soil

Method: ME-(AU)-[ENV]AN420

Original	Duplicate		Parameter	Units	LOR	Original	Duplicate	Criteria %	RPD %
SE160957.036	LB117067.034		Hexachlorobenzene (HCB)	mg/kg	0.1	<0.1	<0.1	200	0
			Alpha BHC	mg/kg	0.1	<0.1	<0.1	200	0
			Lindane	mg/kg	0.1	<0.1	<0.1	200	0
			Heptachlor	mg/kg	0.1	<0.1	<0.1	200	0
			Aldrin	mg/kg	0.1	<0.1	<0.1	200	0
			Beta BHC	mg/kg	0.1	<0.1	<0.1	200	0
			Delta BHC	mg/kg	0.1	<0.1	<0.1	200	0
			Heptachlor epoxide	mg/kg	0.1	<0.1	<0.1	200	0
			o,p'-DDE	mg/kg	0.1	<0.1	<0.1	200	0
			Alpha Endosulfan	mg/kg	0.2	<0.2	<0.2	200	0
			Gamma Chlordane	mg/kg	0.1	<0.1	<0.1	200	0
			Alpha Chlordane	mg/kg	0.1	<0.1	<0.1	200	0
			trans-Nonachlor	mg/kg	0.1	<0.1	<0.1	200	0
			p,p'-DDE	mg/kg	0.1	<0.1	<0.1	200	0
			Dieldrin	mg/kg	0.2	<0.2	<0.2	200	0
			Endrin	mg/kg	0.2	<0.2	<0.2	200	0
			o,p'-DDD	mg/kg	0.1	<0.1	<0.1	200	0
			o,p'-DDT	mg/kg	0.1	<0.1	<0.1	200	0
			Beta Endosulfan	mg/kg	0.2	<0.2	<0.2	200	0
			p,p'-DDD	mg/kg	0.1	<0.1	<0.1	200	0
			p,p'-DDT	mg/kg	0.1	<0.1	<0.1	200	0
			Endosulfan sulphate	mg/kg	0.1	<0.1	<0.1	200	0
			Endrin Aldehyde	mg/kg	0.1	<0.1	<0.1	200	0
			Methoxychlor	mg/kg	0.1	<0.1	<0.1	200	0
			Endrin Ketone	mg/kg	0.1	<0.1	<0.1	200	0
			Isodrin	mg/kg	0.1	<0.1	<0.1	200	0
			Mirex	mg/kg	0.1	<0.1	<0.1	200	0
		Surrogates	Tetrachloro-m-xylene (TCMX) (Surrogate)	mg/kg	-	0.16	0.16	30	1

PAH (Polynuclear Aromatic Hydrocarbons) in Soil

Method: ME-(AU)-[ENV]AN420

Original	Duplicate		Parameter	Units	LOR	Original	Duplicate	Criteria %	RPD %
SE160957.027	LB117067.014		Naphthalene	mg/kg	0.1	<0.1	<0.1	200	0
			2-methylnaphthalene	mg/kg	0.1	<0.1	<0.1	200	0
			1-methylnaphthalene	mg/kg	0.1	<0.1	<0.1	200	0
			Acenaphthylene	mg/kg	0.1	<0.1	<0.1	200	0
			Acenaphthene	mg/kg	0.1	<0.1	<0.1	200	0
			Fluorene	mg/kg	0.1	<0.1	<0.1	200	0
			Phenanthrene	mg/kg	0.1	<0.1	<0.1	200	0
			Anthracene	mg/kg	0.1	<0.1	<0.1	200	0
			Fluoranthene	mg/kg	0.1	<0.1	<0.1	200	0
			Pyrene	mg/kg	0.1	<0.1	<0.1	200	0
			Benzo(a)anthracene	mg/kg	0.1	<0.1	<0.1	200	0
			Chrysene	mg/kg	0.1	<0.1	<0.1	200	0
			Benzo(b&j)fluoranthene	mg/kg	0.1	<0.1	<0.1	200	0
			Benzo(k)fluoranthene	mg/kg	0.1	<0.1	<0.1	200	0
			Benzo(a)pyrene	mg/kg	0.1	<0.1	<0.1	200	0
			Indeno(1,2,3-cd)pyrene	mg/kg	0.1	<0.1	<0.1	200	0

Duplicates are calculated as Relative Percentage Difference (RPD) using the formula: RPD = | OriginalResult - ReplicateResult | x 100 / Mean

The RPD is evaluated against the Maximum Allowable Difference (MAD) criteria and can be graphically represented by a curve calculated from the Statistical Detection Limit (SDL) and Limiting Repeatability (LR) using the formula: MAD = 100 x SDL / Mean + LR

Where the Maximum Allowable Difference evaluates to a number larger than 200 it is displayed as 200.

RPD is shown in **Green** when within suggested criteria or **Red** with an appended reason identifer when outside suggested criteria. Refer to the footnotes section at the end of this report for failure reasons.

PAH (Polynuclear Aromatic Hydrocarbons) in Soil (continued) — Method: ME-(AU)-[ENV]AN420

Original	Duplicate		Parameter	Units	LOR	Original	Duplicate	Criteria %	RPD %
SE160957.027	LB117067.014		Dibenzo(ah)anthracene	mg/kg	0.1	<0.1	<0.1	200	0
			Benzo(ghi)perylene	mg/kg	0.1	<0.1	<0.1	200	0
			Carcinogenic PAHs, BaP TEQ <LOR=0	TEQ (mg/kg)	0.2	<0.2	<0.2	200	0
			Carcinogenic PAHs, BaP TEQ <LOR=LOR	TEQ (mg/kg)	0.3	<0.3	<0.3	134	0
			Carcinogenic PAHs, BaP TEQ <LOR=LOR/2	TEQ (mg/kg)	0.2	<0.2	<0.2	175	0
			Total PAH (18)	mg/kg	0.8	<0.8	<0.8	200	0
		Surrogates	d5-nitrobenzene (Surrogate)	mg/kg	-	0.5	0.5	30	9
			2-fluorobiphenyl (Surrogate)	mg/kg	-	0.5	0.6	30	10
			d14-p-terphenyl (Surrogate)	mg/kg	-	0.5	0.5	30	10
SE160957.033	LB117067.032		Naphthalene	mg/kg	0.1	<0.1	<0.1	200	0
			2-methylnaphthalene	mg/kg	0.1	<0.1	<0.1	200	0
			1-methylnaphthalene	mg/kg	0.1	<0.1	<0.1	200	0
			Acenaphthylene	mg/kg	0.1	<0.1	<0.1	200	0
			Acenaphthene	mg/kg	0.1	<0.1	<0.1	200	0
			Fluorene	mg/kg	0.1	<0.1	<0.1	200	0
			Phenanthrene	mg/kg	0.1	<0.1	<0.1	200	0
			Anthracene	mg/kg	0.1	<0.1	<0.1	200	0
			Fluoranthene	mg/kg	0.1	<0.1	<0.1	200	0
			Pyrene	mg/kg	0.1	<0.1	<0.1	200	0
			Benzo(a)anthracene	mg/kg	0.1	<0.1	<0.1	200	0
			Chrysene	mg/kg	0.1	<0.1	<0.1	200	0
			Benzo(b&j)fluoranthene	mg/kg	0.1	<0.1	<0.1	200	0
			Benzo(k)fluoranthene	mg/kg	0.1	<0.1	<0.1	200	0
			Benzo(a)pyrene	mg/kg	0.1	<0.1	<0.1	200	0
			Indeno(1,2,3-cd)pyrene	mg/kg	0.1	<0.1	<0.1	200	0
			Dibenzo(ah)anthracene	mg/kg	0.1	<0.1	<0.1	200	0
			Benzo(ghi)perylene	mg/kg	0.1	<0.1	<0.1	200	0
			Carcinogenic PAHs, BaP TEQ <LOR=0	TEQ (mg/kg)	0.2	<0.2	<0.2	200	0
			Carcinogenic PAHs, BaP TEQ <LOR=LOR	TEQ (mg/kg)	0.3	<0.3	<0.3	134	0
			Carcinogenic PAHs, BaP TEQ <LOR=LOR/2	TEQ (mg/kg)	0.2	<0.2	<0.2	175	0
			Total PAH (18)	mg/kg	0.8	<0.8	<0.8	200	0
		Surrogates	d5-nitrobenzene (Surrogate)	mg/kg	-	0.4	0.4	30	7
			2-fluorobiphenyl (Surrogate)	mg/kg	-	0.4	0.4	30	5
			d14-p-terphenyl (Surrogate)	mg/kg	-	0.5	0.4	30	11

Total Recoverable Metals in Soil/Waste Solids/Materials by ICPOES — Method: ME-(AU)-[ENV]AN040/AN320

Original	Duplicate	Parameter	Units	LOR	Original	Duplicate	Criteria %	RPD %
SE160957.005	LB117335.014	Arsenic, As	mg/kg	3	<3	<3	94	11
		Cadmium, Cd	mg/kg	0.3	<0.3	<0.3	200	0
		Chromium, Cr	mg/kg	0.3	18	18	33	2
		Copper, Cu	mg/kg	0.5	6.8	6.4	38	5
		Lead, Pb	mg/kg	1	6	5	48	4
		Nickel, Ni	mg/kg	0.5	7.6	7.2	37	5
		Zinc, Zn	mg/kg	0.5	13	13	45	0
SE160957.014	LB117335.024	Arsenic, As	mg/kg	3	<3	<3	86	28
		Cadmium, Cd	mg/kg	0.3	<0.3	<0.3	138	0
		Chromium, Cr	mg/kg	0.3	58	57	31	1
		Copper, Cu	mg/kg	0.5	18	19	33	3
		Lead, Pb	mg/kg	1	9	9	41	2
		Nickel, Ni	mg/kg	0.5	41	41	31	0
		Zinc, Zn	mg/kg	0.5	45	44	35	1
SE160957.024	LB117336.014	Arsenic, As	mg/kg	3	<3	<3	81	7
		Cadmium, Cd	mg/kg	0.3	0.4	0.4	113	1
		Chromium, Cr	mg/kg	0.3	63	65	31	2
		Copper, Cu	mg/kg	0.5	20	21	32	7
		Lead, Pb	mg/kg	1	9	9	41	4
		Nickel, Ni	mg/kg	0.5	50	57	31	13
		Zinc, Zn	mg/kg	0.5	40	41	35	2
SE160957.033	LB117336.024	Arsenic, As	mg/kg	3	<3	<3	70	6
		Cadmium, Cd	mg/kg	0.3	0.3	0.3	121	11
		Chromium, Cr	mg/kg	0.3	59	59	31	1

Duplicates are calculated as Relative Percentage Difference (RPD) using the formula: RPD = | OriginalResult - ReplicateResult | x 100 / Mean

The RPD is evaluated against the Maximum Allowable Difference (MAD) criteria and can be graphically represented by a curve calculated from the Statistical Detection Limit (SDL) and Limiting Repeatability (LR) using the formula: MAD = 100 x SDL / Mean + LR

Where the Maximum Allowable Difference evaluates to a number larger than 200 it is displayed as 200.

RPD is shown in **Green** when within suggested criteria or **Red** with an appended reason identifer when outside suggested criteria. Refer to the footnotes section at the end of this report for failure reasons.

Total Recoverable Metals in Soil/Waste Solids/Materials by ICPOES (continued) — Method: ME-(AU)-[ENV]AN040/AN320

Original	Duplicate		Parameter	Units	LOR	Original	Duplicate	Criteria %	RPD %
SE160957.033	LB117336.024		Copper, Cu	mg/kg	0.5	22	23	32	3
			Lead, Pb	mg/kg	1	10	10	40	1
			Nickel, Ni	mg/kg	0.5	48	49	31	1
			Zinc, Zn	mg/kg	0.5	44	45	35	4
SE160960.006	LB117337.014		Arsenic, As	mg/kg	3	4	<3	61	23
			Cadmium, Cd	mg/kg	0.3	<0.3	<0.3	143	0
			Chromium, Cr	mg/kg	0.3	43	36	31	18
			Copper, Cu	mg/kg	0.5	15	15	33	1
			Lead, Pb	mg/kg	1	13	13	38	4
			Nickel, Ni	mg/kg	0.5	33	29	32	13
			Zinc, Zn	mg/kg	0.5	14	15	44	3
SE160960.015	LB117337.024		Arsenic, As	mg/kg	3	<3	<3	70	13
			Cadmium, Cd	mg/kg	0.3	<0.3	<0.3	178	0
			Chromium, Cr	mg/kg	0.3	16	15	33	11
			Copper, Cu	mg/kg	0.5	12	13	34	5
			Lead, Pb	mg/kg	1	19	16	36	17
			Nickel, Ni	mg/kg	0.5	19	19	33	4
			Zinc, Zn	mg/kg	0.5	32	32	36	2

TRH (Total Recoverable Hydrocarbons) in Soil — Method: ME-(AU)-[ENV]AN403

Original	Duplicate		Parameter	Units	LOR	Original	Duplicate	Criteria %	RPD %
SE160957.027	LB117067.014		TRH C10-C14	mg/kg	20	<20	<20	200	0
			TRH C15-C28	mg/kg	45	<45	<45	200	0
			TRH C29-C36	mg/kg	45	<45	<45	200	0
			TRH C37-C40	mg/kg	100	<100	<100	200	0
			TRH C10-C36 Total	mg/kg	110	<110	<110	200	0
			TRH C10-C40 Total	mg/kg	210	<210	<210	200	0
		TRH F Bands	TRH >C10-C16 (F2)	mg/kg	25	<25	<25	200	0
			TRH >C10-C16 (F2) - Naphthalene	mg/kg	25	<25	<25	200	0
			TRH >C16-C34 (F3)	mg/kg	90	<90	<90	200	0
			TRH >C34-C40 (F4)	mg/kg	120	<120	<120	200	0
SE160957.033	LB117067.031		TRH C10-C14	mg/kg	20	<20	<20	200	0
			TRH C15-C28	mg/kg	45	<45	<45	200	0
			TRH C29-C36	mg/kg	45	<45	<45	200	0
			TRH C37-C40	mg/kg	100	<100	<100	200	0
			TRH C10-C36 Total	mg/kg	110	<110	<110	200	0
			TRH C10-C40 Total	mg/kg	210	<210	<210	200	0
		TRH F Bands	TRH >C10-C16 (F2)	mg/kg	25	<25	<25	200	0
			TRH >C10-C16 (F2) - Naphthalene	mg/kg	25	<25	<25	200	0
			TRH >C16-C34 (F3)	mg/kg	90	<90	<90	200	0
			TRH >C34-C40 (F4)	mg/kg	120	<120	<120	200	0

VOC's in Soil — Method: ME-(AU)-[ENV]AN433

Original	Duplicate		Parameter	Units	LOR	Original	Duplicate	Criteria %	RPD %
SE160960.003	LB117101.014	Monocyclic Aromatic	Benzene	mg/kg	0.1	<0.1	<0.1	200	0
			Toluene	mg/kg	0.1	<0.1	<0.1	200	0
			Ethylbenzene	mg/kg	0.1	<0.1	<0.1	200	0
			m/p-xylene	mg/kg	0.2	<0.2	<0.2	200	0
			o-xylene	mg/kg	0.1	<0.1	<0.1	200	0
		Polycyclic	Naphthalene	mg/kg	0.1	<0.1	<0.1	200	0
		Surrogates	Dibromofluoromethane (Surrogate)	mg/kg	-	4.9	4.9	50	0
			d4-1,2-dichloroethane (Surrogate)	mg/kg	-	5.5	5.6	50	2
			d8-toluene (Surrogate)	mg/kg	-	3.8	3.9	50	2
			Bromofluorobenzene (Surrogate)	mg/kg	-	3.6	3.6	50	0
		Totals	Total Xylenes*	mg/kg	0.3	<0.3	<0.3	200	0
			Total BTEX	mg/kg	0.6	<0.6	<0.6	200	0
SE160960.013	LB117101.025	Monocyclic Aromatic	Benzene	mg/kg	0.1	<0.1	<0.1	200	0
			Toluene	mg/kg	0.1	<0.1	<0.1	200	0
			Ethylbenzene	mg/kg	0.1	<0.1	<0.1	200	0
			m/p-xylene	mg/kg	0.2	<0.2	<0.2	200	0
			o-xylene	mg/kg	0.1	<0.1	<0.1	200	0
		Polycyclic	Naphthalene	mg/kg	0.1	<0.1	<0.1	200	0

Duplicates are calculated as Relative Percentage Difference (RPD) using the formula: RPD = | OriginalResult - ReplicateResult | x 100 / Mean

The RPD is evaluated against the Maximum Allowable Difference (MAD) criteria and can be graphically represented by a curve calculated from the Statistical Detection Limit (SDL) and Limiting Repeatability (LR) using the formula: MAD = 100 x SDL / Mean + LR

Where the Maximum Allowable Difference evaluates to a number larger than 200 it is displayed as 200.

RPD is shown in **Green** when within suggested criteria or **Red** with an appended reason identifer when outside suggested criteria. Refer to the footnotes section at the end of this report for failure reasons.

VOC's in Soil (continued) — Method: ME-(AU)-[ENV]AN433

Original	Duplicate		Parameter	Units	LOR	Original	Duplicate	Criteria %	RPD %
SE160960.013	LB117101.025	Surrogates	Dibromofluoromethane (Surrogate)	mg/kg	-	4.3	4.6	50	7
			d4-1,2-dichloroethane (Surrogate)	mg/kg	-	4.9	5.3	50	9
			d8-toluene (Surrogate)	mg/kg	-	4.0	3.6	50	9
			Bromofluorobenzene (Surrogate)	mg/kg	-	3.8	3.7	50	3
		Totals	Total Xylenes*	mg/kg	0.3	<0.3	<0.3	200	0
			Total BTEX	mg/kg	0.6	<0.6	<0.6	200	0

Volatile Petroleum Hydrocarbons in Soil — Method: ME-(AU)-[ENV]AN433

Original	Duplicate		Parameter	Units	LOR	Original	Duplicate	Criteria %	RPD %
SE160960.003	LB117101.014		TRH C6-C10	mg/kg	25	<25	<25	200	0
			TRH C6-C9	mg/kg	20	<20	<20	200	0
		Surrogates	Dibromofluoromethane (Surrogate)	mg/kg	-	4.9	4.9	30	0
			d4-1,2-dichloroethane (Surrogate)	mg/kg	-	5.5	5.6	30	2
			d8-toluene (Surrogate)	mg/kg	-	3.8	3.9	30	2
			Bromofluorobenzene (Surrogate)	mg/kg	-	3.6	3.6	30	0
		VPH F Bands	Benzene (F0)	mg/kg	0.1	<0.1	<0.1	200	0
			TRH C6-C10 minus BTEX (F1)	mg/kg	25	<25	<25	200	0
SE160960.013	LB117101.025		TRH C6-C10	mg/kg	25	<25	<25	200	0
			TRH C6-C9	mg/kg	20	<20	<20	200	0
		Surrogates	Dibromofluoromethane (Surrogate)	mg/kg	-	4.3	4.6	30	7
			d4-1,2-dichloroethane (Surrogate)	mg/kg	-	4.9	5.3	30	9
			d8-toluene (Surrogate)	mg/kg	-	4.0	3.6	30	9
			Bromofluorobenzene (Surrogate)	mg/kg	-	3.8	3.7	30	3
		VPH F Bands	Benzene (F0)	mg/kg	0.1	<0.1	<0.1	200	0
			TRH C6-C10 minus BTEX (F1)	mg/kg	25	<25	<25	200	0

Laboratory Control Standard (LCS) results are evaluated against an expected result, typically the concentration of analyte spiked into the control during the sample preparation stage, producing a percentage recovery. The criteria applied to the percentage recovery is established in the SGS QA /QC plan (Ref: MP-(AU)-[ENV]QU-022). For more information refer to the footnotes in the concluding page of this report.

Recovery is shown in **Green** when within suggested criteria or **Red** with an appended dagger symbol (†) when outside suggested criteria.

Exchangeable Cations and Cation Exchange Capacity (CEC/ESP/SAR)

Method: ME-(AU)-[ENV]AN122

Sample Number		Parameter	Units	LOR	Result	Expected	Criteria %	Recovery %
LB117341.002		Exchangeable Sodium, Na	mg/kg	2	NA	390	80 - 120	118

Mercury in Soil

Method: ME-(AU)-[ENV]AN312

Sample Number		Parameter	Units	LOR	Result	Expected	Criteria %	Recovery %
LB117281.002		Mercury	mg/kg	0.05	0.22	0.2	70 - 130	110

OC Pesticides in Soil

Method: ME-(AU)-[ENV]AN420

Sample Number		Parameter	Units	LOR	Result	Expected	Criteria %	Recovery %
LB117067.002		Heptachlor	mg/kg	0.1	0.2	0.2	60 - 140	102
		Aldrin	mg/kg	0.1	0.2	0.2	60 - 140	98
		Delta BHC	mg/kg	0.1	0.2	0.2	60 - 140	108
		Dieldrin	mg/kg	0.2	<0.2	0.2	60 - 140	92
		Endrin	mg/kg	0.2	0.2	0.2	60 - 140	112
		p,p'-DDT	mg/kg	0.1	0.2	0.2	60 - 140	124
	Surrogates	Tetrachloro-m-xylene (TCMX) (Surrogate)	mg/kg	-	0.15	0.15	40 - 130	97

PAH (Polynuclear Aromatic Hydrocarbons) in Soil

Method: ME-(AU)-[ENV]AN420

Sample Number		Parameter	Units	LOR	Result	Expected	Criteria %	Recovery %
LB117067.002		Naphthalene	mg/kg	0.1	4.4	4	60 - 140	109
		Acenaphthylene	mg/kg	0.1	4.3	4	60 - 140	108
		Acenaphthene	mg/kg	0.1	4.2	4	60 - 140	104
		Phenanthrene	mg/kg	0.1	4.1	4	60 - 140	103
		Anthracene	mg/kg	0.1	3.9	4	60 - 140	96
		Fluoranthene	mg/kg	0.1	4.2	4	60 - 140	106
		Pyrene	mg/kg	0.1	3.5	4	60 - 140	88
		Benzo(a)pyrene	mg/kg	0.1	5.0	4	60 - 140	125
	Surrogates	d5-nitrobenzene (Surrogate)	mg/kg	-	0.5	0.5	40 - 130	96
		2-fluorobiphenyl (Surrogate)	mg/kg	-	0.5	0.5	40 - 130	100
		d14-p-terphenyl (Surrogate)	mg/kg	-	0.5	0.5	40 - 130	96

Soluble Anions (1:5) in Soil by Ion Chromatography

Method: ME-(AU)-[ENV]AN245

Sample Number		Parameter	Units	LOR	Result	Expected	Criteria %	Recovery %
LB117119.002		Chloride	mg/kg	0.25	97	100	70 - 130	97

Total Recoverable Metals in Soil/Waste Solids/Materials by ICPOES

Method: ME-(AU)-[ENV]AN040/AN320

Sample Number		Parameter	Units	LOR	Result	Expected	Criteria %	Recovery %
LB117335.002		Arsenic, As	mg/kg	3	49	50	80 - 120	98
		Cadmium, Cd	mg/kg	0.3	51	50	80 - 120	102
		Chromium, Cr	mg/kg	0.3	48	50	80 - 120	95
		Copper, Cu	mg/kg	0.5	47	50	80 - 120	93
		Lead, Pb	mg/kg	1	48	50	80 - 120	96
		Nickel, Ni	mg/kg	0.5	50	50	80 - 120	101
		Zinc, Zn	mg/kg	0.5	48	50	80 - 120	96
LB117336.002		Arsenic, As	mg/kg	3	49	50	80 - 120	97
		Cadmium, Cd	mg/kg	0.3	51	50	80 - 120	101
		Chromium, Cr	mg/kg	0.3	47	50	80 - 120	94
		Copper, Cu	mg/kg	0.5	46	50	80 - 120	93
		Lead, Pb	mg/kg	1	48	50	80 - 120	96
		Nickel, Ni	mg/kg	0.5	50	50	80 - 120	99
		Zinc, Zn	mg/kg	0.5	47	50	80 - 120	95
LB117337.002		Arsenic, As	mg/kg	3	48	50	80 - 120	96
		Cadmium, Cd	mg/kg	0.3	48	50	80 - 120	97
		Chromium, Cr	mg/kg	0.3	47	50	80 - 120	95
		Copper, Cu	mg/kg	0.5	47	50	80 - 120	95
		Lead, Pb	mg/kg	1	48	50	80 - 120	96
		Nickel, Ni	mg/kg	0.5	48	50	80 - 120	97
		Zinc, Zn	mg/kg	0.5	48	50	80 - 120	96

Laboratory Control Standard (LCS) results are evaluated against an expected result, typically the concentration of analyte spiked into the control during the sample preparation stage, producing a percentage recovery. The criteria applied to the percentage recovery is established in the SGS QA /QC plan (Ref: MP-(AU)-[ENV]QU-022). For more information refer to the footnotes in the concluding page of this report.

Recovery is shown in **Green** when within suggested criteria or **Red** with an appended dagger symbol (†) when outside suggested criteria.

Total Recoverable Metals in Soil/Waste Solids/Materials by ICPOES (continued)

Method: ME-(AU)-[ENV]AN040/AN320

Sample Number		Parameter	Units	LOR	Result	Expected	Criteria %	Recovery %
LB117337.002		Calcium, Ca	mg/kg	5	49	50	80 - 120	98
		Magnesium, Mg	mg/kg	5	48	50	80 - 120	95
		Sodium, Na	mg/kg	5	48	50	80 - 120	97
		Potassium, K	mg/kg	10	480	500	80 - 120	95

TRH (Total Recoverable Hydrocarbons) in Soil

Method: ME-(AU)-[ENV]AN403

Sample Number		Parameter	Units	LOR	Result	Expected	Criteria %	Recovery %
LB117067.002		TRH C10-C14	mg/kg	20	31	40	60 - 140	78
		TRH C15-C28	mg/kg	45	<45	40	60 - 140	85
		TRH C29-C36	mg/kg	45	<45	40	60 - 140	90
	TRH F Bands	TRH >C10-C16 (F2)	mg/kg	25	32	40	60 - 140	80
		TRH >C16-C34 (F3)	mg/kg	90	<90	40	60 - 140	98
		TRH >C34-C40 (F4)	mg/kg	120	<120	20	60 - 140	80

VOC's in Soil

Method: ME-(AU)-[ENV]AN433

Sample Number		Parameter	Units	LOR	Result	Expected	Criteria %	Recovery %
LB117101.002	Monocyclic Aromatic	Benzene	mg/kg	0.1	2.1	2.9	60 - 140	72
		Toluene	mg/kg	0.1	1.8	2.9	60 - 140	62
		Ethylbenzene	mg/kg	0.1	1.9	2.9	60 - 140	67
		m/p-xylene	mg/kg	0.2	4.7	5.8	60 - 140	82
		o-xylene	mg/kg	0.1	2.1	2.9	60 - 140	72
	Surrogates	Dibromofluoromethane (Surrogate)	mg/kg	-	4.6	5	60 - 140	92
		d4-1,2-dichloroethane (Surrogate)	mg/kg	-	5.2	5	60 - 140	104
		d8-toluene (Surrogate)	mg/kg	-	3.8	5	60 - 140	75
		Bromofluorobenzene (Surrogate)	mg/kg	-	5.2	5	60 - 140	103

Volatile Petroleum Hydrocarbons in Soil

Method: ME-(AU)-[ENV]AN433

Sample Number		Parameter	Units	LOR	Result	Expected	Criteria %	Recovery %
LB117101.002		TRH C6-C10	mg/kg	25	<25	24.65	60 - 140	88
		TRH C6-C9	mg/kg	20	<20	23.2	60 - 140	79
	Surrogates	Dibromofluoromethane (Surrogate)	mg/kg	-	4.6	5	60 - 140	92
		d4-1,2-dichloroethane (Surrogate)	mg/kg	-	5.2	5	60 - 140	104
		d8-toluene (Surrogate)	mg/kg	-	3.8	5	60 - 140	75
		Bromofluorobenzene (Surrogate)	mg/kg	-	5.2	5	60 - 140	103
	VPH F Bands	TRH C6-C10 minus BTEX (F1)	mg/kg	25	<25	7.25	60 - 140	123

Matrix Spike (MS) results are evaluated as the percentage recovery of an expected result, typically the concentration of analyte spiked into a field sub-sample during the sample preparation stage. The original sample's result is subtracted from the sub-sample result before determining the percentage recovery. The criteria applied to the percentage recovery is established in the SGS QA/QC plan (ref: MP-(AU)-[ENV]QU-022). For more information refer to the footnotes in the concluding page of this report.

Recovery is shown in **Green** when within suggested criteria or **Red** with an appended reason identifer when outside suggested criteria. Refer to the footnotes section at the end of this report for failure reasons.

Mercury in Soil

Method: ME-(AU)-[ENV]AN312

QC Sample	Sample Number		Parameter	Units	LOR	Result	Original	Spike	Recovery%
SE160956.005	LB117281.004		Mercury	mg/kg	0.05	0.21	<0.05	0.2	98

OC Pesticides in Soil

Method: ME-(AU)-[ENV]AN420

QC Sample	Sample Number		Parameter	Units	LOR	Result	Original	Spike	Recovery%
SE160957.028	LB117067.033		Hexachlorobenzene (HCB)	mg/kg	0.1	<0.1	<0.1	-	-
			Alpha BHC	mg/kg	0.1	<0.1	<0.1	-	-
			Lindane	mg/kg	0.1	<0.1	<0.1	-	-
			Heptachlor	mg/kg	0.1	0.2	<0.1	0.2	81
			Aldrin	mg/kg	0.1	0.2	<0.1	0.2	75
			Beta BHC	mg/kg	0.1	<0.1	<0.1	-	-
			Delta BHC	mg/kg	0.1	0.2	<0.1	0.2	83
			Heptachlor epoxide	mg/kg	0.1	<0.1	<0.1	-	-
			o,p'-DDE	mg/kg	0.1	<0.1	<0.1	-	-
			Alpha Endosulfan	mg/kg	0.2	<0.2	<0.2	-	-
			Gamma Chlordane	mg/kg	0.1	<0.1	<0.1	-	-
			Alpha Chlordane	mg/kg	0.1	<0.1	<0.1	-	-
			trans-Nonachlor	mg/kg	0.1	<0.1	<0.1	-	-
			p,p'-DDE	mg/kg	0.1	<0.1	<0.1	-	-
			Dieldrin	mg/kg	0.2	<0.2	<0.2	0.2	76
			Endrin	mg/kg	0.2	<0.2	<0.2	0.2	100
			o,p'-DDD	mg/kg	0.1	<0.1	<0.1	-	-
			o,p'-DDT	mg/kg	0.1	<0.1	<0.1	-	-
			Beta Endosulfan	mg/kg	0.2	<0.2	<0.2	-	-
			p,p'-DDD	mg/kg	0.1	<0.1	<0.1	-	-
			p,p'-DDT	mg/kg	0.1	0.2	<0.1	0.2	124
			Endosulfan sulphate	mg/kg	0.1	<0.1	<0.1	-	-
			Endrin Aldehyde	mg/kg	0.1	<0.1	<0.1	-	-
			Methoxychlor	mg/kg	0.1	<0.1	<0.1	-	-
			Endrin Ketone	mg/kg	0.1	<0.1	<0.1	-	-
			Isodrin	mg/kg	0.1	<0.1	<0.1	-	-
			Mirex	mg/kg	0.1	<0.1	<0.1	-	-
		Surrogates	Tetrachloro-m-xylene (TCMX) (Surrogate)	mg/kg	-	0.16	0.17	-	106

PAH (Polynuclear Aromatic Hydrocarbons) in Soil

Method: ME-(AU)-[ENV]AN420

QC Sample	Sample Number		Parameter	Units	LOR	Result	Original	Spike	Recovery%
SE160956.001	LB117067.031		Naphthalene	mg/kg	0.1	3.9	<0.1	4	98
			2-methylnaphthalene	mg/kg	0.1	<0.1	<0.1	-	-
			1-methylnaphthalene	mg/kg	0.1	<0.1	<0.1	-	-
			Acenaphthylene	mg/kg	0.1	3.9	<0.1	4	98
			Acenaphthene	mg/kg	0.1	4.2	<0.1	4	104
			Fluorene	mg/kg	0.1	<0.1	<0.1	-	-
			Phenanthrene	mg/kg	0.1	3.9	<0.1	4	97
			Anthracene	mg/kg	0.1	3.6	<0.1	4	90
			Fluoranthene	mg/kg	0.1	4.0	<0.1	4	100
			Pyrene	mg/kg	0.1	3.7	<0.1	4	92
			Benzo(a)anthracene	mg/kg	0.1	<0.1	<0.1	-	-
			Chrysene	mg/kg	0.1	<0.1	<0.1	-	-
			Benzo(b&j)fluoranthene	mg/kg	0.1	<0.1	<0.1	-	-
			Benzo(k)fluoranthene	mg/kg	0.1	<0.1	<0.1	-	-
			Benzo(a)pyrene	mg/kg	0.1	4.8	<0.1	4	121
			Indeno(1,2,3-cd)pyrene	mg/kg	0.1	<0.1	<0.1	-	-
			Dibenzo(ah)anthracene	mg/kg	0.1	<0.1	<0.1	-	-
			Benzo(ghi)perylene	mg/kg	0.1	<0.1	<0.1	-	-
			Carcinogenic PAHs, BaP TEQ <LOR=0	TEQ	0.2	4.8	<0.2	-	-
			Carcinogenic PAHs, BaP TEQ <LOR=LOR	TEQ (mg/kg)	0.3	5.0	<0.3	-	-
			Carcinogenic PAHs, BaP TEQ <LOR=LOR/2	TEQ (mg/kg)	0.2	4.9	<0.2	-	-
			Total PAH (18)	mg/kg	0.8	32	<0.8	-	-
		Surrogates	d5-nitrobenzene (Surrogate)	mg/kg	-	0.5	0.4	-	90
			2-fluorobiphenyl (Surrogate)	mg/kg	-	0.5	0.4	-	90

Matrix Spike (MS) results are evaluated as the percentage recovery of an expected result, typically the concentration of analyte spiked into a field sub -sample during the sample preparation stage. The original sample's result is subtracted from the sub-sample result before determining the percentage recovery. The criteria applied to the percentage recovery is established in the SGS QA/QC plan (ref: MP-(AU)-[ENV]QU-022). For more information refer to the footnotes in the concluding page of this report.

Recovery is shown in **Green** when within suggested criteria or **Red** with an appended reason identifer when outside suggested criteria. Refer to the footnotes section at the end of this report for failure reasons.

PAH (Polynuclear Aromatic Hydrocarbons) in Soil (continued) — Method: ME-(AU)-[ENV]AN420

QC Sample	Sample Number		Parameter	Units	LOR	Result	Original	Spike	Recovery%
SE160956.001	LB117067.031	Surrogates	d14-p-terphenyl (Surrogate)	mg/kg	-	0.5	0.4	-	94

Total Recoverable Metals in Soil/Waste Solids/Materials by ICPOES — Method: ME-(AU)-[ENV]AN040/AN320

QC Sample	Sample Number		Parameter	Units	LOR	Result	Original	Spike	Recovery%
SE160956.005	LB117335.004		Arsenic, As	mg/kg	3	42	<3	50	78
			Cadmium, Cd	mg/kg	0.3	42	<0.3	50	85
			Chromium, Cr	mg/kg	0.3	45	6.6	50	77
			Copper, Cu	mg/kg	0.5	57	19	50	76
			Lead, Pb	mg/kg	1	54	20	50	69 ⑨
			Nickel, Ni	mg/kg	0.5	43	4.9	50	77
			Zinc, Zn	mg/kg	0.5	51	15	50	72
SE160957.015	LB117336.004		Arsenic, As	mg/kg	3	30	<3	50	55 ⑨
			Cadmium, Cd	mg/kg	0.3	39	<0.3	50	77
			Chromium, Cr	mg/kg	0.3	84	50	50	67 ⑨
			Copper, Cu	mg/kg	0.5	55	17	50	76
			Lead, Pb	mg/kg	1	44	9	50	69 ⑨
			Nickel, Ni	mg/kg	0.5	70	34	50	73
			Zinc, Zn	mg/kg	0.5	69	31	50	76
SE160957.039	LB117337.004		Arsenic, As	mg/kg	3	44	<3	50	84
			Cadmium, Cd	mg/kg	0.3	44	<0.3	50	88
			Chromium, Cr	mg/kg	0.3	63	21	50	84
			Copper, Cu	mg/kg	0.5	52	6.0	50	92
			Lead, Pb	mg/kg	1	49	5	50	87
			Nickel, Ni	mg/kg	0.5	53	8.3	50	89
			Zinc, Zn	mg/kg	0.5	64	17	50	95

TRH (Total Recoverable Hydrocarbons) in Soil — Method: ME-(AU)-[ENV]AN403

QC Sample	Sample Number		Parameter	Units	LOR	Result	Original	Spike	Recovery%
SE160956.001	LB117067.032		TRH C10-C14	mg/kg	20	39	<20	40	98
			TRH C15-C28	mg/kg	45	<45	<45	40	110
			TRH C29-C36	mg/kg	45	<45	<45	40	98
			TRH C37-C40	mg/kg	100	<100	<100	-	-
			TRH C10-C36 Total	mg/kg	110	120	<110	-	-
			TRH C10-C40 Total	mg/kg	210	<210	<210	-	-
		TRH F Bands	TRH >C10-C16 (F2)	mg/kg	25	40	<25	40	100
			TRH >C10-C16 (F2) - Naphthalene	mg/kg	25	40	<25	-	-
			TRH >C16-C34 (F3)	mg/kg	90	<90	<90	40	113
			TRH >C34-C40 (F4)	mg/kg	120	<120	<120	-	-

VOC's in Soil — Method: ME-(AU)-[ENV]AN433

QC Sample	Sample Number		Parameter	Units	LOR	Result	Original	Spike	Recovery%
SE160957.027	LB117101.004	Monocyclic Aromatic	Benzene	mg/kg	0.1	2.1	<0.1	2.9	72
			Toluene	mg/kg	0.1	1.9	<0.1	2.9	66
			Ethylbenzene	mg/kg	0.1	1.9	<0.1	2.9	64
			m/p-xylene	mg/kg	0.2	4.7	<0.2	5.8	80
			o-xylene	mg/kg	0.1	2.1	<0.1	2.9	71
		Polycyclic	Naphthalene	mg/kg	0.1	<0.1	<0.1	-	-
		Surrogates	Dibromofluoromethane (Surrogate)	mg/kg	-	4.3	4.8	-	86
			d4-1,2-dichloroethane (Surrogate)	mg/kg	-	5.0	5.5	-	100
			d8-toluene (Surrogate)	mg/kg	-	3.7	4.0	-	73
			Bromofluorobenzene (Surrogate)	mg/kg	-	5.0	3.6	-	101
		Totals	Total Xylenes*	mg/kg	0.3	6.8	<0.3	-	-
			Total BTEX	mg/kg	0.6	13	<0.6	-	-

Volatile Petroleum Hydrocarbons in Soil — Method: ME-(AU)-[ENV]AN433

QC Sample	Sample Number		Parameter	Units	LOR	Result	Original	Spike	Recovery%
SE160957.027	LB117101.004		TRH C6-C10	mg/kg	25	<25	<25	24.65	85
			TRH C6-C9	mg/kg	20	<20	<20	23.2	79
		Surrogates	Dibromofluoromethane (Surrogate)	mg/kg	-	4.3	4.8	-	86
			d4-1,2-dichloroethane (Surrogate)	mg/kg	-	5.0	5.5	-	100
			d8-toluene (Surrogate)	mg/kg	-	3.7	4.0	-	73
			Bromofluorobenzene (Surrogate)	mg/kg	-	5.0	3.6	-	101
		VPH F	Benzene (F0)	mg/kg	0.1	2.1	<0.1	-	-

Matrix Spike (MS) results are evaluated as the percentage recovery of an expected result, typically the concentration of analyte spiked into a field sub -sample during the sample preparation stage. The original sample's result is subtracted from the sub-sample result before determining the percentage recovery. The criteria applied to the percentage recovery is established in the SGS QA/QC plan (ref: MP-(AU)-[ENV]QU-022). For more information refer to the footnotes in the concluding page of this report.

Recovery is shown in **Green** when within suggested criteria or **Red** with an appended reason identifer when outside suggested criteria. Refer to the footnotes section at the end of this report for failure reasons.

Volatile Petroleum Hydrocarbons in Soil (continued)

Method: ME-(AU)-[ENV]AN433

QC Sample	Sample Number		Parameter	Units	LOR	Result	Original	Spike	Recovery%
SE160957.027	LB117101.004	VPH F	TRH C6-C10 minus BTEX (F1)	mg/kg	25	<25	<25	7.25	117

Matrix spike duplicates are calculated as Relative Percent Difference (RPD) using the formula: RPD = | OriginalResult - ReplicateResult | x 100 / Mean

The original result is the analyte concentration of the matrix spike. The Duplicate result is the analyte concentration of the matrix spike duplicate.

The RPD is evaluated against the Maximum Allowable Difference (MAD) criteria and can be graphically represented by a curve calculated from the Statistical Detection Limit (SDL) and Limiting Repeatability (LR) using the formula: MAD = 100 x SDL / Mean + LR

Where the Maximum Allowable Difference evaluates to a number larger than 200 it is displayed as 200.

RPD is shown in **Green** when within suggested criteria or **Red** with an appended reason identifer when outside suggested criteria. Refer to the footnotes section at the end of this report for failure reasons.

No matrix spike duplicates were required for this job.

Samples analysed as received.

Solid samples expressed on a dry weight basis.

QC criteria are subject to internal review according to the SGS QA/QC plan and may be provided on request or alternatively can be found here: http://www.sgs.com.au/~/media/Local/Australia/Documents/Technical Documents/MP-AU-ENV-QU-022 QA QC Plan.pdf

*	NATA accreditation does not cover tthe performance of this service.
-	Sample not analysed for this analyte.
IS	Insufficient sample for analysis.
LNR	Sample listed, but not received.
LOR	Limit of reporting.
QFH	QC result is above the upper tolerance.
QFL	QC result is below the lower tolerance.

①	At least 2 of 3 surrogates are within acceptance criteria.
②	RPD failed acceptance criteria due to sample heterogeneity.
③	Results less than 5 times LOR preclude acceptance criteria for RPD.
④	Recovery failed acceptance criteria due to matrix interference.
⑤	Recovery failed acceptance criteria due to the presence of significant concentration of analyte (i.e. the concentration of analyte exceeds the spike level).
⑥	LOR was raised due to sample matrix interference.
⑦	LOR was raised due to dilution of significantly high concentration of analyte in sample.
⑧	Reanalysis of sample in duplicate confirmed sample heterogeneity and inconsistency of results.
⑨	Recovery failed acceptance criteria due to sample heterogeneity.
⑩	LOR was raised due to high conductivity of the sample (required dilution).
†	Refer to Analytical Report comments for further information.

Chain of Custody Form – Ref 7891

Ref: **7891**
Investigator: Envirowest Consulting, 9 Cameron Place, PO Box 8158, ORANGE NSW 2800
Telephone: (02) 6361 4954
Facsimile: (02) 6360 3960
Email: ashleigh@envirowest.net.au
Contact Person: Ashleigh Pickering
Invoice: accounts@envirowest.net.au

Laboratory: SGS SYDNEY, 16/33 Maddox Street, ALEXANDRIA NSW 2015
Quotation #:
Courier/CN:

Sample ID	Container*	Sampling Date/Time	Sample matrix: Water	Soil	Sludge	Sample preservation: Cool	HNO3/HCl	Unpre-served	Analysis (SGS Method Code CL1): 7 Metals	OC Pesticides	CL10: TRH/BTEXN/PAH/ 8 metals		
SR1	A	11/01/2017		X		X		X	X				
SR2	A	11/01/2017		X		X		X	X				
SR3	A	11/01/2017		X		X		X	X				
SR4	A	11/01/2017		X		X		X	X				
SR5	A	11/01/2017		X		X		X	X				
SR6	A	11/01/2017		X		X		X	X				
SR7	A	11/01/2017		X		X		X	X				
SR8	A	11/01/2017		X		X		X	X				
SR9	A	11/01/2017		X		X		X	X				
SR10	A	11/01/2017		X		X		X	X				
SR11	A	11/01/2017		X		X		X	X				
SR12	A	11/01/2017		X		X		X	X				
SR13	A	11/01/2017		X		X		X	X				
SR14	A	11/01/2017		X		X		X	X				
SR15	A	11/01/2017		X		X		X	X				

SGS EHS Alexandria Laboratory
SE160957 COC
Received: 17 – Jan – 2017

Investigator: I attest that the proper field sampling procedures were used during the collection of these samples.

Sampler name: Ashleigh Pickering
Date : 11 & 12/01/2017 Time:

Relinquished by: (print and signature) Ashleigh Pickering — Date 16/01/2017 — Time 17:00

Received by: (print and signature) — Date 17/01/17 — Time @ 11.40

Please return completed form to Envirowest Consulting, *A = Solvent rinsed glass jar with Teflon lined lid and orange label

Chain of Custody Form – Ref 7891

Ref:	**7891**	**Sample matrix**	**Sample preservation**
Investigator:	Envirowest Consulting 9 Cameron Place PO Box 8158 ORANGE NSW 2800		
Telephone:	(02) 6361 4954		
Facsimile:	(02) 6360 3960		
Email:	ashleigh@envirowest.net.au		
Contact Person:	Ashleigh Pickering		
Invoice:	accounts@envirowest.net.au		
Laboratory:	SGS SYDNEY 16/33 Maddox Street ALEXANDRIA NSW 2015		
Quotation #:			
Courier/CN:			

Analysis

Sample ID	Container*	Sampling Date/Time	Water	Soil	Sludge	Cool	HNO3/HCl	Unpre-served	SGS Method Code: CL1 — 7 Metals	OC Pesticides	CL10 — TRH/BTEXN/PAH/ 8 metals		
SR16	A	11/01/2017		X		X		X	X				
SR17	A	11/01/2017		X		X		X	X				
SR18	A	11/01/2017		X		X		X	X				
SR19	A	11/01/2017		X		X		X	X				
SR20	A	11/01/2017		X		X		X	X				
SR21	A	11/01/2017		X		X		X	X				
SR22	A	11/01/2017		X		X		X	X				
SR23	A	11/01/2017		X		X		X	X				
SR24	A	11/01/2017		X		X		X	X				
SR25	A	11/01/2017		X		X		X	X				
SR26	A	11/01/2017		X		X		X	X				
SR27	A	11/01/2017		X		X		X		X	X		
SR28	A	11/01/2017		X		X		X		X	X		
SR29	A	11/01/2017		X		X		X		X	X		
SR30	A	11/01/2017		X		X		X		X	X		

Investigator: I attest that the proper field sampling procedures were used during the collection of these samples.	Sampler name: Ashleigh Pickering Date : 11 & 12/01/2017 Time:
Relinquished by: (print and signature) Ashleigh Pickering [signature] Date 16/01/2017 Time 17:00	Received by: (print and signature) [signature] Date 17/1/17 Time 11:40

Please return completed form to Envirowest Consulting, *A = Solvent rinsed glass jar with Teflon lined lid and orange label

Chain of Custody Form – Ref 7891

Ref:	**7891**
Investigator:	Envirowest Consulting 9 Cameron Place PO Box 8158 ORANGE NSW 2800
Telephone:	(02) 6361 4954
Facsimile:	(02) 6360 3960
Email:	ashleigh@envirowest.net.au
Contact Person:	Ashleigh Pickering
Invoice:	accounts@envirowest.net.au
Laboratory:	SGS SYDNEY 16/33 Maddox Street ALEXANDRIA NSW 2015
Quotation #:	
Courier/CN:	

			Sample matrix			**Sample preservation**			**Analysis**					
									SGS Method Code					
									CL1		**CL10**			
Sample ID	**Container***	**Sampling Date/Time**	Water	Soil	Sludge	Cool	HNO3/HCl	Unpre-served	7 Metals	OC Pesticides	TRH/BTEXN/PAH/ 8 metals	Chlorides	Cations	Exchangeable sodium percentage
SR31	A	11/01/2017		X		X		X		X	X			
SR32	A	12/02/2017		X		X		X		X	X			
SR33	A	12/02/2017		X		X		X		X	X			
SR73	A	11/01/2017		X		X		X		X				
SR91	A	11/01/2017		X		X		X		X				
SR113	A	11/01/2017		X		X		X		X				
SR184	A	11/01/2017		X		X		X		X				
SR224	A	11/01/2017		X		X		X		X				
SRA	A	11/01/2017		X		X		X	X					
SRB	A	11/01/2017		X		X		X	X					
BH16-100	A	11/01/2017		X		X		X				X	X	X
BH16-1500	A	11/01/2017		X		X		X				X	X	X

Investigator: I attest that the proper field sampling procedures were used during the collection of these samples.	Sampler name: Ashleigh Pickering Date : 11 & 12/01/2017 Time:
Relinquished by: (print and signature) Ashleigh Pickering [signature] Date 16/01/2017 Time 17:00	Received by: (print and signature) [signature] Date 17/01/17 Time 11:40

Please return completed form to Envirowest Consulting, *A = Solvent rinsed glass jar with Teflon lined lid and orange label

ANALYTICAL REPORT

Accreditation No. 2562

CLIENT DETAILS		LABORATORY DETAILS	
Contact	Ashleigh Pickering	Manager	Huong Crawford
Client	ENVIROWEST CONSULTING PTY LIMITED	Laboratory	SGS Alexandria Environmental
Address	PO BOX 8158 ORANGE NSW 2800	Address	Unit 16, 33 Maddox St Alexandria NSW 2015
Telephone	61 2 63614954	Telephone	+61 2 8594 0400
Facsimile	(Not specified)	Facsimile	+61 2 8594 0499
Email	ashleigh@envirowest.net.au	Email	au.environmental.sydney@sgs.com
Project	**7891-1**	SGS Reference	**SE162373 R0**
Order Number	(Not specified)	Date Received	24/2/2017
Samples	7	Date Reported	3/3/2017

COMMENTS

Accredited for compliance with ISO/IEC 17025. NATA accredited laboratory 2562(4354).

SIGNATORIES

Bennet Lo
Senior Organic Chemist/Metals Chemist

Ly Kim Ha
Organic Section Head

OC Pesticides in Soil [AN420] Tested: 27/2/2017

PARAMETER	UOM	LOR	SR201 SOIL - 22/2/2017 SE162373.001	SR202 SOIL - 22/2/2017 SE162373.002	SR203 SOIL - 22/2/2017 SE162373.003	SR204 SOIL - 22/2/2017 SE162373.004	SRV301 SOIL - 22/2/2017 SE162373.005
Hexachlorobenzene (HCB)	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Alpha BHC	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Lindane	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Heptachlor	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Aldrin	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Beta BHC	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Delta BHC	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Heptachlor epoxide	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
o,p'-DDE	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Alpha Endosulfan	mg/kg	0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Gamma Chlordane	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Alpha Chlordane	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
trans-Nonachlor	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
p,p'-DDE	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Dieldrin	mg/kg	0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Endrin	mg/kg	0.2	<0.2	<0.2	<0.2	<0.2	<0.2
o,p'-DDD	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
o,p'-DDT	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Beta Endosulfan	mg/kg	0.2	<0.2	<0.2	<0.2	<0.2	<0.2
p,p'-DDD	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
p,p'-DDT	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Endosulfan sulphate	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Endrin Aldehyde	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Methoxychlor	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Endrin Ketone	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Isodrin	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Mirex	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1

OC Pesticides in Soil [AN420] Tested: 27/2/2017 (continued)

PARAMETER	UOM	LOR	SRV302 SOIL - 22/2/2017 SE162373.006	SRV303 SOIL - 22/2/2017 SE162373.007
Hexachlorobenzene (HCB)	mg/kg	0.1	<0.1	<0.1
Alpha BHC	mg/kg	0.1	<0.1	<0.1
Lindane	mg/kg	0.1	<0.1	<0.1
Heptachlor	mg/kg	0.1	<0.1	<0.1
Aldrin	mg/kg	0.1	<0.1	<0.1
Beta BHC	mg/kg	0.1	<0.1	<0.1
Delta BHC	mg/kg	0.1	<0.1	<0.1
Heptachlor epoxide	mg/kg	0.1	<0.1	<0.1
o,p'-DDE	mg/kg	0.1	<0.1	<0.1
Alpha Endosulfan	mg/kg	0.2	<0.2	<0.2
Gamma Chlordane	mg/kg	0.1	<0.1	<0.1
Alpha Chlordane	mg/kg	0.1	<0.1	<0.1
trans-Nonachlor	mg/kg	0.1	<0.1	<0.1
p,p'-DDE	mg/kg	0.1	<0.1	<0.1
Dieldrin	mg/kg	0.2	<0.2	<0.2
Endrin	mg/kg	0.2	<0.2	<0.2
o,p'-DDD	mg/kg	0.1	<0.1	<0.1
o,p'-DDT	mg/kg	0.1	<0.1	<0.1
Beta Endosulfan	mg/kg	0.2	<0.2	<0.2
p,p'-DDD	mg/kg	0.1	<0.1	<0.1
p,p'-DDT	mg/kg	0.1	<0.1	<0.1
Endosulfan sulphate	mg/kg	0.1	<0.1	<0.1
Endrin Aldehyde	mg/kg	0.1	<0.1	<0.1
Methoxychlor	mg/kg	0.1	<0.1	<0.1
Endrin Ketone	mg/kg	0.1	<0.1	<0.1
Isodrin	mg/kg	0.1	<0.1	<0.1
Mirex	mg/kg	0.1	<0.1	<0.1

Total Recoverable Metals in Soil/Waste Solids/Materials by ICPOES [AN040/AN320] Tested: 2/3/2017

PARAMETER	UOM	LOR	SR201 SOIL - 22/2/2017 SE162373.001	SR202 SOIL - 22/2/2017 SE162373.002	SR203 SOIL - 22/2/2017 SE162373.003	SR204 SOIL - 22/2/2017 SE162373.004	SRV301 SOIL - 22/2/2017 SE162373.005
Arsenic, As	mg/kg	1	3	3	3	3	3
Cadmium, Cd	mg/kg	0.3	0.4	0.4	0.4	0.4	0.5
Chromium, Cr	mg/kg	0.5	47	51	60	52	75
Copper, Cu	mg/kg	0.5	21	22	20	15	25
Lead, Pb	mg/kg	1	17	19	13	16	11
Nickel, Ni	mg/kg	0.5	42	38	49	31	55
Zinc, Zn	mg/kg	2	55	80	23	48	51

PARAMETER	UOM	LOR	SRV302 SOIL - 22/2/2017 SE162373.006	SRV303 SOIL - 22/2/2017 SE162373.007
Arsenic, As	mg/kg	1	3	3
Cadmium, Cd	mg/kg	0.3	0.5	0.5
Chromium, Cr	mg/kg	0.5	77	76
Copper, Cu	mg/kg	0.5	25	26
Lead, Pb	mg/kg	1	11	11
Nickel, Ni	mg/kg	0.5	55	57
Zinc, Zn	mg/kg	2	49	53

Moisture Content [AN002] Tested: 27/2/2017

PARAMETER	UOM	LOR	SR201 SOIL - 22/2/2017 SE162373.001	SR202 SOIL - 22/2/2017 SE162373.002	SR203 SOIL - 22/2/2017 SE162373.003	SR204 SOIL - 22/2/2017 SE162373.004	SRV301 SOIL - 22/2/2017 SE162373.005
% Moisture	%w/w	1	2.4	7.9	4.6	2.5	7.1
% Total Solids	%w/w	1	97.6	92.1	95.4	97.5	92.9

PARAMETER	UOM	LOR	SRV302 SOIL - 22/2/2017 SE162373.006	SRV303 SOIL - 22/2/2017 SE162373.007
% Moisture	%w/w	1	7.3	7.5
% Total Solids	%w/w	1	92.7	92.5

METHOD	METHODOLOGY SUMMARY
AN002	The test is carried out by drying (at either 40°C or 105°C) a known mass of sample in a weighed evaporating basin. After fully dry the sample is re-weighed. Samples such as sludge and sediment having high percentages of moisture will take some time in a drying oven for complete removal of water.
AN040/AN320	A portion of sample is digested with nitric acid to decompose organic matter and hydrochloric acid to complete the digestion of metals. The digest is then analysed by ICP OES with metals results reported on the dried sample basis. Based on USEPA method 200.8 and 6010C.
AN040	A portion of sample is digested with Nitric acid to decompose organic matter and Hydrochloric acid to complete the digestion of metals and then filtered for analysis by ASS or ICP as per USEPA Method 200.8.
AN420	SVOC Compounds: Semi-Volatile Organic Compounds (SVOCs) including OC, OP, PCB, Herbicides, PAH, Phthalates and Speciated Phenols in soils, sediments and waters are determined by GCMS/ECD technique following appropriate solvent extraction process (Based on USEPA 3500C and 8270D).

FOOTNOTES

*	NATA accreditation does not cover the performance of this service.	-	Not analysed.	UOM	Unit of Measure.
**	Indicative data, theoretical holding time exceeded.	NVL	Not validated.	LOR	Limit of Reporting.
		IS	Insufficient sample for analysis.	↑↓	Raised/lowered Limit of Reporting.
		LNR	Sample listed, but not received.		

Samples analysed as received.
Solid samples expressed on a dry weight basis.

Where "Total" analyte groups are reported (for example, Total PAHs, Total OC Pesticides) the total will be calculated as the sum of the individual analytes, with those analytes that are reported as <LOR being assumed to be zero. The summed (Total) limit of reporting is calculated by summing the individual analyte LORs and dividing by two. For example, where 16 individual analytes are being summed and each has an LOR of 0.1 mg/kg, the "Totals" LOR will be 1.6 / 2 (0.8 mg/kg). Where only 2 analytes are being summed, the " Total" LOR will be the sum of those two LORs.

Some totals may not appear to add up because the total is rounded after adding up the raw values.

If reported, measurement uncertainty follow the ± sign after the analytical result and is expressed as the expanded uncertainty calculated using a coverage factor of 2, providing a level of confidence of approximately 95%, unless stated otherwise in the comments section of this report.

Results reported for samples tested under test methods with codes starting with ARS-SOP, radionuclide or gross radioactivity concentrations are expressed in becquerel (Bq) per unit of mass or volume or per wipe as stated on the report. Becquerel is the SI unit for activity and equals one nuclear transformation per second.
Note that in terms of units of radioactivity:

a. 1 Bq is equivalent to 27 pCi
b. 37 MBq is equivalent to 1 mCi

For results reported for samples tested under test methods with codes starting with ARS-SOP, less than (<) values indicate the detection limit for each radionuclide or parameter for the measurement system used. The respective detection limits have been calculated in accordance with ISO 11929.

The QC criteria are subject to internal review according to the SGS QAQC plan and may be provided on request or alternatively can be found here : http://www.sgs.com.au/~/media/Local/Australia/Documents/Technical%20Documents/MP-AU-ENV-QU-022%20QA%20QC%20Plan.pdf

STATEMENT OF QA/QC PERFORMANCE

SE162373 R0

CLIENT DETAILS

Contact	Ashleigh Pickering	Manager	Huong Crawford
Client	ENVIROWEST CONSULTING PTY LIMITED	Laboratory	SGS Alexandria Environmental
Address	PO BOX 8158 ORANGE NSW 2800	Address	Unit 16, 33 Maddox St Alexandria NSW 2015
Telephone	61 2 63614954	Telephone	+61 2 8594 0400
Facsimile	(Not specified)	Facsimile	+61 2 8594 0499
Email	ashleigh@envirowest.net.au	Email	au.environmental.sydney@sgs.com
Project	**7891-1**	SGS Reference	**SE162373 R0**
Order Number	(Not specified)	Date Received	24 Feb 2017
Samples	7	Date Reported	03 Mar 2017

LABORATORY DETAILS (right columns)

COMMENTS

All the laboratory data for each environmental matrix was compared to SGS' stated Data Quality Objectives (DQO). Comments arising from the comparison were made and are reported below.

The data relating to sampling was taken from the Chain of Custody document and was supplied by the Client.
This QA/QC Statement must be read in conjunction with the referenced Analytical Report.
The Statement and the Analytical Report must not be reproduced except in full.

All Data Quality Objectives were met with the exception of the following:

Matrix Spike	Total Recoverable Metals in Soil/Waste Solids/Materials by ICPOES	1 item

SAMPLE SUMMARY

Samples clearly labelled	Yes	Complete documentation received	Yes
Sample container provider	SGS	Sample cooling method	Ice Bricks
Samples received in correct containers	Yes	Sample counts by matrix	7 Soil
Date documentation received	24/2/2017	Type of documentation received	COC
Samples received in good order	Yes	Samples received without headspace	Yes
Sample temperature upon receipt	16.1°C	Sufficient sample for analysis	Yes
Turnaround time requested	Standard		

SGS holding time criteria are drawn from current regulations and are highly dependent on sample container preservation as specified in the SGS "Field Sampling Guide for Containers and Holding Time" (ref: GU-(AU)-ENV.001). Soil samples guidelines are derived from NEPM "Schedule B(3) Guideline on Laboratory Analysis of Potentially Contaminated Soils". Water sample guidelines are derived from "AS/NZS 5667.1 : 1998 Water Quality - sampling part 1" and APHA "Standard Methods for the Examination of Water and Wastewater" 21st edition 2005.

Extraction and analysis holding time due dates listed are calculated from the date sampled, although holding times may be extended after laboratory extraction for some analytes. The due dates are the suggested dates that samples may be held before extraction or analysis and still be considered valid.

Extraction and analysis dates are shown in **Green** when within suggested criteria or **Red** with an appended dagger symbol (†) when outside suggested criteria. If the sampled date is not supplied then compliance with criteria cannot be determined. If the received date is after one or both due dates then holding time will fail by default.

Moisture Content — Method: ME-(AU)-[ENV]AN002

Sample Name	Sample No.	QC Ref	Sampled	Received	Extraction Due	Extracted	Analysis Due	Analysed
SR201	SE162373.001	LB119431	22 Feb 2017	24 Feb 2017	08 Mar 2017	27 Feb 2017	04 Mar 2017	28 Feb 2017
SR202	SE162373.002	LB119431	22 Feb 2017	24 Feb 2017	08 Mar 2017	27 Feb 2017	04 Mar 2017	28 Feb 2017
SR203	SE162373.003	LB119431	22 Feb 2017	24 Feb 2017	08 Mar 2017	27 Feb 2017	04 Mar 2017	28 Feb 2017
SR204	SE162373.004	LB119431	22 Feb 2017	24 Feb 2017	08 Mar 2017	27 Feb 2017	04 Mar 2017	28 Feb 2017
SRV301	SE162373.005	LB119431	22 Feb 2017	24 Feb 2017	08 Mar 2017	27 Feb 2017	04 Mar 2017	28 Feb 2017
SRV302	SE162373.006	LB119431	22 Feb 2017	24 Feb 2017	08 Mar 2017	27 Feb 2017	04 Mar 2017	28 Feb 2017
SRV303	SE162373.007	LB119431	22 Feb 2017	24 Feb 2017	08 Mar 2017	27 Feb 2017	04 Mar 2017	28 Feb 2017

OC Pesticides in Soil — Method: ME-(AU)-[ENV]AN420

Sample Name	Sample No.	QC Ref	Sampled	Received	Extraction Due	Extracted	Analysis Due	Analysed
SR201	SE162373.001	LB119368	22 Feb 2017	24 Feb 2017	08 Mar 2017	27 Feb 2017	08 Apr 2017	01 Mar 2017
SR202	SE162373.002	LB119368	22 Feb 2017	24 Feb 2017	08 Mar 2017	27 Feb 2017	08 Apr 2017	01 Mar 2017
SR203	SE162373.003	LB119368	22 Feb 2017	24 Feb 2017	08 Mar 2017	27 Feb 2017	08 Apr 2017	02 Mar 2017
SR204	SE162373.004	LB119368	22 Feb 2017	24 Feb 2017	08 Mar 2017	27 Feb 2017	08 Apr 2017	02 Mar 2017
SRV301	SE162373.005	LB119368	22 Feb 2017	24 Feb 2017	08 Mar 2017	27 Feb 2017	08 Apr 2017	02 Mar 2017
SRV302	SE162373.006	LB119368	22 Feb 2017	24 Feb 2017	08 Mar 2017	27 Feb 2017	08 Apr 2017	02 Mar 2017
SRV303	SE162373.007	LB119368	22 Feb 2017	24 Feb 2017	08 Mar 2017	27 Feb 2017	08 Apr 2017	02 Mar 2017

Total Recoverable Metals in Soil/Waste Solids/Materials by ICPOES — Method: ME-(AU)-[ENV]AN040/AN320

Sample Name	Sample No.	QC Ref	Sampled	Received	Extraction Due	Extracted	Analysis Due	Analysed
SR201	SE162373.001	LB119680	22 Feb 2017	24 Feb 2017	21 Aug 2017	02 Mar 2017	21 Aug 2017	03 Mar 2017
SR202	SE162373.002	LB119680	22 Feb 2017	24 Feb 2017	21 Aug 2017	02 Mar 2017	21 Aug 2017	03 Mar 2017
SR203	SE162373.003	LB119681	22 Feb 2017	24 Feb 2017	21 Aug 2017	02 Mar 2017	21 Aug 2017	03 Mar 2017
SR204	SE162373.004	LB119681	22 Feb 2017	24 Feb 2017	21 Aug 2017	02 Mar 2017	21 Aug 2017	03 Mar 2017
SRV301	SE162373.005	LB119681	22 Feb 2017	24 Feb 2017	21 Aug 2017	02 Mar 2017	21 Aug 2017	03 Mar 2017
SRV302	SE162373.006	LB119681	22 Feb 2017	24 Feb 2017	21 Aug 2017	02 Mar 2017	21 Aug 2017	03 Mar 2017
SRV303	SE162373.007	LB119681	22 Feb 2017	24 Feb 2017	21 Aug 2017	02 Mar 2017	21 Aug 2017	03 Mar 2017

Surrogate results are evaluated against upper and lower limit criteria established in the SGS QA/QC plan (Ref: MP-(AU)-[ENV]QU-022). At least two of three routine level soil sample surrogate spike recoveries for BTEX/VOC are to be within 70-130% where control charts have not been developed and within the established control limits for charted surrogates. Matrix effects may void this as an acceptance criterion. Water sample surrogate spike recoveries are to be within 40-130%. The presence of emulsions, surfactants and particulates may void this as an acceptance criterion.

Result is shown in **Green** when within suggested criteria or **Red** with an appended reason identifer when outside suggested criteria. Refer to the footnotes section at the end of this report for failure reasons.

OC Pesticides in Soil

Method: ME-(AU)-[ENV]AN420

Parameter	Sample Name	Sample Number	Units	Criteria	Recovery %
Tetrachloro-m-xylene (TCMX) (Surrogate)	SR201	SE162373.001	%	60 - 130%	73
	SR202	SE162373.002	%	60 - 130%	73
	SR203	SE162373.003	%	60 - 130%	79
	SR204	SE162373.004	%	60 - 130%	73
	SRV301	SE162373.005	%	60 - 130%	77
	SRV302	SE162373.006	%	60 - 130%	77
	SRV303	SE162373.007	%	60 - 130%	75

Blank results are evaluated against the limit of reporting (LOR), for the chosen method and its associated instrumentation, typically 2.5 times the statistically determined method detection limit (MDL).

Result is shown in **Green** when within suggested criteria or **Red** with an appended dagger symbol (†) when outside suggested criteria.

OC Pesticides in Soil

Method: ME-(AU)-[ENV]AN420

Sample Number		Parameter	Units	LOR	Result
LB119368.001		Hexachlorobenzene (HCB)	mg/kg	0.1	<0.1
		Alpha BHC	mg/kg	0.1	<0.1
		Lindane	mg/kg	0.1	<0.1
		Heptachlor	mg/kg	0.1	<0.1
		Aldrin	mg/kg	0.1	<0.1
		Beta BHC	mg/kg	0.1	<0.1
		Delta BHC	mg/kg	0.1	<0.1
		Heptachlor epoxide	mg/kg	0.1	<0.1
		Alpha Endosulfan	mg/kg	0.2	<0.2
		Gamma Chlordane	mg/kg	0.1	<0.1
		Alpha Chlordane	mg/kg	0.1	<0.1
		p,p'-DDE	mg/kg	0.1	<0.1
		Dieldrin	mg/kg	0.2	<0.2
		Endrin	mg/kg	0.2	<0.2
		Beta Endosulfan	mg/kg	0.2	<0.2
		p,p'-DDD	mg/kg	0.1	<0.1
		p,p'-DDT	mg/kg	0.1	<0.1
		Endosulfan sulphate	mg/kg	0.1	<0.1
		Endrin Aldehyde	mg/kg	0.1	<0.1
		Methoxychlor	mg/kg	0.1	<0.1
		Endrin Ketone	mg/kg	0.1	<0.1
		Isodrin	mg/kg	0.1	<0.1
		Mirex	mg/kg	0.1	<0.1
	Surrogates	Tetrachloro-m-xylene (TCMX) (Surrogate)	%	-	72

Total Recoverable Metals in Soil/Waste Solids/Materials by ICPOES

Method: ME-(AU)-[ENV]AN040/AN320

Sample Number	Parameter	Units	LOR	Result
LB119680.001	Arsenic, As	mg/kg	1	<1
	Cadmium, Cd	mg/kg	0.3	<0.3
	Chromium, Cr	mg/kg	0.5	<0.5
	Copper, Cu	mg/kg	0.5	<0.5
	Lead, Pb	mg/kg	1	<1
	Nickel, Ni	mg/kg	0.5	<0.5
	Zinc, Zn	mg/kg	2	<2
LB119681.001	Arsenic, As	mg/kg	1	<1
	Cadmium, Cd	mg/kg	0.3	<0.3
	Chromium, Cr	mg/kg	0.5	<0.5
	Copper, Cu	mg/kg	0.5	<0.5
	Lead, Pb	mg/kg	1	<1
	Nickel, Ni	mg/kg	0.5	<0.5
	Zinc, Zn	mg/kg	2	<2

Duplicates are calculated as Relative Percentage Difference (RPD) using the formula: RPD = | OriginalResult - ReplicateResult | x 100 / Mean

The RPD is evaluated against the Maximum Allowable Difference (MAD) criteria and can be graphically represented by a curve calculated from the Statistical Detection Limit (SDL) and Limiting Repeatability (LR) using the formula: MAD = 100 x SDL / Mean + LR

Where the Maximum Allowable Difference evaluates to a number larger than 200 it is displayed as 200.

RPD is shown in **Green** when within suggested criteria or **Red** with an appended reason identifer when outside suggested criteria. Refer to the footnotes section at the end of this report for failure reasons.

Moisture Content — Method: ME-(AU)-[ENV]AN002

Original	Duplicate	Parameter	Units	LOR	Original	Duplicate	Criteria %	RPD %
SE162369.003	LB119431.011	% Moisture	%w/w	1	3.2670454545	3.1645569620	61	3
SE162373.003	LB119431.022	% Moisture	%w/w	1	4.6	4.5	52	1
SE162375.003	LB119431.033	% Moisture	%w/w	1	4.9	4.2	52	17
SE162383.003	LB119431.044	% Moisture	%w/w	1	11	12	39	3
SE162383.012	LB119431.054	% Moisture	%w/w	1	8.4	8.9	42	5

OC Pesticides in Soil — Method: ME-(AU)-[ENV]AN420

Original	Duplicate		Parameter	Units	LOR	Original	Duplicate	Criteria %	RPD %
SE162373.006	LB119368.025		Hexachlorobenzene (HCB)	mg/kg	0.1	<0.1	0	200	0
			Alpha BHC	mg/kg	0.1	<0.1	0	200	0
			Lindane	mg/kg	0.1	<0.1	0	200	0
			Heptachlor	mg/kg	0.1	<0.1	0	200	0
			Aldrin	mg/kg	0.1	<0.1	0	200	0
			Beta BHC	mg/kg	0.1	<0.1	0	200	0
			Delta BHC	mg/kg	0.1	<0.1	0	200	0
			Heptachlor epoxide	mg/kg	0.1	<0.1	0	200	0
			o,p'-DDE	mg/kg	0.1	<0.1	0	200	0
			Alpha Endosulfan	mg/kg	0.2	<0.2	0	200	0
			Gamma Chlordane	mg/kg	0.1	<0.1	0	200	0
			Alpha Chlordane	mg/kg	0.1	<0.1	0	200	0
			trans-Nonachlor	mg/kg	0.1	<0.1	0	200	0
			p,p'-DDE	mg/kg	0.1	<0.1	0	200	0
			Dieldrin	mg/kg	0.2	<0.2	0	200	0
			Endrin	mg/kg	0.2	<0.2	0	200	0
			o,p'-DDD	mg/kg	0.1	<0.1	0	200	0
			o,p'-DDT	mg/kg	0.1	<0.1	0	200	0
			Beta Endosulfan	mg/kg	0.2	<0.2	0	200	0
			p,p'-DDD	mg/kg	0.1	<0.1	0	200	0
			p,p'-DDT	mg/kg	0.1	<0.1	0	200	0
			Endosulfan sulphate	mg/kg	0.1	<0.1	0	200	0
			Endrin Aldehyde	mg/kg	0.1	<0.1	0	200	0
			Methoxychlor	mg/kg	0.1	<0.1	0	200	0
			Endrin Ketone	mg/kg	0.1	<0.1	0	200	0
			Isodrin	mg/kg	0.1	<0.1	0	200	0
			Mirex	mg/kg	0.1	<0.1	0	200	0
		Surrogates	Tetrachloro-m-xylene (TCMX) (Surrogate)	mg/kg	-	0.12	0.112	30	3
SE162376.005	LB119368.023		Hexachlorobenzene (HCB)	mg/kg	0.1	0	0	200	0
			Alpha BHC	mg/kg	0.1	0	0	200	0
			Lindane	mg/kg	0.1	0	0	200	0
			Heptachlor	mg/kg	0.1	0	0	200	0
			Aldrin	mg/kg	0.1	0	0	200	0
			Beta BHC	mg/kg	0.1	0	0	200	0
			Delta BHC	mg/kg	0.1	0	0	200	0
			Heptachlor epoxide	mg/kg	0.1	0	0	200	0
			o,p'-DDE	mg/kg	0.1	0	0	200	0
			Alpha Endosulfan	mg/kg	0.2	0	0	200	0
			Gamma Chlordane	mg/kg	0.1	0	0	200	0
			Alpha Chlordane	mg/kg	0.1	0	0	200	0
			trans-Nonachlor	mg/kg	0.1	0	0	200	0
			p,p'-DDE	mg/kg	0.1	0	0	200	0
			Dieldrin	mg/kg	0.2	0	0	200	0
			Endrin	mg/kg	0.2	0	0	200	0
			o,p'-DDD	mg/kg	0.1	0	0	200	0
			o,p'-DDT	mg/kg	0.1	0	0	200	0
			Beta Endosulfan	mg/kg	0.2	0	0	200	0
			p,p'-DDD	mg/kg	0.1	0	0	200	0
			p,p'-DDT	mg/kg	0.1	0	0	200	0
			Endosulfan sulphate	mg/kg	0.1	0	0	200	0
			Endrin Aldehyde	mg/kg	0.1	0	0	200	0
			Methoxychlor	mg/kg	0.1	0	0	200	0
			Endrin Ketone	mg/kg	0.1	0	0	200	0

Duplicates are calculated as Relative Percentage Difference (RPD) using the formula: RPD = | OriginalResult - ReplicateResult | x 100 / Mean

The RPD is evaluated against the Maximum Allowable Difference (MAD) criteria and can be graphically represented by a curve calculated from the Statistical Detection Limit (SDL) and Limiting Repeatability (LR) using the formula: MAD = 100 x SDL / Mean + LR

Where the Maximum Allowable Difference evaluates to a number larger than 200 it is displayed as 200.

RPD is shown in **Green** when within suggested criteria or **Red** with an appended reason identifer when outside suggested criteria. Refer to the footnotes section at the end of this report for failure reasons.

OC Pesticides in Soil (continued) — Method: ME-(AU)-[ENV]AN420

Original	Duplicate		Parameter	Units	LOR	Original	Duplicate	Criteria %	RPD %
SE162376.005	LB119368.023		Isodrin	mg/kg	0.1	0	0	200	0
			Mirex	mg/kg	0.1	0	0	200	0
		Surrogates	Tetrachloro-m-xylene (TCMX) (Surrogate)	mg/kg	-	0.106	0.107	30	1

Total Recoverable Metals in Soil/Waste Solids/Materials by ICPOES — Method: ME-(AU)-[ENV]AN040/AN320

Original	Duplicate	Parameter	Units	LOR	Original	Duplicate	Criteria %	RPD %
SE162369.006	LB119680.014	Arsenic, As	mg/kg	1	1.9479789778	1.8356576075	83	6
		Cadmium, Cd	mg/kg	0.3	0.0797130935	0.0612904053	200	0
		Chromium, Cr	mg/kg	0.5	7.2505849609	7.1270739715	37	2
		Copper, Cu	mg/kg	0.5	1.4538406949	1.6052042123	63	10
		Lead, Pb	mg/kg	1	12.857089866	12.418085194	38	3
		Nickel, Ni	mg/kg	0.5	0.5466566184	0.4729970578	128	9
		Zinc, Zn	mg/kg	2	14.002721526	15.251488379	44	9
SE162373.002	LB119680.024	Arsenic, As	mg/kg	1	3	3	67	2
		Cadmium, Cd	mg/kg	0.3	0.4	0.4	108	1
		Chromium, Cr	mg/kg	0.5	51	52	31	0
		Copper, Cu	mg/kg	0.5	22	22	32	0
		Lead, Pb	mg/kg	1	19	23	35	19
		Nickel, Ni	mg/kg	0.5	38	38	31	2
		Zinc, Zn	mg/kg	2	80	87	32	9
SE162376.002	LB119681.014	Arsenic, As	mg/kg	1	41.389563866	55.769132292	31	10
		Cadmium, Cd	mg/kg	0.3	0.3066875989	0.3340051512	124	9
		Chromium, Cr	mg/kg	0.5	18.083155266	21.195453521	33	16
		Copper, Cu	mg/kg	0.5	14.016823812	14.678378058	33	5
		Lead, Pb	mg/kg	1	16.806985474	14.963020282	36	12
		Nickel, Ni	mg/kg	0.5	4.5032652213	5.2877047609	40	16
		Zinc, Zn	mg/kg	2	47.978228726	54.323254926	31	3
SE162384.004	LB119681.024	Arsenic, As	mg/kg	1	6.5267983716	7.2692989215	44	11
		Cadmium, Cd	mg/kg	0.3	0.1948775383	0.2013926581	181	0
		Chromium, Cr	mg/kg	0.5	11.090823754	10.281914049	35	8
		Copper, Cu	mg/kg	0.5	20.230833333	26.231228725	32	26
		Lead, Pb	mg/kg	1	54.060416666	64.638415196	32	18
		Nickel, Ni	mg/kg	0.5	7.1853232758	6.6524281127	37	8
		Zinc, Zn	mg/kg	2	69.618726053	70.666109264	33	1

Laboratory Control Standard (LCS) results are evaluated against an expected result, typically the concentration of analyte spiked into the control during the sample preparation stage, producing a percentage recovery. The criteria applied to the percentage recovery is established in the SGS QA /QC plan (Ref: MP-(AU)-[ENV]QU-022). For more information refer to the footnotes in the concluding page of this report.

Recovery is shown in **Green** when within suggested criteria or **Red** with an appended dagger symbol (†) when outside suggested criteria.

OC Pesticides in Soil

Method: ME-(AU)-[ENV]AN420

Sample Number		Parameter	Units	LOR	Result	Expected	Criteria %	Recovery %
LB119368.002		Heptachlor	mg/kg	0.1	0.2	0.2	60 - 140	91
		Aldrin	mg/kg	0.1	0.2	0.2	60 - 140	83
		Delta BHC	mg/kg	0.1	0.2	0.2	60 - 140	81
		Dieldrin	mg/kg	0.2	<0.2	0.2	60 - 140	80
		Endrin	mg/kg	0.2	<0.2	0.2	60 - 140	81
		p,p'-DDT	mg/kg	0.1	0.2	0.2	60 - 140	99
	Surrogates	Tetrachloro-m-xylene (TCMX) (Surrogate)	mg/kg	-	0.11	0.15	40 - 130	74

Total Recoverable Metals in Soil/Waste Solids/Materials by ICPOES

Method: ME-(AU)-[ENV]AN040/AN320

Sample Number	Parameter	Units	LOR	Result	Expected	Criteria %	Recovery %
LB119680.002	Arsenic, As	mg/kg	1	50	50	80 - 120	100
	Cadmium, Cd	mg/kg	0.3	49	50	80 - 120	98
	Chromium, Cr	mg/kg	0.5	50	50	80 - 120	101
	Copper, Cu	mg/kg	0.5	53	50	80 - 120	105
	Lead, Pb	mg/kg	1	50	50	80 - 120	99
	Nickel, Ni	mg/kg	0.5	51	50	80 - 120	102
	Zinc, Zn	mg/kg	2	51	50	80 - 120	101
LB119681.002	Arsenic, As	mg/kg	1	49	50	80 - 120	98
	Cadmium, Cd	mg/kg	0.3	49	50	80 - 120	97
	Chromium, Cr	mg/kg	0.5	50	50	80 - 120	100
	Copper, Cu	mg/kg	0.5	51	50	80 - 120	102
	Lead, Pb	mg/kg	1	49	50	80 - 120	98
	Nickel, Ni	mg/kg	0.5	51	50	80 - 120	102
	Zinc, Zn	mg/kg	2	50	50	80 - 120	100

Matrix Spike (MS) results are evaluated as the percentage recovery of an expected result, typically the concentration of analyte spiked into a field sub -sample during the sample preparation stage. The original sample's result is subtracted from the sub-sample result before determining the percentage recovery. The criteria applied to the percentage recovery is established in the SGS QA/QC plan (ref: MP-(AU)-[ENV]QU-022). For more information refer to the footnotes in the concluding page of this report.

Recovery is shown in **Green** when within suggested criteria or **Red** with an appended reason identifer when outside suggested criteria. Refer to the footnotes section at the end of this report for failure reasons.

OC Pesticides in Soil — Method: ME-(AU)-[ENV]AN420

QC Sample	Sample Number		Parameter	Units	LOR	Original	Spike	Recovery%
SE162373.003	LB119368.024		Hexachlorobenzene (HCB)	mg/kg	0.1	<0.1	-	-
			Alpha BHC	mg/kg	0.1	<0.1	-	-
			Lindane	mg/kg	0.1	<0.1	-	-
			Heptachlor	mg/kg	0.1	<0.1	0.2	95
			Aldrin	mg/kg	0.1	<0.1	0.2	86
			Beta BHC	mg/kg	0.1	<0.1	-	-
			Delta BHC	mg/kg	0.1	<0.1	0.2	85
			Heptachlor epoxide	mg/kg	0.1	<0.1	-	-
			o,p'-DDE	mg/kg	0.1	<0.1	-	-
			Alpha Endosulfan	mg/kg	0.2	<0.2	-	-
			Gamma Chlordane	mg/kg	0.1	<0.1	-	-
			Alpha Chlordane	mg/kg	0.1	<0.1	-	-
			trans-Nonachlor	mg/kg	0.1	<0.1	-	-
			p,p'-DDE	mg/kg	0.1	<0.1	-	-
			Dieldrin	mg/kg	0.2	<0.2	0.2	82
			Endrin	mg/kg	0.2	<0.2	0.2	80
			o,p'-DDD	mg/kg	0.1	<0.1	-	-
			o,p'-DDT	mg/kg	0.1	<0.1	-	-
			Beta Endosulfan	mg/kg	0.2	<0.2	-	-
			p,p'-DDD	mg/kg	0.1	<0.1	-	-
			p,p'-DDT	mg/kg	0.1	<0.1	0.2	107
			Endosulfan sulphate	mg/kg	0.1	<0.1	-	-
			Endrin Aldehyde	mg/kg	0.1	<0.1	-	-
			Methoxychlor	mg/kg	0.1	<0.1	-	-
			Endrin Ketone	mg/kg	0.1	<0.1	-	-
			Isodrin	mg/kg	0.1	<0.1	-	-
			Mirex	mg/kg	0.1	<0.1	-	-
		Surrogates	Tetrachloro-m-xylene (TCMX) (Surrogate)	mg/kg	-	0.12	-	76

Total Recoverable Metals in Soil/Waste Solids/Materials by ICPOES — Method: ME-(AU)-[ENV]AN040/AN320

QC Sample	Sample Number	Parameter	Units	LOR	Result	Original	Spike	Recovery%
SE162373.003	LB119681.004	Arsenic, As	mg/kg	1	37	3	50	69 ⑨
		Cadmium, Cd	mg/kg	0.3	41	0.4	50	81
		Chromium, Cr	mg/kg	0.5	99	60	50	77
		Copper, Cu	mg/kg	0.5	67	20	50	94
		Lead, Pb	mg/kg	1	50	13	50	74
		Nickel, Ni	mg/kg	0.5	87	49	50	77
		Zinc, Zn	mg/kg	2	68	23	50	91

Matrix spike duplicates are calculated as Relative Percent Difference (RPD) using the formula: RPD = | OriginalResult - ReplicateResult | x 100 / Mean

The original result is the analyte concentration of the matrix spike. The Duplicate result is the analyte concentration of the matrix spike duplicate.

The RPD is evaluated against the Maximum Allowable Difference (MAD) criteria and can be graphically represented by a curve calculated from the Statistical Detection Limit (SDL) and Limiting Repeatability (LR) using the formula: MAD = 100 x SDL / Mean + LR

Where the Maximum Allowable Difference evaluates to a number larger than 200 it is displayed as 200.

RPD is shown in **Green** when within suggested criteria or **Red** with an appended reason identifer when outside suggested criteria. Refer to the footnotes section at the end of this report for failure reasons.

No matrix spike duplicates were required for this job.

Samples analysed as received.

Solid samples expressed on a dry weight basis.

QC criteria are subject to internal review according to the SGS QA/QC plan and may be provided on request or alternatively can be found here: http://www.sgs.com.au/~/media/Local/Australia/Documents/Technical Documents/MP-AU-ENV-QU-022 QA QC Plan.pdf

*	NATA accreditation does not cover tthe performance of this service.
-	Sample not analysed for this analyte.
IS	Insufficient sample for analysis.
LNR	Sample listed, but not received.
LOR	Limit of reporting.
QFH	QC result is above the upper tolerance.
QFL	QC result is below the lower tolerance.

①	At least 2 of 3 surrogates are within acceptance criteria.
②	RPD failed acceptance criteria due to sample heterogeneity.
③	Results less than 5 times LOR preclude acceptance criteria for RPD.
④	Recovery failed acceptance criteria due to matrix interference.
⑤	Recovery failed acceptance criteria due to the presence of significant concentration of analyte (i.e. the concentration of analyte exceeds the spike level).
⑥	LOR was raised due to sample matrix interference.
⑦	LOR was raised due to dilution of significantly high concentration of analyte in sample.
⑧	Reanalysis of sample in duplicate confirmed sample heterogeneity and inconsistency of results.
⑨	Recovery failed acceptance criteria due to sample heterogeneity.
⑩	LOR was raised due to high conductivity of the sample (required dilution).
†	Refer to Analytical Report comments for further information.

ANALYTICAL REPORT

Accreditation No. 2562

CLIENT DETAILS

Contact	Ashleigh Pickering
Client	ENVIROWEST CONSULTING PTY LIMITED
Address	PO BOX 8158 ORANGE NSW 2800
Telephone	61 2 63614954
Facsimile	(Not specified)
Email	ashleigh@envirowest.net.au
Project	**7891-1 - Additional**
Order Number	(Not specified)
Samples	7

LABORATORY DETAILS

Manager	Huong Crawford
Laboratory	SGS Alexandria Environmental
Address	Unit 16, 33 Maddox St Alexandria NSW 2015
Telephone	+61 2 8594 0400
Facsimile	+61 2 8594 0499
Email	au.environmental.sydney@sgs.com
SGS Reference	**SE162373A R0**
Date Received	7/3/2017
Date Reported	9/3/2017

COMMENTS

Accredited for compliance with ISO/IEC 17025. NATA accredited laboratory 2562(4354).

SIGNATORIES

Ly Kim Ha
Organic Section Head

Volatile Petroleum Hydrocarbons in Soil [AN433] Tested: 7/3/2017

PARAMETER	UOM	LOR	SRV301 SOIL - 22/2/2017 SE162373A.005	SRV302 SOIL - 22/2/2017 SE162373A.006	SRV303 SOIL - 22/2/2017 SE162373A.007
Benzene (F0)	mg/kg	0.1	<0.1	<0.1	<0.1
TRH C6-C9	mg/kg	20	<20	<20	<20
TRH C6-C10	mg/kg	25	<25	<25	<25
TRH C6-C10 minus BTEX (F1)	mg/kg	25	<25	<25	<25

TRH (Total Recoverable Hydrocarbons) in Soil [AN403] Tested: 8/3/2017

PARAMETER	UOM	LOR	SRV301 SOIL - 22/2/2017 SE162373A.005	SRV302 SOIL - 22/2/2017 SE162373A.006	SRV303 SOIL - 22/2/2017 SE162373A.007
TRH C10-C14	mg/kg	20	<20	<20	<20
TRH C15-C28	mg/kg	45	67	230	600
TRH C29-C36	mg/kg	45	89	<45	<45
TRH C37-C40	mg/kg	100	<100	<100	<100
TRH >C10-C16 (F2)	mg/kg	25	<25	26	53
TRH >C16-C34 (F3)	mg/kg	90	130	210	540
TRH >C34-C40 (F4)	mg/kg	120	<120	<120	<120
TRH C10-C36 Total	mg/kg	110	160	230	600
TRH C10-C40 Total	mg/kg	210	<210	240	590

METHOD	METHODOLOGY SUMMARY
AN403	Total Recoverable Hydrocarbons: Determination of Hydrocarbons by gas chromatography after a solvent extraction. Detection is by flame ionisation detector (FID) that produces an electronic signal in proportion to the combustible matter passing through it. Total Recoverable Hydrocarbons (TRH) are routinely reported as four alkane groupings based on the carbon chain length of the compounds: C6-C9, C10-C14, C15-C28 and C29-C36 and in recognition of the NEPM 1999 (2013), >C10-C16 (F2), >C16-C34 (F3) and >C34-C40 (F4). F2 is reported directly and also corrected by subtracting Naphthalene (from VOC method AN433) where available.
AN403	Additionally, the volatile C6-C9 fraction may be determined by a purge and trap technique and GC /MS because of the potential for volatiles loss. Total Petroleum Hydrocarbons (TPH) follows the same method of analysis after silica gel cleanup of the solvent extract. Aliphatic/Aromatic Speciation follows the same method of analysis after fractionation of the solvent extract over silica with differential polarity of the eluent solvents .
AN403	The GC/FID method is not well suited to the analysis of refined high boiling point materials (ie lubricating oils or greases) but is particularly suited for measuring diesel, kerosene and petrol if care to control volatility is taken. This method will detect naturally occurring hydrocarbons, lipids, animal fats, phenols and PAHs if they are present at sufficient levels, dependent on the use of specific cleanup /fractionation techniques. Reference USEPA 3510B, 8015B.
AN433	VOCs and C6-C9/C6-C10 Hydrocarbons by GC-MS P&T: VOC`s are volatile organic compounds. The sample is presented to a gas chromatograph via a purge and trap (P&T) concentrator and autosampler and is detected with a Mass Spectrometer (MSD). Solid samples are initially extracted with methanol whilst liquid samples are processed directly. References: USEPA 5030B, 8020A, 8260.

FOOTNOTES

*	NATA accreditation does not cover the performance of this service.	-	Not analysed.	UOM	Unit of Measure.
**	Indicative data, theoretical holding time exceeded.	NVL	Not validated.	LOR	Limit of Reporting.
		IS	Insufficient sample for analysis.	↑↓	Raised/lowered Limit of Reporting.
		LNR	Sample listed, but not received.		

Samples analysed as received.
Solid samples expressed on a dry weight basis.

Where "Total" analyte groups are reported (for example, Total PAHs, Total OC Pesticides) the total will be calculated as the sum of the individual analytes, with those analytes that are reported as <LOR being assumed to be zero. The summed (Total) limit of reporting is calculated by summing the individual analyte LORs and dividing by two. For example, where 16 individual analytes are being summed and each has an LOR of 0.1 mg/kg, the "Totals" LOR will be 1.6 / 2 (0.8 mg/kg). Where only 2 analytes are being summed, the " Total" LOR will be the sum of those two LORs.

Some totals may not appear to add up because the total is rounded after adding up the raw values.

If reported, measurement uncertainty follow the ± sign after the analytical result and is expressed as the expanded uncertainty calculated using a coverage factor of 2, providing a level of confidence of approximately 95%, unless stated otherwise in the comments section of this report.

Results reported for samples tested under test methods with codes starting with ARS-SOP, radionuclide or gross radioactivity concentrations are expressed in becquerel (Bq) per unit of mass or volume or per wipe as stated on the report. Becquerel is the SI unit for activity and equals one nuclear transformation per second.
Note that in terms of units of radioactivity:

a. 1 Bq is equivalent to 27 pCi
b. 37 MBq is equivalent to 1 mCi

For results reported for samples tested under test methods with codes starting with ARS-SOP, less than (<) values indicate the detection limit for each radionuclide or parameter for the measurement system used. The respective detection limits have been calculated in accordance with ISO 11929.

The QC criteria are subject to internal review according to the SGS QAQC plan and may be provided on request or alternatively can be found here : http://www.sgs.com.au/~/media/Local/Australia/Documents/Technical%20Documents/MP-AU-ENV-QU-022%20QA%20QC%20Plan.pdf

STATEMENT OF QA/QC PERFORMANCE

SE162373A R0

CLIENT DETAILS

Contact	Ashleigh Pickering
Client	ENVIROWEST CONSULTING PTY LIMITED
Address	PO BOX 8158 ORANGE NSW 2800
Telephone	61 2 63614954
Facsimile	(Not specified)
Email	ashleigh@envirowest.net.au
Project	**7891-1 - Additional**
Order Number	(Not specified)
Samples	7

LABORATORY DETAILS

Manager	Huong Crawford
Laboratory	SGS Alexandria Environmental
Address	Unit 16, 33 Maddox St Alexandria NSW 2015
Telephone	+61 2 8594 0400
Facsimile	+61 2 8594 0499
Email	au.environmental.sydney@sgs.com
SGS Reference	**SE162373A R0**
Date Received	07 Mar 2017
Date Reported	09 Mar 2017

COMMENTS

All the laboratory data for each environmental matrix was compared to SGS' stated Data Quality Objectives (DQO). Comments arising from the comparison were made and are reported below.

The data relating to sampling was taken from the Chain of Custody document and was supplied by the Client.
This QA/QC Statement must be read in conjunction with the referenced Analytical Report.
The Statement and the Analytical Report must not be reproduced except in full.

All Data Quality Objectives were met (within the SGS Alexandria Environmental laboratory).

SAMPLE SUMMARY

Samples clearly labelled	Yes	Complete documentation received	Yes
Sample container provider	SGS	Sample cooling method	Ice Bricks
Samples received in correct containers	Yes	Sample counts by matrix	3 Soil
Date documentation received	7/3/17@9.40am	Type of documentation received	Email
Samples received in good order	Yes	Samples received without headspace	Yes
Sample temperature upon receipt	16.1°C	Sufficient sample for analysis	Yes
Turnaround time requested	Three Days		

SGS holding time criteria are drawn from current regulations and are highly dependent on sample container preservation as specified in the SGS "Field Sampling Guide for Containers and Holding Time" (ref: GU-(AU)-ENV.001). Soil samples guidelines are derived from NEPM "Schedule B(3) Guideline on Laboratory Analysis of Potentially Contaminated Soils". Water sample guidelines are derived from "AS/NZS 5667.1 : 1998 Water Quality - sampling part 1" and APHA "Standard Methods for the Examination of Water and Wastewater" 21st edition 2005.

Extraction and analysis holding time due dates listed are calculated from the date sampled, although holding times may be extended after laboratory extraction for some analytes. The due dates are the suggested dates that samples may be held before extraction or analysis and still be considered valid.

Extraction and analysis dates are shown in **Green** when within suggested criteria or **Red** with an appended dagger symbol (†) when outside suggested criteria. If the sampled date is not supplied then compliance with criteria cannot be determined. If the received date is after one or both due dates then holding time will fail by default.

TRH (Total Recoverable Hydrocarbons) in Soil — Method: ME-(AU)-[ENV]AN403

Sample Name	Sample No.	QC Ref	Sampled	Received	Extraction Due	Extracted	Analysis Due	Analysed
SRV301	SE162373A.005	LB119976	22 Feb 2017	07 Mar 2017	08 Mar 2017	08 Mar 2017	17 Apr 2017	09 Mar 2017
SRV302	SE162373A.006	LB119976	22 Feb 2017	07 Mar 2017	08 Mar 2017	08 Mar 2017	17 Apr 2017	09 Mar 2017
SRV303	SE162373A.007	LB119976	22 Feb 2017	07 Mar 2017	08 Mar 2017	08 Mar 2017	17 Apr 2017	09 Mar 2017

Volatile Petroleum Hydrocarbons in Soil — Method: ME-(AU)-[ENV]AN433

Sample Name	Sample No.	QC Ref	Sampled	Received	Extraction Due	Extracted	Analysis Due	Analysed
SRV301	SE162373A.005	LB119969	22 Feb 2017	07 Mar 2017	08 Mar 2017	07 Mar 2017	16 Apr 2017	09 Mar 2017
SRV302	SE162373A.006	LB119969	22 Feb 2017	07 Mar 2017	08 Mar 2017	07 Mar 2017	16 Apr 2017	09 Mar 2017
SRV303	SE162373A.007	LB119969	22 Feb 2017	07 Mar 2017	08 Mar 2017	07 Mar 2017	16 Apr 2017	09 Mar 2017

Surrogate results are evaluated against upper and lower limit criteria established in the SGS QA /QC plan (Ref: MP-(AU)-[ENV]QU-022). At least two of three routine level soil sample surrogate spike recoveries for BTEX/VOC are to be within 70-130% where control charts have not been developed and within the established control limits for charted surrogates. Matrix effects may void this as an acceptance criterion. Water sample surrogate spike recoveries are to be within 40-130%. The presence of emulsions, surfactants and particulates may void this as an acceptance criterion.

Result is shown in **Green** when within suggested criteria or **Red** with an appended reason identifer when outside suggested criteria. Refer to the footnotes section at the end of this report for failure reasons.

Volatile Petroleum Hydrocarbons in Soil

Method: ME-(AU)-[ENV]AN433

Parameter	Sample Name	Sample Number	Units	Criteria	Recovery %
Bromofluorobenzene (Surrogate)	SRV301	SE162373A.005	%	60 - 130%	83
	SRV302	SE162373A.006	%	60 - 130%	79
	SRV303	SE162373A.007	%	60 - 130%	83
d4-1,2-dichloroethane (Surrogate)	SRV301	SE162373A.005	%	60 - 130%	94
	SRV302	SE162373A.006	%	60 - 130%	98
	SRV303	SE162373A.007	%	60 - 130%	94
d8-toluene (Surrogate)	SRV301	SE162373A.005	%	60 - 130%	87
	SRV302	SE162373A.006	%	60 - 130%	90
	SRV303	SE162373A.007	%	60 - 130%	86
Dibromofluoromethane (Surrogate)	SRV301	SE162373A.005	%	60 - 130%	88
	SRV302	SE162373A.006	%	60 - 130%	88
	SRV303	SE162373A.007	%	60 - 130%	80

Blank results are evaluated against the limit of reporting (LOR), for the chosen method and its associated instrumentation, typically 2.5 times the statistically determined method detection limit (MDL).

Result is shown in **Green** when within suggested criteria or **Red** with an appended dagger symbol (†) when outside suggested criteria.

TRH (Total Recoverable Hydrocarbons) in Soil

Method: ME-(AU)-[ENV]AN403

Sample Number		Parameter	Units	LOR	Result
LB119976.001		TRH C10-C14	mg/kg	20	<20
		TRH C15-C28	mg/kg	45	<45
		TRH C29-C36	mg/kg	45	<45
		TRH C37-C40	mg/kg	100	<100
		TRH C10-C36 Total	mg/kg	110	<110

Volatile Petroleum Hydrocarbons in Soil

Method: ME-(AU)-[ENV]AN433

Sample Number		Parameter	Units	LOR	Result
LB119969.001		TRH C6-C9	mg/kg	20	<20
	Surrogates	Dibromofluoromethane (Surrogate)	%	-	94
		d4-1,2-dichloroethane (Surrogate)	%	-	96
		d8-toluene (Surrogate)	%	-	84

Duplicates are calculated as Relative Percentage Difference (RPD) using the formula: RPD = | OriginalResult - ReplicateResult | x 100 / Mean

The RPD is evaluated against the Maximum Allowable Difference (MAD) criteria and can be graphically represented by a curve calculated from the Statistical Detection Limit (SDL) and Limiting Repeatability (LR) using the formula: MAD = 100 x SDL / Mean + LR

Where the Maximum Allowable Difference evaluates to a number larger than 200 it is displayed as 200.

RPD is shown in **Green** when within suggested criteria or **Red** with an appended reason identifer when outside suggested criteria. Refer to the footnotes section at the end of this report for failure reasons.

TRH (Total Recoverable Hydrocarbons) in Soil — Method: ME-(AU)-[ENV]AN403

Original	Duplicate		Parameter	Units	LOR	Original	Duplicate	Criteria %	RPD %
SE162730.002	LB119976.026		TRH C10-C14	mg/kg	20	0	0	200	0
			TRH C15-C28	mg/kg	45	0	0	200	0
			TRH C29-C36	mg/kg	45	0	0	200	0
			TRH C37-C40	mg/kg	100	0	0	200	0
			TRH C10-C36 Total	mg/kg	110	0	0	200	0
			TRH C10-C40 Total	mg/kg	210	0	0	200	0
		TRH F Bands	TRH >C10-C16 (F2)	mg/kg	25	0	0	200	0
			TRH >C16-C34 (F3)	mg/kg	90	0	0	200	0
			TRH >C34-C40 (F4)	mg/kg	120	0	0	200	0

Volatile Petroleum Hydrocarbons in Soil — Method: ME-(AU)-[ENV]AN433

Original	Duplicate		Parameter	Units	LOR	Original	Duplicate	Criteria %	RPD %
SE162730.006	LB119969.014		TRH C6-C10	mg/kg	25	0	0	200	0
			TRH C6-C9	mg/kg	20	0.49	0.14	200	0
		Surrogates	Dibromofluoromethane (Surrogate)	mg/kg	-	3.7	3.78	30	2
			d4-1,2-dichloroethane (Surrogate)	mg/kg	-	4.42	4.52	30	2
			d8-toluene (Surrogate)	mg/kg	-	3.84	3.89	30	1
			Bromofluorobenzene (Surrogate)	mg/kg	-	3.86	3.84	30	1
		VPH F Bands	Benzene (F0)	mg/kg	0.1	0	0	200	0
			TRH C6-C10 minus BTEX (F1)	mg/kg	25	-0.07	-0.07	200	0

Laboratory Control Standard (LCS) results are evaluated against an expected result, typically the concentration of analyte spiked into the control during the sample preparation stage, producing a percentage recovery. The criteria applied to the percentage recovery is established in the SGS QA /QC plan (Ref: MP-(AU)-[ENV]QU-022). For more information refer to the footnotes in the concluding page of this report.

Recovery is shown in **Green** when within suggested criteria or **Red** with an appended dagger symbol (†) when outside suggested criteria.

TRH (Total Recoverable Hydrocarbons) in Soil

Method: ME-(AU)-[ENV]AN403

Sample Number		Parameter	Units	LOR	Result	Expected	Criteria %	Recovery %
LB119976.002		TRH C10-C14	mg/kg	20	35	40	60 - 140	88
		TRH C15-C28	mg/kg	45	<45	40	60 - 140	95
		TRH C29-C36	mg/kg	45	<45	40	60 - 140	83
	TRH F Bands	TRH >C10-C16 (F2)	mg/kg	25	35	40	60 - 140	88
		TRH >C16-C34 (F3)	mg/kg	90	<90	40	60 - 140	98
		TRH >C34-C40 (F4)	mg/kg	120	<120	20	60 - 140	75

Volatile Petroleum Hydrocarbons in Soil

Method: ME-(AU)-[ENV]AN433

Sample Number		Parameter	Units	LOR	Result	Expected	Criteria %	Recovery %
LB119969.002		TRH C6-C10	mg/kg	25	<25	24.65	60 - 140	90
		TRH C6-C9	mg/kg	20	<20	23.2	60 - 140	79
	Surrogates	Dibromofluoromethane (Surrogate)	mg/kg	-	4.3	5	60 - 140	86
		d4-1,2-dichloroethane (Surrogate)	mg/kg	-	4.7	5	60 - 140	94
		d8-toluene (Surrogate)	mg/kg	-	4.2	5	60 - 140	83
		Bromofluorobenzene (Surrogate)	mg/kg	-	3.8	5	60 - 140	76
	VPH F Bands	TRH C6-C10 minus BTEX (F1)	mg/kg	25	<25	7.25	60 - 140	86

Matrix Spike (MS) results are evaluated as the percentage recovery of an expected result, typically the concentration of analyte spiked into a field sub -sample during the sample preparation stage. The original sample's result is subtracted from the sub-sample result before determining the percentage recovery. The criteria applied to the percentage recovery is established in the SGS QA/QC plan (ref: MP-(AU)-[ENV]QU-022). For more information refer to the footnotes in the concluding page of this report.

Recovery is shown in **Green** when within suggested criteria or **Red** with an appended reason identifer when outside suggested criteria. Refer to the footnotes section at the end of this report for failure reasons.

Volatile Petroleum Hydrocarbons in Soil

Method: ME-(AU)-[ENV]AN433

QC Sample	Sample Number		Parameter	Units	LOR	Result	Original	Spike	Recovery%
SE162373A.005	LB119969.004		TRH C6-C10	mg/kg	25	<25	<25	24.65	96
			TRH C6-C9	mg/kg	20	<20	<20	23.2	77
		Surrogates	Dibromofluoromethane (Surrogate)	mg/kg	-	4.4	4.4	-	88
			d4-1,2-dichloroethane (Surrogate)	mg/kg	-	5.0	4.7	-	100
			d8-toluene (Surrogate)	mg/kg	-	4.6	4.4	-	91
			Bromofluorobenzene (Surrogate)	mg/kg	-	4.5	4.1	-	89
		VPH F Bands	Benzene (F0)	mg/kg	0.1	2.3	<0.1	-	-
			TRH C6-C10 minus BTEX (F1)	mg/kg	25	<25	<25	7.25	108

Matrix spike duplicates are calculated as Relative Percent Difference (RPD) using the formula: RPD = | OriginalResult - ReplicateResult | x 100 / Mean

The original result is the analyte concentration of the matrix spike. The Duplicate result is the analyte concentration of the matrix spike duplicate.

The RPD is evaluated against the Maximum Allowable Difference (MAD) criteria and can be graphically represented by a curve calculated from the Statistical Detection Limit (SDL) and Limiting Repeatability (LR) using the formula: MAD = 100 x SDL / Mean + LR

Where the Maximum Allowable Difference evaluates to a number larger than 200 it is displayed as 200.

RPD is shown in **Green** when within suggested criteria or **Red** with an appended reason identifer when outside suggested criteria. Refer to the footnotes section at the end of this report for failure reasons.

No matrix spike duplicates were required for this job.

Samples analysed as received.

Solid samples expressed on a dry weight basis.

QC criteria are subject to internal review according to the SGS QA/QC plan and may be provided on request or alternatively can be found here: http://www.sgs.com.au/~/media/Local/Australia/Documents/Technical Documents/MP-AU-ENV-QU-022 QA QC Plan.pdf

*	NATA accreditation does not cover tthe performance of this service.
-	Sample not analysed for this analyte.
IS	Insufficient sample for analysis.
LNR	Sample listed, but not received.
LOR	Limit of reporting.
QFH	QC result is above the upper tolerance.
QFL	QC result is below the lower tolerance.

①	At least 2 of 3 surrogates are within acceptance criteria.
②	RPD failed acceptance criteria due to sample heterogeneity.
③	Results less than 5 times LOR preclude acceptance criteria for RPD.
④	Recovery failed acceptance criteria due to matrix interference.
⑤	Recovery failed acceptance criteria due to the presence of significant concentration of analyte (i.e. the concentration of analyte exceeds the spike level).
⑥	LOR was raised due to sample matrix interference.
⑦	LOR was raised due to dilution of significantly high concentration of analyte in sample.
⑧	Reanalysis of sample in duplicate confirmed sample heterogeneity and inconsistency of results.
⑨	Recovery failed acceptance criteria due to sample heterogeneity.
⑩	LOR was raised due to high conductivity of the sample (required dilution).
†	Refer to Analytical Report comments for further information.

Appendix 3. Field sampling log

Sampling log

Client	Maas Property Group Pty Ltd
Contact	Steven Guy
Job number	R7891
Location	Lot 2 DP880413, 24R Sheraton Road, Dubbo NSW
Date	10 and 11 January 2017
Investigator(s)	Leah Desborough and Ashleigh Pickering
Weather conditions	Fine

Sample id	Matrix	Date	Analysis required	Observations/comments
SR1	Soil	11/01/2017	Arsenic (As), cadmium (Ca), chromium (Cr), copper (Cu), lead (Pb), nickel (Ni), zinc (Zn)	Composite comprising 11, 12, 13, 14
SR2	Soil	11/01/2017	As, Ca, Cr, Cu, Pb, Ni, Zn	Composite comprising 21, 22, 23, 24
SR3	Soil	11/01/2017	As, Ca, Cr, Cu, Pb, Ni, Zn	Composite comprising 31, 32, 33, 34
SR4	Soil	11/01/2017	As, Ca, Cr, Cu, Pb, Ni, Zn	Composite comprising 41, 42, 43, 44
SR5	Soil	11/01/2017	As, Ca, Cr, Cu, Pb, Ni, Zn	Composite comprising 51, 52, 53, 54
SR6	Soil	11/01/2017	As, Ca, Cr, Cu, Pb, Ni, Zn	Composite comprising 61, 62, 63, 64
SR7	Soil	11/01/2017	As, Ca, Cr, Cu, Pb, Ni, Zn	Composite comprising 71, 72, 73, 74
SR8	Soil	11/01/2017	As, Ca, Cr, Cu, Pb, Ni, Zn	Composite comprising 81, 82, 83, 84
SR9	Soil	11/01/2017	As, Ca, Cr, Cu, Pb, Ni, Zn	Composite comprising 91, 92, 93, 94
SR10	Soil	11/01/2017	As, Ca, Cr, Cu, Pb, Ni, Zn	Composite comprising 101, 102, 103, 104
SR11	Soil	11/01/2017	As, Ca, Cr, Cu, Pb, Ni, Zn	Composite comprising 111, 112, 113, 114
SR12	Soil	11/01/2017	As, Ca, Cr, Cu, Pb, Ni, Zn	Composite comprising 121, 122, 123, 124
SR13	Soil	11/01/2017	As, Ca, Cr, Cu, Pb, Ni, Zn	Composite comprising 131, 132, 133, 134
SR14	Soil	11/01/2017	As, Ca, Cr, Cu, Pb, Ni, Zn	Composite comprising 141, 142, 143, 144
SR15	Soil	11/01/2017	As, Ca, Cr, Cu, Pb, Ni, Zn	Composite comprising 151, 152, 153, 154
SR16	Soil	11/01/2017	As, Ca, Cr, Cu, Pb, Ni, Zn	Composite comprising 161, 162, 163, 164
SR17	Soil	11/01/2017	As, Ca, Cr, Cu, Pb, Ni, Zn	Composite comprising 171, 172, 173, 174
SR18	Soil	11/01/2017	As, Ca, Cr, Cu, Pb, Ni, Zn	Composite comprising 181, 182, 183, 184
SR19	Soil	11/01/2017	As, Ca, Cr, Cu, Pb, Ni, Zn	Composite comprising 191, 192, 193, 194
SR20	Soil	11/01/2017	As, Ca, Cr, Cu, Pb, Ni, Zn	Composite comprising 201, 202, 203, 204
SR21	Soil	11/01/2017	As, Ca, Cr, Cu, Pb, Ni, Zn	Composite comprising 211, 212, 213, 214
SR22	Soil	11/01/2017	As, Ca, Cr, Cu, Pb, Ni, Zn	Composite comprising 221, 222, 223, 224
SR23	Soil	11/01/2017	As, Ca, Cr, Cu, Pb, Ni, Zn	Composite comprising 231, 232, 233, 234
SR24	Soil	11/01/2017	As, Ca, Cr, Cu, Pb, Ni, Zn	Composite comprising 241, 242, 243, 244
SR25	Soil	11/01/2017	As, Ca, Cr, Cu, Pb, Ni, Zn	Composite comprising 251, 252, 253, 254
SR26	Soil	11/01/2017	As, Ca, Cr, Cu, Pb, Ni, Zn	Composite comprising 261, 262, 263, 264
SR27	Soil	11/01/2017	As, Ca, Cr, Cu, Pb, Ni, Zn	Composite comprising 271, 272, 273, 274
SR28	Soil	11/01/2017	As, Ca, Cr, Cu, Pb, Ni, Zn, Total Recoverable Hydrocabons (TRH), Benzene, Toluene, Ethylbenzene, Xylenes, Naphthalene (BTEXN), Organochlorine pesticides (OCP), Polycyclic Aromatic Hydrocarbons (PAH)	Discrete sample
SR29	Soil	11/01/2017	As, Ca, Cr, Cu, Pb, Ni, Zn, OCP, PAH, TRH, BTEXN	Discrete sample
SR30	Soil	11/01/2017	As, Ca, Cr, Cu, Pb, Ni, Zn, OCP, PAH, TRH, BTEXN	Discrete sample
SR31	Soil	11/01/2017	As, Ca, Cr, Cu, Pb, Ni, Zn, OCP, PAH, TRH, BTEXN	Discrete sample
SR32	Soil	12/01/2017	As, Ca, Cr, Cu, Pb, Ni, Zn, OCP, PAH, TRH, BTEXN	Discrete sample
SR33	Soil	12/01/2017	As, Ca, Cr, Cu, Pb, Ni, Zn, OCP, PAH, TRH, BTEXN	Discrete sample
SR73	Soil	11/01/2017	OCP	Discrete sample
SR91	Soil	11/01/2017	OCP	Discrete sample
SR113	Soil	11/01/2017	OCP	Discrete sample
SR184	Soil	11/01/2017	OCP	Discrete sample
SR224	Soil	11/01/2017	OCP	Discrete sample
SRA	Soil	11/01/2017	As, Ca, Cr, Cu, Pb, Ni, Zn	Duplicate of SR2
SRB	Soil	11/01/2017	As, Ca, Cr, Cu, Pb, Ni, Zn	Duplicate of SR20
2S	Asbestos	11/01/2017	Asbestos identification	Fragments from within cottage area

Sampling log

Client	Maas Property Group Pty Ltd
Contact	Steven Guy
Job number	R7891-1
Location	Lot 2 DP880413, 24R Sheraton Road, Dubbo NSW
Date	22 February 2017
Investigator(s)	Ashleigh Pickering
Weather conditions	Fine

Sample id	Matrix	Date	Analysis required	Observations/comments
SR201	Soil	22/2/2017	As, Ca, Cr, Cu, Pb, Ni, Zn, OCP	Old cottage area
SR202	Soil	22/2/2017	As, Ca, Cr, Cu, Pb, Ni, Zn, OCP	Old cottage area
SR203	Soil	22/2/2017	As, Ca, Cr, Cu, Pb, Ni, Zn, OCP	Old cottage area
SR204	Soil	22/2/2017	As, Ca, Cr, Cu, Pb, Ni, Zn, OCP	Old cottage area
SRV301	Soil	22/2/2017	TRH	AST area
SRV302	Soil	22/2/2017	TRH	AST area
SRV303	Soil	22/2/2017	TRH	AST area

Appendix 4. Waste Disposal Dockets

Whylandra
DUBBO REGIONAL COUNCIL
ABN 53 539 070 9

WHYLANDRA WASTE & RECYCLING CENTRE
COOBA ROAD
DUBBO NSW 2830

TAX INVOICE

Docket: WI71881\1
Date: 23/02/2017 8:18
Printed: 23/02/2017 8:18
Operator: RJW

Customer: Maas Civil Pty Ltd
Vehicle: 2219A
Order No:

ASBESTOS OVER 1 TONNE
7380kg @ $228.00/t $1682.64

Subtotal	$1529.67
GST	$152.97
Total Including GST	**$1682.64**

Gross	13680 kg
Tare	6300 kg
Net	7380 kg

For payment options contact council's customer service centre phone on 6801 4000.

Payment/Refund	$1682.64
Paid By	Account
Ref No	4295014539

Whylandra
DUBBO REGIONAL COUNCIL
ABN 53 539 070 9

WHYLANDRA WASTE & RECYCLING CENTRE
COOBA ROAD
DUBBO NSW 2830

TAX INVOICE

Docket: WI71868\1
Date: 22/02/2017 3:23
Printed: 22/02/2017 3:23
Operator: MS

Customer: Maas Civil Pty Ltd
Vehicle: 2219A
Order No:

ASBESTOS OVER 1 TONNE
6160kg @ $228.00/t $1404.48

Subtotal	$1276.80
GST	$127.68
Total Including GST	**$1404.48**

Gross	12400 kg
Tare	6240 kg
Net	6160 kg

For payment options contact council's customer service centre phone on 6801 4000.

Payment/Refund	$1404.48
Paid By	Account
Ref No	4295014533

Whylandra
DUBBO REGIONAL COUNCIL
ABN 53 539 070 9

WHYLANDRA WASTE & RECYCLING CENTRE
COOBA ROAD
DUBBO NSW 2830

TAX INVOICE

Docket: WI71924\1
Date: 23/02/2017 12:18
Printed: 23/02/2017 12:18
Operator: MS

Customer: Maas Civil Pty Ltd
Vehicle: 2219A
Order No:

CONTAMINATED SO WEIGHED
1860kg @ $75.00/t $139.50

Subtotal	$126.82
GST	$12.68
Total Including GST	$139.50

Gross	8460 kg
Tare	6600 kg
Net	1860 kg

For payment options contact council's customer service centre phone on 6801 4000.

Payment/Refund	$139.50
Paid By	Account
Ref No	4295014568

Whylandra
DUBBO REGIONAL COUNCIL
ABN 53 539 070 9

WHY... WASTE & RECYCLING CENTRE
...OOBA ROAD
...UBBO NSW 2830

TAX INVOICE

Docket: WI71873\1
Date: 22/02/2017 4:32
Printed: 22/02/2017 4:32
Operator: RJW

Customer: Maas Civil Pty Ltd
Vehicle: 2219A
Order No:

ASBESTOS OVER 1 TONNE
7340kg @ $228.00/t $1673.52

Subtotal	$1521.38
GST	$152.14
Total Including GST	$1673.52

Gross	15540 kg
Tare	8200 kg
Net	7340 kg

For payment options contact council's customer service centre phone on 6801 4000.

Payment/Refund	$1673.52
Paid By	Account
Ref No	4295014535

Appendix 4. Unexpected finds protocol

1. Introduction
Investigations have been undertaken including boreholes, soil sampling and analysis to evaluate the contamination status of Lot 2 DP880413, 24R Sheraton Road, Dubbo NSW.

A procedure is required describing the actions if potential contamination or hazards are encountered during excavation/construction activities.

2. Scope
Prepare a procedure to enable the identification and management of unexpected hazards identified during excavation works and/or construction activities.

3. Site identification
Lot 2 DP880413, 24R Sheraton Road, Dubbo NSW.

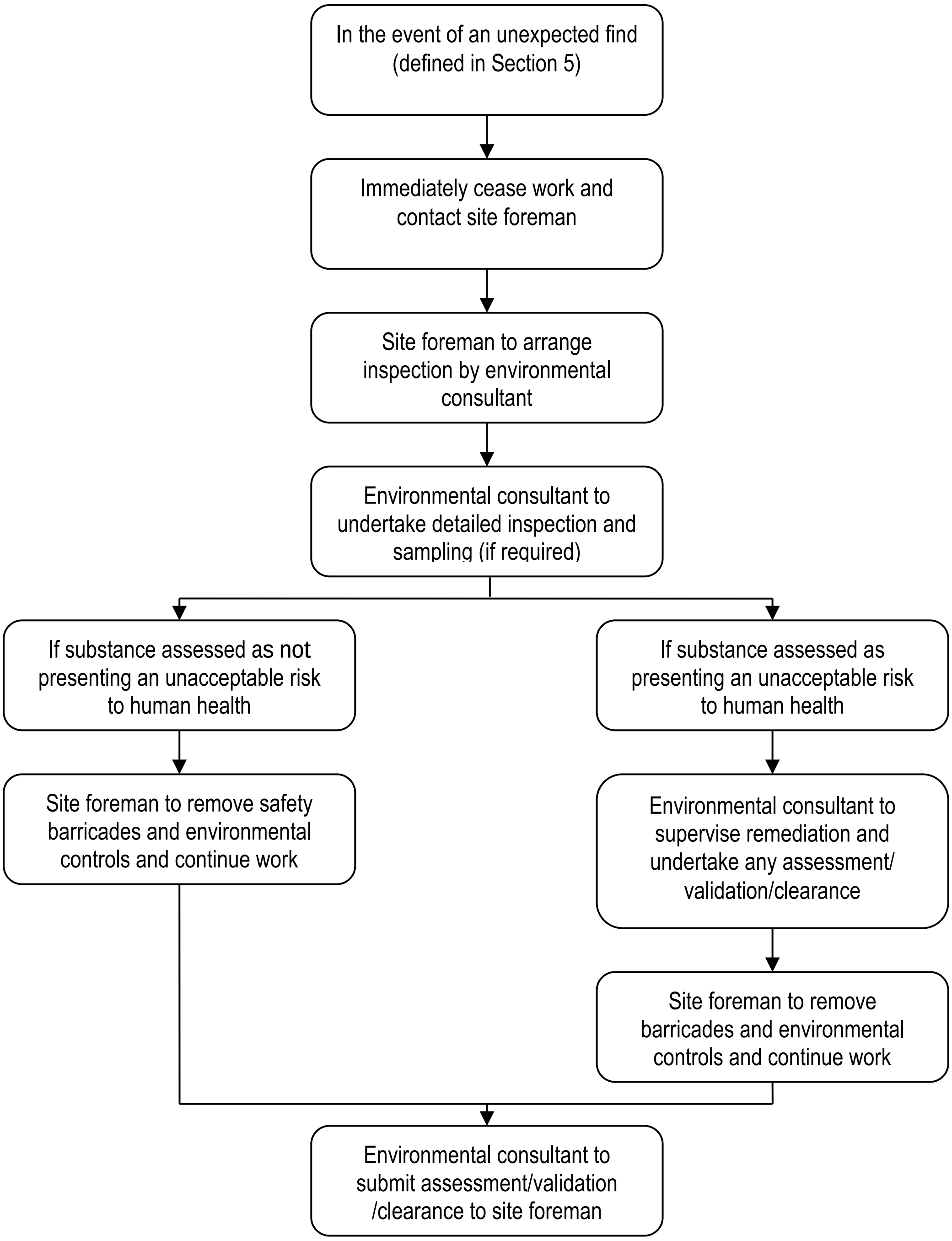
4. Responsible person
The landowner is responsible for implementation of the unexpected finds protocol. The land owner will appoint an environmental scientist to induct and provide information on hazard identification and responses to earthwork supervisors and personnel which may uncover unexpected hazards.

5. Identification of unexpected hazards
Potential hazards will be identified by appearance and odour and include:

- A filled pit or gully
- Demolition waste
- Discoloured soil
- Oil/diesel/tar
- Sheens on water
- An offensive odour
- Asbestos cement sheeting
- Ash or slag
- Underground storage tank

6. Training and induction
All excavation/construction personnel are to be inducted on the identification of potential hazards. The induction can be undertaken at the time of general site induction and toolbox meetings. The training will include display of the poster below to alert worker of potential hazards.

7. Procedure



8. Recommencement of works

The potential hazards will be assessed by the environmental scientist and a report prepared describing:

- Preliminary assessment of the contamination and need for cleanup
- Preparation of a remediation action plan
- All works to be undertaken in accordance with contaminated site regulations and guidelines
- Remediation works
- Validation of the remediation
- Works can commence on the potentially hazardous area after the environmental scientist has provided a clearance.

BE AWARE

UNEXPECTED HAZARDS MAY BE PRESENT

drums

asbestos

chemical bottles

blood stains

odour

ash / slag

demolition waste

if you SEE or SMELL anything unusual

STOP WORK & contact the Site Foreman

do not restart working before the area has been investigated and cleared by an Environmental Consultant

Groundwater and salinity study

Lot 2 DP880413

24R Sheraton Road, Dubbo NSW

Ref: R7891s1
Date: 9 March 2017

Envirowest Consulting Pty Ltd ABN 18 103 955 246
• 9 Cameron Place, PO Box 8158, Orange NSW 2800 • Tel (02) 6361 4954 •
• Fax (02) 6360 3960 • Email admin@envirowest.net.au • Web www.envirowest.net.au •

Environmental
Geotechnical
Asbestos
Services

Prepared by:	Envirowest Consulting Pty Ltd 9 Cameron Place Orange NSW 2800
Client:	Maas Group Properties Lot 2 Jannali Road Dubbo NSW 2830
Assessor:	Leah Desborough BNatRes (Hons) Senior Environmental Scientist
Checked by:	Greg Madafiglio PhD Senior Environmental Scientist
Authorising Officer:	Greg Madafiglio PhD Senior Environmental Scientist

Report number:	R7891s1
Date:	9 March 2017

Executive summary

Background

A residential subdivision is proposed for Lot 2 DP880413, 24R Sheraton Road Dubbo NSW. The subdivision design will include residential lots, access roads, a proposed freight way and a riparian zone. A groundwater salinity assessment is required as part of the development process.

Objectives of the investigation

A site investigation was undertaken to assess the existing salinity conditions of the soil and groundwater and determine the impact of the development on groundwater.

Investigation

A soil and groundwater investigation was undertaken of the site. An initial investigation and desktop review was undertaken to collect existing information on groundwater on and around the site and the likelihood of salinity across the site. A detailed investigation was undertaken on 10 and 11 January 2017.

The detailed site investigation included landscape description, soil investigation, laboratory analysis and groundwater investigation. The soil profile investigation was undertaken by constructing 25 boreholes up to 9m in depth. Representative soil samples were collected and analysed for pH, electrical conductivity, colour, dispersion, texture, chlorides and exchangeable sodium percentage.

The investigation results and proposed development were evaluated to identify impacts and recommend management outcomes to minimise impact on salinity occurrence. Soil moisture levels under land-use scenarios were modelled using rainfall data to estimate infiltration. Soil moisture and infiltration was simulated by the CLASS U3M-1D model with daily rainfall inputs from 1980 to 2014. Surface water flow containing sediment, nitrogen and phosphorus were modelled using Chafer (2003).

The impact of the development on water infiltration on the site was discussed and best practice procedures recommended which will minimise the effects on groundwater.

Conclusions

The site had a pasture grazing land-use. No bare areas resulting from sheet erosion or salinity were identified. The risk of erosion is low

Soils on the site comprised topsoil of variable depth consisting of strong brown to dark red loamy sand to silty clay. Subsoils were dark yellowish brown to red sandy clay to medium clay with increasing weathered basalt cobble and weathered rock with depth. Basalt cobbles and weathered rock were encountered from varying depths over the site between 1.1 to 9.0m resulting in drill refusal.

The northern half of the site is located in the Dubbo Basalt Hydro-geological Landscape (HGL). Lithology of the Dubbo Basalt Hydro-geological Landscape consists of Cainozoic basalt consisting of in situ Olivine rich alkali basalt with some colluvial material and quartzite derived from the underlying sandstone and siltstone. Soil salinity is isolated at areas along drainage lines, at the intersection with the Purlewaugh formation, depressions and footslopes. Saline soils also occur due to local perching of the water table. Groundwater flow is unconfined to semi-confined in consolidated fractured rock. Groundwater salinity is fresh to marginal.

The southern section of the site is located in the Purlewaugh/Napperby HGL. The landscape is characterised by low flat hills and rises with a stepped geomorphology. Lithology of the

Purlewaugh/Napperby HGL consists of Purlewaugh Formation, Napperby Formation and Boulderwood Formation comprising mainly ferruginous red siltstone, carbonaceous mudstone, fine to medium grained lithic sandstone, ironstone, minor coal and minor conglomerate. Groundwater flow is unconfined to semi-confined flows through fractures in sandstone and sedimentary bedrock, permeable soils and saprolite. Lateral flow occurs through colluvial sediments on lower slopes. High recharge rates occur across the landscape particularly in areas where cropping is practised. Water electrical conductivity is moderate to high.

The change in slope in the central to southern section of the site is an example of stepped geomorphology characteristic of the Purlewaugh/Napperby HGL. It is also the expected location of the intersection of the Dubbo Basalt and Purlewaugh Formation. The stepped landscape broadly correspond to resistant layers in the stratigraphy. Saline areas in the Purlewaugh/Napperby HGL typically occur at these stepped locations and also at the intersection of the Dubbo Basalt and Purlewaugh Formation.

Subsoil samples collected from two boreholes constructed along the stepped geomorphology contained moderately to highly saline subsoils from 1m. Subsoils in other boreholes located in the northern half of the site and along Eulomogo Creek were non-saline. All topsoils samples were determined to be non-saline.

Groundwater or groundwater indicators were not encountered in the soil to a depth of 9m. Groundwater monitoring bores within 1km of the site and installed to depths of 15m have been mostly dry since monitoring began in 2005. Groundwater recharge within the Dubbo Basalt HGL is greatest on plateau areas and within the Purlewaugh/Napperby HGL is high across the landscape. Groundwater residence times are short.

No groundwater discharge areas were identified on the site.

Modelling of soil moisture levels over the past 34 years indicated variations in infiltration occur with the amount of rainfall pre and post development. Variations occur due to seasonal rainfall and land-use. Irrigation of lawn of 1mm/day results in infiltration in years with high rainfall at 1m and no infiltration at 3m.

Overall site the infiltration will be reduced in the development. Reduced infiltration is a result of the increase in runoff due to impermeable areas (roads, roofs, driveways) and increase in deep rooted vegetation extracting soil moisture from depth. The establishment of trees in strategic areas will offset any additional infiltration from lawn over watering.

The risk of groundwater contamination from the proposed land-use is equal or lower to the current land-use. Nitrogen contributions will decrease as a result of smaller available areas for fertilisation and a decrease in animal waste; domestic pet waste will generally be disposed off-site. Phosphorous and sediment contributions will also decrease. Washing of cars on permeable areas will not be a significant contributor to nutrient levels. Reuse of greywater will be small volumes of unregulated use or larger volumes which require specific conditions of use or regulation by Council. Conditions of use and regulation will ensure overwatering does not occur.

No impact on groundwater including contamination and changed groundwater levels is expected from the development if recommendations are adopted. The development will not impact on quantity or quality of both unconfined and confined aquifers.

Recommendations

The development water and soil design will include:

- Promote plantings of deep rooted vegetation as street trees, along the proposed freight way and within the riparian zone
- Deep rooted trees should be established in the road reserves in accordance with council policy of 1 tree per block
- Additional plantings of deep rooted vegetation in the road reserves located at the geological interface. The trees should be planted with 20m spacings (25 trees/ha).
- Planting of trees in expected areas of lithological/hydrological interfaces to minimise saline soils/groundwater
- Piping of surface water off-site
- Promote water sensitive design of dwellings and gardens
- Stormwater retention basins lined with an impermeable layer
- Design road levels similar to natural soil levels to minimise excavations
- Earthworks comprising cut should be minimised
- Excavated material with elevated salinity should be backfilled, utilised as fill under roads or disposed to landfill
- Assessment of soil salinity prior to house construction to enable appropriate design of footings

Contents

1. Introduction

A residential subdivision is proposed for Lot 2 DP880413, 24R Sheraton Road Dubbo NSW. The subdivision design will include residential lots, access roads a proposed freight way and a riparian zone. A groundwater salinity assessment is required as part of the development process.

2. Scope of work

Envirowest Consulting Pty Ltd was commissioned by Steven Guy on behalf of Maas Group Properties, to undertake a groundwater investigation and salinity study of Lot 2 DP880413, 24R Sheraton Road Dubbo NSW. The objective was to assess the existing conditions and possible future impact of the proposed development on soil, groundwater and salinity.

3. Site identification

Address	24R Sheraton Road Dubbo NSW
Client	Maas Group Properties Pty Ltd
Deposited plans	Lot 2 DP880413
Universal grid reference	UTM Zone 55H, E655142m, N6428025m
Locality map	Figure 1
Site plan	Figure 2
Photographs	Figure 14
Area	Approximately 50 hectares
Dates of inspection and assessment	10 and 11 January 2017

4. Proposed development

The proposed development is a residential subdivision which will include a proposed freight way and a riparian zone (Figure 13). The proposed lots will have hard surface areas comprising roofs and driveways where rainfall will run-off into stormwater pipes and permeable areas comprising lawns and gardens where infiltration into the soil will occur. Roads, footpaths and a stormwater system will be constructed throughout the estate. The dwellings will be serviced by town sewer. The existing dam and drainage line on the property will be remediated to form a riparian zone and enable transfer of stormwater off the estate to Eulomogo Creek. The riparian zone is expected to be planted with trees.

5. Site condition and surrounding environment

5.1 Land-use

The current land-use is stock grazing on semi-improved pasture. An occupied residential dwelling is located in the central section of the site.

5.2 Vegetation

The site has been predominately cleared of native tree species. Eucalypts and cyprus pines occur within the south eastern section of the site. Pasture species are exotic and native grasses and legumes with weeds. The weed species include Paterson's curse, cat head, clover, saffron thistle and khaki weed.

5.3 Topography

The site is predominantly located on a mid-slope. A hillock is located in the north western section. Stepped geomorphology occurs in the central to southern section of the site. Aspect is predominantly south and slopes are gently inclined and generally less than 5%. Elevation ranges between 268 and 295 metres above sea level. The lowest elevation occurs on the southern boundary where Eulomogo Creek traverses the site. No groundwater seepage or discharge areas were observed on the site.

5.4 Soils and geology

The majority of the site is located within the Wongarbon Soil Landscape. The south western corner of the site is located within the Bunglegumbie Soil Landscape (Murphy *et al.* 1998).

Soil in the Wongarbon landscape consists of euchrozems and red and brown cracking clays. Parent material is basalt. Soil salinity occurs as isolated areas along drainage lines, depression and footslopes. Soils are slightly to moderately erodible with erosion hazard increasing on slopes of 3 to 8% when cultivated or surface cover is low.

Soil in the Bunglegumbie landscape consists of red brown earths, red earth, non-calcic brown soils and yellow podzolic/solodic soils. Parent material is relatively old and weathered alluvium. Soil salinity problems are absent. Erosion hazard is low on slopes less than 3%.

Lithology of the southern section of the site is Napperby Formation comprising siltstone thinly interbedded with fine-medium grained lithic quartz sandstone with minor conglomerate. Lithology of the northern section is Cainozoic Basalt comprising tholeiite, alkali basalt and alkali ultramafic (Colquhoun *et al.*1997). The site inspections and borehole construction identified the hillock in the north western section comprised of rounded quartz sandstone with strong hematite cementing possibly reworked volcanic. The hillock is expected to be an isolated plug that provides a geological contrast for groundwater movement.

Soils on the site comprised topsoil of strong brown to dark red loamy sand to silty clay of variable depth. Subsoils were dark yellowish brown to red sandy clay to medium clay with increasing weathered basalt cobble and weathered rock with depth. Basalt cobbles and weathered rock were encountered from varying depths over the site between 1.1 to 9.0m resulting in drill refusal.

5.5 Surface water

A dam has been formed within the site and is fed by the natural slope of the site forming a shallow drainage line running north to south west. Surface water over the site predominantly flows south and into the Eulomogo Creek. Eulomogo Creek flows east to west through the southern section of the site.

Eulomogo Creek empties into the Macquarie River approximately 1.8km west of the site.

5.6 Groundwater

The Australian Natural Resources Atlas identifies the site within the Upper Macquarie Alluvium Groundwater Management Unit. The management unit has an area of 414km^2 with approximately 17.95 GL consumed per year. Average salinity levels are greater than 1500mg/L.

A search of the NSW DPI groundwater database located thirty two bores within 1km of the site including eight bores constructed on the site. The bores are predominantly located to the north and south west. Two bores are licensed for monitoring and form part of the Dubbo Regional Council salinity network. The DRC monitoring bores are located in unconfined sand, gravel and clay to depths of less than 7.5m. Other bores are licensed for domestic, stock, commercial, test and public/municipal/town water supplies and have water bearing zones at depths greater than 6m.

Eight bores have been constructed across the site to depths from 29m to 149m. One bore is licensed for stock supplies and had water bearing zones from 57m in consolidated sandstone. No details are provided for the other bores and it is expected they did not intercept groundwater and were not cased.

6. Groundwater and soil salinity investigation

The groundwater and soil salinity investigation comprised a desktop study, field assessment and soil analysis. The desktop study included a review of soil landscape maps, hydro-geological landscapes and groundwater databases. Soil moisture modelling was also undertaken.

The field assessment included an initial site investigation and detailed profile descriptions and soil analysis in a grid pattern over the site. The soil and landscape information collected provided an adequate description of the physical processes on the site to enable salinity issues to be identified and managed. The frequency of tests undertaken was in accordance to the frequency in Table 1 of Lillicrap and McGhie (2002) for moderately intensive construction.

6.1 Soil landscapes

Soil landscape data was reviewed for information regarding soil types in the locality, occurrence of salinity, erosion and sodic soils.

6.2 Hydro-geological landscapes

Hydro-geological landscape (HGL) data for the locality was reviewed (Figure 3) for information regarding the groundwater aquifer including lithology, aquifer type, recharge and discharge characteristics.

6.3 Groundwater

An investigation of registered bores in the area was undertaken to determine the depth and salinity of the groundwater. Groundwater information was found from a review of the NSW Primary Industries website and Dubbo Regional Council Salinity Network.

The groundwater was divided into deep and shallow groundwater. Deep groundwater is located in river gravels, sands and sandstone at depths greater than 15 metres. The shallow groundwater is expected to generally be unconfined in a local aquifer controlled by drainage lines and/or lithological contrasts within the site.

Water criteria for salinity are presented in Tables 1 and 2. The conversion from EC (dS/m) to total dissolved solids or TDS (mg/L) is undertaken by applying the conversion factor of 640 for an average concentration of salts present (Lillicrap and McGhie 2002).

Table 1. Drinking water criteria for salinity (ADWG 2004)

Criteria	EC (dS/m)	Total dissolved solids -Salinity (mg/L)
Good quality drinking water	0.78	500
Acceptable based on taste	0.78-1.56	500-1000
Unsatisfactory taste	1.56	Greater than 1000
Seawater	Greater than 55	-

Table 2. Total dissolved solids of water for agricultural use (Reid 1990)

Class	Description	Total dissolved solids -Salinity (mg/L)
1	Low salinity	0-175
2	Medium salinity	175-500
3	High salinity	500-1500
4	Very high salinity	1500-3500
5	Extremely high salinity	>3500

Table 3. Guidelines on salinity class determination (Dubbo City Council Urban Salinity Plan)

Electrical conductivity (dS/m)	Salinity class
0-2	Low
2-6	Moderate
6-15	High
>15	Extreme

6.4 DLWC groundwater vulnerability mapping

The NSW Department of Land and Water Conservation have undertaken groundwater vulnerability mapping of the Dubbo locality (Piscope and Dwyer 2001). The vulnerability mapping utilises the DRASTIC technique which is a composite description of all the major geologic and hydro-geologic factors that affect and control groundwater movement into, through and out of an area. It involves the overlaying of various hydro-geological settings via a Geographical Information System (GIS). Each hydro-geological setting describes topography, soil type, bedrock type, estimate of rainfall and net recharge depth to watertable (DTWT), aquifer yield, relative conductivity and any particular features associated with the setting that are available. Groundwater vulnerability is classified into high, moderately high, moderate, low moderate and low (Figure 4).

6.5 Dubbo LEP (2011) groundwater vulnerability map

The Dubbo LEP (2011) Natural Resource – Groundwater vulnerability map describes the areas within the Dubbo Regional Council area where groundwater is considered vulnerable to depletion and contamination as a result of development (Figure 5).

6.6 Hydraulic model

An unsaturated moisture movement model is appropriate to evaluate the hydraulic flows of the existing and proposed land-use. The moisture model selected was CLASS U3M-1D as released by CRC Catchment Hydrology (Vaze *et al*. 2004).

6.6.1 Inputs

The model inputs are daily rainfall and evaporation. The model used climate data from 1980 to 2014 (SILO) under pre and post land-use scenarios (Table 4) to predict soil moisture and excess soil moisture. The pre development land-use comprised improved pasture and a residential area.

The post development land-use comprised residential lots, roadways and vegetated road reserves. The vegetated areas will be planted to trees as offset for possible over irrigation of lawns.

The model input data was rainfall and evaporation for the inferred climate at Hennessy Drive as obtained from SILO. The key soil moisture pre land-use scenario was pasture and post development land-use scenario was irrigated lawn. The key scenarios (Table 4) were applied across the time period for pre and post development scenarios in the land-use areas.

Table 4. Land-use in the soil moisture model

Land-use	Pre development (ha)	Post development (ha)	Rainfall parameter
Improved pasture	49.4	0	100% Rainfall
Urban (Dwellings and lawns)	0.1	28.5	Rainfall plus 1mm/day
Road verges	0	3.7	Rainfall (allowance for road runoff)
Roads	0.5	7.1	Run off site
Tree areas	0	10.7	Rainfall plus 1mm/day (allowance for lawn overwatering)
Total	50	50	

Other parameters applied in the model are soil type and depth and default values (Table 5).

Table 5. Model parameters

Parameter	Data/description
Soil profile	Layer 1 1600-3000 Layer 2 900-1600 Layer 3 300-900 Layer 4 0-300 (topsoil)
Land-use	Pasture, lawn, default climate
Soil hydraulic parameters	Layer 1 Sandy clay Layer 2 Light clay Layer 3 Sandy clay Layer 4 Silty clay loam (topsoil) CLASS U3M-1D
Time step	Default
Root distribution	Default

6.6.2 Outputs

The outputs from the model are soil moisture and excess soil moisture by layer in 10 cm increments. Excess soil moisture is the lateral drainage component and is the difference between available moisture and saturated soil moisture.

6.6.3 Nutrient model

A simulation model was developed to predict surface runoff, sediment loss, nitrogen and phosphorus export, pre and post development. The area for each land-use pre and post development was estimated from site walkover, topographical map, subdivision plans and an aerial photograph. The site was classified into the different land-use areas pre and post development. These areas are summarised in Table 6.

Table 6. Land use areas for nutrient model

Land-use areas (ha)	Pre	Post
Improved pasture	47.2	0
Disturbed landscapes	2.2	0
Roads (earth)	0.5	0
Roads (sealed)	0	7.1
Urban (dwellings and lawn)	0.1	28.5
Open space	0	3.7
Trees	0	10.7
Total	50	50

Land-use on-site are as follows;

- *Improved grazing* is the main pre-development land-use. Superphosphate is regularly applied and clovers and other pasture species sown to improve pasture. The pasture area is assumed to be improved for sediment loss and feed.
- *Disturbed landscapes* refers to the eroded drainage line and dam that has been established.
- *Roads (earth)* is a calculation of farm tracks and roads that have been created on-site.
- *Roads (sealed)* is a calculation of bitumen roads that will be on-site post development.
- Urban (dwellings and lawns) is based on the area proposed for 600m^2, 800m^2 and 2,000m^2 lots.
- *Open space* refers to road reserves.
- *Trees* refers to vegetation cover over the site which is recommended.

Sediment, nitrogen and phosphorus export was estimated for low, median and high scenarios for each land-use class as detailed in Appendix 1 (Chafer 2003).

6.7 Initial site investigation

An initial site investigation was conducted by collecting information on vegetation, slope, bare areas and other indicators of salinity at 100 locations across the site (Figure 6). This density is in accordance with the recommendations by Lillicrap and McGhie (2002).

6.8 Detailed profile descriptions and laboratory analysis

Twenty seven boreholes were constructed with an EVH truck mounted hydraulic drilling rig with solid auger on 10 and 11 January 2017 to provide information on the soil profiles and enable sampling. The boreholes were constructed at various local elevations on the site (Figure 7). Six boreholes were constructed to a depth of 9m or drill refusal. A 50mm diameter monitoring well was constructed along Eulomogo Creek (BH27) and at the expected stepped geomorphology and geological interface (BH16) to intercept groundwater.

The soil profile was described for colour, texture and moisture. Soil samples were collected from seven boreholes at 100mm, 200mm, 300mm, 500mm, and 500mm intervals to the depth of the borehole. Additional samples were collected from potentially saline material identified from visual observation. The sampling is expected to provide an adequate description of subsoil salinity conditions. Soil samples were analysed for pH, electrical conductivity and dispersion.

Soil electrical conductivity (EC) results of the 1:5 (soil:water suspension) were converted to saturated extracts (ECe). EC values are converted to ECe by using a multiplier factor (Charman and Murphy, 1991), which is dependent on the soil texture (Table 7). Saline soils are defined as those with an electrical conductivity (ECe) greater than 4 dS/m (Charman and Murphy, 2001). Soil salinity ratings and effects on plant growth are presented in Table 8.

Table 7. ECe texture based conversion factors (Charman and Murphy 2001)

Soil texture	Conversion factor
Loamy sand, clayey sand, sand	23
Sandy loam, fine sandy loam, light sandy clay loam	14
Loam, loam fine sandy, silt loam, sandy clay loam	9.5
Clay loam, silty clay loam, fine sandy clay loam	8.6
Sandy clay, silty clay, light clay	7.5
Light medium clay, medium clay, heavy clay	5.8

Table 8. Soil salinity ratings based on ECe readings

Salinity rating	ECe (dS/m)*	Effects on Plants
Non saline (NS)	0-2	Salinity effects negligible
Slightly saline (SS)	2-4	Very salt sensitive plant growth restricted
Moderately saline (MS)	4-8	Salt sensitive plant growth restricted
Highly saline (HS)	8-16	Only salt tolerant plants unaffected
Extremely saline (ES)	>16	Only extremely tolerant plants unaffected

*ECe - Electrical conductivity of a saturated extract

Soil with ECe below 2 dS/m will have negligible effects on plant growth and soil stability. Soil with ECe of between 2 and 4 dS/m may restrict very salt sensitive plant growth. Soil with ECe between 4 and 8 dS/m will restrict the growth of salt sensitive plants.

Samples were analysed for dispersion using the Emerson aggregate test. Table 9 details the eight dispersion classes.

Table 9. Emerson dispersion classes

Class	Description
1	Highly dispersive (slakes, complete dispersion)
2	Moderately dispersive, slakes, some dispersion
3	Slightly dispersive, slakes, some dispersion after remoulding
4	Non-dispersive, slakes, carbonate or gypsum present
5	Non-dispersive, slakes, dispersion in shaken suspension
6	Non-dispersive, slakes, flocculates in shaken suspension
7	Non-dispersive, no slaking, swells in water
8	Non-dispersive, no slaking, does not swell in water

Representative soil samples were collected from the topsoil and subsoil and analysed for chloride and sodicity. Chloride criteria for corrosiveness to building material are presented in Table 10 and are an extract from AS2159-1995 Piling – design and installation.

Aggressive soils criteria for salinity and sulfate impacts on building structures are presented in Australia Standard AS2870-2011 (Appendix 2). The AS2870 standard also describes requirements to mitigate salinity and sulphate on footings.

Table 10. Chloride corrosiveness to building materials (AS2159-1995 Piling – design and installation)

Concrete piles		Steel piles	
Chlorides in water (mg/kg)	Soil conditions for low permeability soils or all soils above groundwater	Chlorides in water (mg/kg)	Soil conditions for low permeability soils or all soils above groundwater
<2,000	Non-aggressive	<1,000	Non-aggressive
2,000-6,000	Non-aggressive	1,000-10,000	Non-aggressive
6,000-12,000	Mild	10,000-20,000	Mild
12,000-30,000	Moderate	>20,000	Moderate
>30,000	Severe		

Sodicity is expressed as a percentage of the cation exchange capacity or exchangeable sodium percentage (ESP). Ranking of sodicity is presented in Table 11 (Lillicrap and McGhie 2002). An ESP of less than 5% indicates a non-sodic soil, ESP of between 5 and 15% indicates a sodic soil and an ESP of greater than 15% indicates a highly sodic soil.

Table 11. Ranking of exchangeable sodium percentage

Exchangeable sodium percentage	Ranking
<5%	Non-sodic
5-15%	Sodic
>15%	Highly sodic

7. Results and discussion

7.1 Soil landscape maps

The majority of the site is located within the Wongarbon Soil Landscape. The south western corner section of the site is located within the Bunglegumbie Soil Landscape (eSpade 2017).

Soil in the Wongarbon landscape consists of euchrozems and red and brown cracking clays. Parent material is basalt. Soil salinity occurs as isolated areas along drainage lines, depression and footslopes. Soils are slightly to moderately erodible with erosion hazard increasing on slopes of 3 to 8% when cultivated or surface cover is low.

Soil in the Bunglegumbie landscape consists of red brown earths, red earth, non-calcic brown soils and yellow podzolic/solodic soils. Parent material is relatively old and weathered alluvium. Soil salinity problems are absent. Erosion hazard is low on slopes less than 3%.

7.2 Hydro-geological landscapes

The northern half of the site is located in the Dubbo Basalt HGL and the southern half of the site is in the Purlewaugh/Napperby HGL (eSpade 2017). The site and associated hydro-geological landscapes are depicted in Figure 3.

Lithology of the Dubbo Basalt HGL consists of Cainozoic basalt consisting of in-situ Olivine rich alkali basalt with some colluvial material and quartzite derived from the underlying sandstone and siltstone. Soil salinity is isolated at areas along drainage lines, at the intersection with the Purlewaugh formation depressions and footslopes. Saline soils also occur due to local perching of the water table. Groundwater flow is unconfined to semi-confined in consolidated fractured rock. Groundwater salinity is fresh to marginal.

The southern section of the site is located in the Purlewaugh/Napperby HGL. The landscape is characterised by low flat hills and rises with a stepped geomorphology. Lithology of the

Purlewaugh/Napperby HGL consists of Purlewaugh Formation, Napperby Formation and Boulderwood Formation comprising mainly ferruginous red siltstone, carbonaceous mudstone, fine to medium grained lithic sandstone, ironstone, minor coal and minor conglomerate. Large areas of salinity occur along contours and are repeated at different topographic levels. Severe salt sites occur in the lower landscape. Salt load is very high to extreme due to water readily mobilising salts stored within the sedimentary pile. Groundwater flow is unconfined to semi-confined flows through fractures in sandstone and sedimentary bedrock, permeable soils and saprolite. Lateral flow occurs through colluvial sediments on lower slopes. High recharge rates occur across the landscape particularly in areas where cropping is practised. Water electrical conductivity is moderate to high.

7.3 Groundwater

7.3.1 OEH registered bores

Thirty two registered water abstraction bores were identified within a 1km radius of the site on the NSW Government Department of Primary Industries website (2017) (Figure 8). Data known about each bore within 1km of the site from the Department of Primary Industries website is summarised in Appendix 3. Bores are predominantly located to the north and south west of the site.

Two bores form part of the Dubbo Regional Council salinity network and as such have been constructed to intersect shallow unconfined groundwater. The characteristics of these bores are discussed in Section 7.3.2. The remainder of the bores are licenced for domestic, stock, commercial, test and public/municipal/town water.

Water-bearing zones (WBZ's) and standing water levels were recorded for fourteen bores. The Department of Primary Industries website shows that SWL's and WBZ's in bores (for which data was recorded) were at depths greater than 7m (Figure 8 and Appendix 3). The water bearing zones are located in unconfined sand, gravel and clay and confined sandstone.

A salinity description was recorded for four bores. All were considered to contain non-saline water, with descriptions of 'good', '0-500ppm' and 'fresh'. '

7.3.2 Dubbo Regional Council salinity network

Two Dubbo Regional Council (DRC) monitoring bores are located at less than 1km from the site and twelve are located between 1 and 2km west to north of the site (Figure 9 and Appendix 4). Bore depths ranged from 2m to 15m with water bearing zones located in unconfined regolith comprising clay. The majority of bores have been dry since monitoring begun in March 2005 and three of the bores have not been monitored due to accessibility issues.

The bores identified within 1km of the site are identified as DCC19 and DCC20 (Figure 10). DCC19 is located on the northern boundary of the site and has a depth of 3m. DCC20 is located to the west of the site and has a depth of 15m. DCC19 and DCC20 have generally been dry or too shallow to bail since monitoring began in March 2005 indicating groundwater in the northern section of the site is greater than 3m and in the southern section greater than 15m.

Standing water levels in Dubbo Regional Council (DRC) monitoring bores within 2km of the site in July to November 2016 ranged between 2.01m and 7.05m and five were dry (Table 11 and Figure 9). Electrical conductivity of these bores was classed as low salinity. Levels of total dissolved solids were medium to high for agricultural use with levels ranging between 371mg/L to 909mg/L (Appendix 4).

7.3.3 On-site groundwater

A groundwater monitoring well was installed in BH16 located in the western section of the site at the presumed stepped geomorphology and lithological interface between medium grained lithic sandstone and tertiary basalt. The well was installed at a depth of 5.6m in clayey sand and sandy clay with drill refusal on rock. Groundwater was not encountered in the monitoring well one week after construction.

Table 11. Dubbo Regional Council salinity network

Sampling location (see Figure 10)	Depth (m)	Date sampled	Standing water level (m)	EC (dS/m)	Total dissolved solids (EC x 640) (mg/L)
DCC18	15	Jul-16	2.94	1.23	787
		Sep-16	2.71	1.11	710
		Nov-16	3.61	1.42	909
DCC19	3	Jul-16	Dry	-	-
		Sep-16	Dry	-	-
		Nov-16	Dry	-	-
DCC20	15	Jul-16	Dry	-	-
		Sep-16	Dry	-	-
		Nov-16	Dry	-	-
DCC42	2	Jul-16	Dry	-	-
		Sep-16	Dry	-	-
		Nov-16	Dry	-	-
DCC44	6	Jul-16	2.41	0.79	506
		Sep-16	2.15	0.58	371
		Nov-16	2.66	0.87	557
DCC45	9	Jul-16	6.60	1.25	800
		Sep-16	6.31	1.17	749
		Nov-16	7.04	1.17	749
DCC49	15	Jul-16	Dry	-	-
		Sep-16	Dry	-	-
		Nov-16	Dry	-	-
DCC53	9	Jul-16	Missing	-	-
		Sep-16	Missing	-	-
		Nov-16	Missing	-	-
DCC87	6	Jul-16	Missing	-	-
		Sep-16	Missing	-	-
		Nov-16	Missing	-	-
DCC111	6	Jul-16	Dry	-	-
		Sep-16	Dry	-	-
		Nov-16	Dry	-	-
DCC115	9	Jul-16	Missing	-	-
		Sep-16	Missing	-	-
		Nov-16	Missing	-	-
DCC116	3.5	Jul-16	2.88	0.99	634
		Sep-16	2.69	0.84	538
		Nov-16	2.02	0.96	614

TSTB- too shallow to bail

The second groundwater monitoring well was installed in BH27 located on the northern bank of Eulomogo Creek. The well was installed at 3.9m in clayey sand with gravel and cobbles with drill refusal on rock. Groundwater was not encountered one week after construction.

Unconfined groundwater may occur along the drainage line following periods of high rainfall.

Eight bores have been historically constructed across the site to depths from 29m to 149m. One bore is licensed for stock supplies and have water bearing zones from 57m in consolidated sandstone. No details are provided for the other bores and it is expected they did not intercept groundwater and were not cased.

7.4 Groundwater vulnerability

The Department of Land and Water Conservation (Piscope and Dwyer 2001) identifies the majority of the site as having a low groundwater vulnerability rating (Figure 4). The south western section of the site had a moderate groundwater vulnerability rating.

Land adjacent the eastern boundary has a low groundwater vulnerability rating and adjacent the western boundary had a moderately high groundwater vulnerability. Land to the south west and along the Macquarie River had a high groundwater vulnerability rating.

7.5 Dubbo LEP (2011) groundwater vulnerability map

The Dubbo LEP (2011) identifies the site in a moderately high groundwater vulnerability area (Figure 5). Areas to the south west along the Macquarie River and to the east have a high groundwater vulnerability rating. No groundwater vulnerability rating applies to land to the north east.

7.6 Initial site investigation

The initial site investigation was conducted on an 70m x 70m grid across the site (Figure 6 and Appendix 5).

The site has a historical land-use of grazing. Minor amounts of cropping are expected to have occurred on the mid to lower slopes of the site.

Scattered eucalypts and cyprus pines occur within the south eastern section of the site. A residential area including dwelling, tennis court and swimming pool were identified in the central area of the site. A large machinery shed and associated horse stables were also identified within this area.

Pasture species are exotic grasses and legumes with weeds. The weed species include Paterson’s curse, hedge mustard, cat head, clover, saffron thistle and khaki weed. Vegetation cover was greater than 90% across the majority of the site. Bare areas were due to farm tracks.

The majority of the site was very gently inclined with slopes ranging from 0 to 2%.

Basalt cobbles were identified in the north western section of the site.

No indicators of salinity were observed.

7.7 Soil characteristics

Boreholes were constructed to depths of 2m, 3m, 9m or drill refusal. Drill refusal due to rock was encountered in the majority of boreholes from depths between 1.1m and 9m. Borelogs are presented in Appendix 6.

7.7.1 Texture and colour

Soils on the site comprised topsoil of of strong brown to dark red loamy sand to silty clay of variable depth. Subsoils were dark yellowish brown to red sandy clay to medium clay with increasing weathered basalt cobble and weathered rock with depth. Basalt cobbles and weathered rock were encountered from varying depths over the site between 1.1 to 9.0m resulting in drill refusal.

Table 12. Soil colour, texture, pH, EC and ECe (detailed profile descriptions)

Borehole No - depth (mm)	Soil colour	Soil texture	pH	EC1:5	ECe (dS/m)	Emerson aggregate test
1-100	Strong brown	Sandy clay	6.7	0.12	0.90	5
1-200	Strong brown	Fine sandy clay	7.1	0.12	0.90	5
1-300	Strong brown	Light clay with fine sand and fine gravel	7.3	0.11	0.83	5
1-500	Strong brown	Light clay with fine sand and fine gravel	7.3	0.11	0.83	5
1-1000	Strong brown	Light clay with fine sand and fine gravel	7.3	0.12	0.9	5
1-1500	Strong brown	Light clay with fine sand and fine gravel	7.4	0.17	1.28	6
1-2000	Dark yellowish brown	Light clay	7.5	0.20	1.50	6
1-2500	Dark yellowish brown	Medium clay	7.6	0.21	1.22	6
1-3000	Dark yellowish brown	Medium clay	7.6	0.17	0.99	6
1-3500	Dark yellowish brown	Sandy clay	7.7	0.15	1.23	6
1-4000	Dark yellowish brown	Sandy clay with fine gravel	8.1	0.16	1.20	5
1-4500	Dark yellowish brown	Sandy clay with fine gravel	8.2	0.18	1.35	5
1-5000	Dark yellowish brown	Sandy clay loam	8.4	0.15	1.43	5
1-5500	Yellowish brown	Fine sandy clay loam	8.2	0.13	1.24	5
1-6000	Yellowish brown	Fine sandy clay loam	8.3	0.13	1.24	5
1-6500	Yellowish brown	Fine sandy clay loam with gravel	8.3	0.12	1.14	5
1-7000	Yellowish brown	Fine sandy clay loam with gravel	8.4	0.10	0.95	5
1-7500	Yellowish brown	Sandy clay	7.9	0.08	0.60	3
1-8000	Yellowish brown	Silty clay	8.5	0.07	0.53	3
1-8500	Light yellowish brown	Silty clay	8.2	0.09	0.68	3
1-9000	Yellowish brown	Silty clay	8.2	0.08	0.60	3
3-100	Reddish brown	Sandy clay loam	5.8	0.03	0.29	3
3-200	Reddish brown	Fine sandy clay loam	6.3	0.02	0.15	3
3-300	Dark red	Fine sandy clay	6.7	0.01	0.08	3
3-500	Dark red	Light clay	6.6	0.01	0.08	5
3-1000	Dark red	Light clay	6.9	0.02	0.15	5
3-1500	Dark red	Medium clay	6.8	0.01	0.06	5
3-1800	Dark red	Medium clay	7.1	0.01	0.06	3
4-100	Reddish brown	Sandy loam	5.8	0.04	0.56	3
4-200	Dark red	Silty clay	5.6	0.02	0.17	2
4-300	Dark red	Silty clay with gravel	6.1	0.02	0.17	3
12-100	Dusky red	Loamy fine sand	5.4	0.02	0.19	2
12-200	Dusky red	Sandy clay loam	5.8	0.02	0.19	1
12-300	Dark red	Silty clay	6.4	0.01	0.08	1
12-500	Reddish brown	Silty clay	6.6	0.01	0.08	3
12-1000	Yellowish red	Silty clay	7.3	0.02	0.15	5
12-1500	Yellowish red	Silty clay	7.3	0.02	0.15	3
12-2000	Reddish brown	Silty clay	7.3	0.02	0.15	3
12-2500	Brown	Silty clay	7.5	0.02	0.15	2
12-3000	Strong brown	Light clay	6.6	0.02	0.15	2
12-3500	Brown	Sandy clay with gravel	6.8	0.02	0.15	2
12-4000	Strong brown	Sandy clay with gravel	7.3	0.02	0.15	2
12-4500	Dark brown	Sandy clay with gravel	6.8	0.02	0.15	2
12-5000	Dark brown	Sandy clay with gravel	7.0	0.02	0.15	2

13-1600	Light yellowish brown	Loamy sand	8.9	0.16	3.68	3
15-2800	Pinkish grey	Silty loam	8.6	0.11	1.05	1
16-100 (MW2)	Dark brown	Loamy sand	4.9	0.03	0.69	2
16-200 (MW2)	Brown	Loamy sand	5.0	0.03	0.69	2
16-500 (MW2)	Reddish brown	Loamy sand	5.7	0.0	0.46	2
16-1500 (MW2)	Dark red	Loamy sand	8.3	0.08	1.84	2
16-2500 (MW2)	Reddish brown	Clayey sand	8.5	0.27	6.21	2
16-3000 (MW2)	Brown	Sandy clay	8.4	0.29	2.18	2
16-3500 (MW2)	Light grey	Clayey sand	9.5	0.41	9.43	2
16-4000 (MW2)	Reddish grey	Sandy clay	9.3	0.40	3.0	2
16-4500 (MW2)	Brown	Fine sandy clay loam	9.2	0.32	3.04	2
16-5000 (MW2)	Reddish grey	Clayey sand	9.5	0.34	7.82	2
16-5500 (MW2)	Dark yellowish brown	Fine sandy clay loam with gravel	9.3	0.31	2.67	2
17-700	Light grey	Fine sandy clay loam	7.6	0.04	0.34	3
18-700	Pale yellow	Sand	7.3	0.02	0.46	2
19-1600	Pale yellow	Silty clay	9.6	0.38	2.85	3
19-2500	Light grey	Sandy clay with gravel	8.9	0.12	0.90	2
20-100	Very dark brown	Loamy sand	5.9	0.03	0.69	3
20-200	Dark brown	Loamy sand	6.6	0.03	0.69	2
20-300	Dark brown	Loamy sand	6.9	0.03	0.69	2
20-500	Reddish brown	Sandy clay	9.0	0.11	0.83	2
20-1000	Reddish brown	Light clay with gravel	9.5	0.53	3.98	3
20-1500	Strong brown	Sandy clay	9.5	0.56	4.20	2
20-2000	Strong brown	Sandy clay	9.3	0.52	3.90	2
20-2500	Grey brown	Silty clay	9.0	0.57	4.28	2
20-3000	Grey brown	Silty clay	9.4	0.60	4.50	2
20-3500	Strong brown	Sandy clay	9.4	0.55	4.20	2
20-4000	Strong brown	Sandy clay	9.6	0.55	4.13	2
20-4500	Strong brown	Sandy clay	9.7	0.52	3.90	2
20-4900	Strong brown	Sandy clay	9.7	0.45	3.38	2
27-100 (MW1)	Dark brown	Loamy sand	6.0	0.03	0.69	3
27-200 (MW1)	Strong brown	Loamy sand	5.7	0.02	0.46	3
27-300 (MW1)	Strong brown	Loamy sand	6.1	0.02	0.46	3
27-500 (MW1)	Dark medium brown	Sandy clay loam	6.6	0.02	0.19	3
27-1000 (MW1)	Dark red	Light clay	6.7	0.01	0.08	3
27-1500 (MW1)	Red	Light clay	6.9	0.01	0.08	3
27-2000 (MW1)	Reddish brown	Loamy sand with gravel	6.7	0.02	0.46	3
27-2500 (MW1)	Brown	Loamy sand with gravel	7.3	0.02	0.46	3
27-3000 (MW1)	Brown	Loamy sand	7.5	0.02	0.46	3
27-3500 (MW1)	Dark brown	Sandy clay with gravel	7.7	0.02	0.46	3

7.7.2 Salinity (electrical conductivity)

All topsoils samples were determined to be non-saline. Subsoils in the majority of the site were classified as non-saline (BH1, BH3, BH4, BH12 and BH27) with electrical conductivity of less than 2dS/m (Figure 10).

Subsoil samples collected from two boreholes (BH16 and BH20) constructed along the stepped geomorphology contained moderately to highly saline subsoils from 1m (Table 12).

7.7.3 pH
The topsoil was slightly acidic (Table 12). The pH generally increased with increasing depth. Subsoil was generally slightly alkaline.

7.7.4 Emerson aggregate test
Topsoil and subsoil on the site was non-dispersive to slightly dispersive in BH1, BH3 and BH27. Topsoil and subsoil was moderately to highly dispersive in BH12, BH16 and BH20 (Table 12).

7.7.5 Chlorides
Levels of chlorides in the samples analysed were less than 2,000mg/kg and considered non-aggressive soils for concrete and steel piles (Table 13).

Table 13. Soil results for chlorides and exchangeable sodium percentage (ESP) (Appendix 7)

Sample ID	Borehole and depth (mm) (Figure 5)	Chlorides (mg/kg)	ESP (%)
BH16-100	16-100	7.6	3.3
BH16-1500	16-1500	50	36.5

ND – Not detected at the laboratory limits

7.7.6 Exchangeable sodium percentage
Exchangeable sodium percentage for the topsoil sample collected from Borehole 16 at the expected geological interface was non-sodic. The subsoil sample was highly sodic (Table 13).

7.8 Indicators of salinity
7.8.1 Bare soil
No bare soil resulting from sheet erosion or salinity were present on site

7.8.2 Salt crystals
No salt crystals present on site.

7.8.3 Vegetation indicators
No highly salt tolerant plant species are present on site.

7.8.4 Die back
No vegetation or tree die back was observed on or surrounding the site.

7.8.5 Effects on buildings
The existing dwelling located on the site had no evidence of salinity impact.

7.8.6 Conditions of roads
No evidence of surface undulations or break-up of bitumen on the roads surrounding the site.

7.9 Soil moisture model
The soil moisture varies with rainfall in both land-use scenarios. Soil moisture at 1m and 3m depths was greater under irrigated lawn with large variations throughout the year. Soil moisture levels under irrigated lawn was saturated for a short time in some years at 1m and did not exceed field capacity at 3m depth (Figures 11 and 12).

Management of areas with elevated salinity identified at the geological interface with permanent vegetation will prevent mobilization of salts in the surface or subsurface.

7.10 Nitrogen

Nitrogen soil levels in the grazing system are typically low with concentrated areas around animal wastes. Nitrogen fertilisers are also used in cropping operations and biological synthesis occurs in legumes. Off-site movement occurs from sediment loss. Water soluble nitrogen has potential to leach into the groundwater.

Post development sources of nitrogen are from fertilisers applied to lawns. Post development fertilisation will only occur in a small proportion of the site that is lawns and gardens. Nitrogen fertilisation is not expected to occur on the road verge. Nitrogen fertiliser will not be required in native gardens. The impact from lawn fertilisers will be less than the impact of animal wastes. Maintained gardens and lawns will have the capacity to utilise the nitrogen applied. The impact of nitrogen fertiliser post development will be reduced.

The nutrient balance indicates the development will reduce nitrogen export by 194 kg/year under the median scenarios (Table 14). Reduced pasture area and an increase in hard surface areas has resulted in a decrease in the nitrogen loss.

Table 14. Land-use nitrogen export pre and post development (kg/year)

Land-use areas	Pre-development	Post-development	Impact
Native bushland	0.00	25.68	-25.68
Disturbed landscapes	26.4	0.00	26.4
Remediated gullies	0.00	3.00	-3.00
Improved pasture	420.08	0.00	420.08
Roads (sealed)	0.00	42.60	-42.60
Roads (earth)	1.10	0.00	1.10
Urban	0.61	173.85	-173.24
Urban (open space)	0.00	11.84	-11.84
TOTAL	448.19	253.97	194.22

7.11 Phosphorus

The main phosphorus sources pre-development are from animal waste and fertilisers. Horses are currently grazed on the site. Off-site movement of phosphorus will occur in sediments and susceptible times are when vegetation cover is low.

Stock numbers will decrease in the post development land-use. Domestic pet numbers on the site are expected to increase. The majority of domestic pet scats are expected to be disposed to landfill by collection of the scats by owners or removal with kitty litter. The result will be a decrease contribution of phosphorus on the site.

Phosphorus binds to soil and the primary method of movement is in sediments. Vegetation cover is expected to be higher post development resulting in filtering of runoff, reduced sediment loads exported and consequently lower phosphorus export.

The nutrient balance indicates the development will decrease phosphorus export by 0.82 kg/year under the median scenarios (Table 15). Phosphorus export will increase under the high scenarios. This is at the extreme end of the modelling and is only expected to occur occasionally in small areas of the site. Riparian planting and wetland design can reduce phosphorus levels at stormwater discharge areas.

Table 15. Land-use phosphorus exports pre and post development (kg/year)

Land-use areas	Pre-development	Post-development	Impact
Native bushland	0.00	1.39	-1.39
Disturbed landscapes	2.73	0.00	2.73
Improved pasture	63.72	0.00	63.72
Roads (sealed)	0.00	12.78	-12.78
Roads (earth)	0.86	0.00	0.86
Urban	0.22	51.87	-51.87
Urban (open space)	0.00	0.63	-0.63
TOTAL	67.49	66.67	0.82

7.12 Sediment

The nutrient balance indicates the development will reduce sediment by 14,899 kg/year under the median scenario (Table 16). Sediments are reduced due to the decrease in contribution from the pasture area.

Table 16. Land-use sediment export pre and post development (kg/year)

Land-use areas	Pre-development	Post-development	Impact
Native bushland	0.00	428.00	-428.00
Disturbed landscapes	1,914.00	0.00	1,914.00
Improved pasture	24,544.00	0.00	24,544.00
Roads (sealed)	0.00	1,349.00	-1,349.00
Roads (earth)	70.00	0.00	70.00
Urban	30.00	8,550.00	-8,520.00
Urban (open space)	0.00	1,332.00	-1,332.00
TOTAL	26,558.00	11,659.00	14,899.00

7.13 Garden fertilisers and chemicals

Minor usage of herbicides may occur post development on lawns. All fertilisers and agricultural chemicals will be utilised by the vegetation or degrade rapidly in the environment. No impact on surface water or groundwater will occur.

No industrial activities including bulk storage or use of chemicals will occur in the development.

7.14 Other contaminants

7.14.1 Greywater reuse

NSW Health approves the following methods for greywater reuse:

- Bucketing: Generally only small volumes of greywater are reused and the action is unlikely to occur during wet weather. Risk of overwatering and therefore impact on groundwater is low.
- Greywater diversion devices: Does not require Council approval if conditions relating to installation and use are met. Conditions include undertaking checks and maintenance of the irrigation system, use biodegradable detergents low in phosphorus, sodium, boron and chloride, no irrigation during rain, undertake a water balance prior to installation, monitor soil and plant response to irrigation, do not overwater and notify the local water utility of the device. Notification to the local water utility (Dubbo Regional Council) ensures Council is aware the system is in place and can check on compliance. Conditions ensure the water is used sustainably with minimal impact on the groundwater.
- Greywater treatment system: Requires approval from Council. Council can regulate the suitability and number of systems in the locality and check on the satisfactory operation of the system. Regulation of the system ensures minimal impact on groundwater.

7.14.2 Car washing

Minor washing of cars by householders is expected to be undertaken post development. Most car owner clean cars in commercial washing bays. Small numbers of cars will be washed either on permeable areas resulting in infiltration or non-permeable areas with water moving into the reticulated stormwater system and off-site. Water and detergents infiltrating permeable areas will be utilised by vegetation. Some deeper infiltration may occur but volumes are not expected to be significant. Car washing is not expected to occur during rain.

8. Soil and water impact assessment

8.1 Soil

Surface soils and subsoils in the northern and southern sections of the site were non-saline. Moderate to highly saline subsoils were identified at a depth of greater than 1m at the expected geological interface through the central to southern section of the site. The moderate to highly saline subsoils are associated with the sandstone lithology. Excavation works from the development are not expected to intercept the saline subsoil, following adoption of the recommendations in this report

8.2 Water

8.2.1 Surface water

Runoff will be directed into a piped stormwater system. The pipes will discharge into a stormwater management system proposed to be constructed off-site to the west. The existing dam located on site will be decommissioned.

8.2.2 Groundwater

8.2.2.1 Recharge

Modelling has shown under a number of scenarios that soil moisture infiltration will not be significant in the development. Moderate irrigation of lawns will not result in infiltration at a depth of 3m. The proposed planting of deep-rooted vegetation as street trees and within the southern road reserve will aid in the extraction of soil moisture within the profile and reduce the occurrence of deep infiltration that may occur in high rainfall years. .

Additional infiltration in the non-saline areas from possible over irrigation of lawn will not contribute to salinity. Large areas of impervious surface (roads and roof areas) will increase in rainfall runoff and reduce infiltration. Deep infiltration of groundwater within the area is expected to be similar pre and post development. Groundwater levels are not expected to rise as a result of the development.

Regular monitoring has been undertaken by the NSW Office of Water of the Dubbo town water supply extraction area located south west of the site. These bores have shown a long term declining trend with falls of up to 18m (Smithson, 2010).

8.2.2.2 Discharge

No shallow groundwater discharge areas were identified on the site. Discharge is unlikely to occur at the boundary between the basalt and sandstone lithology in the central to southern section as this was not observed from surface or subsurface observations.

8.2.2.3 Clause 7.5 of the Dubbo LEP 2011

(1) The objective of this clause is to maintain the hydrological functions of key groundwater systems and to protect vulnerable groundwater resources from depletion and contamination as a result of inappropriate development.

Response: The development and groundwater at the site is described in the Groundwater and Salinity report prepared by Envirowest Consulting Pty Ltd (Report number R7891s1).

(2) This clause applies to the land identified as "Groundwater vulnerability" on the Natural Resources – Groundwater Vulnerability Map.

Response: The site is located in a mapped moderately high groundwater vulnerability area.

(3) Before determining a development application for development on land to which this clause applies, the consent authority must consider:

> *(a) whether the development (including any on-site storage or disposal of solid or liquid waste chemicals) will cause any groundwater contamination or any adverse effect on groundwater dependent ecosystems.*

Response:
The development has a low potential to adversely affect groundwater and groundwater dependent ecosystems. Groundwater and groundwater dependent ecosystems may be impacted by use of fertilisers on lawns and gardens, greywater reuse and car washing. The post development impact is expected to be similar or less than under the pre-development agricultural land-use.

Post development lawn inputs will only occur in a small proportion of the site that is lawns and gardens. Nitrogen fertiliser will not be required in native gardens. The impact from lawn fertilisers will be managed by riparian vegetation and stormwater design which will removed any potential increase in nitrogen rich fertilizers. Maintained gardens and lawns will have the capacity to utilise the nitrogen applied. The impact of nitrogen inputs post development will be reduced.

The post development scenario is expected to result in a decrease in contribution of phosphorus, nitrogen and suspended sediments. Fertilizer use in the residential subdivision with be less than the agricultural land-use. Stock numbers will decrease in the post development land-use while domestic pet numbers on the site are expected to increase. The majority of domestic pet scats are expected to be disposed to landfill by collection of the scats by owners or removal with kitty litter disposed as refuse to landfill.

Minor usage of herbicides may occur post development on lawns. All fertilisers and agricultural chemicals are not residual and will be utilised by the vegetation or degrade rapidly in the environment. No impact on surface water or groundwater will occur.

NSW Health approves the following methods for greywater reuse:

- Bucketing: Generally only small volumes of greywater are reused and the action is unlikely to occur during wet weather. Risk of overwatering and therefore impact on groundwater is low.
- Greywater diversion devices: Does not require Council approval if conditions relating to installation and use are met. Conditions include undertaking checks and maintenance of the irrigation system, use biodegradable detergents low in phosphorus, sodium, boron and chloride, no irrigation during rain, undertake a water balance prior to installation, monitor

soil and plant response to irrigation, do not overwater and notify the local water utility of the device. Notification to the local water utility (Dubbo Regional Council) ensures Council is aware the system is in place and can check on compliance. Conditions ensure the water is used sustainably with minimal impact on the groundwater.

- Greywater treatment system: Requires approval from Council. Council can regulate the suitability and number of systems in the locality and check on the satisfactory operation of the system. Regulation of the system ensures minimal impact on groundwater.

Minor washing of cars by householders is expected to be undertaken post development. Most car owners clean cars in commercial washing bays. Small numbers of cars will be washed either on permeable areas resulting in infiltration or non-permeable areas with water moving into the reticulated stormwater system and off-site. Water and detergents infiltrating permeable areas will be utilised by vegetation. Some deeper infiltration may occur but volumes are not expected to be significant. Car washing is not expected to occur during rain.

No industrial activities including bulk storage or use of chemicals will occur in the development.

(b) The cumulative impact (including the impact on nearby groundwater extraction for potable water supply or stock water supply) of the development and any other existing development on groundwater.

Response:
Impact on groundwater from nitrogen contamination is expected to be less post development compared to pre-development due to lower contributions from animals and fertilisers. Other contaminates such as greywater reuse and car washing are expected to have a negligible impact on groundwater quality due to low risk of overwatering resulting in deep infiltration and regulation. The cumulative impact of the development and adjacent existing development on groundwater quality is expected to be negligible.

(4) Development consent must not be granted to development on land to which this clause applies unless the consent authority is satisfied that:

(a) The development is designed, sited and will be managed to avoid any significant adverse environmental impact, or
(b) If that impact cannot be avoided by adopting feasible alternatives – the development is designed, sited and will be managed to minimise that impact, or
(c) If that impact cannot be minimised – the development will be managed to mitigate that impact.

No impacts from the development are expected if additional implementations are adopted. Offset contingences have also been proposed to provide additional assurance.

Mitigation measures will be adopted within the development to off-set the unlikely impacts on groundwater quality. The mitigation measures will comprise planting of deep-rooted vegetation off-sets as street trees and in the southern road reserve. The vegetation will intercept groundwater and nutrients and will reduce the potential impact on groundwater quality.

Deep-rooted vegetation comprising native species selected from the species list provided in DCC Water Wise and Salt Tolerant Plants list (no date) will be planted in proposed open space.

8.3 Vegetation

Most of the site contains annual species which are shallow rooted. No impact from saline soils and groundwater on the vegetation was observed.

Pasture grasses will be replaced with introduced or native garden species including deep rooted perennials. Garden species to be planted will be shallow rooted or salt tolerant and no impact on growth is expected. Trees will be planted as street trees, within the proposed freight way road reserve and within the riparian zone. The proposed residential development will contain irrigated and unirrigated lawns with plantings of shrubs and trees. Ecowise gardens of native and drought tolerant species will be promoted in the development. Costs associated with irrigation will ensure overwatering and leaching does not occur. On-site shallow groundwater is not expected to be a viable source of irrigation water due to the unreliable shallow groundwater aquifer. The deeper confined aquifer has been proven as a reliable source however recent reports suggest licences may be difficult due to groundwater decline within the upper Macquarie groundwater management area. The use of fertiliser and herbicides on lawn will be utilised by plants and will not move out of the rooting zone.

The new land-use will contain a mix of shallow and deep rooted vegetation. Species planted in lawns will utilise soil moisture all year round compared to the current pasture species mix which are mostly summer active only. Trees will be planted along roadways, garden areas and the riparian zone.

8.4 Infrastructure

Non to slightly saline soils were identified to a depth of 9.0m across the majority of the site which is below the footing depth for residential buildings. Moderately to highly saline soils were identified from 1.0m in the central to southern section of the assessment area. Excavations that are required to be at depths greater than 1.0m in the central to southern section of the assessment area should be consider salt protected materials for services and be undertaken in accordance with building in saline areas. Groundwater is present at depths greater than building depths. No special construction requirements addressing salinity are expected to be required for infrastructure including roads and buildings in the remainder of the site.

8.5 Pollution risk control

The subsoil is clay with depth of greater than 9 metres to groundwater. The soil layer provides significant filtration and absorption capacity to reduce contamination loading.

Occasional fertilizer and chemical use is expected from the residential land-use. Fertilisers will be utilised by plants. All agricultural chemicals degrade rapidly in the environment. No impact on surface water or groundwater will occur.

The site currently has a grazing land-use. Waste from the animals contains significant nutrients and pathogens which has potential to move in surface water flows.

Stock will be excluded in the post development land-use. Domestic pet numbers on the site are expected to increase. The majority of domestic pet scats are expected to be disposed to landfill by collection of the scats by owners or removal with kitty litter. The result will be a decrease contribution by animals to nutrients on the site.

Vegetation cover around the dwellings, in the nature strips and riparian zone will provide a biofilter resulting in reduced sediment loads exported. Nutrient impact on surface water will be reduced post development.

The site area is considered important as it forms part of the Macquarie River catchment. ANZECC (2000) has determined water quality indicators for river systems in regard to various environmental values (Table 17). The environmental values relate to the protection of:

- aquatic ecosystems
- aquatic foods
- primary contact recreation
- secondary contact recreation
- drinking water
- visual amenity
- irrigation water supplies
- homestead water supplies
- livestock water supplies
- human consumption of fish

The irrigation water quality indicators are considered appropriate for the catchment. The potential impact of the development on each water quality indicator has been assessed (Table 18). Potential issues relate to current and future land-use and management of the site.

The impact of the development on each water quality indicator will be negligible.

8.6 Earthworks

Moderate earthworks are expected for the development. Excavations in the central to southern section of the site should be restricted to depths of less than 1m reducing the risk of exposure of saline subsoils. The roads will be designed to ensure road levels are as close as possible to the existing natural levels to ensure saline-subsoils are not exposed. Subsoils in the majority of the site were classified as non-saline to slightly saline.

8.7 Other impacts of the development

Nil

9. Management recommendation

9.1 Design

The development water and soil design will include:

- Promote plantings of deep rooted vegetation as street trees, along the proposed freight way and within the riparian zone
- Deep rooted trees should be established in the road reserves in accordance with council policy of 1 tree per block
- Additional plantings of deep rooted vegetation in the road reserves located at the geological interface. The trees should be planted with 20m spacings (25 trees/ha).
- Planting of trees in expected areas of lithological/hydrological interfaces to minimise saline soils/groundwater
- Piping of surface water off-site
- Promote water sensitive design of dwellings and gardens
- Stormwater retention basins lined with an impermeable layer
- Design road levels similar to natural soil levels to minimise excavations
- Earthworks comprising cut should be minimised
- Excavated material with elevated salinity should be backfilled, utilised as fill under roads or disposed to landfill

- Assessment of soil salinity prior to house construction to enable appropriate design of footings

Table 17. Impacts of development on water quality (Environmental objectives)

Indicator	Objective	Impact of development
Nitrogen	5 mg/L	Nitrogen may be applied to the site as fertilisers. Nitrogen will be used by plants, digested by microbes or volatilised into the atmosphere. Infiltration for nitrogen into the subsoil and impact on groundwater systems will not occur. Maintenance of groundcover by minimal cultivation and no grazing are important factors in reducing nitrogen export. Nutrient modelling indicates nitrogen will decrease on site.
Faecal coliform	<10 cfu/100mL to 10,000cfu/100mL	The site will be serviced by the town sewer. No impact on faecal coliform levels is expected to result from the development.
Aluminium	5 mg/L	No impact.
Iron	0.2 mg/L	No impact.
Manganese	0.2 mg/L	No impact.
Dissolved oxygen	>6.5 mg/L	No effluent applied to the site. Vegetated areas are expected to be managed. No impact.
Phosphorus	0.05mg/L	Phosphorus may be applied to the site as fertilisers or in domestic pet scats. Domestic pet scats are expected to be removed by collection by owners or disposal of kitty litter and will not significantly contribute to phosphorus levels on the site. Phosphorus will be used by plants and absorbed in the soil. Groundcover will be enhanced in the development resulting in reduced sediment and phosphorus export. Post development fertiliser application rates will be reduced and the effect on phosphorus less. Nutrient modelling indicates phosphorous will decrease on site post development. Riparian planting and will additionally reduce phosphorus levels at stormwater discharge areas.
pH	between 6.0 and 8.5	Fertilisers have a declining influence on pH and effects off-site will be negligible.
Cyanobacteria	-	Cyanobacteria are dependent on the levels of nitrogen, phosphorus and water temperature. The development will not increase nitrogen and phosphorus therefore will have negligible impact. No cyanobacteria are present in fertilisers.
Conductivity	-	Exposure of saline soils and off-site movement will be minimised by adoption of recommendations including minimising depth of cut and implementation of erosion and sediment control plans. No impact expected.
Turbidity	-	Negligible impact due to small size of the development and the absence of any disturbed areas on site.

9.2 Buildings

Soil saturated extract electrical conductivity (EC_e) was determined to be less than 1.84 dS/m in the soil samples tested within the expected footing depth range of 0.6m (exposure classification A1). The lowest soil pH was 4.9 (exposure classification A2). Design characteristic strength for concrete is a minimum 25MPa and minimum curing requirement is continuous curing for at least 3 days will be required for the most aggressive sites (Appendix 2). Minimum reinforcement cover for concrete in soils is 45mm (Appendix 2). Site specific testing should be undertaken to classify the soil for footing design and construction in accordance with AS2870-2011 and confirm exposure classification (Appendix 2).

9.3 Exposure classification for concrete

Soil saturated extract electrical conductivity (EC_e) was determined to be <4dS/m in the soil samples tested from the expected footing depth (Table 13). The soil pH was greater than 4.9. Exposure classification for concrete is A2. Minimum design characteristic strength for concrete is 25MPa and minimum curing requirement is continuous curing for at least 3 days (Appendix 2). Minimum reinforcement cover for concrete in soils is 45mm (Appendix 2).

10. Conclusions

The site had a pasture grazing land-use. No bare areas resulting from sheet erosion or salinity were identified. The risk of erosion is low

Soils on the site comprised topsoil of variable depth consisting of strong brown to dark red loamy sand to silty clay. Subsoils were dark yellowish brown to red sandy clay to medium clay with increasing weathered basalt cobble and weathered rock with depth. Basalt cobbles and weathered rock were encountered from varying depths over the site between 1.1 to 9.0m resulting in drill refusal.

The northern half of the site is located in the Dubbo Basalt Hydro-geological Landscape (HGL). Lithology of the Dubbo Basalt Hydro-geological Landscape consists of Cainozoic basalt consisting of in situ Olivine rich alkali basalt with some colluvial material and quartzite derived from the underlying sandstone and siltstone. Soil salinity is isolated at areas along drainage lines, at the intersection with the Purlewaugh formation, depressions and footslopes. Saline soils also occur due to local perching of the water table. Groundwater flow is unconfined to semi-confined in consolidated fractured rock. Groundwater salinity is fresh to marginal.

The southern section of the site is located in the Purlewaugh/Napperby HGL. The landscape is characterised by low flat hills and rises with a stepped geomorphology. Lithology of the Purlewaugh/Napperby HGL consists of Purlewaugh Formation, Napperby Formation and Boulderwood Formation comprising mainly ferruginous red siltstone, carbonaceous mudstone, fine to medium grained lithic sandstone, ironstone, minor coal and minor conglomerate. Groundwater flow is unconfined to semi-confined flows through fractures in sandstone and sedimentary bedrock, permeable soils and saprolite. Lateral flow occurs through colluvial sediments on lower slopes. High recharge rates occur across the landscape particularly in areas where cropping is practised. Water electrical conductivity is moderate to high.

The change in slope in the central to southern section of the site is an example of stepped geomorphology characteristic of the Purlewaugh/Napperby HGL. It is also the expected location of the intersection of the Dubbo Basalt and Purlewaugh Formation. The stepped landscape broadly correspond to resistant layers in the stratigraphy. Saline areas in the Purlewaugh/Napperby HGL typically occur at these stepped locations and also at the intersection of the Dubbo Basalt and Purlewaugh Formation.

Subsoil samples collected from two boreholes constructed along the stepped geomorphology contained moderately to highly saline subsoils from 1m. Subsoils in other boreholes located in the northern half of the site and along Eulomogo Creek were non-saline. All topsoils samples were determined to be non-saline.

Groundwater or groundwater indicators were not encountered in the soil to a depth of 9m. Groundwater monitoring bores within 1km of the site and installed to depths of 15m have been mostly dry since monitoring began in 2005. Groundwater recharge within the Dubbo Basalt HGL is greatest on plateau areas and within the Purlewaugh/Napperby HGL is high across the landscape. Groundwater residence times are short.

No groundwater discharge areas were identified on the site.

Modelling of soil moisture levels over the past 34 years indicated variations in infiltration occur with the amount of rainfall pre and post development. Variations occur due to seasonal rainfall and land-use. Irrigation of lawn of 1mm/day results in infiltration in years with high rainfall at 1m and no infiltration at 3m.

Overall site the infiltration will be reduced in the development. Reduced infiltration is a result of the increase in runoff due to impermeable areas (roads, roofs, driveways) and increase in deep rooted vegetation extracting soil moisture from depth. The establishment of trees in strategic areas will offset any additional infiltration from lawn over watering.

The risk of groundwater contamination from the proposed land-use is equal or lower to the current land-use. Nitrogen contributions will decrease as a result of smaller available areas for fertilisation and a decrease in animal waste; domestic pet waste will generally be disposed off-site. Phosphorous and sediment contributions will also decrease. Washing of cars on permeable areas will not be a significant contributor to nutrient levels. Reuse of greywater will be small volumes of unregulated use or larger volumes which require specific conditions of use or regulation by Council. Conditions of use and regulation will ensure overwatering does not occur.

No impact on groundwater including contamination and changed groundwater levels is expected from the development if recommendations are adopted. The development will not impact on quantity or quality of both unconfined and confined aquifers.

11. Recommendations

The development water and soil design will include:

- Promote plantings of deep rooted vegetation as street trees, along the proposed freight way and within the riparian zone
- Deep rooted trees should be established in the road reserves in accordance with council policy of 1 tree per block
- Additional plantings of deep rooted vegetation in the road reserves located at the geological interface. The trees should be planted with 20m spacings (25 trees/ha).
- Planting of trees in expected areas of lithological/hydrological interfaces to minimise saline soils/groundwater
- Piping of surface water off-site
- Promote water sensitive design of dwellings and gardens
- Stormwater retention basins lined with an impermeable layer
- Design road levels similar to natural soil levels to minimise excavations
- Earthworks comprising cut should be minimised
- Excavated material with elevated salinity should be backfilled, utilised as fill under roads or disposed to landfill
- Assessment of soil salinity prior to house construction to enable appropriate design of footings

12. Report limitations and intellectual property

This report has been prepared for the use of the client to achieve the objectives given the clients requirements. The level of confidence of the conclusion reached is governed by the scope of the investigation and the availability and quality of existing data. Where limitations or uncertainties are known, they are identified in the report. No liability can be accepted for failure to identify conditions or issues which arise in the future and which could not reasonably have been predicted using the scope of the investigation and the information obtained.

The investigation identifies the actual subsurface conditions only at those points where samples are taken, when they are taken. Data derived through sampling and subsequent laboratory testing is interpreted by geologists, engineers or scientists who then render an opinion about overall conditions, the nature and extent of likely impacts of the proposed development, and appropriate remediation measures. Actual conditions may differ from those inferred to exist, because no professional, no matter how well qualified, and no sub surface exploration program, no matter how comprehensive, can reveal what is hidden by earth, rock or time. The actual interface between materials may be far more gradual or abrupt than a report indicates. Actual conditions in areas not sampled may differ from predictions. It is thus import to understand the limitations of the investigation and recognise that we are not responsible for these limitations.

This report, including data contained, its findings and conclusions, remain the intellectual property of Envirowest Consulting Pty Ltd. A licence to use the report for the specific purpose identified is granted for the persons identified in that section after full payment for the services involved in preparation of the report. This report should not be used by persons or for purposes other than those stated, and not reproduced without the permission of Envirowest Consulting Pty Ltd.

13. References

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Figures

Figure 1: Locality plan		
Lot 2 DP880413, 24R Sheraton Road, Dubbo NSW		
	Envirowest Consulting Pty Ltd	
Job – R7891s1	Drawn by: AP	Date: 20/01/2017

North

Legend

⊗	Sampling location	— · —	Fence
———	Lot boundary	———	Eulomogo Creek and drainage line
	Dam		

Approximate Scale 1: 6,200

0 62 124 248m

Figure 2: Site plan		
Lot 2 DP880413, 24R Sheraton Road, Dubbo NSW		
	Envirowest Consulting Pty Ltd	
Job – R7891s1	Drawn by: AP	Date: 20/01/2017

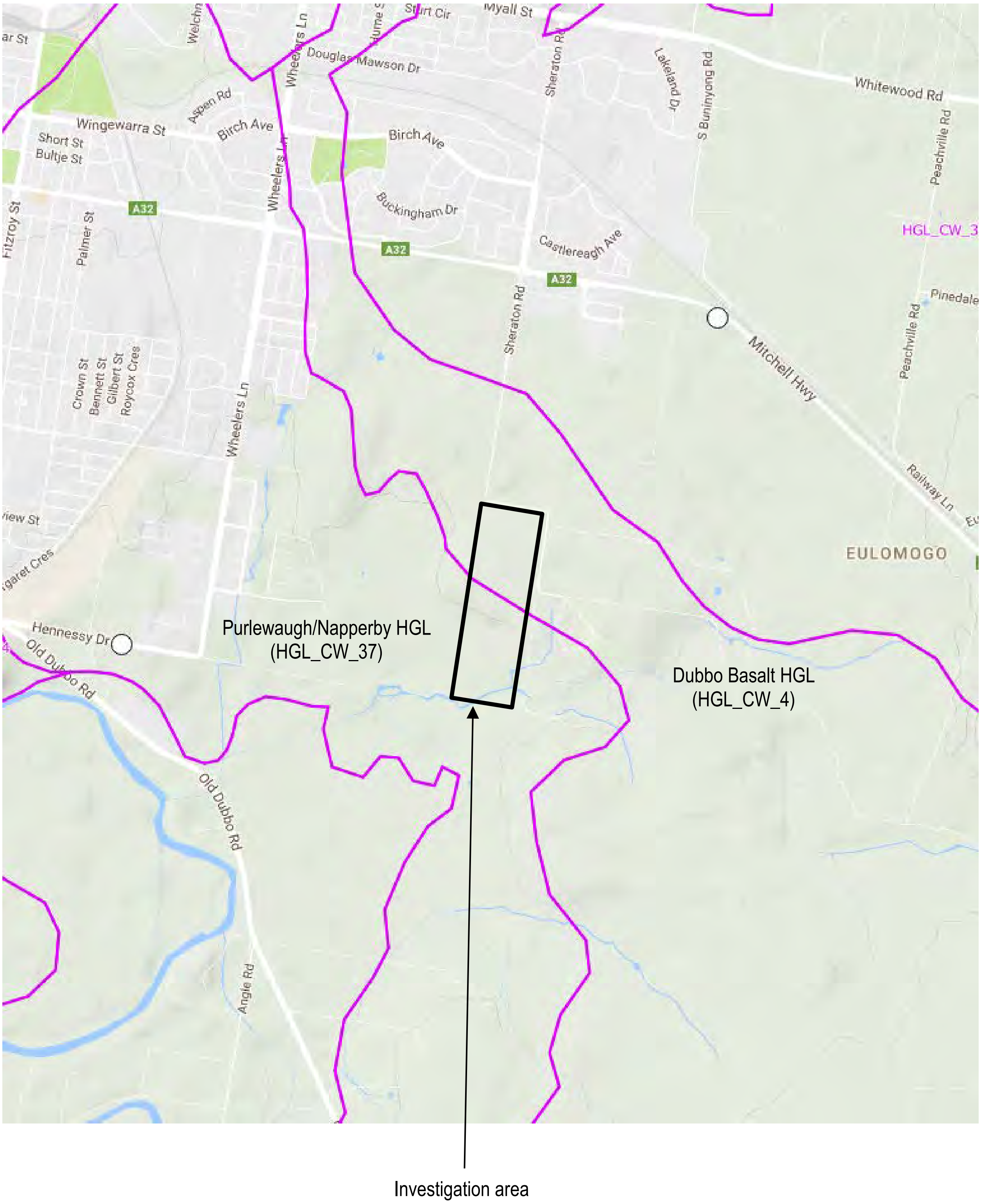


Figure 3: Hydro-geological landscapes (eSpade 2017)		
Lot 2 DP880413, 24R Sheraton Road, Dubbo NSW		
	Envirowest Consulting Pty Ltd	
Job – R7891s1	Drawn by: -	Date: 20/1/2017

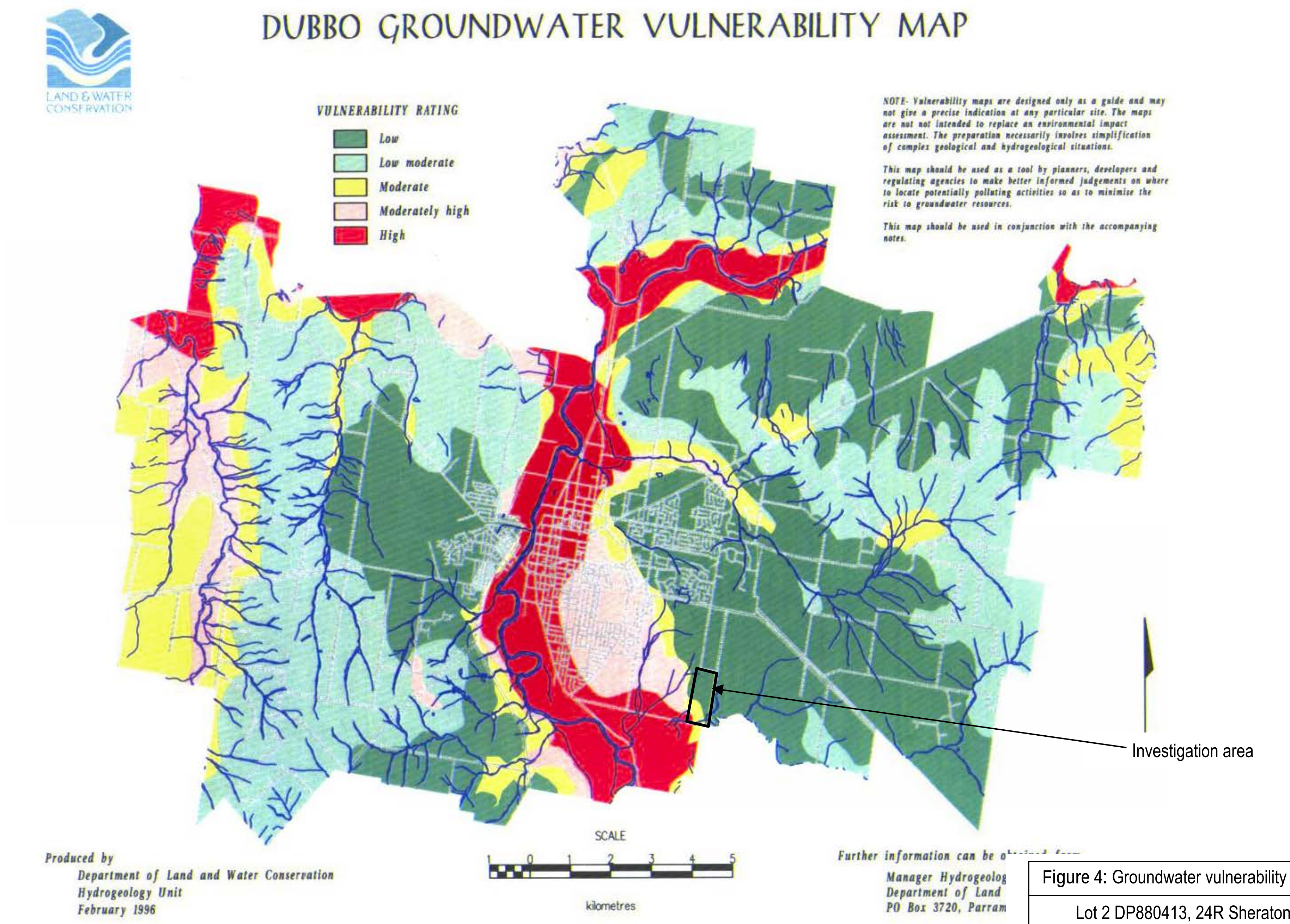


Figure 4: Groundwater vulnerability map of Dubbo - DECCW		
Lot 2 DP880413, 24R Sheraton Road, Dubbo NSW		
	Envirowest Consulting Pty Ltd	
Job: R7891s1	Drawn by: -	Date: 20/01/2017

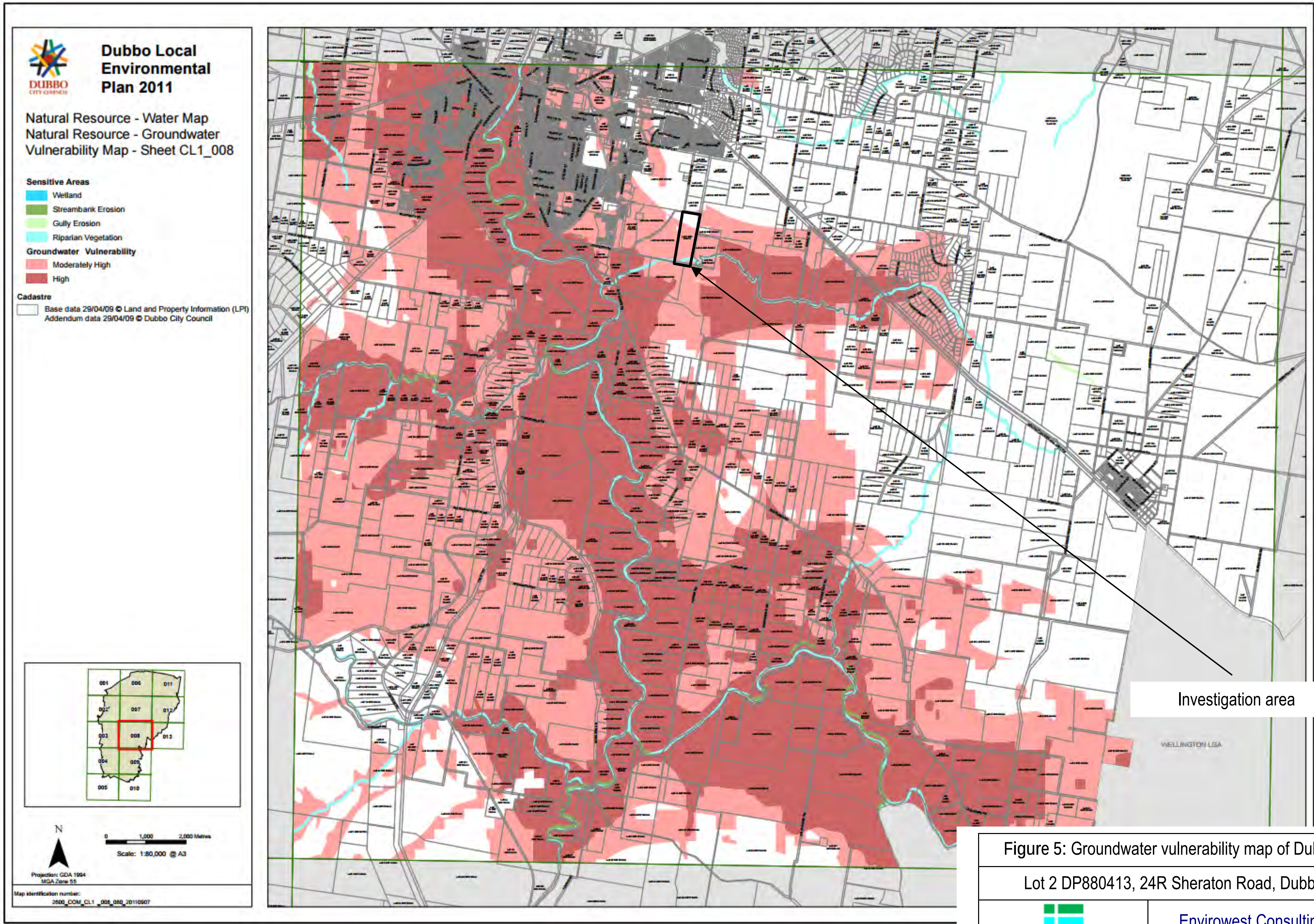
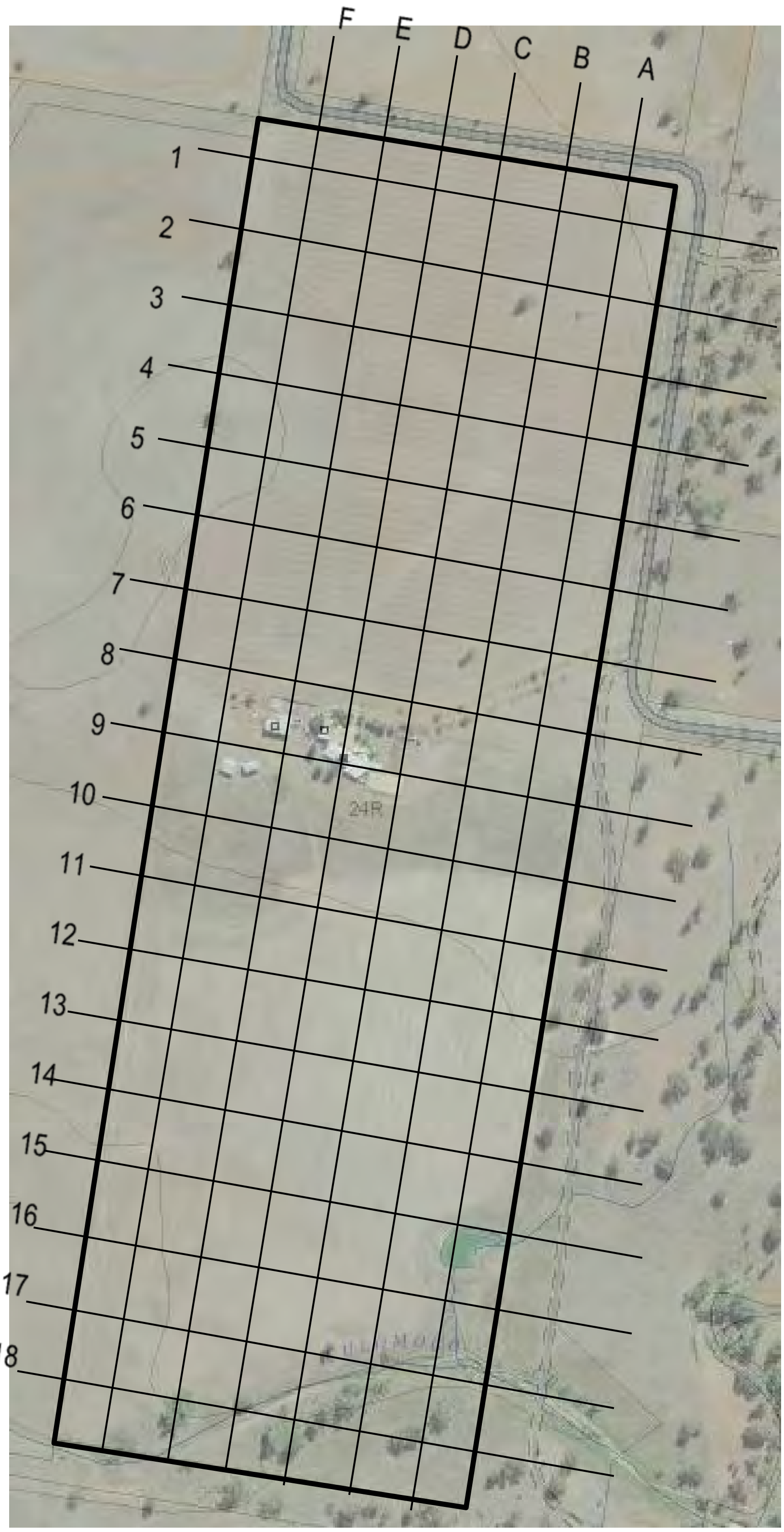


Figure 5: Groundwater vulnerability map of Dubbo - DCC		
Lot 2 DP880413, 24R Sheraton Road, Dubbo NSW		
	Envirowest Consulting Pty Ltd	
Job: R7891s1	Drawn by: -	Date: 20/01/2017

North



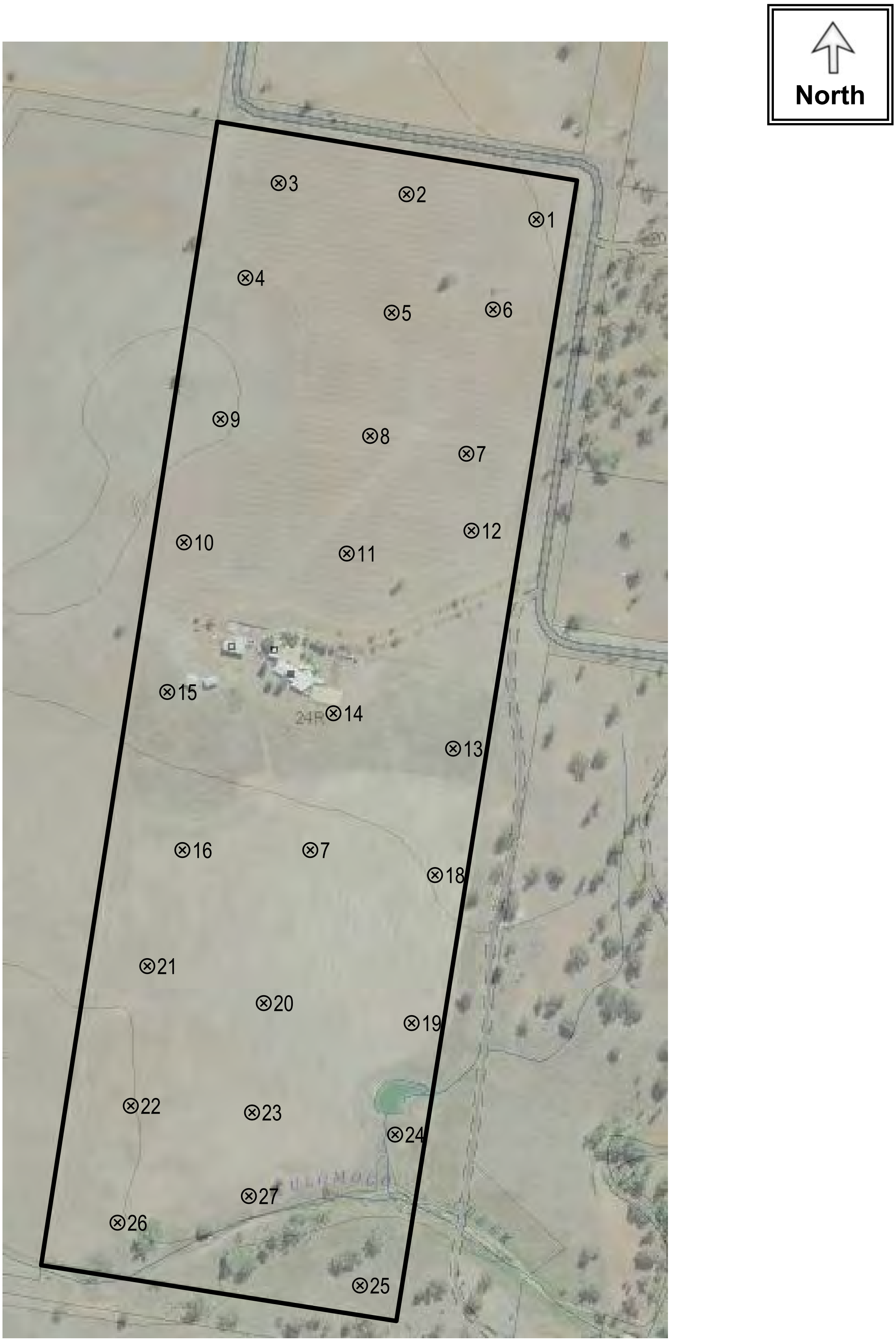
Legend

Investigation area

Approximate Scale 1: 6,800

0 68 136 272m

Figure 6: Initial investigation locations		
Lot 2 DP880413, 24R Sheraton Road, Dubbo NSW		
	Envirowest Consulting Pty Ltd	
Job – R7891s1	Drawn by: AP	Date: 20/01/2017



Approximate Scale 1: 6,800

0 68 136 272m

Legend

Investigation area

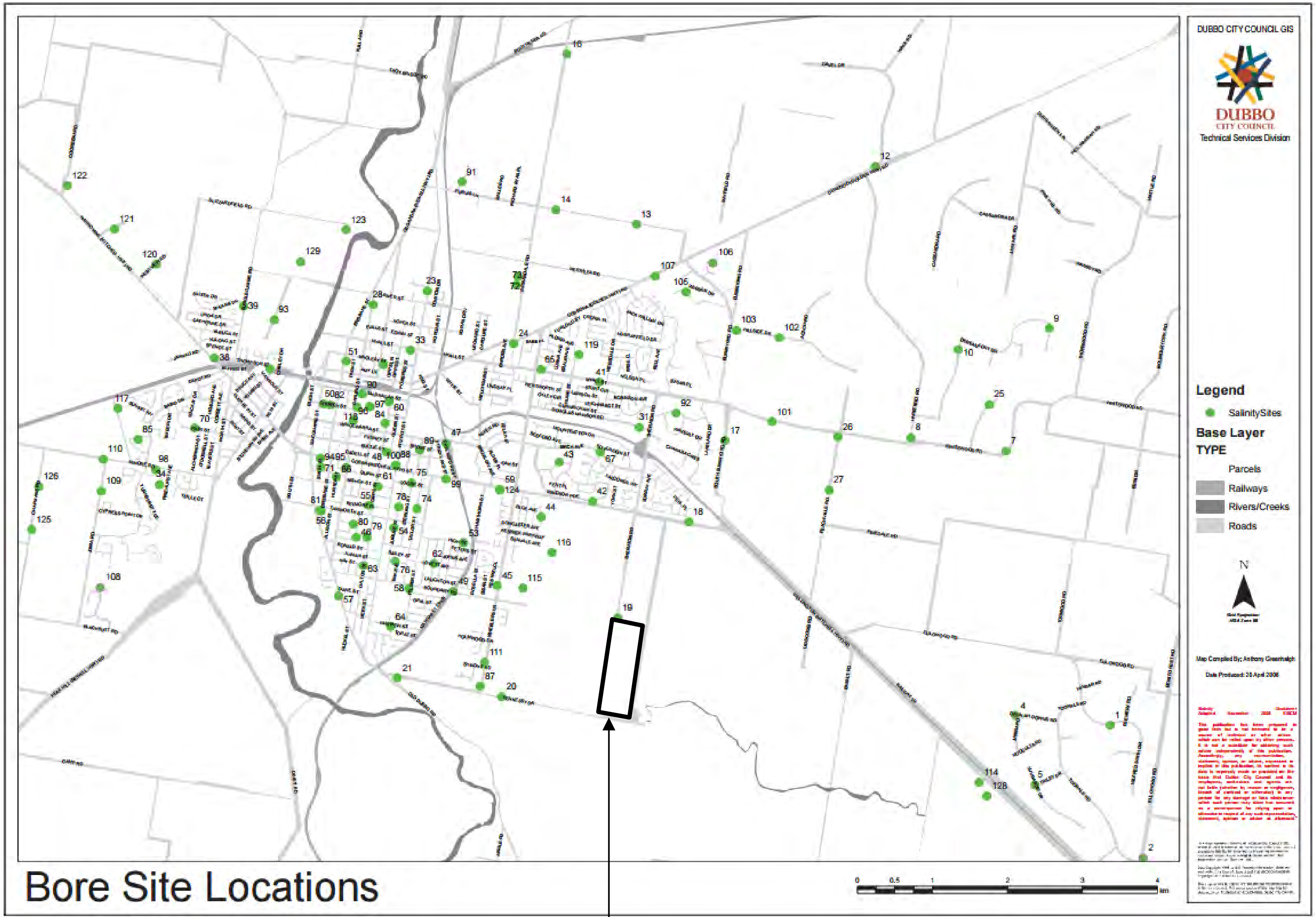
Figure 7: Detailed investigation locations		
Lot 2 DP880413, 24R Sheraton Road, Dubbo NSW		
	Envirowest Consulting Pty Ltd	
Job – R7891s1	Drawn by: AP	Date: 20/01/2017

Approximate Scale 1: 15,200

0 152 304 608m

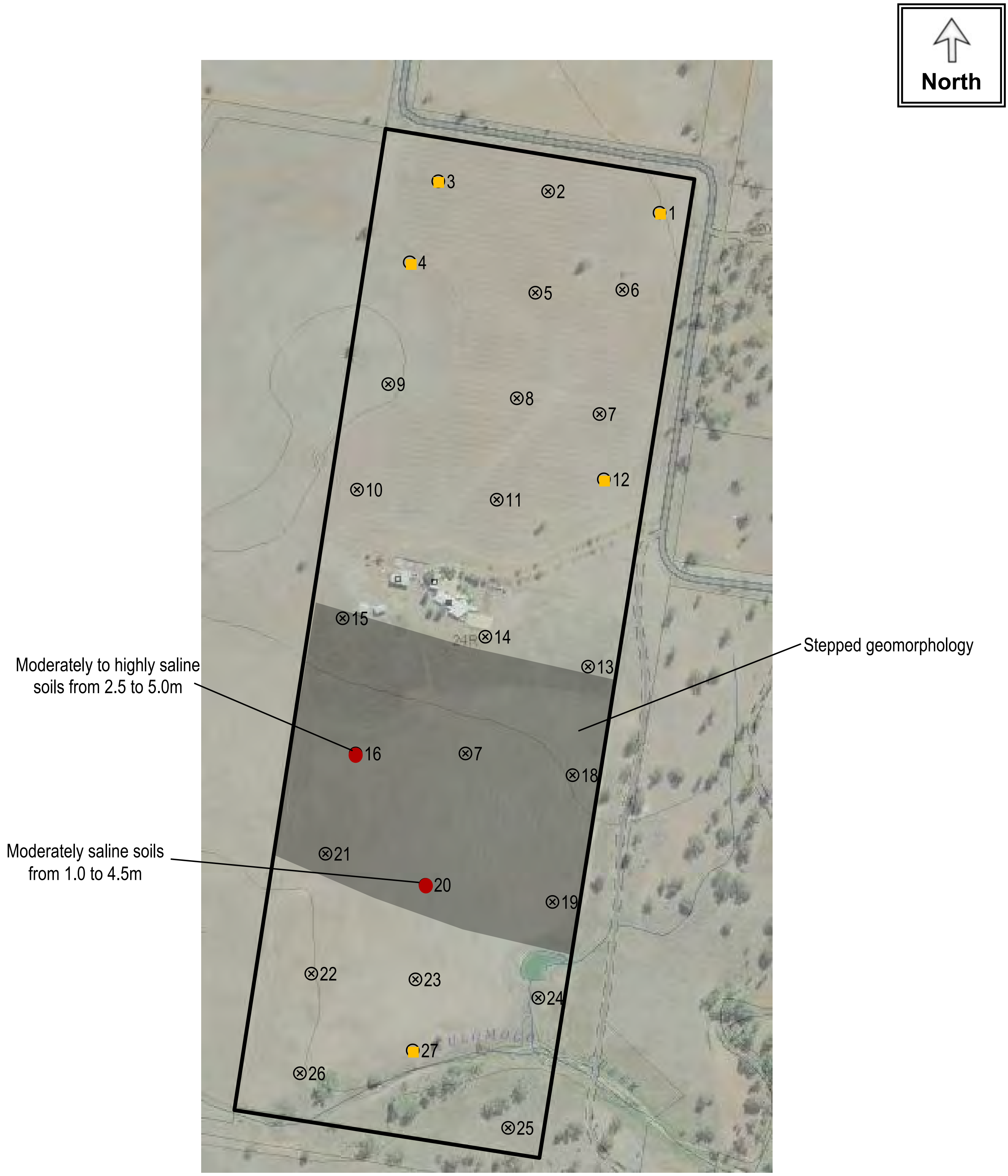
Figure 8: Location of groundwater bores within 1km of the site		
Lot 2 DP880413, 24R Sheraton Road, Dubbo NSW		
	Envirowest Consulting Pty Ltd	
Job – R7891s1	Drawn by: AP	Date: 20/01/2017

North



Investigation area

Figure 9: Dubbo Regional Council Salinity Network		
Lot 2 DP880413, 24R Sheraton Road, Dubbo NSW		
	Envirowest Consulting Pty Ltd	
Job: R7891s1	Drawn by: -	Date: 20/01/2017



Legend

Investigation area	Saline soil identified in profile
Non-saline to slightly saline soil identified in soil profile to drilling depth	

Approximate Scale 1: 6,800

0 68 136 272m

Figure 10: Soil analysis results for salinity		
Lot 2 DP880413, 24R Sheraton Road, Dubbo NSW		
	Envirowest Consulting Pty Ltd	
Job: R7891s1	Drawn by: LD	Date: 30/01/2017

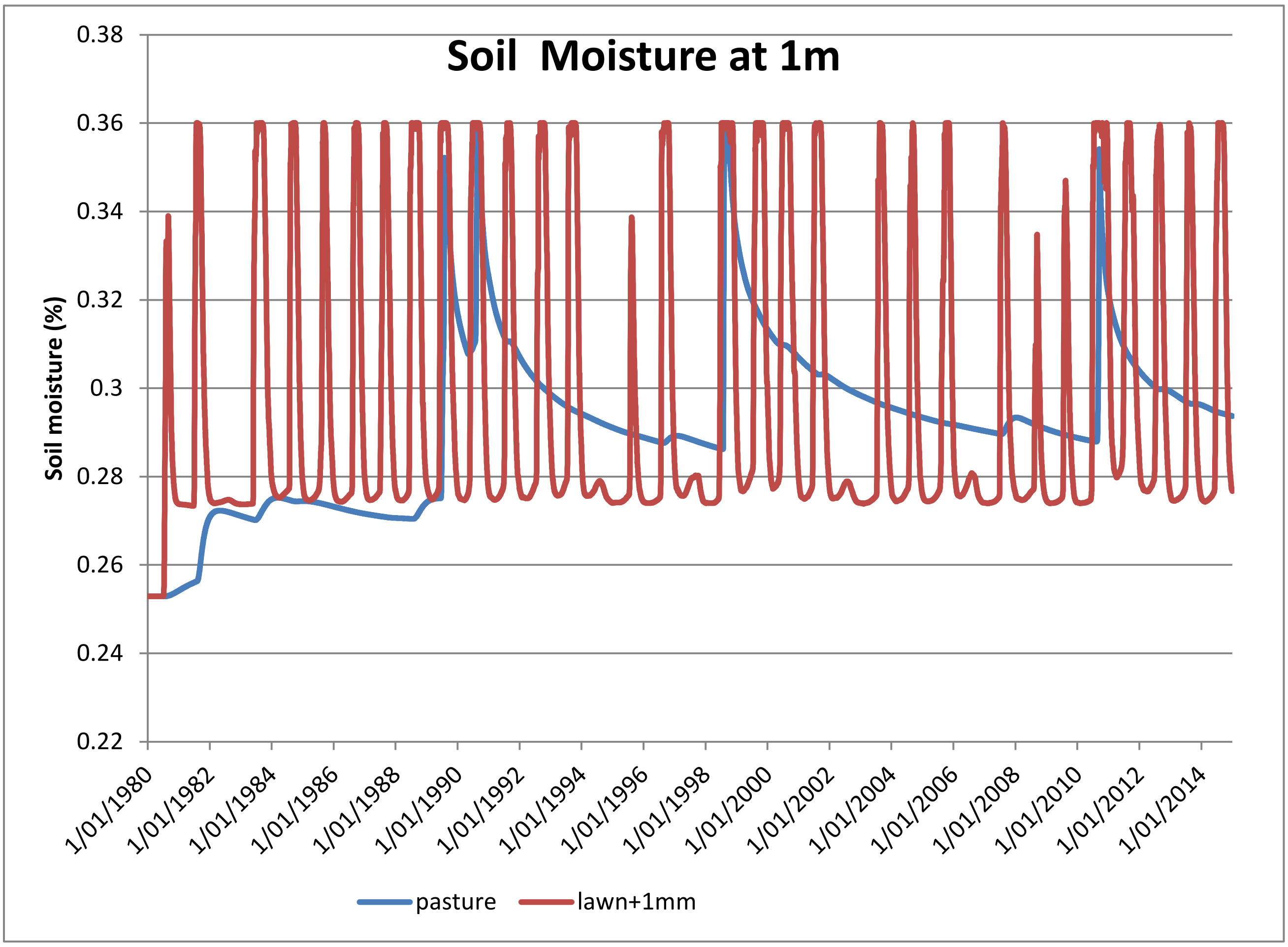


Figure 11. Soil moisture at 1m		
Lot 2 DP880413, 24R Sheraton Road, Dubbo NSW		
	Envirowest Consulting Pty Ltd	
Job – R7891s1	Drawn by: LD	Date: 30/01/2017

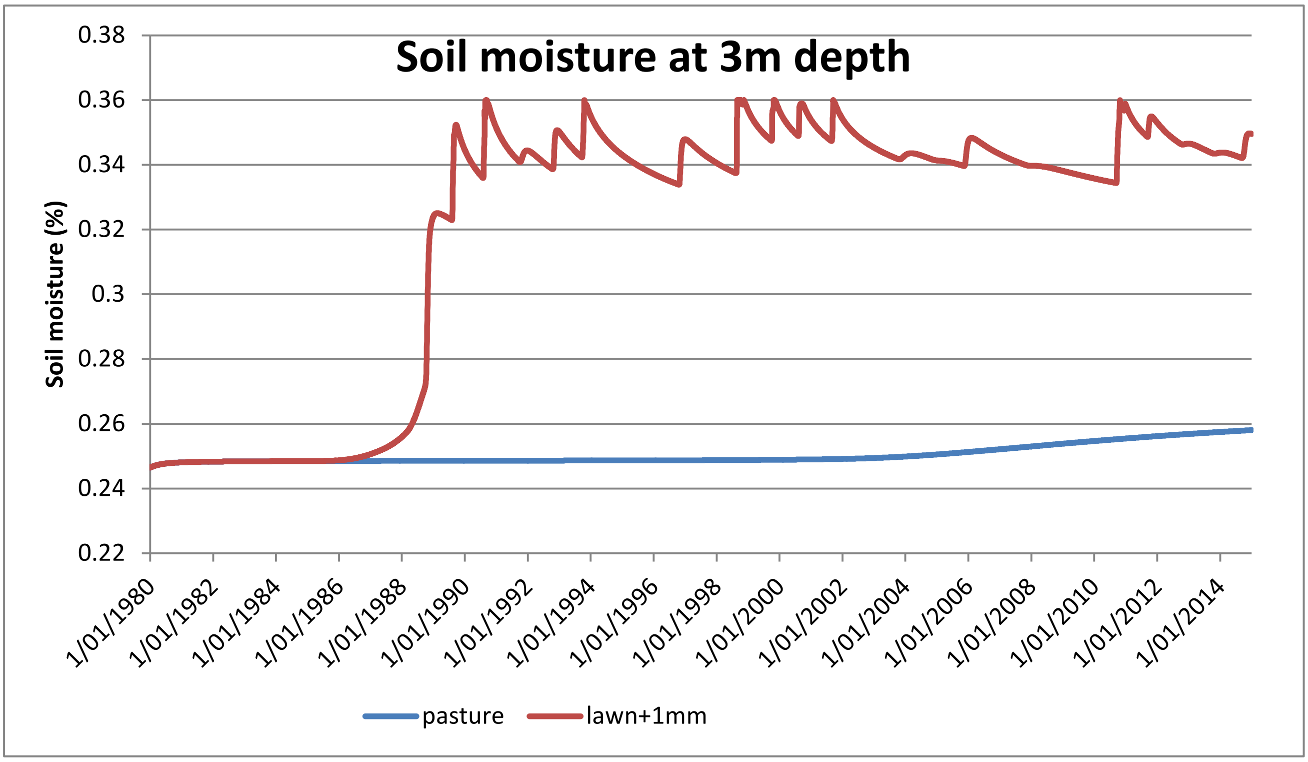


Figure 12. Soil moisture at 3m		
Lot 2 DP880413, 24R Sheraton Road, Dubbo NSW		
	Envirowest Consulting Pty Ltd	
Job – R7891s1	Drawn by: LD	Date: 30/01/2017

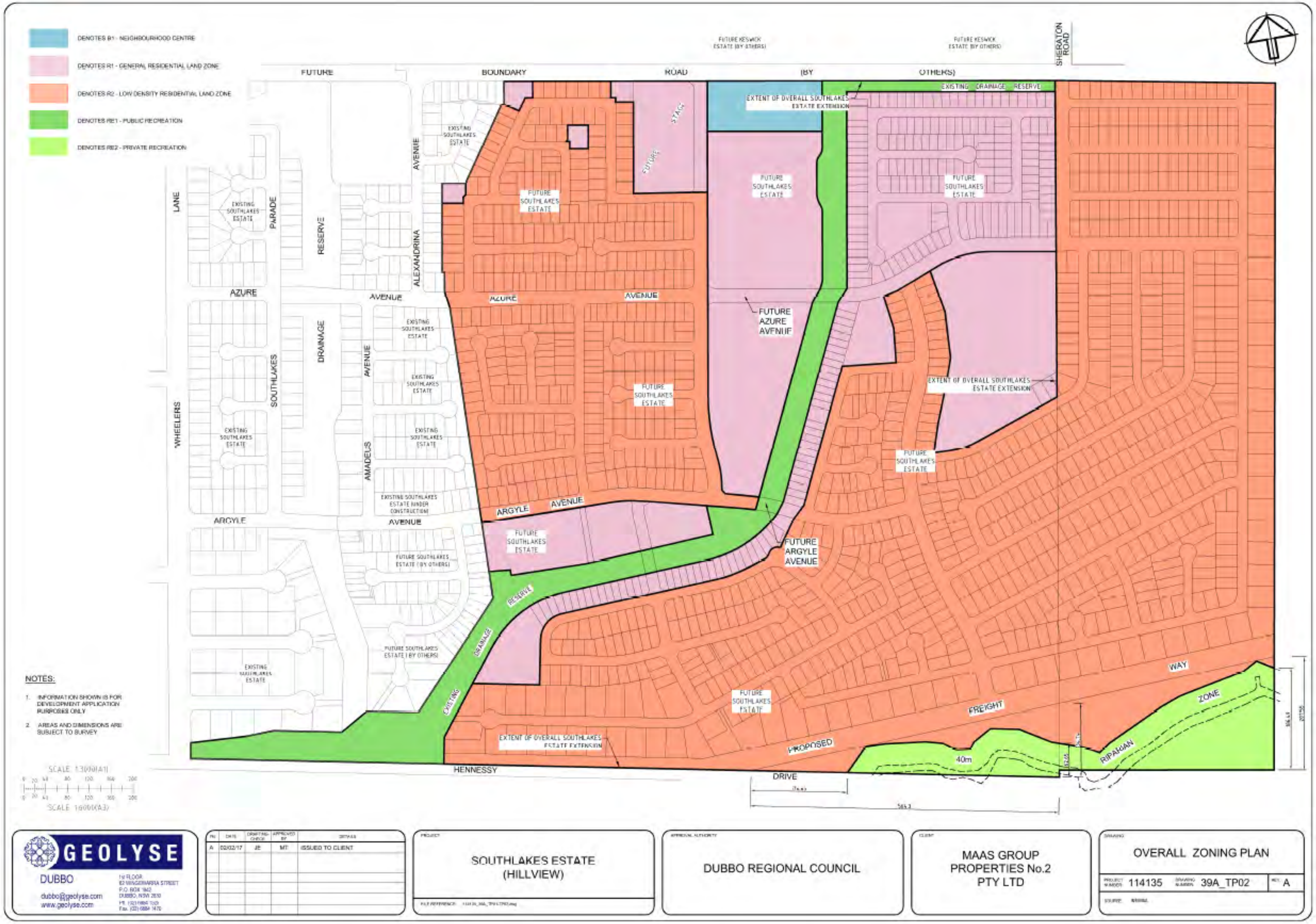


Figure 13: Proposed zoning plan		
Lot 2 DP880413, 24R Sheraton Road, Dubbo NSW		
	Envirowest Consulting Pty Ltd	
Job: R7891s1	Drawn by: -	Date: 3/2/2017

Figure 14. Photographs of the site

Looking south across paddocks

Looking north across Eulomogo Creek

Looking east across paddocks

Looking west over the site

Appendices

Appendix 1. Nutrient and sediment modelling
Appendix 2. Aggressive soils, extract from Australia Standards, AS 2870-2011, 2011
Appendix 3. Details of registered bores within 1km of the site – NSW Department of Primary Industries
Appendix 4. Salinity results from the Dubbo Regional Council Salinity Network
Appendix 5. Initial site investigation characteristics
Appendix 6. Field and laboratory sheets
Appendix 7. Reference methods for soil testing
Appendix 8. SGS laboratory report SE160957 and chain of custody form

Appendix 1. Nutrient and sediment modelling

Land-use export rates for sediments, nitrogen and phosphorus mg/kg/year (Chafer 2003)

Land use class	Suspended sediment (kg/ha/yr)		
	Low	Median	High
Native bushland	20	40	60
Disturbed landscapes	330	870	2290
Remediated gullies	165	435	1145
Cropped	420	570	720
Pine plantations	65	380	680
Improved pasture	140	520	870
Unimproved pasture	140	190	230
Roads (sealed)	140	190	230
Roads (earth)	25	140	500
Urban	30	300	1200
Urban (open space)	160	360	1000
Rural residential	140	190	230
Industrial	180	200	4800
Commercial	180	200	4800
Golf course	0	10	20
Orchard	490	680	870

Land use class	Total Nitrogen (kg/ha/yr)		
	Low	Median	High
Native bushland	0.9	2.4	4
Disturbed landscapes	4.2	12	20
Remediated gullies	2.1	6	10
Cropped	4.2	8.9	13.5
Pine plantations	0.8	2.9	8.3
Improved pasture	4.2	8.9	13.5
Unimproved pasture	1.3	3.2	5.1
Roads (sealed)	2	6	10
Roads (earth)	1.3	2.2	3.1
Urban	2.2	6.1	10
Urban (open space)	1.3	3.2	5.1
Rural residential	2.2	6.1	10
Industrial	4	7.4	10
Commercial	4	7.4	10
Golf course	0	3.2	5
Orchard	1.7	8.9	5

Land use class	Total Phosphorus		
	Low	Median	High
Native bushland	0.01	0.13	0.25
Disturbed landscapes	0.3	1.24	2.2
Remediated gullies	0.15	0.62	1.1
Cropped	0.5	1.35	2.2
Pine plantations	0.1	1.16	2.5
Improved pasture	0.5	1.35	2.2
Unimproved pasture	0.1	0.17	0.25
Roads (sealed)	0.3	1.8	3.4
Roads (earth)	0.3	1.72	3.2
Urban	0.2	1.82	3.6
Urban (open space)	0.1	0.17	0.25
Rural residential	0.2	1.72	3.6
Industrial	1.4	1.82	2.2
Commercial	1.4	1.8	2.2
Golf course	0	0.3	3.6
Orchard	0.1	0.3	0.5

Sediment export kg/yr

LOW	PRE	POST	IMPACT
Native bushland	0.00	214.00	-214.00
Disturbed landscapes	726.00	0.00	726.00
Remediated gullies	0.00	0.00	0.00
Cropped	0.00	0.00	0.00
Pine plantations	0.00	0.00	0.00
Improved pasture	6608.00	0.00	6608.00
Open area	0.00	0.00	0.00
Roads (sealed)	0.00	994.00	-994.00
Roads (earth)	12.50	0.00	12.50
Urban	3.00	855.00	-852.00
Urban (open space)	0.00	592.00	-592.00
Rural residential	0.00	0.00	0.00
Industrial	0.00	0.00	0.00
Commercial	0.00	0.00	0.00
Golf course	0.00	0.00	0.00
Orchard	0.00	0.00	0.00
TOTAL	**7349.50**	**2655.00**	**4694.50**

MEDIAN	PRE	POST	IMPACT
Native bushland	0.00	428.00	-428.00
Disturbed landscapes	1914.00	0.00	1914.00
Remediated gullies	0.00	0.00	0.00
Cropped	0.00	0.00	0.00
Pine plantations	0.00	0.00	0.00
Improved pasture	24544.00	0.00	24544.00
Open area	0.00	0.00	0.00
Roads (sealed)	0.00	1349.00	-1349.00
Roads (earth)	70.00	0.00	70.00
Urban	30.00	8550.00	-8520.00
Urban (open space)	0.00	1332.00	-1332.00
Rural residential	0.00	0.00	0.00
Industrial	0.00	0.00	0.00
Commercial	0.00	0.00	0.00
Golf course	0.00	0.00	0.00
Orchard	0.00	0.00	0.00
TOTAL	**26558.00**	**11659.00**	**14899.00**

HIGH	PRE	POST	IMPACT
Native bushland	0.00	642.00	-642.00
Disturbed landscapes	5038.00	0.00	5038.00
Remediated gullies	0.00	0.00	0.00
Cropped	0.00	0.00	0.00
Pine plantations	0.00	0.00	0.00
Improved pasture	41064.00	0.00	41064.00
Open area	0.00	0.00	0.00
Roads (sealed)	0.00	1633.00	-1633.00
Roads (earth)	250.00	0.00	250.00
Urban	120.00	34200.00	-34080.00
Urban (open space)	0.00	3700.00	-3700.00
Rural residential	0.00	0.00	0.00
Industrial	0.00	0.00	0.00
Commercial	0.00	0.00	0.00
Golf course	0.00	0.00	0.00
Orchard	0.00	0.00	0.00
TOTAL	**46472.00**	**40175.00**	**6297.00**

Total Nitrogen kg/yr

LOW	PRE	POST	IMPACT
Native bushland	0.00	0.00	0.00
Disturbed landscapes	9.24	0.00	9.24
Remediated gullies	0.00	0.00	0.00
Cropped	0.00	0.00	0.00
Pine plantations	0.00	0.00	0.00
Improved pasture	198.24	0.00	198.24
Open area	0.00	0.00	0.00
Roads (sealed)	0.00	14.20	-14.20
Roads (earth)	0.65	0.00	0.65
Urban	0.22	62.70	-62.48
Urban (open space)	0.00	4.81	-4.81
Rural residential	0.00	0.00	0.00
Industrial	0.00	0.00	0.00
Commercial	0.00	0.00	0.00
Golf course	0.00	0.00	0.00
Orchard	0.00	0.00	0.00
TOTAL	**208.35**	**81.71**	**126.64**

MEDIAN	PRE	POST	IMPACT
Native bushland	0.00	25.68	-25.68
Disturbed landscapes	26.40	0.00	26.40
Remediated gullies	0.00	0.00	0.00
Cropped	0.00	0.00	0.00
Pine plantations	0.00	0.00	0.00
Improved pasture	420.08	0.00	420.08
Open area	0.00	0.00	0.00
Roads (sealed)	0.00	42.60	-42.60
Roads (earth)	1.10	0.00	1.10
Urban	0.61	173.85	-173.24
Urban (open space)	0.00	11.84	-11.84
Rural residential	0.00	0.00	0.00
Industrial	0.00	0.00	0.00
Commercial	0.00	0.00	0.00
Golf course	0.00	0.00	0.00
Orchard	0.00	0.00	0.00
TOTAL	**448.19**	**253.97**	**194.22**

HIGH	PRE	POST	IMPACT
Native bushland	0.00	42.80	-42.80
Disturbed landscapes	44.00	0.00	44.00
Remediated gullies	0.00	0.00	0.00
Cropped	0.00	0.00	0.00
Pine plantations	0.00	0.00	0.00
Improved pasture	637.20	0.00	637.20
Open area	0.00	0.00	0.00
Roads (sealed)	0.00	71.00	-71.00
Roads (earth)	1.55	0.00	1.55
Urban	1.00	285.00	-284.00
Urban (open space)	0.00	18.87	-18.87
Rural residential	0.00	0.00	0.00
Industrial	0.00	0.00	0.00
Commercial	0.00	0.00	0.00
Golf course	0.00	0.00	0.00
Orchard	0.00	0.00	0.00
TOTAL	**683.75**	**417.67**	**266.08**

Total Phosphorus kg/yr

LOW	**PRE**	**POST**	**IMPACT**
Native bushland	0.00	0.11	-0.11
Disturbed landscapes	0.66	0.00	0.66
Remediated gullies	0.00	0.00	0.00
Cropped	0.00	0.00	0.00
Pine plantations	0.00	0.00	0.00
Improved pasture	23.60	0.00	23.60
Open area	0.00	0.00	0.00
Roads (sealed)	0.00	2.13	-2.13
Roads (earth)	0.15	0.00	0.15
Urban	0.02	5.70	-5.68
Urban (open space)	0.00	0.37	-0.37
Rural residential	0.00	0.00	0.00
Industrial	0.00	0.00	0.00
Commercial	0.00	0.00	0.00
Golf course	0.00	0.00	0.00
Orchard	0.00	0.00	0.00
TOTAL	**24.43**	**8.31**	**16.12**

MEDIAN	**PRE**	**POST**	**IMPACT**
Native bushland	0.00	1.39	-1.39
Disturbed landscapes	2.73	0.00	2.73
Remediated gullies	0.00	0.00	0.00
Cropped	0.00	0.00	0.00
Pine plantations	0.00	0.00	0.00
Improved pasture	63.72	0.00	63.72
Open area	0.00	0.00	0.00
Roads (sealed)	0.00	12.78	-12.78
Roads (earth)	0.86	0.00	0.86
Urban	0.18	51.87	-51.69
Urban (open space)	0.00	0.63	-0.63
Rural residential	0.00	0.00	0.00
Industrial	0.00	0.00	0.00
Commercial	0.00	0.00	0.00
Golf course	0.00	0.00	0.00
Orchard	0.00	0.00	0.00
TOTAL	**67.49**	**66.67**	**0.82**

HIGH	**PRE**	**POST**	**IMPACT**
Native bushland	0.00	2.68	-2.68
Disturbed landscapes	4.84	0.00	4.84
Remediated gullies	0.00	0.00	0.00
Cropped	0.00	0.00	0.00
Pine plantations	0.00	0.00	0.00
Improved pasture	103.84	0.00	103.84
Open area	0.00	0.00	0.00
Roads (sealed)	0.00	24.14	-24.14
Roads (earth)	1.60	0.00	1.60
Urban	0.36	102.60	-102.24
Urban (open space)	0.00	0.93	-0.93
Rural residential	0.00	0.00	0.00
Industrial	0.00	0.00	0.00
Commercial	0.00	0.00	0.00
Golf course	0.00	0.00	0.00
Orchard	0.00	0.00	0.00
TOTAL	**110.64**	**130.34**	**-19.70**

Appendix 2. Aggressive soils, extract from Australian Standards, *AS 2870-2011*, 2011

Exposure classification for concrete in saline soils

Saturated extract electrical conductivity (EC_e), dS/m	Exposure classification
<4	A1
4-8	A2
8-16	B1
>16	B2

Notes:
1. Guidance on concrete in saline soils can be found in CCAA T56
2. Exposure classifications are from AS 3600
3. The currently accepted method of determining the salinity level of the soil is by measuring the extract electrical conductivity (*EC*) of a soil and water mixture in deciSiemens per metre (dS/m) and using conversion factors that allow for the soil texture, to determine the saturated extract electrical conductivity (EC_e)
4. The division between a non-saline and saline soil is generally regarded as an EC_e value of 4dS/m, therefore no increase in the minimum concrete strength is required below this value

Exposure classification for concrete in sulfate soils

Exposure conditions			Exposure classification	
Sulfates (expressed as SO_4)*		pH	Soil conditions A**	Soil conditions B†
In soil (ppm)	In groundwater (ppm)			
<5,000	<1,000	>5.5	A2	A1
5,000-10,000	1,000-3,000	4.5-5.5	B1	A2
10,000-20,000	3,000-10,000	4-4.5	B2	B1
>20,000	>10,000	<4	C2	B2

* Approximately 100ppm SO_4 = 80ppm SO_3
** Soil conditions A – high permeability soils (e.g. sands and gravels) that are in groundwater
† Soil conditions B – low permeability soils (e.g. silts and clays) or all soils above groundwater

Minimum design characteristic strength (f_c') and curing requirements for concrete

Exposure classification	Minimum f_c' MPa	Minimum initial curing requirement
A1	20	Cure continuously for at least 3 days
A2	25	
B1	32	Cure continuously for at least 7 days
B2	40	
C1	≥50	
C2	≥50	

Minimum reinforcement cover for concrete

Exposure classification	Minimum cover in saline soils * mm	Minimum cover in sulfate soils ** (mm)
A1	See Clause 5.3.2	40
A2	45	50
B1	50	60
B2	55	65
C1	†	70
C2	†	85

* Where a damp-proofing membrane is installed, the minimum reinforcement cover in saline soils may be reduced to 30mm.
** Where a damp-proofing membrane is installed, the minimum reinforcement cover in sulfate soils may be reduced by 10mm.
† Saline soils have a maximum exposure classification of B2.

Appendix 3. Details of registered bores within 1km of the site – NSW Department of Primary Industries.

Bore record No. (Figure 8)	Eastings	Northings	Drilled / Completed depth (m)	Salinity description	Water bearing zones (m)	Standing water level (m)	Date drilled and or tested	Purpose
GW802554	654491	6428905	9	-	6.5-7.5	-	2004	Monitoring
GW801343	65493	6428486	59	-	-	-	1992	Unknown
GW802528	654952	6428393	3	-	2-3	2.9	2004	Monitoring
GW005558	654961	6428252	57.9	-	26.2-33.8	18.3	1959	Stock
GW801344	655053	6428466	32	-	-	-	1992	Unknown
GW801345	655153	6428459	34	-	-	-	1992	Unknown
GW044627	655566	6428489	-	-	-	-	1975	Domestic / Stock
GW043040	655879	6428423	87.78	-	-	-	1974	Stock, domestic
GW003368	656208	6427678	49.68	Fresh	43.9	34.7	1935	Unknown
GW803646	655720	6427105	10	-	-	-	2008	Industrial / Commercial
GW037126	654588	6426101	57.9	-	-	-	1973	Test Bore / Public Municiple
GW060589	654612	6425978	12.5	-	-	-	-	Stock
GW042708	654431	6426104	49.3	Good	7-23.7	6.7	1974	Town water supply
GW801334	654198	6426159	46	-	13-35	12.9	2001	Town water supply
GW043755	654223	6426199	61	Good	7.9-20.7 41.1-47.5	6	1973	Test Bore
GW035817	653989	6426295	54.8	-	6-25.2	5.1	1973	Test
GW043754	654147	6426385	76.2	-	40.8-46.8	6	1973	Test
GW042707	653923	6426548	46.6	0-500ppm	41.1-46.5	7	1974	Town water
GW043753	654020	6426603	68.5	-	15.2-22.8	7.2	1973	Test bore
GW096140	653928	6426550	48	-	41.2-47	15.9	2003	Town water
GW805385	-	-	-	-	-	-	-	-
GW058296	653743	6427346	29.5	-	19.8-29.5	19.8	1983	Stock/ Domestic
GW055350	653851	6427529	21.6	-	-	-	-	Stock/ Domestic
GW055351	654606	6427302	-	-	-	-	-	Stock
GW801338	654839	6428083	149	-	-	-	1992	Unknown
GW801339	655140	6428060	29	-	-	-	1992	Unknown
GW011014	655192	6428002	67.1	-	57.9-60.9	-	1954	Stock
GW801341	655069	6427708	83	-	-	-	1992	Unknown
GW066591	654792	6427484	93	-	-	-	1990	Domestic / Stock
GW801342	654991	6427237	72	-	-	-	1991	Unknown
GW801337	654636	6426994	65	-	-	-	1992	Unknown
GW801340	654937	6426884	53	-	-	-	1992	Unknown

Appendix 4. Salinity and Standing Water Level (SWL) data from Dubbo Regional Council Salinity Network

Dubbo Regional Council Salinity Network site number (Figure 9)		DCC18	DCC19	DCC20	DCC42	DCC44	DCC45	DCC49	DCC53	DCC87	DCC111	DCC115	DCC116
Sampling date	Drilled depth (m)	15	3	15	2	6	9	15	9	6	6	9	3.5
Mar-05	EC(dS/m)	-	TSTB	TSTB	-	-	-	-	-	-	-	-	-
	SWL (m)	DRY	2.9	14.72	DRY	DRY	DRY	DRY	DRY	DRY	5.46	DRY	DRY
Apr-05	EC(dS/m)	-	TSTB	-	-	TSTB	0.3	-	-	-	-	-	-
	SWL (m)	5.91	2.83	14.57	0.2	6	6.8	DRY	DRY	DRY	DRY	DRY	DRY
May-05	EC(dS/m)	-	-	-	-	-	0.3	-	-	-	-	-	-
	SWL (m)	DRY	DRY	14.9	DRY	DRY	5.87	DRY	DRY	DRY	DRY	DRY	DRY
Jun-05	EC(dS/m)	-	-	-	-	-	1.4	-	-	-	-	-	-
	SWL (m)	DRY	DRY	DRY	DRY	DRY	5.95	DRY	DRY	DRY	DRY	DRY	DRY
Jul-05	EC(dS/m)	-	-	-	-	-	1.3	-	-	-	-	0.3	-
	SWL (m)	DRY	DRY	DRY	DRY	DRY	6.9	DRY	DRY	DRY	DRY	7.01	DRY
Aug-05	EC(dS/m)	-	-	-	-	-	1.3	-	-	-	-	0.4	-
	SWL (m)	DRY	DRY	DRY	DRY	DRY	7.4	DRY	DRY	DRY	DRY	8.0	DRY
Sep-05	EC(dS/m)	-	-	-	-	-	-	-	-	-	-	0.1	-
	SWL (m)	DRY	DRY	DRY	DRY	DRY	8.76	DRY	DRY	DRY	DRY	5.87	DRY
Oct-05	EC(dS/m)	-	-	-	-	-	0.9	-	-	-	-	0.2	0.7
	SWL (m)	DRY	DRY	DRY	DRY	DRY	7.45	DRY	DRY	DRY	DRY	6.37	2.3
Nov-05	EC(dS/m)	-	-	-	-	-	-	-	-	-	1.00	0.2	-
	SWL (m)	DRY	DRY	DRY	DRY	DRY	7.4	DRY	DRY	DRY	3.81	6.4	DRY
Dec-05	EC(dS/m)	-	-	-	-	-	DRY	-	-	-	0.80	-	-
	SWL (m)	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	3.71	DRY	DRY
Jan-06	EC(dS/m)	-	-	-	-	-	DRY	-	-	-	0.90	0.3	-
	SWL (m)	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	4.04	8.0	DRY
Feb-06	EC(dS/m)	-	-	TSTB	-	-	TSTB	-	-	-	0.90	TSTB	TSTB
	SWL (m)	DRY	DRY	-	DRY	DRY	8.75	DRY	DRY	DRY	3.80	8.5	3.26
Mar-06	EC(dS/m)	-	-	-	-	-	DRY	-	-	-	0.90	-	-
	SWL (m)	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	4.00	DRY	DRY
Apr-06	EC(dS/m)	-	-	-	-	-	0.9	-	-	-	1.40	-	-
	SWL (m)	DRY	DRY	DRY	DRY	DRY	4.6	DRY	DRY	DRY	4.53	DRY	DRY

TSTB – Too shallow to bail

Dubbo Regional Council Salinity Network site number (Figure 9)		DCC18	DCC19	DCC20	DCC42	DCC44	DCC45	DCC49	DCC53	DCC87	DCC111	DCC115	DCC116
Sampling date	Drilled depth (m)	15	3	15	2	6	9	15	9	6	6	9	3.5
May-06	EC(dS/m)	-	-	-	-	-	0.7	-	-	-	1.10	-	TSTB
	SWL (m)	DRY	DRY	DRY	DRY	DRY	3.29	DRY	DRY	DRY	4.98	DRY	3.26
Jun-06	EC(dS/m)	-	-	-	-	-	1.0	-	-	-	1.00	-	TSTB
	SWL (m)	DRY	DRY	DRY	DRY	DRY	4.25	DRY	DRY	DRY	5.30	DRY	3.3
Jul-06	EC(dS/m)	-	-	-	-	-	0.9	-	-	-	TSTB	0.1	-
	SWL (m)	DRY	DRY	DRY	DRY	DRY	2.87	DRY	DRY	DRY	5.81	5.75	DRY
Aug-06	EC(dS/m)	-	-	-	-	-	0.8	-	-	-	-	0.3	-
	SWL (m)	DRY	DRY	DRY	DRY	DRY	7.42	DRY	DRY	DRY	DRY	7.59	DRY
Sep-06	EC(dS/m)	-	-	-	-	-	0.9	-	-	-	-	-	-
	SWL (m)	DRY	DRY	DRY	DRY	DRY	8.45	DRY	DRY	DRY	DRY	DRY	DRY
Oct-06	EC(dS/m)	-	-	-	-	-	-	-	-	-	-	-	-
	SWL (m)	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY
Nov-06	EC(dS/m)	-	-	-	-	-	-	-	-	-	-	-	-
	SWL (m)	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY
Dec-06	EC(dS/m)	-	-	-	-	-	-	-	-	-	-	-	-
	SWL (m)	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY
Jan-07	EC(dS/m)	-	-	-	-	-	0.8	-	-	-	-	-	TSTB
	SWL (m)	DRY	DRY	DRY	DRY	DRY	7.5	DRY	DRY	DRY	DRY	DRY	3.29
Feb-07	EC(dS/m)	-	-	-	-	-	0.9	-	-	-	-	-	TSTB
	SWL (m)	DRY	DRY	DRY	DRY	DRY	4.96	DRY	DRY	DRY	DRY	DRY	3.3
Mar-07	EC(dS/m)	-	-	-	-	-	0.8	-	-	-	-	-	-
	SWL (m)	DRY	DRY	DRY	DRY	DRY	7.43	DRY	DRY	DRY	DRY	DRY	DRY
Apr-07	EC(dS/m)	-	-	-	-	-	1.8	-	-	-	-	-	TSTB
	SWL (m)	DRY	DRY	DRY	DRY	DRY	7.46	DRY	DRY	DRY	DRY	DRY	3.3
May-07	EC(dS/m)	-	-	-	-	-	0.8	-	-	-	-	TSTB	TSTB
	SWL (m)	DRY	DRY	DRY	DRY	DRY	7.09	DRY	DRY	DRY	DRY	6.33	3.3
Jun-07	EC(dS/m)	TSTB	TSTB	-	-	-	0.7	-	-	-	-	-	TSTB
	SWL (m)	4.59	2.79	DRY	DRY	DRY	7.47	DRY	DRY	DRY	DRY	5.47	3.32

TSTB – Too shallow to bail