4.0 Local Water Management Strategy

4.1 Stormwater Management Plan

4.1.1 General

A Stormwater Management Plan has been prepared for the site. It consists of a number of elements and addresses a large range of issues, including:

- protection of receiving waters
- integration of the stormwater system into the urban and landscape design
- provision of sustainable stormwater

This report describes the proposed stormwater system for the site, including the design criteria and how the criteria will be achieved by the proposed system.

The following design criteria have been established for the Stormwater Management Plan for the Briggs Road development site:

- stormwater treatment in accordance with Environment Protection Authority (EPA) Best Practice and DOW guidelines
- ease of management and maintenance of the stormwater system. The sustainability and cost effectiveness of the ongoing management of the system is to be considered in the planning and design of the stormwater system
- incorporation of Water Sensitive Urban Design (WSUD) and Best Management Practice into the overall urban design of the proposed development
- street drainage to be in accordance with the requirements of the Shire of Serpentine-Jarrahdale and the *Byford Townsite Drainage and Water Management Strategy*
- drains and flow paths are to be provided to safely pass stormwater flows through the site without inundating proposed buildings or allotments.

4.1.2 Proposed Catchments and Drainage Layout

The Stormwater Management Plan for the site showing the proposed development and drainage network is shown in **Appendix Four**. The plan has been prepared following consideration of the proposed stormwater treatment measures.

The primary aim for stormwater management within the subdivision is for minimised collection, and on-site retention and infiltration of both stormwater and entrained contaminants. On-site retention and infiltration (in defined areas and detention zones/structures) of stormwater will help to limit the impact of the development upon the surrounding catchment, and will ensure compliance with the *Byford Townsite Drainage & Water Management Plan*.

The drainage system upstream of the stormwater treatment train will consist of conventional urban drainage infrastructure and overland drainage paths composing of a combination of a system of piped drains and a system of drainage 'living streams' or infiltration swales. Overland flow paths for major flows during severe storms will travel along roads and reserves and will convey peak flows up to 100 ARI storm event.

A pipe drainage network in conjunction with overland path flows is proposed for a number of reasons including;

- area constraints for the placement of swales along active street frontages
- lower risk of algal blooms and other environmental problems that could occur in the water features with lower flows and insufficient water movement
- well understood design and construction standards for contractors and the Shire of Serpentine-Jarrahdale
- ease of maintenance and consistency of practices with other areas in the Shire of Serpentine-Jarrahdale

The capacity of the major detention swales, being at the north west corner and along the length of the multiple use corridor in the south are shown in **Table 1** below.

Table 1: Capacity of Detention Swales (as calculated by VDM Engineering at 24 hr durations).

Location	Storage Maximum per event (cubic metres)			
	1:1 year	1:5 years	1:10 years	1:100 years
North west	2503	4005	4527	7276
Corridor	1324	2119	2395	3849

NOTE: above figures are for **full retention of post development drainage on site** and are hence not practical to achieve over 1 in 10 year storm events.

4.2 Drainage Design

The proposed stormwater drainage design is a combination of a conventional piped drainage system draining into open dry infiltration swales, and flush kerbed roads draining directly into swales adjacent to areas of open space (**Appendix One, SK01**).

The stormwater runoff from the site is self contained for storm flows up to one in five year storm events. With storm events of less frequent recurrence intervals (that is greater than one in five years) flows may overtop the swales and discharge informally to the Outfall Treatment System and living stream drainage system depending on infiltration rates and the groundwater levels at the time of the storm event (**SK02**).

The design incorporates aspects of water sensitive design through the use of dry infiltration swales and flush kerbed roads adjacent to areas of open space for residents.

As discussed above, the majority of street run-off will be conveyed via street drainage and underground piping to vegetated stormwater infiltration swales. Stormwater runoff from storm events having a recurrence interval of 1-in-5 years or less will infiltrate via swale drains and other storage / soakage features throughout the site to the shallow soil profile and then to the superficial aquifer below the swales. Prior to discharging into each swale stormwater will pass through a Gross Pollutant Trap (GPT) or similar.

The objective of this design approach is to minimise stormwater collection, and maximise the amount of stormwater which is locally managed by direct infiltration to the superficial aquifer, in accordance with DOW Local Water Management objectives. This in turn reduces the potential for entrained contaminants to be exported from the site in surface runoff to receiving water bodies, thereby reducing the risk of poor water quality in these water bodies, in this instance, the Serpentine River Catchment.

Roof runoff is generally infiltrated on site on individual allotments with overflows to the street drainage. Allowance has been made in the stormwater infiltration swale size for these additional contributing flows.

4.2.1 Stormwater Infiltration Swale Design

It is proposed to create shallow vegetated stormwater infiltration swales. Where provided, these swales will be designed to contain up to the 1-in-5 year ARI event associated with runoff from streets and verges within the site. The design configuration of the swales is shown in **Appendix One**.

Side slopes in each swale will be a maximum of one vertical in six horizontal for safety and ease of maintenance. The maximum depth of water in each swale is 0.6 metres.

Preliminary discussions with the Shire of Serpentine Jarrahdale indicate that the design philosophy for drainage in the area is to ensure that downstream discharges are limited to existing discharge flows. Additional water is to be compensated on site using alternative measures to an end of pipe solution.

To achieve this, compensation basins and nutrient stripping will be required prior to water being allowed to overflow into the adjacent road drainage network as discussed above.

All road reserves will be drained; however not necessarily with a conventional piped drainage system (consisting of collector pits, manholes and controlled outfalls). It is proposed that where possible soakage/environmental attenuation areas in road side swales (that would contain up to the 1:5 year storm events) would be installed to allow for

appropriate nutrient stripping areas and infiltration that would incorporate water sensitive design and quality principles as discussed in more detail in preceding paragraphs.

It is envisaged that up to a 1 in 10 year storm event (full developed flows) can be accommodated within the drainage swale systems proposed within the areas dedicated to common areas and community spaces.

The 1:100 year storm events will be retained within the development but at this level of detention, roads, swales, living stream systems and storage areas will all be working in unison to attenuate the internal flows allowing the 1:100year external events time to concentrate and subside. The internal system will then drain as the stormwater levels external to the site recede.

DOW current policy is to encourage low frequency events to be stored in drainage swales with flood routes for the maximum events exiting to drainage outfalls.

4.2.2 Proposed Treatment Train System

The proposed treatment train system of the site includes sedimentation ponds, pools, drop structures and riffle zones. The location of these features is shown on the Stormwater Management Plan in **Appendix One.**

The treatment train features are proposed to have the following general arrangements:

- a treatment volume above the full supply level that will temporarily store stormwater to allow it to be treated
- a flood storage volume above the treatment volume to reduce peak flows by delaying and controlling peak flow floods. The outlet structure for the flood storage will be designed to ensure that post development flows are no greater than pre-development conditions

The outlet arrangements will also be designed to ensure that floating material, including oils and litter, cannot pass from upstream catchments as the GPTs within the proposed subdivision will cater for capture of these materials.

4.2.3 Proposed Litter Removal Systems

Gross Pollutant Traps (GPTs), together with Sedimentation Ponds, will achieve litter removal and some pre treatment for other pollutants prior to stormwater being discharged. Elements of the litter removal system comprise of:

- GPTs in line on the pipe drainage system will be used to remove litter prior to entry to the sedimentation ponds. GPT units will be used to provide pre-treatment by removing gross pollutants and significant amounts of sediment. The GPT units will be selected based on treatment efficiency, ease of maintenance and frequency of emptying (assumed to be approximately 3 to 6 times per year)

- floating litter that is not captured by the GPT units may be collected within the sedimentation pond. The inlet zones will be designed as a primary litter and sediment trap. Due to low litter load from residential areas and the GPT upstream, the frequency of litter removal is expected to be relatively infrequent.

4.2.4 Best Management Practises to Achieve Design Targets

The concept design is in line with similar approved designs on the Swan Coastal Plain and as such should be capable of attaining the targets as set out below from the *Byford Townsite Drainage and Water Management Strategy* Checklist.

4.7 Water quality management BMPs to achieve design targets

Item	Submission		Assessment	
	Document ref. 1	Comments 2	Compliance	Comment
Vegetated bioretention systems sized at 2% of the constructed impervious area they receive runoff from	4.1.2 Table 1			
OR to achieve:				
at least 80% reduction of total suspended solids	4.1.2, Section 4.2 and 4.4	Vegetated swales and riffle zones		monitoring
at least 60% reduction of total phosphorus	4.1.2, Section 4.2 and 4.4	Vegetated swales and riffle zones		monitoring
at least 45% reduction of total nitrogen	4.1.2, Section 4.2 and 4.4	Vegetated swales and riffle zones		monitoring
at least 70% reduction of gross pollutants	4.2.3	Installation of GPT's before entry to swales		monitoring

4.3 Management

The issues relating to the ongoing management of the proposed system can be grouped into the following categories:

- Roles and Responsibilities
- Maintenance and lifecycle issues
- Safety
- Water Quality
- Monitoring

4.3.1 Roles and Responsibilities

The roles and responsibilities for management of the water treatment system are as those outlined in the *Byford Townsite Drainage and Water Management Strategy,* Table 9.4 Action Plan. In summary **Table 2** list those actions that the developer will be responsible for.

Table 2: Developer Responsibilities.

Strategy	Action	Lead agency	Timing
Protection of environmental assets			
Assess and manage impacts on sites of indigenous significance	Undertake more detailed assessments at the local structure plan stage, including details of management measures as required	Developers in consultation with DIA and SJ Shire	Through local structure planning
Groundwater management			
Manage groundwater levels to protect infrastructure and assets	Monitor superficial aquifer groundwater levels pre- and post-development at the local scale	Developers' data to be passed by SJ Shire to DoW for collation	3 years each pre and post development
	Manage groundwater levels within ranges reported in this *Drainage and water management plan* via a combination of imported fill and groundwater abstraction as appropriate for management of groundwater rise, and via recharge mechanisms for falling groundwater levels	Developers for 3 years post-development, after that time responsibility of SJ Shire	Commencing immediately and ongoing
Monitoring and implementation			
Adopt an adaptive management approach	Monitor water quality and flows pre- and post development, within developments and at strategic locations in waterways and at outlets into treatment train and drainage infrastructure at key control points (to be identified). This includes both regular (monthly) sampling for flow and water quality	At the local scale: developers then SJ Shire, data to be passed to DoW for collation. At the regional scale (sub-catchment outlets): DoW	3 years pre- and post development, then ongoing

Strategy	Action	Lead agency	Timing
	and targeted peak flow during storm events. Locations to include key outlets to waterways		
	Collate and analyse monitoring data to establish baseline water quality data throughout DSP area	Developer to pass data to DoW, DoW to collate and organise data, CSIRO's real-time data collection system to support the data analysis	Commencing immediately and ongoing
	Assess behavioural patterns with respect to non-structural measures and the effectiveness of non-structural measures, using a method such as community-based social marketing	Developer to implement with guidance from local government, local government to take over responsibility 3 years post-development	Ongoing

4.3.2 Maintenance and Lifecycle Issues

There are items in the proposed stormwater system that will require ongoing attention and maintenance. These requirements have been considered in the concept design and therefore the system should not have significant need for attention beyond what would normally be required. The key maintenance and lifecycle issues are expected to be as follows:

- during the construction phase of the project the site will need to be managed to minimise the generation of pollutants and to trap pollutants prior to discharge to receiving waters. Minimisation of exposed soils, and the use of temporary filter zones, hay bales, silt fence and sediment traps will be required. Staging of works to be planned to provide for the trapping of sediments and monitoring site practices
- litter removal from the GPTs and pond inlet zones is expected to be required approximately once every three months, however maintenance frequency may be extended due to lower litter loads in residential areas
- inspection points will be provided to make it easy to check for blockages and other problems
- visual checking for litter at the inlet zones in the riffle zones will be simple procedures as any litter will be visible on the surface of the riffle zones (typically around the edges)
- the water bodies in the treatment train system, wherever possible, will be set above the 100 year ARI flood level so that the water bodies are not subject to floodplain flows that may resuspend some sediments

4.3.3 Safety Issues

For the treatment train pools, the landscaping and edge treatments will consider safety and railings may need to be provided where necessary.

4.4 Water Quality

Some of the site characteristics identified by the *Byford Townsite Drainage and Water Management Strategy* indicated the following in relation to groundwater quality:

- the limited groundwater quality monitoring that has been undertaken in the Byford area indicated groundwater contained low levels of phosphorus and a very small proportion of moderate concentrations of nitrogen (i.e. total N) and moderate concentration of nitrate and nitrite. While total nitrogen concentrations in groundwater exceeded relevant water quality guidelines the concentrations are relatively low compared to typical sites on the Swan Coastal Plain that have been historically used for pasture or horticulture.
- the soils of the Byford area are highly variable in their capacity to retain phosphorus. Grey brown sands in particular were found to be low in their ability to retain this nutrient.

Water quality management will be achieved by maintaining pre-development discharge rates and volumes which is expected to prevent the majority of contaminants from reaching the waterways by ensuring that the majority of flows from high frequency events are detained or infiltrated on site (Department of Water, 2008). The proposed use and design of swales and detention basins should ensure water quality flows from the proposed development are maintained at pre-development levels. Monitoring at entry to the treatment trains and outlets to existing waterways or dedicated discharge points will be undertaken to compare nutrients levels are within these limits.

The subject land is within the Peel Inlet – Harvey Estuary EPP 1992 (Environmental Protection Authority, 1992) area which has a number of objectives related to reducing nutrient input into the system to reduce algal growth rate and biomass production.

Phosphorus levels have been set by the *Peel Inlet–Harvey Estuary EPP 1992* (Environmental Protection Authority, 1992) at mean concentrations of 0.1 mg/L TP and specifies that reductions of 30-40% for load and concentrations are required in the upper Serpentine Catchment to meet these requirements. The proposed development intends to carry out many of the Best Management Practises, as set out in the *Byford Townsite Drainage and Water Management Strategy,* using principles such as:

- requiring the use of non-phosphorus fertilisers
- reduced turf areas
- planting with water wise native plants of local origin
- soil remediation techniques

- use of water sensitive urban design treatment trains, e.g. swales and detention areas

The water sensitive and urban design principles proposed for the development promote infiltration and should aid in the prevention of possible local flooding from increased runoff due to urbanisation. These drainage treatments also treat the water prior to its discharge to waterways by containing appropriate amounts of vegetation that "strip" nutrients from the water.

The *Byford Townsite Drainage and Water Management Strategy* has identified key stormwater quality-related design objectives as a summary which are put in terms of both concentrations and load based objectives, summarised below in **Table 3**.

Table 3: Objectives of the Byford Townsite Drainage and Water Management Strategy.

Category	Criteria
Concentration-based design objectives	Total Phosphorus (TP) 0.065 mg/L: Total Nitrogen (TN) 1.2 mg/L median concentrations.
Load-based design objectives	The predicted mean annual loads of TP, TN and total suspended solids (TSS) leaving the site are not increased following development of the site.

Structural and Non Structural Water Quality Measures

A number of structural and non structural water quality measures have been suggested by the *Byford Townsite Drainage and Water Management Strategy* for managing water quality. These methods are in line with recommendations proposed in Water Sensitive Design in the Stormwater Management Manual for WA (Department of Environment, 2004). The principal methods used for managing stormwater quality are:

- use of ephemeral wetlands in the public open space system to act as part of the bioretention system
- swale drains which infiltrate stormwater and assist to strip nutrients

The vegetated swale drains proposed for the roads conform to the guidance given in the *Byford Townsite Drainage and Water Management Strategy* in that they are vegetated swales with an underlying trench of soil filtration media. The vegetated material is most likely to be lawn or similar which is easy to maintain. Soils proposed to be used in the upper layers of the swale drains are those that have been amended (e.g. sandy loams) to increase their capacity to remove nutrients.

Living streams are proposed as the main treatment method for attenuating nutrients.

The living streams are proposed to be constructed with a number of features to help attenuate nutrients, these include:

- amended upper surface soils to help remove nutrients;
- vegetated with perennial wetland species that are tolerant of periodic inundation and summer drought conditions;
- planting at densities that allow full coverage in a relatively quick period;
- use of locally occurring species that contribute to local ecological and aesthetic values; and
- incorporation of appropriate rock structures to ensure minimal scouring of surface inflows.

Non-Structural Methods

Non-structural measures are effective components of Water Sensitive Urban Design to ensure that pollutants are minimised leaving the site through ground and surface water flows. These measures complement structural measures such as living streams.

Some of the non-structural measures proposed to be employed in the proposal include:

- minimisation of lawn areas in the open spaces
- minimal use of fertilisers in open space lawn areas
- use of native species throughout the public open space which do not require fertilizers
- development of dwellings with minimal landscaping to ensure lawn sizes are minimised
- provision of educational material to prospective purchasers about fertilizer impacts, water use, landscaping and nutrient management (e.g. detergent use and washing cars) .

4.5 Monitoring

Surface water and groundwater monitoring is a major recommendation of the *Byford Townsite Drainage and Water Management Strategy* for determining baseline data for water quality management across the site.

The monitoring program for the subject area will incorporate both surface and groundwater parameters. Monitoring of groundwater levels will be initially on a monthly basis to establish water level fluctuations. Surface water monitoring will take place within the Multiple Use Corridor drain and infiltration swales. Samples will be analysed for at least the following water quality parameters:

- *in-situ* pH, electrical conductivity and temperature
- heavy metals - arsenic, cadmium, chromium, copper, lead, nickel, zinc, mercury
- total suspended solids
- total nitrogen and total kjeldahl nitrogen

- ammonia (NH4)
- nitrate and nitrite (NO_x)
- total phosphorus (TP)
- orthophosphate (PO_4^{3-})

A network of three bores has been placed across the site, on the northern boundary, central Open Space and within the Multiple Use Corridor. Monitoring is being undertaken on a quarterly basis and an initial monthly sampling period of approximately 6 months.

Pre-development monitoring will rely on data collected from installed bores and data from nearby development projects groundwater sampling points located in close proximity to the study area. The data for these sites will provide the water quality aspects of the local area and will be used to compare with post development data which is to be collected from the bores within the development site.

All monitoring results will be provided to the Department of Water in agreed format should a trigger contingency action be reached. Monitoring sampling will follow Australian Standards AS/NZ 5667 series of *Water quality sampling* guidance notes and a National Association of Testing Authorities accredited laboratory is required to perform water quality testing, Ecoscape proposes SGS Australia Pty Ltd to perform analysis of samples.

Mosquitoes

Insects, including mosquitoes and midges, are a feature of all lake/wetland environments and form an essential part of the aquatic food chain. The number of insects breeding at a particular lake/wetland depends on the productivity of the water body (mostly a function of nutrient availability) and physical characteristics such as the presence of extensive areas of shallow or still water.

Environmental factors influencing the occurrence of problematic midge populations include the following:

- high nutrient water levels;
- disturbed wetlands with limited fringing vegetation (that act as filters); and
- lack of natural predators.

An important aspect of the proposed living streams is that they are seasonal and allow for rapid infiltration of stormwater, therefore the potential for midge, nuisance insects and mosquito breeding is limited.

4.6 WAPC Planning Bulletin No.61

In September 2003, the Western Australian Planning Commission issued Planning Bulletin No. 61, which addresses urban stormwater management. The Bulletin provides a background to the needs for management of stormwater in the urban environment so as to prevent flooding. It also notes the recent recognition that there is a need to manage the quality and quantity of stormwater prior to it reaching a receiving water body.

Reference to design criteria and policy and guideline documents is also made, including the Water and Rivers Commission (WRC) *Manual for Managing Stormwater Quality in Western Australia*, Urban Water Management in WA, Principles and Objectives, the State Sustainability Policy and Water Conservation Strategy and WAPC Policies DC1.1 Subdivision of Land-General Principles.

In terms of General Implementation, reference is made to relevant WAPC policies, Liveable Neighbourhoods, relevant land use and water management strategies and general pollution prevention and generally accepted environmental management strategies.

Importantly, Bulletin 61 recognises that priorities established in respect of stormwater management *"need to be weighed in the context of overall urban design parameters such as residential densities, landscape amenity, commercial, education and retail facility location"*.

It is further noted that *"stormwater management design is dependent on the local soil, water table and drainage characteristics of any particular area and thus will vary depending on location"*.

4.7 Landscape Concept Design

The landscape concept design has incorporated up-to-date water sensitive urban design features to alleviate water of adverse quality from leaving the site. The use of bioretention swales and streams are considered more amenable to nutrient stripping than large constructed lakes and provide a visual amenity at the same time.

As can be seen in the concept design there is limited space to provide drainage swales to all road frontages, however the water that is collected by pipes is treated by infiltration swales and living streams at the end of the pipes. The length of the living streams, incorporating the riffle zones, on both the north and eastern boundaries of the site allow for the treatment of adequate volumes of stormwater as indicated by the engineering report. This is in keeping with the *Byford Townsite Drainage and Water Management Strategy* (Department of Water, 2008) requirements.

There are two large detention basins located in the north west corner and the central open space. These "riffle" zones have been designed to maximise the surface area of the treatment zones by contouring the base area and providing plantings between the "riffles". These areas will assist in the retention of rainfall events and treat water volumes at an appropriate rate as indicated by the engineering report.

The open spaces for residents of the project provide recreational and amenity opportunities. The theme for the concepts has been derived from the rural landscape, waterway system and linearity of the sites.

Elements include:

- retention and regeneration of the existing natural environment and processes;
- manage stormwater runoff with bioretention basins within the open spaces;
- integration of passive and active recreational areas; and
- increase the visual amenity of the areas;

The concept plan has identified the open space sites as areas which will consist of largely level topography integrated with bioretention nutrient stripping basins, ephemeral waterways, passive recreational opportunities, and pockets of natural vegetation and revegetation.

These areas will encompass the following management strategies and experiences:

- to provide areas for passive recreation and retention basins for stormwater management
- integrate retention basins to filter storm water from the development using indigenous sedges and rushes
- pathways to connect these series of spaces with open space to the south of the site along the multiple use corridor
- the basins and the waterway will visually and physically be connected, using floodway dominant species
- revegetation of the existing vegetation fringe using native/indigenous species where possible to enhance the ecology of the waterway system

The above features are shown on the Concept plans for the site in **Appendix One.**

4.8 Future Urban Water Management Plan

An Urban Water Management Plan will be developed to accompany the development proposal of a retirement complex on this site. The Plan will follow the guidelines of the Department of Water document *"Urban Water Management Plans - Guidelines for preparing plans and for complying with subdivision conditions"* and will include the following sections;

- Summary
- Planning approval
- Design objectives
- Site characteristics
- Water sustainability initiatives
- Stormwater and groundwater management
- Other issues
- Managing subdivision works
- Monitoring program
- Implementation plan

4.8.1 Summary

All design and development elements and objectives of water management will be summarised and shown to comply with DOW and Council requirements. Critical control points will be identified and explained how they will be managed in the urban environment. Design elements will closely follow those identified in this document.

4.8.2 Planning Approval

A Location Plan, Site Context Plan and Lot layout Plan have already been developed and will be incorporated into the Plan.

4.8.3 Design Objectives

All agreed objectives of urban water management will be demonstrated to comply with DOW and Council requirements.

4.8.4 Site Characteristics

All relevant information has been investigated or is under development with respect to the following;

- Site conditions of
    - Topography
    - Aerial photography
    - Major physical features
- Geotechnical characteristics
    - Soils
    - Finished levels
    - earthworks
- Environmental
    - Vegetation
    - Wetlands and Waterways
- Surface water
    - Topography
    - Flow paths
- Groundwater

- Bore locations
- Monitoring strategy underway

- Floodways
  - 100 year flow paths and depths
- Landscape Concept Design in place

4.8.5 Water sustainability initiatives

The UWMS will incorporate those water sustainability practises as outlined in this document.

- WSUD principles in place, proposing the following
  - Use of native endemic species in infiltration swales
  - Reduction of turf areas
  - Use of Phosphorus free fertilisers
  - Public education

4.8.6 Stormwater and Groundwater Management

- Flood protection study completed
- Stormwater management system developed incorporating
  - Fill requirements
  - Structural and non structural management practises
  - Acid sulfate soils management strategies
  - Waterway protection buffers
  - Remnant vegetation plans
  - Management of nuisance vectors

4.8.7 Subdivision Works

- Development of CEMP to be developed

4.8.8 Monitoring program

- Sampling regime in place and commenced as of July 2009

4.8.9 Implementation plan

- Roles and responsibilities determined
- Maintenance arrangements under negotiation

5.0 Conclusions

Local Water Management Strategy: Briggs and Thomas Roads, Byford

The environmental values of the subject Lots are minimal in both a local and regional context. The site has been greatly modified and there are very few environmental values remaining on the site. There is now little evidence of the Guildford vegetation complex remaining on the site and consequently development would have no impact on the status of this vegetation complex.

The study site has been classified as a Multiple Use wetland which has the management objective of use, development and management considered in the context of water, town and environmental planning. The site is small and surrounded by land altered by similar landuses therefore development of the property would have little or no impact on the status of this small portion of the wetland.

There are no impacts on Bush Forever sites, Environmentally Sensitive Areas, Public Drinking Water Source Areas or Conservation and Resource Enhancement wetlands from the development of the Lots. Consideration would need to be made for the disturbance of Acid Sulfate Soils, otherwise proposed urban development appears unconstrained by environmental issues.

In conclusion the Local Water Management Strategy for the proposed development meets all of the design criteria, including:

- the proposed stormwater system consists of a network of piped drains and landscaped overland flow paths draining through a stormwater treatment system consisting of GPTs, sedimentation ponds and wetland features
- stormwater treatment will exceed Best Practice objectives for reductions in pollutants
- Water Sensitive Urban Design integrates the stormwater system into the proposed development
- the local street drainage system will be constructed to Shire of Serpentine-Jarrahdale standards
- maintenance, lifecycle and safety issues have been considered in the design of the stormwater system
- the outlet structure for flood storage will be designed to ensure that post development flows are no greater that pre-development condition
- external catchments have not been included in stormwater treatment analysis

References

Local Water Management Strategy: Briggs and Thomas Roads, Byford

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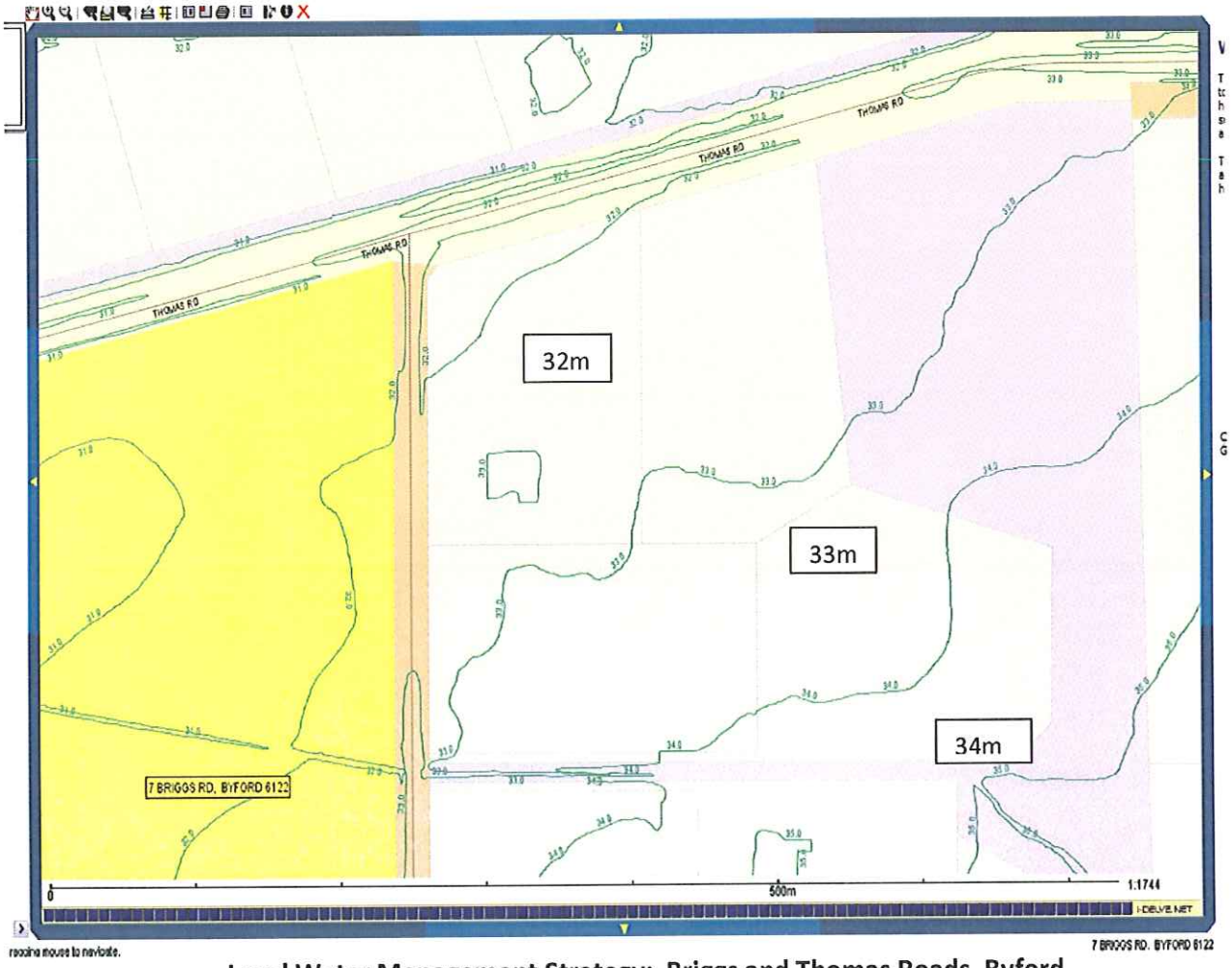
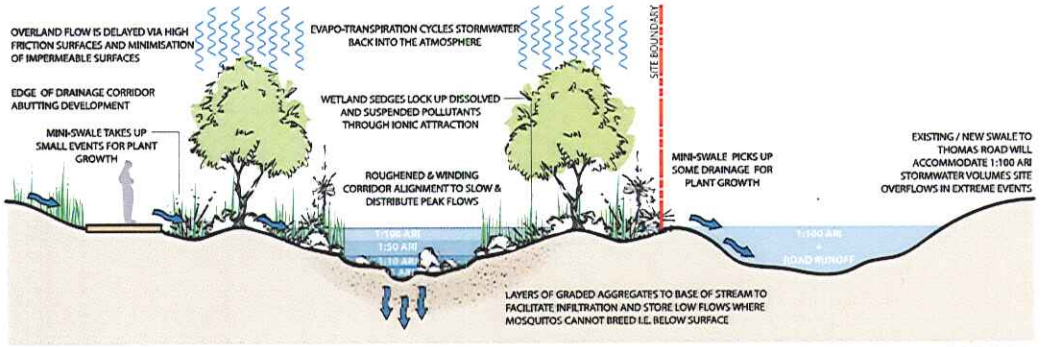
Appendix One: Concept Plan

Local Water Management Strategy: Briggs and Thomas Roads, Byford



Local Water Management Strategy: Briggs and Thomas Roads, Byford

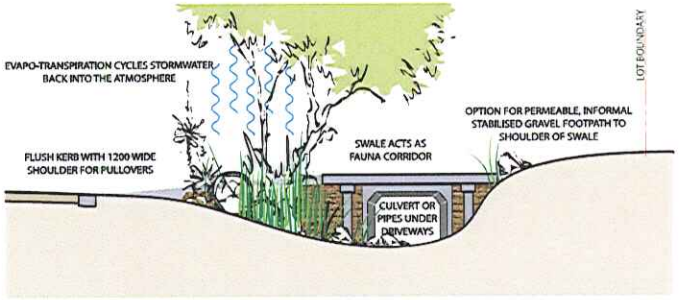
Map 1: Contour Elevations



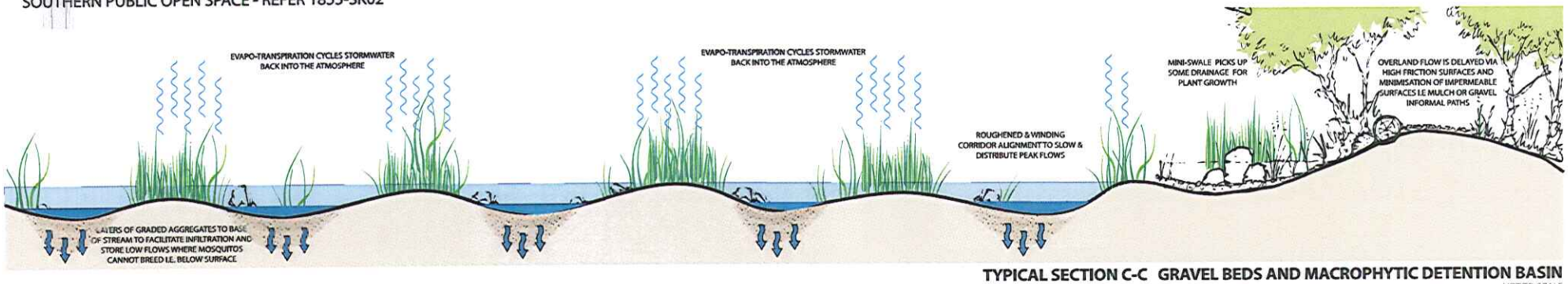
TYPICAL SECTION A-A LIVING STREAM DRAINAGE CORRIDOR
NOT TO SCALE

LEGEND

- SITE BOUNDARY
- EXISTING TREES
- PROPOSED TREES
- GROUNDCOVER
- TURF
- LIVING STREAM
- SWALE
- REGIONAL WATER FLOW
- LOCAL WATER FLOW
- WATER DETENTION AREA
- FOOTPATH
- BOARDWALK



TYPICAL SECTION B-B ROAD SIDE SWALE & CROSSOVER
NOT TO SCALE



TYPICAL SECTION C-C GRAVEL BEDS AND MACROPHYTIC DETENTION BASIN
NOT TO SCALE

rev D

SK 01

NOV 2008

briggs road housing estate

Water Sensitive Urban Drainage Concepts

CORONA CAPITAL

0 10 20 30 40 50m

Scale 1:2000 @ A3. (This Plan is Diagrammatic Only)

Project No. 1855-07

ecoscape

Appendix Four: Drainage Layout

Local Water Management Strategy: Briggs and Thomas Roads, Byford