Appendix 6: Environmental impact assessment

Briggs Park

Prepared for Serpentine-Jarrahdale Shire

By Essential Environmental

May 2016

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1 INTRODUCTION

1.1 Background and scope

This report presents an assessment of the potential environmental impacts of proposed drainage improvements to western playing fields at Briggs Park Recreation Centre.

1.2 Study area description

Briggs Park Recreation Centre is located within Brickwood Reserve in the Shire of Serpentine Jarrahdale as shown in Figure 1.

Brickwood Reserve is a Bush Forever Site (No: 321) and is noted as containing "one of the largest and most intact examples of a critically endangered threatened ecological community, protected under Federal and State policies, on the Swan Coastal Plain" (SJ Shire, 2009).

1.3 Previous studies

Brickwood Reserve and Briggs Park Management Plan (SJ Shire) was prepared in 2009 to guide and prioritise the use and management of the reserve, recognising the likely pressures associated with the surrounding urban expansion of Byford. The protection of the important environmental values of this reserve is the key objective of this environmental impact assessment.

Shire of Serpentine Jarrahdale Briggs Park Drainage Upgrade (Cardno, 2016) presents options and recommendations for engineering works to upgrade drainage of the western playing fields at Briggs Park Recreation Centre. The report provides preliminary designs and costing information for three (3) possible options for the works that are described in section 3 of this report. The assessment of potential environmental impacts of these options is the subject of this environmental impact assessment report.

Serpentine Jarrahdale Shire: Briggs Park Environmental Impact Assessment
Figure 1: Location

LEGEND

Road centrelines

Cadastre

Briggs Park - western playing fields

Data source: Landgate, SJ Shire, DER, DPaw. Created by: HB. Projection: MGA: zone 50.

Scale 1: 9000 at A4

0 180m

N

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2 PROPOSAL DESCRIPTION

2.1 Drainage improvement works

Proposals for drainage improvement works at Briggs Park have been developed by Cardno to address issues with the lower oval at Briggs Park, Byford getting inundated with water during the winter months making the oval almost unusable during this period.

Each of the options under consideration proposes to construct a subsoil drainage system to control the rise of the groundwater across the western oval to improve its usability in winter. The options vary in their management of the discharge and in the level at which the drainage is set. In summary, *Shire of Serpentine Jarrahdale Briggs Park Drainage Upgrade* (Cardno, 2016) describes the options under consideration as follows:

2.2 Option 1

Construct subsoil drainage under the western oval and gravity feed it to a Humes Jellyfish Filter system for treatment and then pump it into the existing open drain in Mead Street.

2.3 Option 2

Construct subsoil drainage under the western oval and gravity feed it to the North West corner of the site before boring under the existing natural bushland and trees through to the existing open drain in Mead Street. This open drain would then be converted to a living steam to provide the necessary treatment to the stormwater. It is understood that the existing natural bushland and trees to the west is a bush forever site and as such significant environmental approvals would be required to achieve this option.

2.4 Option 3

Construct subsoil drainage under the western oval and gravity feed it to the existing open drain in Mead Street. This open drain would then be converted to a living steam to provide the necessary treatment to the stormwater. This option requires significant bulk earthworks and fill material as well as the construction of a 2.7m high retaining wall.

2.5 Engineering recommendation

Shire of Serpentine Jarrahdale Briggs Park Drainage Upgrade (Cardno, 2016) recommends:

Based on Cardno's assessment of the subsoil drainage systems, research and recent experience, Option 2 would be the preferred construction option to proceed. However the ability to construct Option 2 is heavily contingent on getting the required approvals from the relevant environmental authorities to bore a drainage pipe through the bush forever site to allow the system to drain under gravity. If approval cannot be achieved then Option 1 should be considered in the short term due to current budget constraints.

2.6 Extension of recreation centre buildings

The Shire of Serpentine-Jarrahdale intends to extend the existing recreation centre buildings to the west. The expansion will require clearing of 2,473 m2 vegetation between the existing buildings and the existing limestone fire access track to the west as shown in Figure 2.

Serpentine Jarrahdale Shire: Briggs Park Environmental Impact Assessment
Figure 2: Proposed area for clearing

Data source: Landgate, SJ Shire, DER, DPaw. Created by: HB. Projection: MGA: zone 50.

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3 SUMMARY OF ENVIRONMENTAL ISSUES

3.1 Biodiversity

3.1.1 Vegetation complex

The vegetation complex that exists within and adjacent to the study area is the Forrestfield Complex (Ridge Hill Shelf, Darling Plateau).

The vegetation of the Forrestfield Complex ranges from open forest of *C. calophylla - E. wandoo - E. marginata* to open forest of *E. marginata - C. calophylla - C. fraseriana* - Banksia species. Fringing woodland of *E. rudis* may be present in the gullies that dissect this landform (WAPC, 2000). Table 1 provides the conservation status of the vegetation complex, as described in *Bush Forever* (WAPC, 2000) and SJ Shire *Local Biodiversity Strategy* (2008).

Table 1: Regional and local conservation status of Forrestfield Complex

Complex	Percentage of pre-European extent remaining	Percentage of pre-European extent protected
Serpentine Jarrahdale Shire	266ha (6%)	145 (4%)
Perth metropolitan area	1020 (9%)	219 (2%)

3.1.2 Flora

Searches of the EPBC Protected Matters Search Tool, NatureMap and Department of Parks and Wildlife databases were undertaken to identify flora species of conservation significance potentially occurring in the study area.

Table 2 outlines the results from the DPaW Threatened (Declared Rare) and Priority Flora (TPFL) and Western Australian Herbarium Specimen databases and EPBC Act Protected maters search.

Table 2: Conservation significant flora likely to occur in the study area

Taxa	Conservation status WC Act	Conservation status EPBC Act	Likelihood, preferred habitat
Andersonia gracilis (Slender Andersonia)	Threatened	Endangered	Unlikely, shrub near swamps
Caladenia huegelii (King Spider-orchid)	Threatened	Endangered	Unlikely, clay loam soils
Darwinia foetida (Muchea Bell)	Threatened	Critically Endangered	Unlikely, swampy, seasonally wet
Diuris micrantha (Dwarf Bee-orchid)	Threatened	Vulnerable	Unlikely, swampy, seasonally wet
Diuris purdiei (Purdie's Donkey-orchid)	Threatened	Endangered	Unlikely, swampy, seasonally wet
Drakaea elastic (Glossy-leafed Hammer-orchid)	Threatened	Endangered	Unlikely, swampy, seasonally wet

Taxa	Conservation status WC Act	EPBC Act	Likelihood, preferred habitat
*Drakaea micrantha (*Dwarf Hammer-orchid)	Threatened	Vulnerable	Unlikely, white grey sand
Drosera occidentalis subsp. occidentalis	Priority 4		Unlikely, swampy, seasonally wet
Eucalyptus balanites (Cadda Road Mallee)	Threatened	Endangered	Unlikely, Sandy soils, lateritic gravel
Grevillea curviloba subsp. Incurve (Narrow curved-leaf Grevillea)	Threatened	Endangered	Unlikely, Peaty and clay soils
Johnsonia pubescens subsp. Cygnorum	Priority 2		Unlikely, swampy, seasonally wet
Meeboldina decipiens subsp. *Decipiens*	Priority 3		Unlikely, swampy, seasonally wet
Schoenus pennisetis	Priority 3		Unlikely, swampy, seasonally wet
Synaphea sp. Fairbridge Farm (D.Papenfus 696)(Selena's Synaphea)	Threatened	Critically Endangered	Unlikely, Sandy with lateritic pebbles
Synaphea sp. Serpentine	Threatened		Unlikely, Brown sandy clay
Thelymitra stellata (Star Sun-orchid)	Threatened	Endangered	Unlikely, swampy, seasonally wet
Trichocline sp. Treeton			Unlikely, swampy, seasonally wet

Preferred habitat sourced from Florabase (DEC, 2015), Department of Environment Database (2015) as well as the DPaW database searches.

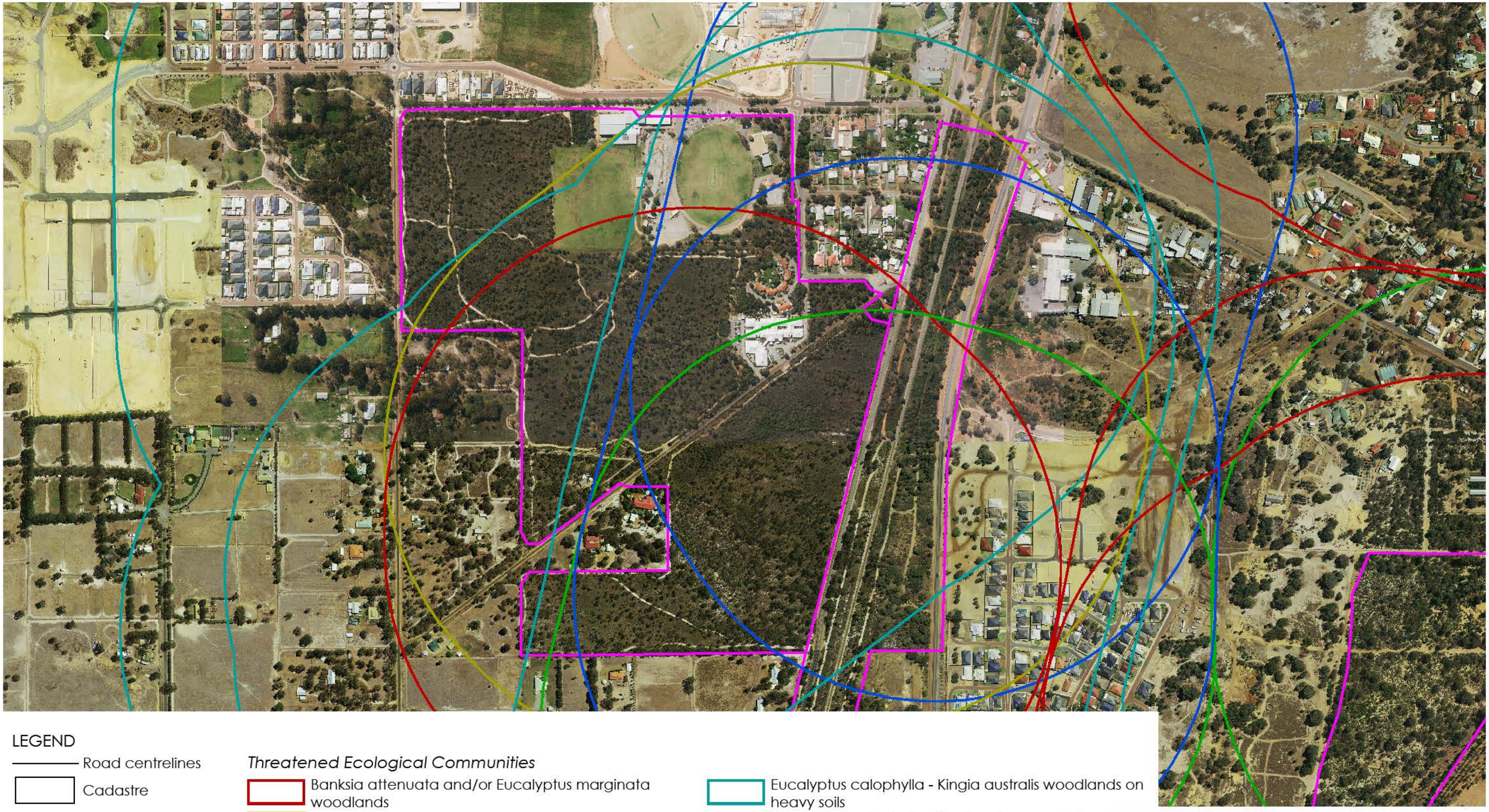
3.1.3 Vegetation communities

Brickwood Reserve (Bush Forever Site No: 321) contains recorded Threatened Ecological Communities. Table 3 and Figure 3 depict the recorded TECs associated with the study area, in order of conservation status.

Table 3: Threatened ecological communities database search

Status	Community Name
Critically endangered	*Corymbia calophylla-Xanthorrhoea preissii* woodlands and shrublands
	Corymbia calophylla – Kingia australias woodlands
Endangered	*Banksia attenuate* and/or *Eucalyptus marginate* woodlands
Vulnerable	*Corymbia calophylla - Eucalyptus marginata*

Serpentine Jarrahdale Shire: Briggs Park Environmental Impact Assessment
Figure 3: Vegetation



LEGEND

Road centrelines

Cadastre

Vegetation

Bush forever site / parks and recreation

Threatened Ecological Communities

Banksia attenuata and/or Eucalyptus marginata woodlands

Dense shrublands on clay flats

Eucalyptus calophylla - Eucalyptus marginata woodlands on sandy clay soils

Eucalyptus calophylla - Kingia australis woodlands on heavy soils

Eucalyptus calophylla - Xanthorrhoea preissii woodlands and shrublands

Data source: Landgate, SJ Shire, DER, DPaw. Created by: HB. Projection: MGA: zone 50.

Scale 1: 9000 at A4

0 180m

N

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3.1.4 Fauna

A search of the DPaW Threatened (Declared Rare) and Priority Fauna database identified six (6) species of conservation significance as being located in the vicinity of the study area. The results are summarised in Table 4.

Table 4: Conservation significant fauna likely to occur in the study area

Taxa	Common Name	Conservation status WC Act	 EPBC Act	Likelihood
Calyptorhynchus latirostris	Carnaby's Cockatoo	Threatened	Endangered	Likely
Calyptorhynchus baudinii	Bauldin's Cockatoo	Threatened	Vulnerable	Likely
Calyptorhynchus banksia subsp.naso	Forest Red-tailed Black-Cockatoo	Threatened	Vulnerable	Likely
Merops ornatus	Rainbow bee-eater	Protected under international agreement	Migratory	Likely
Acanthophis antarcticus	Southern Death Adder	Priority 3	-	Unlikely
Isoodon obesulus fusciventer	Quenda	Priority 5	-	Likely

3.1.5 Potential biodiversity impacts

Any physical disturbance within vegetated portions of the reserve has the potential to impact on its biodiversity values and as such should be avoided.

3.2 Soils and hydrology

A large proportion (approximately 70%) of Brickwood Reserve has been classified as Conservation Category Wetland by the Department of Parks and Wildlife in its Swan Coastal Plain geomorphic wetlands database (mapped in Figure 3) identified as Armadale Palusplain: seasonally waterlogged flat land.

There is one minor watercourse that traverses the reserve from east to west to the south of the study area and then skirts the western boundary of the reserve.

There are two small drains to either side of a track along the northern boundary of the reserve.

The Department of Water has modelled groundwater in the area at a district scale for the *Lower Serpentine Hydrological Studies*. The Department of Water's modelled maximum groundwater level is presented in Figure 4.

A geotechnical investigation was undertaken for the site by Cardno in December 2015 within the boundaries of the western playing fields only. During the geotechnical investigations, topsoil was encountered at each borehole location to depths of between 0.05 and 0.15 m, overlying FILL comprising loose to dense SILTY SAND (SM) to depths of between 0.25 m and 0.7 m. This layer of FILL was observed to be underlain by natural soils comprising medium dense to very dense CLAYEY SAND (SC) and CLAYEY SAND/SANDY CLAY (SC-CI) to borehole termination depths. The natural soils have been interpreted as Guildford Formation soils.

Infiltration testing was also carried out by Cardno in December 2015 at depths between 0.2 m and 0.4 m to determine the unsaturated permeability. The infiltration tests were conducted at shallow depth and within existing fill material. The results of the infiltration testing indicate that the drainage characteristics of the FILL layer, at the time of testing, were good with greater than 10 m/day being the reported hydraulic conductivity at all locations.

No geotechnical investigations were undertaken within bushland areas.

3.2.1 Potential hydrological impacts

The localised lowering of groundwater levels through installation of subsoil drainage within the western playing fields has the potential to extend into the adjacent conservation category wetlands and change the natural hydrology of the site.

3.3 Water quality

Pre-development water quality testing was undertaken as part of The Glades development which abuts Briggs Park to the north of Mead Street and west of Warrington Rd. Surface water and groundwater samples were taken approximately 250m downstream of the end of the open drain in Meads Street from Sept 2007 to Apr 2009.

Surface water quality averages showed low to moderate levels of total nitrogen and phosphorous (1.02 and 0.07mg/L respectively), however slightly higher values of nitrates/nitrites and filterable reactive phosphorous (0.46 and 0.05mg/L respectively) when compared to ANZECC water quality guidelines. A similar distribution of results is seen in the groundwater sampling, however with slightly higher concentrations overall, with the exception of filterable reactive phosphorous which was lower than reportable limits, indicating a large proportion of phosphorous being held in the soil profile.

3.3.1 Potential water quality impacts

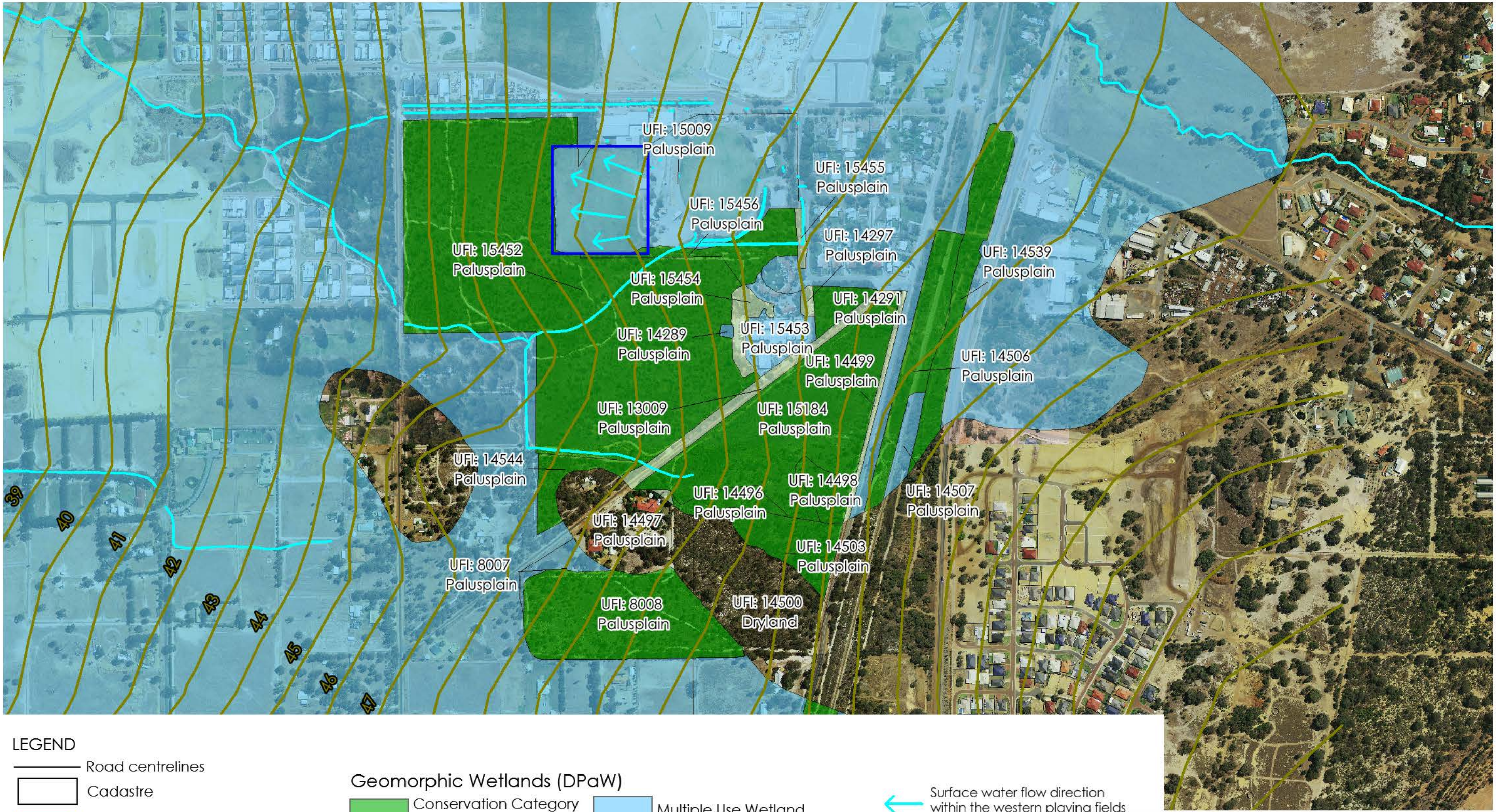
The installation of subsoil drainage beneath turfed public open space has the potential to increase the export rate of nutrients applied to the site as fertiliser. Treatment of subsoil drainage discharges will be necessary to limit the export of nutrients to the downstream environment.

3.4 Summary of potential impacts

The identified critical issues for assessment of environmental impact are:

- Depth of subsoil drainage – impact on wetland hydrology
- Drainage discharge location – physical impacts to vegetation
- Drainage discharge treatment – impacts to downstream water quality
- Clearing – physical impacts to vegetation

Serpentine Jarrahdale Shire: Briggs Park Environmental Impact Assessment
Figure 4: Hydrology



LEGEND

- Road centrelines
- Cadastre
- Briggs Park - western playing fields
- Drainage

Geomorphic Wetlands (DPaW)

- Conservation Category Wetland
- Resource Enhancement Wetland
- Multiple Use Wetland
- Not Assessed/Not a Wetland

Surface water flow direction within the western playing fields

Data source: Landgate, SJ Shire, DER, DPaW. Created by: HB. Projection: MGA: zone 50.

Scale 1: 9000 at A4

0 180m

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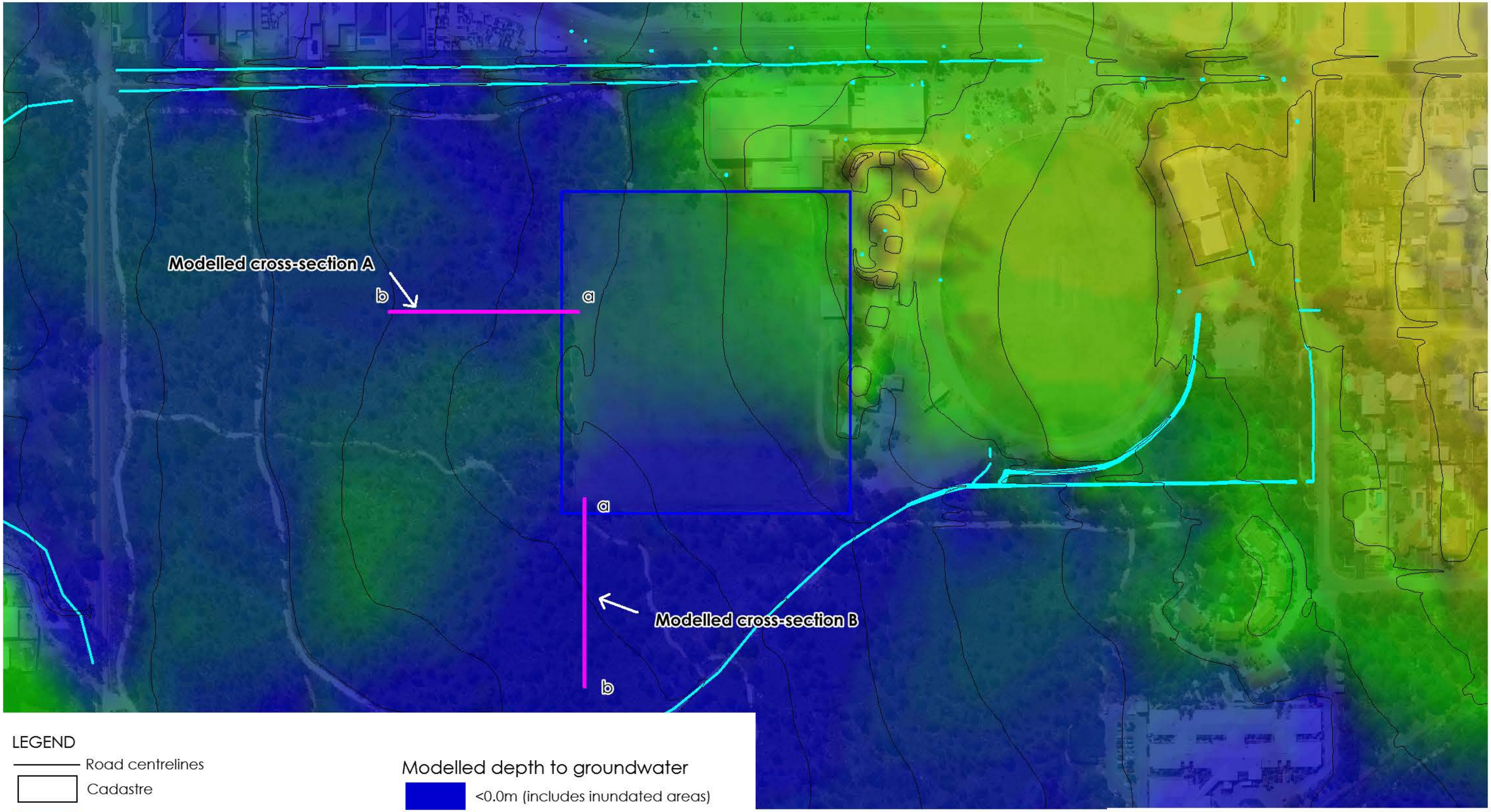
Serpentine Jarrahdale Shire: Briggs Park Environmental Impact Assessment
Figure 5: Modelled depth to groundwater



LEGEND

Road centrelines

Cadastre

Briggs Park - western playing fields

Drainage

Modelled depth to groundwater

<0.0m (includes inundated areas)

0.0-1.5m

>3.0m

Data source: Landgate, SJ Shire, DER, DPaw. Created by: HB. Projection: MGA: zone 50.

Scale 1: 3000 at A4

0 60m

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4 PRELIMINARY REVIEW AND SITE INSPECTION

A preliminary desktop review of the proposed drainage improvement options followed by site inspection was undertaken by Essential Environmental. The following are a summary of the findings of this review in relation to the three options and identifying any modifications that will be considered as a part of the detailed impact assessment.

As discussed in Section 3, the critical issues for assessment of environmental impact that were considered by the preliminary review and site inspection are:

- Depth of subsoil drainage – impact on wetland hydrology
- Discharge location – physical impacts to vegetation
- Discharge treatment – impacts to downstream water quality

4.1 Site inspection

The site inspection was undertaken on 24 March 2016 by Helen Brookes of Essential Environmental accompanied by Serpentine Jarrahdale Shire staff members.

Site inspection has identified that there is at least one significant large tree located very close to the western boundary of the western playing fields (Plate 1). The structural root zone (SRZ) of this tree is likely to extend within the playing field boundary and as such may be vulnerable to damage during construction of the subsoil drainage system.

Plate1: Significant large tree close to western boundary of playing fields (looking south)

Vegetation to the north-west and west of the playing fields is a mix of large and small trees together with relatively dense understory of shrubs and grasses (Plate 2). There are a number of species present that are likely to have deep root structures and there is no obvious clearing or pathway that could be used for a pipeline route.

Plate 2: Vegetation to north-west of playing fields (looking west)

A limestone fire access track heads directly north from the playing fields approximately 30 m west of the recreation centre buildings (Plate 3). This track would be the preferred route for any discharge pipeline to minimise disturbance and facilitate future expansion of the recreation centre.

Plate 3: Limestone fire access track to north of playing fields (looking north)

Vegetation between the recreation centre and the fire access track is generally mid-sized trees with minimal degraded understory vegetation (Plate 4). Physical disturbance in this area could be tolerated with minimal impacts to the values of the reserve. Future expansion of the recreation centre is likely in this area and it is preferred that drainage works avoid this area.

Plate 4: Vegetation to north of playing fields beside recreation centre buildings (looking north)

The existing no-through road parallel to Mead Street and immediately north of the recreation centre has two associated drainage channels. The drain to the north of the road was flowing at the time of the site inspection and is understood to collect subsoil drainage discharges from developments to the northeast. The drain to the south of the road, dry at the time of the site inspection, along the northern boundary of the reserve is proposed as the principal discharge pathway for the proposed subsoil drainage system.

Plate 5: Road to north of playing fields and south of Mead St (looking west)

Plate 6: Drains to south (left) north (right) of no-through road (looking west)

4.2 Desktop review of drainage options

4.2.1 Option 1

The use of pumped discharges and jellyfish filter systems would not generally be recommended for this application since the ongoing management and maintenance costs are likely to be higher than gravity systems with vegetated treatment. It is noted that comments from the Shire have previously identified a preference for vegetated treatment and that a potential modification to the design, integrating a living stream has been identified. Specific comments in relation to the key issues for consideration follow.

Depth of subsoil drainage

This option proposes to lower the groundwater level beneath the western playing fields. This gives a high probability of hydrological impacts to the wetland.

Discharge location

This option proposes to discharge into the northern drain via a pressurised pipe alongside the recreation centre buildings.

The use of a pumped discharge enables a high degree of flexibility for the discharge location and as such facilitates minimisation of physical disturbance within vegetated portions of the reserve.

Discharge treatment

Whilst the use of Jellyfish filter treatment is not generally recommended for this application, it could be expected to provide the necessary treatment efficacy. The proposed alternate 'living stream' treatment is considered preferable because it is expected to provide similar efficacy at a lower ongoing management and maintenance cost. Approximately 250 m of living stream could potentially be provided for this option.

4.2.2 Option 2

Depth of subsoil drainage

This option proposes to lower the groundwater level beneath the western playing fields. This gives a high probability of hydrological impacts to the wetland.

Discharge location

This option proposes to discharge into the northern drain via a gravity pipe alongside the recreation centre buildings.

The use of a gravity discharge requires the discharge location to be further downstream having passed through vegetated portions of the reserve. To minimise physical disturbance boring is proposed for pipeline construction.

To minimise potential damage of roots it will be necessary to select a route that avoids passing directly beneath tree trunks and is sufficiently deep to avoid the majority of the root-plates of trees and other deep rooted vegetation.

The pipeline proposed is approximately 1.5 m below the natural surface at the edge of the playing fields and approximately 1 m below natural surface at its discharge point into the northern drain. It is likely that this depth is sufficient to avoid the majority of the root-plates of trees and other deep rooted vegetation.

Discharge treatment

This option proposes living stream treatment downstream of the discharge point. Approximately 150 m of living stream could potentially be provided for this option.

4.2.3 Option 3

Depth of subsoil drainage

This option proposes to avoid substantially lowering the groundwater level beneath the western playing fields to minimise the probability of hydrological impacts to the wetland.

Discharge location

This option proposes to discharge into the northern drain via a gravity pipe alongside the recreation centre buildings.

In order to provide a gravity discharge and avoid physical impacts to vegetated portions of the reserve it is proposed to import sand fill and construct a retaining wall along the boundary of the playing field which would need to be up to 2.7 m high in places.

Discharge treatment

This option proposes living stream treatment downstream of the discharge point. Approximately 250 m of living stream could potentially be provided for this option.

4.3 Recommended revisions to proposed drainage options

Recent work undertaken by the Department of Water (South-West region) to develop guidelines for the use of subsoil drainage in the South West of Western Australia has recommended a minimum grade of 1:1000. It is noted that this is flatter than the usual industry standard on the basis that many areas in the SW Region have very low natural grades and that systems can be designed to achieve reasonable flushing velocities and avoid sediment ingress such that the risk of blockages will be low.

Recent investigations undertaken by Essential Environmental to develop guidelines for groundwater separations for incorporation into the IPWEA subdivisional guidelines have identified that the functionality of public open spaces where separation from a controlled groundwater system is minimal is significantly influenced by the drainage characteristics of the soils. Provided that a layer of well-drained soil is provided above the subsoil drainage system, turf can be expected to function well with minimal separation from the highest groundwater level between subsoil drainage lines.

Site inspection has identified that the preferred discharge route from the proposed subsoil drainage system would be along the limestone fire access track to the north of the playing fields. The natural surface at this location is approximately one metre lower than the originally proposed discharge route and the design could therefore be achieved with reduced fill.

A revised design for the subsoil drainage system including reduced grade and application of a shallow layer of coarse sand could be used to substantially reduce the fill requirements for option 3 which has the lowest likelihood of hydrological impacts to the wetland.

A revised discharge location utilising the limestone fire access track is recommended for both options 1 and 3, this would reduce the amount of fill and retaining walls required for option 3 and avoid land likely to be used for future expansion of the recreation centre buildings in both options. This revision will reduce the available length for provision of a living stream to approximately 200 m.

4.4 Desktop review of proposed clearing

Site inspection has identified that vegetation between the recreation centre and the fire access track is generally mid-sized trees with minimal degraded understory vegetation (Plate 4). Clearing of this vegetation is expected to have minimal impacts to the values of the reserve.

5 ASSESSMENT OF DRAINAGE ENVIRONMENTAL IMPACTS

As discussed in Section 3, the critical issues for assessment of environmental impact that were considered by the preliminary review and site inspection are:

- Depth of subsoil drainage – impact on wetland hydrology
- Discharge location – physical impacts to vegetation
- Discharge treatment – impacts to downstream water quality

5.1 Hydrological impacts

Two one-dimensional cross section models were developed to consider the response of groundwater levels adjacent to the drainage system. The model was used to provide an estimation of the likely extent of hydrological impact outside of the drained area. Each cross-section is 110 m long and their locations are shown in Figure 4. The cross section locations were selected as representative of the interaction between the proposed subsurface drainage system and the surrounding vegetated wetland areas. The cross sections extend in two directions (Section A to the west and section B to the south) from the edge of the drained area (marked 'a') into surrounding vegetated wetland areas (marked 'b').

Within the boundaries of the playing fields, the model considers two soil layers; one pervious and one impervious consistent with the findings of the geotechnical investigations undertaken on the site. The permeable layer has been modelled as 1.0m thick with an average hydraulic conductivity of 7.5m/day consistent with a combination of 0.5m in-situ fill material with 10m/day hydraulic conductivity and 0.5 m in-situ clayey sand with 5m/day hydraulic conductivity.

Outside of the playing fields the model also consists of two layers although the upper layer is modelled as 0.5m thick with 5m/day hydraulic conductivity consistent with in-situ soils and no fill material.

For options 1 and 2, subsoil drains have been modelled within the playing fields with a minimum invert level of 47.28m AHD at the north-western corner of the playing fields and the impermeable layer lowered locally to 100mm beneath the drain. This results in the drainage level being approximately 0.5m below the existing impervious layer for cross section (a) and close to the existing impervious layer for cross section (b).

For option 3, subsoil drains have been modelled within the playing fields with a minimum invert level of 48.5 at the system's discharge point (entry to limestone fire access track). This option results in the drainage level being approximately 0.8m and 1.4m higher than the existing impervious layer for cross sections (a) and (b) respectively.

A revised version of option 3 has also been modelled, assuming a longitudinal gradient of 1:1000 and a discharge level of 48.5 mAHD allowing for reduced fill and a gravity discharge via the limestone access track. This option results in the drainage level being approximately 0.6m and 0.7m higher than the existing impervious layer for cross sections (a) and (b) respectively.

Additional fill has been modelled in all scenarios to provide a minimum of 0.3m separation from maximum groundwater level approximately 5m from the subsoil drain (allows for 10m drain spacings).

5.1.1 Existing site

Modelled cross-sections demonstrate that the maximum groundwater level is approximately 0.5m below ground level within the northern portion (section A) of the playing fields and close to the natural surface in the vegetated wetland part of the reserve. In the southern portion of the site (section B) the groundwater level is at or above the ground surface throughout the cross section. This is in close correlation to the regional maximum groundwater level modelled by the Department of Water and shown in Figure 4.

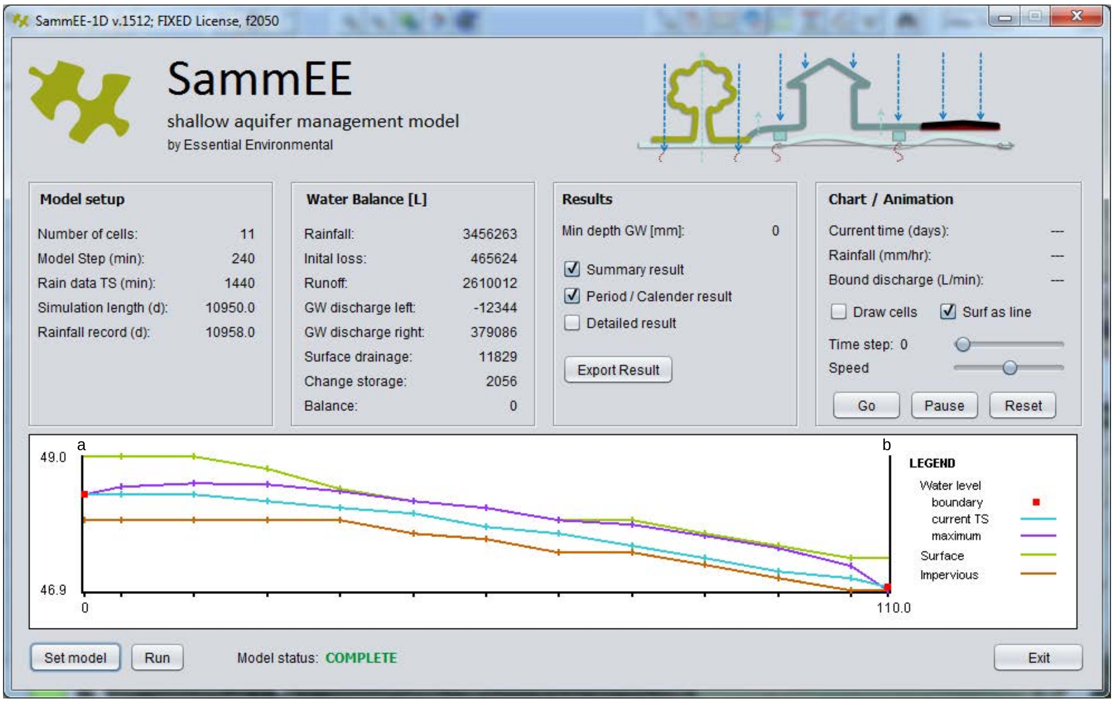


Figure 6: Modelled cross section A – existing site

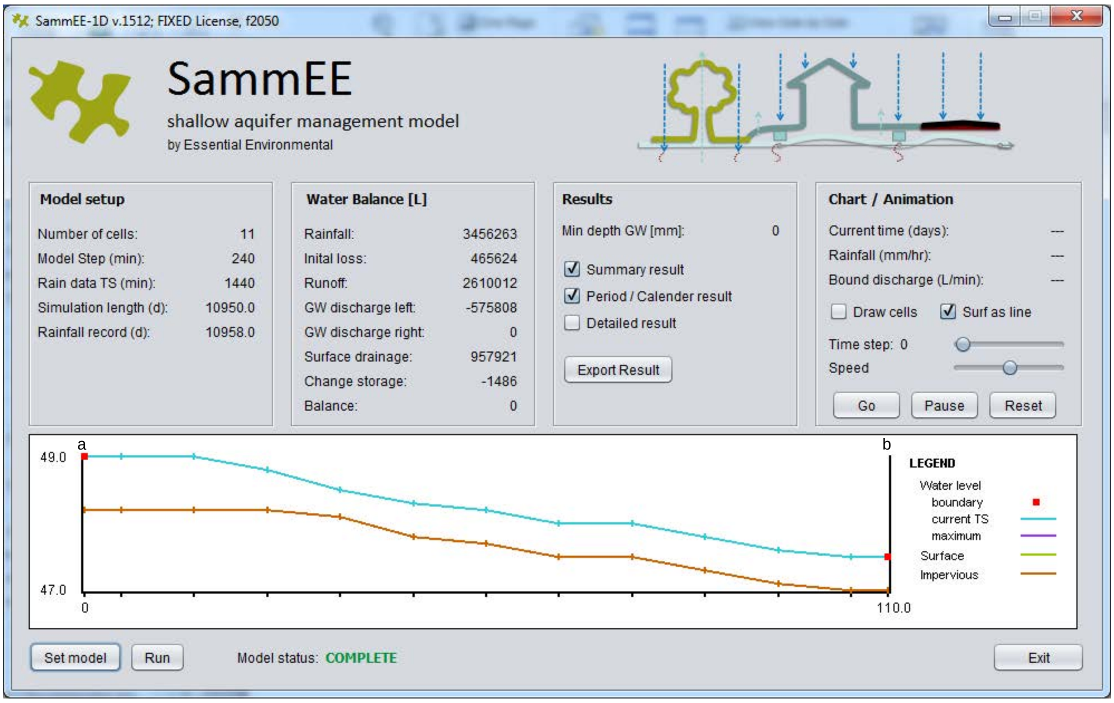


Figure 7: Modelled cross section B – existing site

5.1.2 Option 1 and 2

Modelled cross-section A predicts that the drawdown effects of subsoil drainage in Options 1 and 2 extend throughout the cross section. The maximum groundwater level is lowered by 0.9m at the drain, 0.3m at 30 m from the drain (approximate edge of the playing fields) and 0.1m at 110 m from the drain.

The maximum groundwater level within the playing fields is approximately 48.01 m AHD at 5 m from the drain which indicates that the current playing surface level is approximately 1m above the maximum predicted groundwater level in these options. Therefore no additional fill would be required along this cross section.

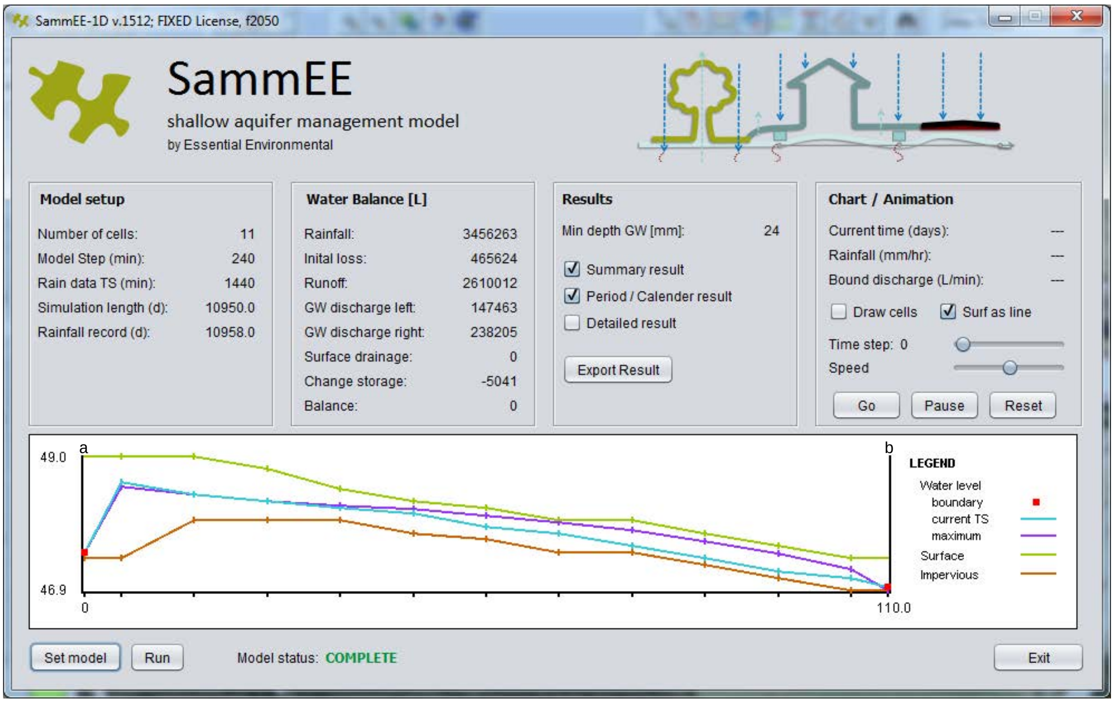


Figure 8: Modelled cross section A – Options 1 and 2

Modelled cross-section B predicts that the drawdown effects of subsoil drainage in Options 1 and 2 extend approximately 10m along the cross section. The maximum groundwater level is lowered by 1.0m at the drain and 0.1m at 10 m from the drain (approximate edge of the playing fields).

The maximum groundwater level within the playing fields is approximately 48.47 m AHD at 5 m from the drain which indicates that the current playing surface level is approximately 0.5m above the maximum predicted groundwater level in these options. Therefore no additional fill would be required along this cross section.

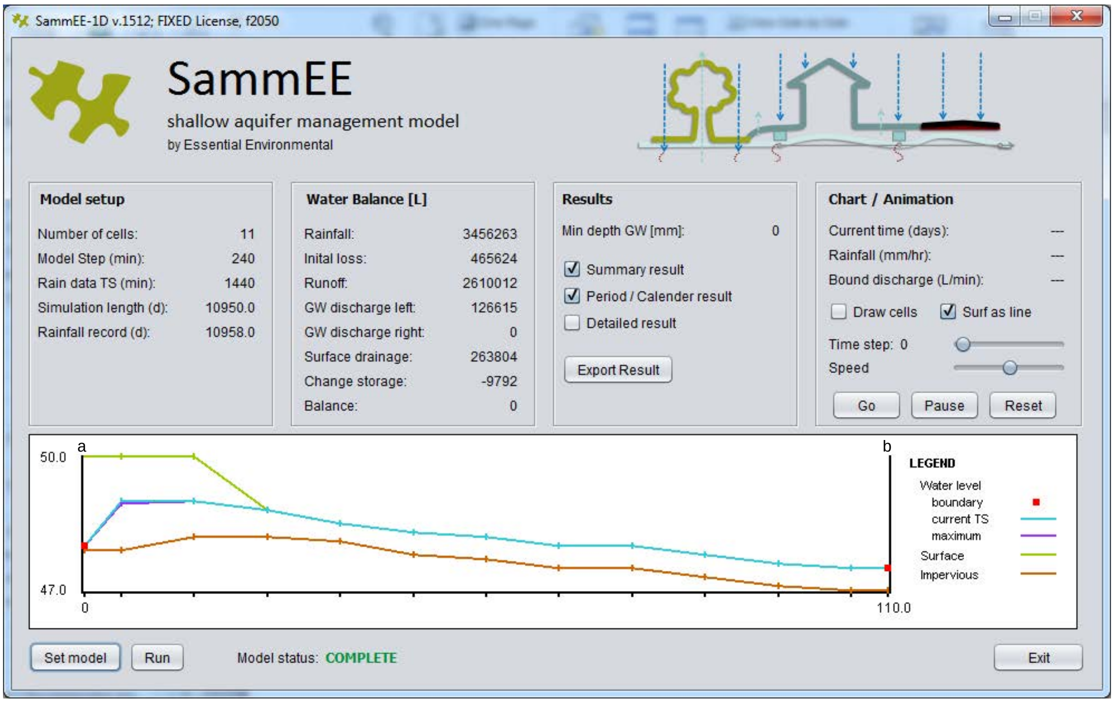


Figure 9: Modelled cross section B – Options 1 and 2

5.1.3 Option 3

Modelled cross-section A predicts that there is no drawdown effect from subsoil drainage.

The maximum groundwater level within the playing fields is approximately 48.46 m AHD at 5 m from the drain which indicates that the current playing surface level is approximately 0.5m above the maximum predicted groundwater level in this option. Therefore no additional fill would be required along this cross section.

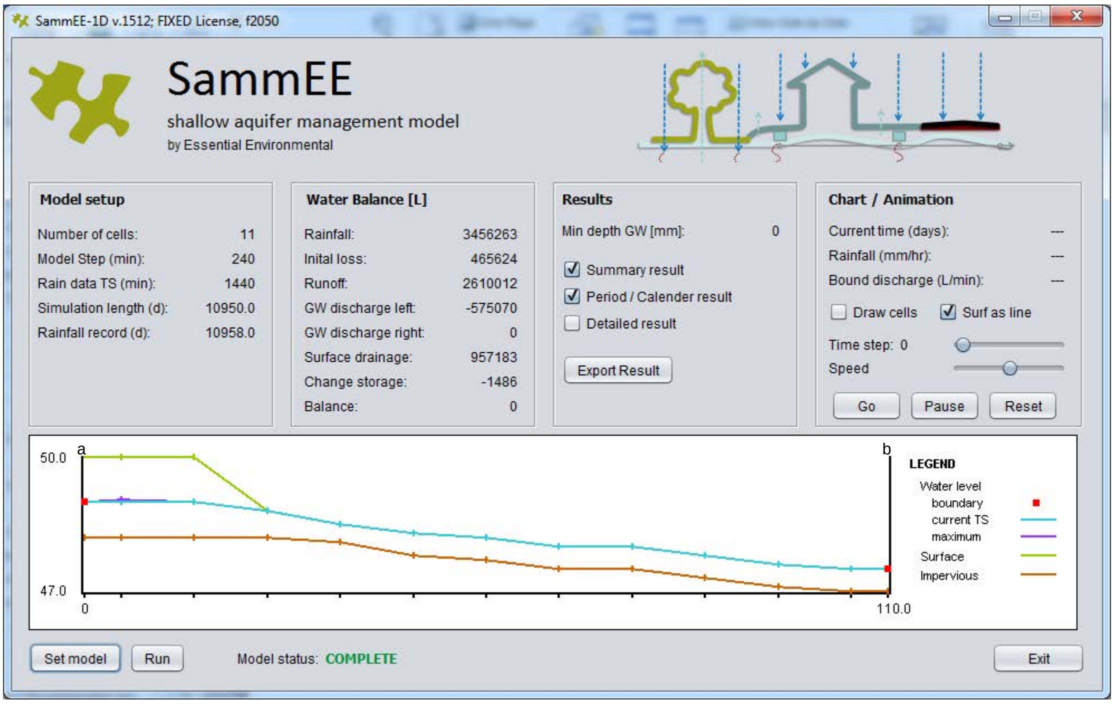


Figure 10: Modelled cross section A – Option 3

Modelled cross-section B predicts that there is no drawdown effect from subsoil drainage.

The maximum groundwater level within the playing fields is approximately 49.02 m AHD at 5 m from the drain which is slightly above the current playing surface level. Therefore approximately 350mm of additional fill would be required along this cross section.

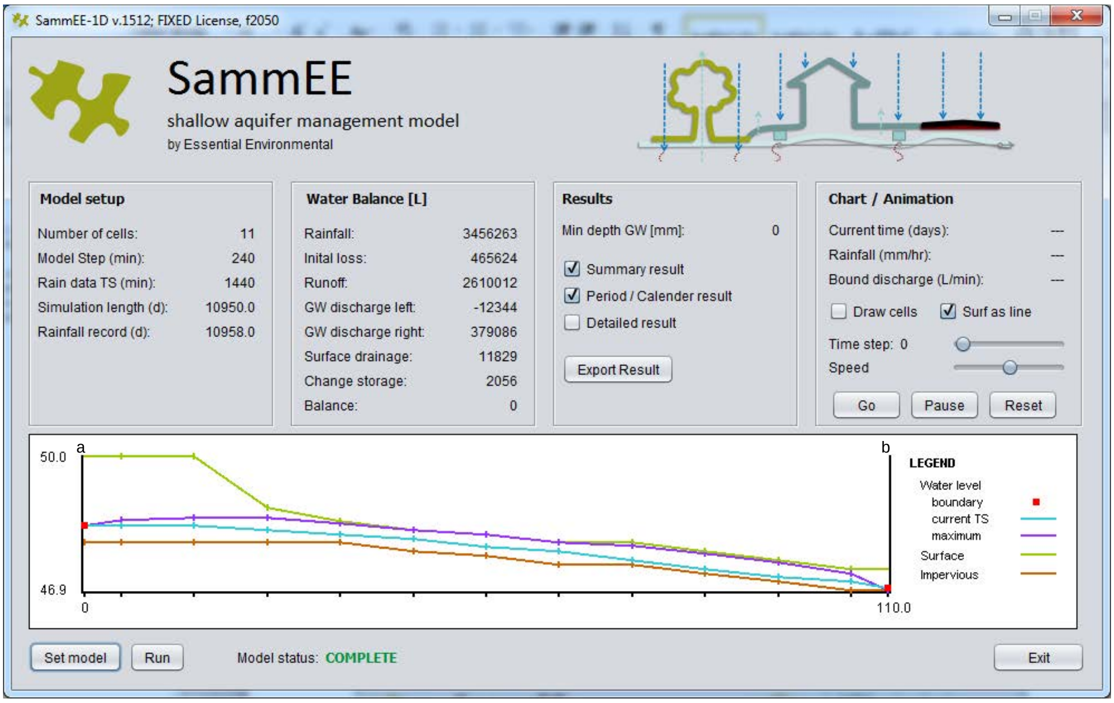


Figure 11: Modelled cross section B – Option 3

5.1.4 Revised Option 3

Modelled cross-section A predicts that there is no drawdown effect from subsoil drainage.

The maximum groundwater level within the playing fields is approximately 48.46 m AHD at 5 m from the drain which indicates that the current playing surface level is approximately 0.5m above the maximum predicted groundwater level in this option. Therefore no additional fill would be required along this cross section.

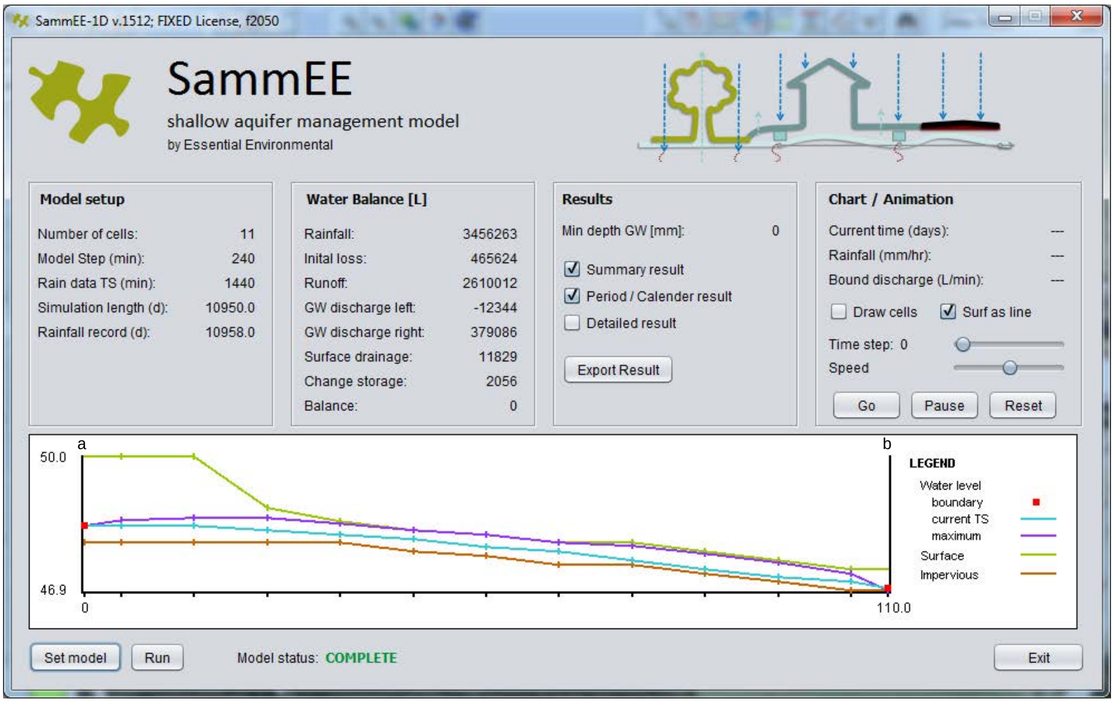


Figure 12: Modelled cross section A – Revised Option 3

Modelled cross-section B predicts that the drawdown effects of subsoil drainage in this option extends approximately 10m along the cross section. The maximum groundwater level is lowered by 0.3m at the drain, <0.1m at 10 m from the drain (approximate edge of the playing fields) and there is no drawdown at 20m from the drain and beyond.

The maximum groundwater level within the playing fields is approximately 48.84 m AHD at 5 m from the drain which is approximately 160mm below the current playing surface level. Therefore approximately 140mm of additional fill would be required along this cross section.

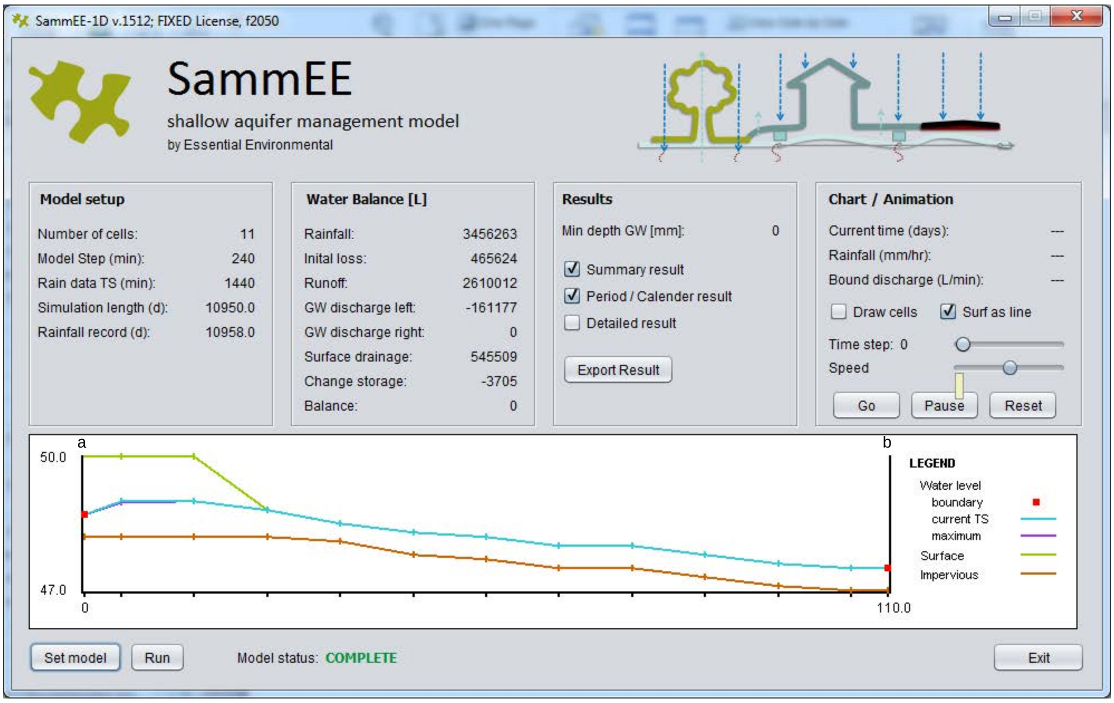


Figure 13: Modelled cross section B – Revised Option 3

5.1.5 Summary and recommendations

Table 5 presents the key findings for each of the modelled options and identifies the relative risk of hydrological impacts within the vegetated wetland portion of the reserve.

Table 5: Groundwater modelling results

	Max groundwater level at ch. along cross-section									
	0m	5m	10m	20m	40m	60m	80m	100m	110m	Risk of Impact
Cross section A										
Existing	48.40	48.46	48.53	48.58	48.46	48.20	47.93	47.56	47.29	Low
Options 1 & 2	47.50	48.01	48.52	48.41	48.24	48.08	47.85	47.47	47.24	Moderate
Option 3	48.40	48.46	48.53	48.58	48.46	48.20	47.93	47.56	47.29	Low
Revised Option 3	48.40	48.46	48.53	48.58	48.46	48.20	47.93	47.56	47.29	Low
Cross section B										
Existing	49.00	49.00	49.00	48.99	48.50	48.20	48.00	47.60	47.50	Low
Options 1 & 2	48.00	48.47	48.94	48.99	48.50	48.20	48.00	47.60	47.50	Low
Option 3	49.00	49.02	49.04	48.99	48.50	48.20	48.00	47.60	47.50	Low
Revised Option 3	48.70	48.84	48.98	48.99	48.50	48.20	48.00	47.60	47.50	Low

On the basis of this assessment of hydrological impact it is recommended that detailed designs are progressed for Option 3 with the recommended revisions to minimise required fill and retaining walls.

5.2 Physical impacts

A vegetation survey was conducted for a 5 m wide pathway through the vegetated land to the north west of the western playing fields along the approximate proposed discharge alignment for option 2.

The vegetation survey, as conducted by SJ Shire 14 April 2016 (Appendix A – Vegetation Survey Species List), shows the vegetation generally consists of smaller trees, shrubs and sedges in amongst the larger *C. calophylla* trees.

A desktop review of root zone depth information for the encountered vegetation suggests that in Pinjarra soils with shallow groundwater, vegetation generally have a shallow root growth habit that reflects the availability of shallow groundwater. Further to this, *C. calophylla* has been noted to have the deepest root zone depth of the species, because of its phreatophytic root growth habit (Bodenstaff 2015). Normally *C. calophylla* root zone would reach the capillary fringe of the water table and root growth would be in response to the seasonal fluctuations (Canham et al 2012).

5.2.1 Option 1 (revised discharge location)

Option 1(revised discharge location) utilises the limestone fire access track as the discharge route.

The proposed discharge route avoids the need to clear or otherwise disturb vegetation.

5.2.2 Option 2

Option 2 utilises a discharge route through vegetation to the north west of the western playing fields.

Boring of the proposed discharge pipeline will avoid the need to clear vegetation along its alignment.

The proposed pipeline is approximately 1.5 m below the natural surface at the edge of the playing fields and approximately 1 m below natural surface at its discharge point into the northern drain.

Analysis of the vegetation types along this alignment and the local soil conditions indicates that root-plates may be expected to a depth of equal or less than 1-1.5m below the natural surface, with the exception of *C. calophylla and Jacksonia furcellata,* which have deeper root plates. Therefore the proposed boring methodology is expected to avoid significant physical impacts to the majority of vegetation. Selection of a route to avoid boring directly beneath *C. calophylla and Jacksonia furcellata* is recommended to further minimise the risk of possible impacts of this option.

5.2.3 Option 3 (revised discharge location)

Option 3(revised discharge location) utilises the limestone fire access track as the discharge route.

The proposed discharge route avoids the need to clear or otherwise disturb vegetation.

5.3 Water quality impacts

The site was conceptualised using the Department of Water's UNDO (Urban Nutrient Decision Outcomes) tool. The model enables consideration of the treatment efficacy of living streams based on the length of stream provided and the resulting nutrient exports from a variety of land uses including turfed public open space with subsoil drainage.

The predicted nutrient inputs for the western playing fields are 232.5kg/year of nitrogen and 18.6kg/year of phosphorus.

The in-situ and imported soils, groundwater levels and proposed subsoil drainage system result in predicted untreated nutrient exports of 35.87kg/year of nitrogen and 3.31kg/year of phosphorus from the western playing fields.

5.3.1 Option 1 (revised discharge location)

Option 1(revised) enables the provision of approximately 200 m of living stream.

The proposed living stream results in predicted treated nutrient exports of 17.97 kg/year (5.77kg/ha/year) of nitrogen and 2.52 kg/year (0.81kg/ha/year) of phosphorus from the western playing fields.

5.3.2 Option 2

Option 2 enables the provision of approximately 150 m of living stream.

The proposed living stream results in predicted treated nutrient exports of 19.06 kg/year (6.15kg/ha/year) of nitrogen and 2.58 kg/year (0.83kg/ha/year) of phosphorus from the western playing fields.

5.3.3 Option 3 (revised discharge location)

Option 3 (revised) enables the provision of approximately 200 m of living stream.

The proposed living stream results in predicted treated nutrient exports of 17.97 kg/year (5.77kg/ha/year) of nitrogen and 2.52 kg/year (0.81kg/ha/year) of phosphorus from the western playing fields.

5.4 Comparison of impacts

Table 5 provides a summary of the risk of environmental impacts from the considered drainage improvement options.

Option 3 provides the least impact although it is recognised that the significant cost of this option may preclude it. The revised option 3 that has been considered maintains a similarly low risk of impact and can be achieved at a reduced cost through optimisation of the proposed design.

Table 6: Relative risk of impacts from various options considered

Potential impact	Option 1	Option 2	Option 3	Revised Option 3
Depth of subsoil drainage – impact on wetland hydrology	Moderate	Moderate	Low	Low
Discharge location – physical impacts to vegetation	Low	Moderate	Low	Low
Discharge treatment – impacts to downstream water quality	Low	Low	Low	Low

5.5 Recommendations

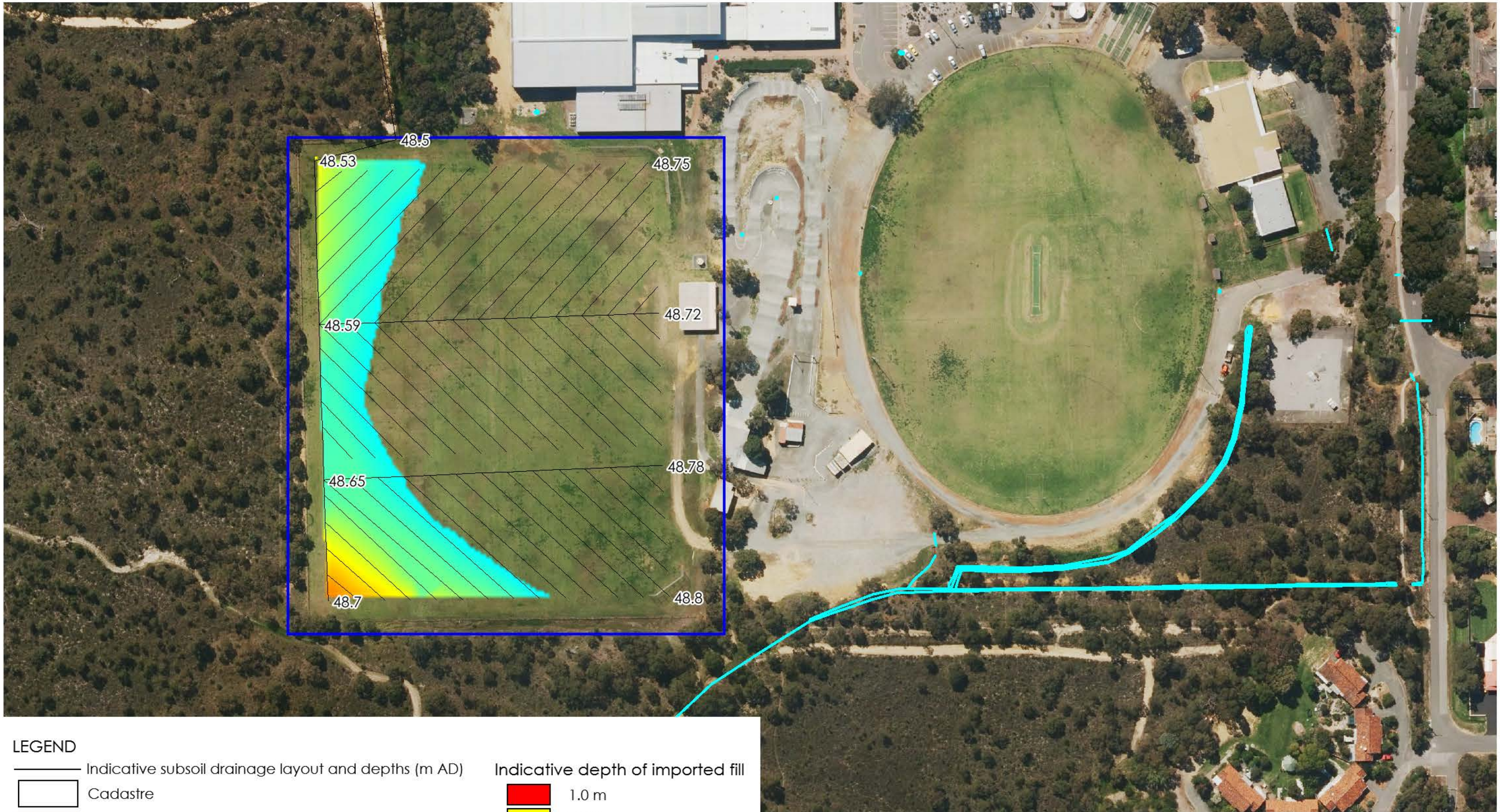
Detailed design of option 3 is recommended with modifications to the discharge location, subsoil drainage system longitudinal grade and fill amounts. Suggested design parameters are:

- Discharge via gravity pipe along limestone fire access track route
- Minimum longitudinal grade of 1:1000
- Minimum cover to subsoil drainage of 0.5m free draining material

The areas requiring the addition of imported fill to achieve the recommended cover to subsoil drainage are identified in Figure 14.

Serpentine Jarrahdale Shire: Briggs Park Environmental Impact Assessment

Figure 14: Land areas requiring fill to achieve minimum recommended cover to subsoil drainage



LEGEND

- Indicative subsoil drainage layout and depths (m AD)
- Cadastre
- Briggs Park - western playing fields
- Drainage

Indicative depth of imported fill

- 1.0 m
- 0.5 m
- 0.0 m

Data source: Landgate, SJ Shire, DER, DPaw. Created by: HB. Projection: MGA: zone 50.

Scale 1: 2000 at A4

0 40m

N

essential environmental

6 ASSESSMENT OF CLEARING ENVIRONMENTAL IMPACTS

A vegetation survey was conducted for land between the existing recreation centre buildings and the limestone fire access track to the west.

The vegetation survey, as conducted by SJ Shire 14 April 2016 (Appendix A – Vegetation Survey Species List) found the following species present:

- Acacia saligna
- Corymbia calophylla (51 trees)
- Dasypogon bromeliifolius
- Jacksonia furcellata
- Kingia australis (16 plants)
- Lepidosperma pubisquameum
- Xanthorrhoea preissii (2 plants)

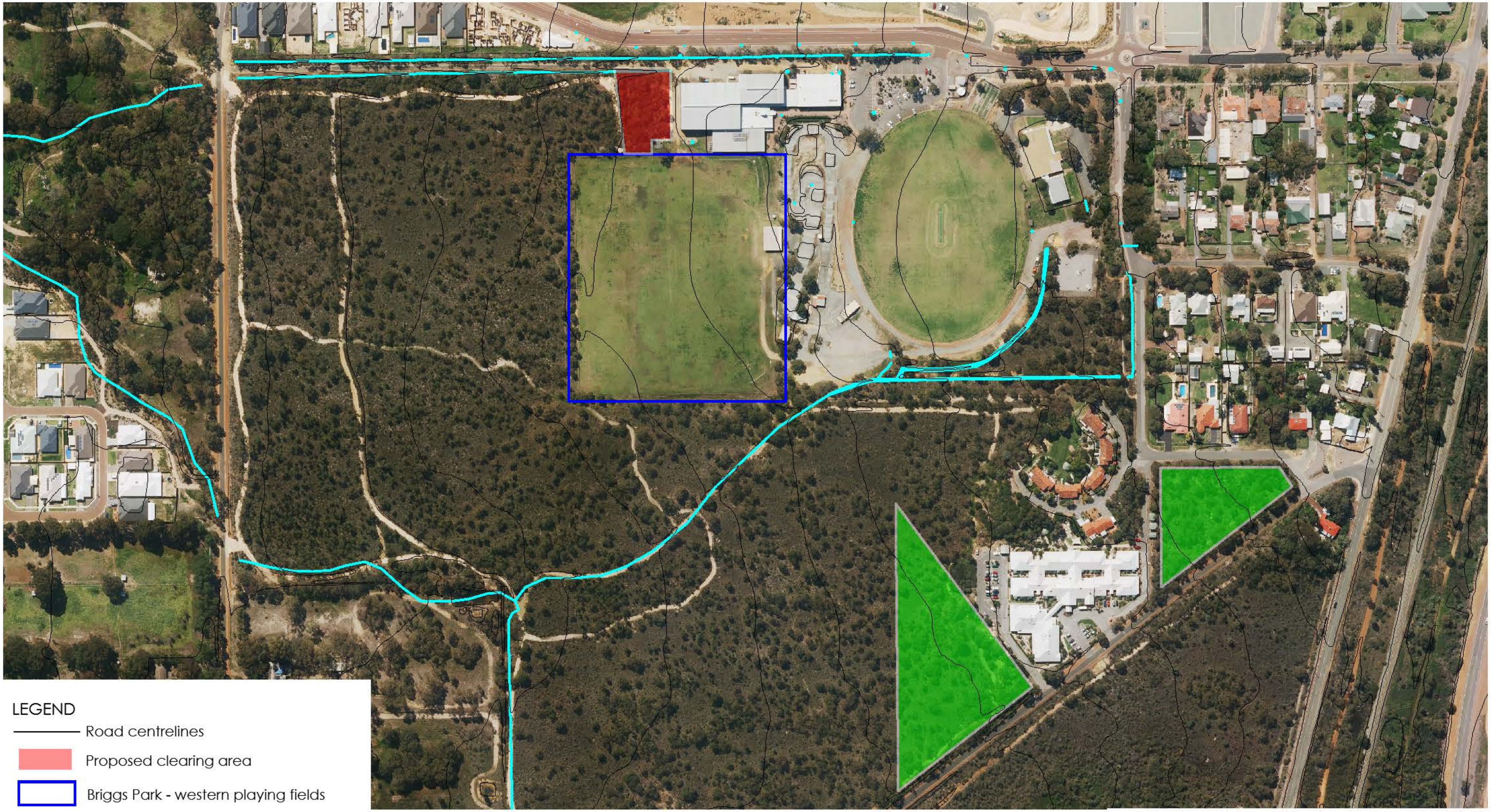
All of these species are better represented within the main vegetated portion of the reserve and the total clearing proposed amounts to approximately 0.2Ha and provides for over 40Ha of the reserve to remain vegetated.

6.1 Recommendations

It is recommended that the following actions are considered as offsets to the proposed clearing:

- Increased management of the remaining vegetated portion of the site including:
    - Weed management activity
    - Revegetation activity
- Improved delineation of the western boundary of the playing fields, to prevent grass encroachment, possibly through construction of a narrow limestone track provided it can be accommodated with no additional clearing.
- Negotiate with the Baptist Hospital and Homes Trust for Lot 106, Reserve 37404 being added to the Shire's reserve system with a purpose change from Homes for the Aged to conservation (identified in Figure 15). This land area is approximately 1.7 ha (8.5 times the area proposed for clearing)

Serpentine Jarrahdale Shire: Briggs Park Environmental Impact Assessment
Figure 15: Proposed offset land areas for acquisition



LEGEND

- Road centrelines
- Proposed clearing area
- Briggs Park - western playing fields
- Drainage
- Proposed offset land areas for acquisitior

Data source: Landgate, SJ Shire, DER, DPaw. Created by: HB. Projection: MGA: zone 50.

Scale 1: 4000 at A4

0 80m

N

essential environmental

7 REFERENCES AND RESOURCES

Bodenstaff, R. (2015) *Meeting the challenge of managing tree roots & infrastructure*, presentation for the Street Tree Symposium 2015, Arbor Centre, Perth.

Canham, C.A., Froend, R. H., Stocl, W. D., & Davies, M. (2012) *Dynamics of phreatophyte root growth relative to a seasonally fluctuationg water table in a Mediterranean-type environment.* Oecologia, 170, 909-915.

Department of Water (DoW) 2012a, *Report no. WST 45 Lower Serpentine hydrological studies Conceptual model report,* Perth, WA.

Institute of Public Works Engineering Australia, 2011, *Local government guidelines for subdivisional development*, WA

APPENDIX A – VEGETATION SURVEY SPECIES LIST

Brickwood lower oval flora survey

Potential drainage line surveyed by Dr
Penny Hollick on 14/4/2016.

1. *Future extension of recreation centre*

Acacia saligna
Corymbia calophylla (51 trees)
Dasypogon bromeliifolius
Jacksonia furcellata
Kingia australis (16 plants)
Lepidosperma pubisquameum
Xanthorrhoea preissii (2 plants)

2. *Drainage line – outside firebreak and fence*

Acacia saligna
Adenanthos meisneri
Allocasuarina humilis
Baeckea camphorosmae
Banksia nivea
Corymbia calophylla
Dasypogon bromeliifolius
Desmocladus fasciculatus
Gompholobium aristatum
Gompholobium marginatum
Gompholobium tomentosum
Hypocalymma angustifolium
Hypolaena exsulca
Jacksonia furcellata
Jacksonia sternbergiana
Kingia australis
Lepidosperma pubisquameum
Mesomelaena tetragona
Stirlingia latifolia
Tetraria octandra
Thysanotus manglesianus
Xanthorrhoea preissii

3. *Drainage line – additional species from inside firebreak and fence*

(i.e. all of the above from section 2 also present)
Acacia pulchella
Allocasuarina microstachya
Cassytha glabella
Cyathochaeta avenacea
Daviesia decurrens
Daviesia preissii
Hakea ceratophylla
Hakea stenocarpa
Hakea varia
Hibbertia hypericoides
Kunzea recurve
Lyginia imberbis
Neurachne alopecuroidea
Nuytsia floribunda
Patersonia occidentalis
Pericalymma ellipticum
Petrophile linearis
Stylidium bulbiferum
Synaphea petiolaris

APPENDIX B – DETAILED DESIGN SCOPING BRIEF

Scope of Works

The following scope of works is provided as a brief to facilitate development of a detailed scope and cost for the following works:

Detailed design of subsoil drainage system under the western oval of the Briggs Park recreation reserve. The system is to include gravity only discharge to the existing open drain on the southern side of old Mead Street which is to be reconstructed as a vegetated living stream along its current alignment. The discharge connection is to occur alongside the existing limestone fire access track route which is approximately 45 m to the west of existing recreation centre buildings. The design is required to avoid additional clearing of vegetation.

Detailed design of a narrow elevated limestone track not designed for fire truck movements along western and southern boundaries of the western oval of the Briggs Park recreation reserve. The design is required to avoid additional clearing of vegetation.

Study objectives

The principle objectives of the detailed design are:

- To improve the drainage of the western oval of the Briggs Park recreation reserve such that year-round sporting activity can be supported.
- To minimise the use of imported fill and retaining walls
- To minimise environmental impacts to the surrounding bushland and downstream environment

Design criteria

Design criteria for the proposed subsoil drainage system are:

- Discharge via gravity pipe along limestone fire access track route
- Discharge level of 48.5 m AHD at entry to limestone fire access track
- Minimum longitudinal grade of 1:1000
- Minimum cover to subsoil drainage of 0.5m free draining material

Client: Serpentine-Jarrahdale Shire

Report	Version	Prepared by	Reviewed by	Submitted to Client	
				Copies	Date
Draft report	V1	RM/HBr	HBr	Electronic	April 2016
Final report	V2	RM/HBr	HBr	Electronic	May 2016

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