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Lensworth Group Pty Ltd

Information Request Response

Caboolture Waters: Waterways, Soils and Water Quality Management

13 August 2004

Quality Assurance Statement					
Revision No.	**Author**	**Reviewer**	**Approved for Issue**		
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Lensworth Group Pty Ltd
Caboolture Waters: Waterways, Soils and Water Quality Management

Contents

Abbreviations used in this report:

AHD ..... Australian Height Datum
PASS ..... Potential Acid Sulfate Soils
ASS ..... Acid Sulfate Soils

Executive Summary

Lensworth proposes to develop a signature industrial estate on a 515 ha parcel of land at Morayfield, with frontage to the Bruce Highway. Parts of the site border residential estates particularly to the south. The Caboolture River forms the northern boundary and approximately 70% of the site is below the ARI 100 year flood level.

This report provides an assessment of the environment of the site, reviews constraints and opportunities, analyses environmental risks and proposes design and management to protect and enhance the environment. The scope of the report covers:

- Flooding;
- Waterways and wetlands;
- Soils, including Acid Sulfate Soils and contaminated land management;
- Drainage and stormwater management;
- Agricultural land use suitability;
- Flora and fauna; and
- Mosquito management.

Existing environment

The site is adjacent to the middle estuary of the Caboolture River. Large parts of the site are within the floodplain and form part of a stratigraphic sequence of marine and alluvial deposits. Site topography is flat in the floodplain, with gentle slopes grading up to higher terraces near the southern and eastern boundaries. Elevation varies from sea level to typically around 5m AHD, with some parts of the west of the site forming hillocks up to 17.5m AHD. One natural watercourse traverses the site, along with several constructed drains. Tidal and freshwater wetlands occur throughout the lower areas of the site.

Vegetation has been largely cleared from the terrestrial areas. The site was last used as a softwood plantation and prior to that was variously grazed and cropped, including sugar cane. The agricultural suitability is variable. While approximately 35ha (one area of 28ha and another of 7ha) of the site can be considered as good quality agricultural land, given several limitations agriculture is not considered a beneficial land use for the site.

Remnant vegetation occurs generally in the low lying areas of the site, including drainage lines, freshwater swamps, tidal creeks and banks of the Caboolture River. The site contains a number of identified Regional Ecosystems (REs). RE12.3.5 is associated with lower lying areas in the south of the site and is present over approximately 20.5ha of the site. RE12.2.5 covers a minor area (0.334ha) of freshwater swamp in the southeast corner of the site. In total, "Of Concern" vegetation covers approximately 20.84ha. A non-remnant community of open Eucalypt forest/woodland with *Eucalypt tereticornis* (Blue gum) and other species is in mid-stage regrowth and was consequently identified as consistent with RE12.5.2, which has a *Vegetation Management Act 1994* status of "Endangered".

Soils generally have a sandy loam surface, and across the site fall into three categories - red massive, deep yellow massive and deep grey poorly drained soils. They vary from well drained to poorly drained, and parts of the site have also been identified as being subject to potential and actual acid sulfate soils, which will require appropriate treatment as a result of proposed excavation and filling activities associated with development.

Constraints and opportunities

The major constraint to development is flooding with Q100 flood levels between 3 metres and 5.5 metres. Approximately 70% of the site is within the 100 year ARI floodplain. The riparian corridors of the Caboolture River and Raft Creek and associated freshwater and tidal wetlands have high environmental value, and are entirely within the flood prone parts of the site. These represent a potential constraint in some areas where higher (i.e. potentially developable) land is close to waterways. The main issue to be addressed is water quality, which can be mitigated with appropriate stormwater management techniques and retention of natural drainage regimes where possible.

Vegetation does not represent a significant constraint to achieving a useable developable area. However, there are important opportunities to revegetate some areas to improve riparian connectivity and fauna habitat.

Designated mosquito breeding areas are nearby on adjacent land. Some potential habitat is also present on the subject site, though none is designated by Council. The flight range of the likely freshwater and tidal breeding mosquitoes extends well beyond the site boundaries. Residential areas are already present closer to the breeding locations than any developable area on the site. The industrial nature of this development reduces the risks of biting because there will be fewer people per hectare than a residential estate, sheltering habitat will be largely absent within the estate and fewer people will be present at peak activity times for the insects. Consequently, the Mosquito Management Plan has been prepared which focuses on measures to minimise additional breeding during construction and maintenance of buffer zones to reduce shelter at the edge of the development.

ASS are widespread within the floodplain. They will have minimal effect on development of the higher areas, but any excavation for fill will require an ASS Management Plan. Site contamination is minor, being restricted to low lying areas of the flood plain, in the central and eastern portions of the site. The identified areas of contamination can be readily remediated. A Preliminary ASS Management Plan has been prepared, and rehabilitation measures for exposed soil areas have been suggested which will allow future industrial use of the areas.

Potential constraints are summarised in the Table E1.

Table E1: Development Constraints

Constraints	Description
Flood prone areas	A large portion of the site is below 100 year ARI flood inundation and any development within these areas will require filling, with compensatory excavation from within the site. Council requires that there are no adverse environmental impacts and no increase in flood levels.
ASS	Parts of the site have been identified as containing moderate levels of ASS which will require appropriate treatment and management during development activities and appropriate rehabilitation/remediation following earthworks. Stormwater flows in exposed areas subject to ASS also need to be managed to minimise the risk of mobilisation of acidic material or acid leachate from the site to the Caboolture River.
Waterway buffers	Buffers are required to protect fisheries resources and waterway values by Council and the Queensland Government. Typically, these are 100m for tidal waterways and 50m from freshwaters. The distance may be varied depending on the nature of the receiving waters and the proposed techniques water management.
Stormwater	The applicability of structural stormwater quality best management practices (SQBMPs) is constrained by: ▪ The limited infiltration capacity of the sub-strata assumed from preliminary geotechnical assessments. As such, the attenuation of water quality within the subsoils through local infiltration would also be limited; ▪ The low lying nature of the site; and ▪ Sensitive ecological areas (waterways and REs).

Constraints	Description
Significant vegetation	The paperbark vegetation of the freshwater swamps is classified as being 'Of concern', as is small remnant of Bribie Island Pine beach forest. These areas are afforded protection under the *Vegetation Management Act 1999* and State Coastal Management Plan. The balance of site vegetation is regarded as being non-remnant, and is therefore not classified under this system.

Proposed Development

The site is intended to become a landmark development with a blend of parkland, industrial, commercial, and future residential. The parkland will offer opportunities for recreation, conservation and river access and represents a substantial portion of the site.

The intent is to develop the site in two stages. The first stage will predominantly involve developing the areas currently above the 100 year ARI flood level. The second stage will involve developing the remainder of the area above the flood level, and additional parts of the site which will require filling.

An important feature of the proposal is the protection and enhancement of riparian and wetland vegetation, within open space representing a significant proportion of the site area. Stormwater will be managed to preserve natural flows to the waterways and wetlands and to ensure no increase in pollutant loads. This will be achieved through the incorporation of water sensitive design elements.

Environmental Design and Management

The proposed development and environmental management measures take full account of the riverside context of this highly modified tract of land. Through a combination of setbacks, vegetated buffers, water sensitive urban design, comprehensive ASS management and balanced cut and fill, the development will not adversely impact the surrounding landscape.

The development as designed will provide a significant environmental benefit, by retiring rural land uses from the floodplain and protecting a wide riparian corridor for public open space and conservation. This will also provide an opportunity to revegetate the existing, narrow strip of vegetation along the river and surrounding some of the waterways within the site.

Table E2 summarises potential impacts, proposed design and management techniques and overall impacts.

Table E2: Impacts, Design and Significance

Potential Impact	Proposed Mitigation	Impact Following Mitigation
Flood storage capacity and flood levels in the Caboolture River floodplain from excavation and filling.	Excavation and filling has been designed to be in balance to ensure no loss of storage in the floodplain and no increase in flood levels.	Nil
'Of Concern' Regional Ecosystem.	No development activities are proposed in areas of State significance Regional Ecosystem identified on site.	Low
Waterway values	Provision of minimum 100m to Caboolture River, 30m to other tidal areas and 15m to freshwaters.	Low
	However, stormwater will be managed to ensure discharge water quality is consistent with the protection of water quality values in the Caboolture River.	Low

Potential Impact	Proposed Mitigation	Impact Following Mitigation
Biodiversity and habitat values within the site	Habitat values within the site are currently degraded. The proposed development retains significant areas of potential habitat in the portion of the site on the flood plain. Opportunities have been identified for revegetation of excavated areas with endemic flora.	Low
Exposure of acid sulfate soils during excavation for fill.	All areas of ASS/PASS exposed during construction activities will be managed in accordance with the ASS Management Plan and QASSIT Guidelines.	Low
Mosquito breeding and health risk	A Mosquito Management Plan has been prepared which is consistent with relevant Queensland Government Guidelines. No additional habitat will be created by the development. The nature of the development represents a low risk for increased biting potential.	Low

1. Introduction

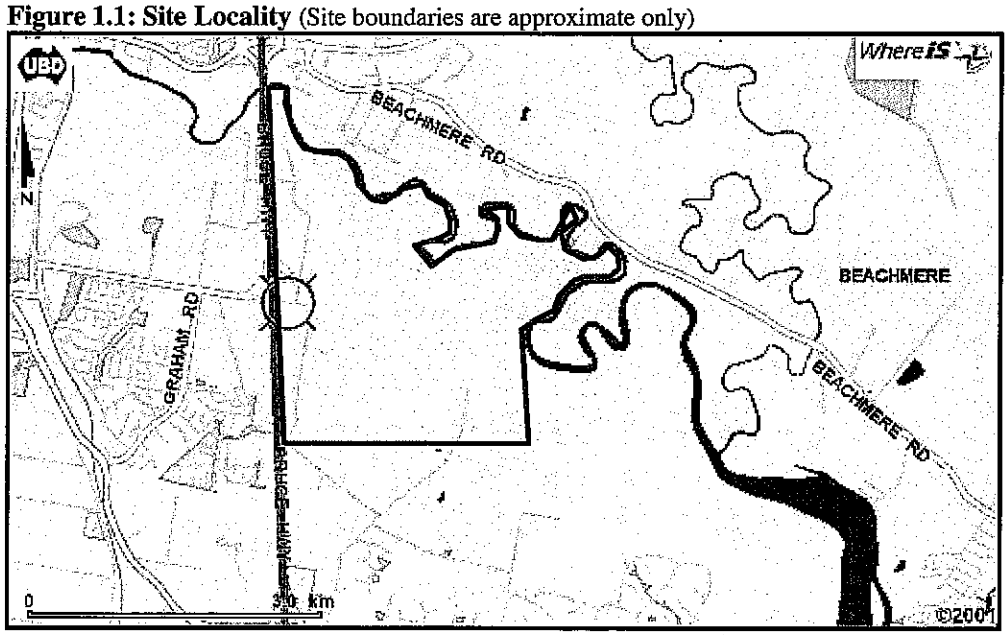
1.1 The Property

Lensworth Group Pty Ltd is proposing to develop a mixed use industrial precinct on a 515.244 hectare site located at Nolan Drive, Morayfield (Figure 1.1). The real property description is Lot 10 on Plan RP902079 and Lot 2 on Plan RP902075, Parish of Caboolture, County of Stanley.

The site is intended to become a landmark development with a blend of parkland, industrial commercial, and future residential land uses. The parkland will offer opportunities for recreation, conservation and river access and represents a substantial portion of the site.

Much of the site is below the Q100 flood contour, and any proposed development within the flood plain will require filling to achieve flood immunity, with compensatory excavation from within the site to ensure no net worsening of flooding characteristics. The intent is to develop the site in two stages, the first stage involving developing the areas where no fill is required, with the second stage involving those areas where fill is needed.

Figure 1.1: Site Locality (Site boundaries are approximate only)



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1.2 Scope

This report has been prepared as part of a response to the Coordinated Information Request, issued by the Department of Local Government and Planning dated 16 August 2002. This report addresses issues on site associated with the management of soil and stormwater, and protection of waterways, and includes:

- A description of existing site characteristics (Section 2), including summaries of issues raised in the Acid Sulfate Soils (ASS) and Geotechnical Report, Site Contamination Investigation Report, Agricultural Land Suitability Report, Flora and

Fauna Report and Preliminary ASS Management Plan - full versions of these reports are attached in the report prepared by PMM;

- Identification of opportunities and constraints (Section 3);
- Discussion of the environmental risks associated with filling above the Q100 flood level and identification of options for stabilisation and revegetation measures in developed areas (Section 5);
- Identification of stormwater management measures and discussion of the level of environmental performance to be achieved (Section 6);
- Discussion of the environmental risks associated with soil disturbance associated with winning of fill, and identification of suitable rehabilitation measures for these areas (Section 7); and
- Discussion of Management of Mosquitoes (Section 8 & separate Management Plan).

Table 1.2 notes the specific items included in the Information Request for which responses are provided in this report, with reference to the relevant section.

Table 1.2: Information Request Tasks

Agency	Information Request Item	Section(s) to Refer
Caboolture Shire Council	3.0 Stormwater Quality Management	Section 6
	3.1 Site-based Stormwater Quality Management Plan	
	3.2 Treatment Measures and Examples	
	3.3 Buffers and setbacks on Plan	
	5.0 & 5.1 Mosquito Management	Section 8 See also separate report
Environmental Protection Agency	4.2 Stormwater Management	Section 6
Department of Primary Industries	1.0 Plan showing aquatic features, tidal lands, protected marine plants and site layout	Section 4
	2.0 Details of impacts fisheries resources (i.e. to aquatic features, tidal lands, marine plants) and appropriate buffers	Section 3, 6
	3.0 Assessment of buffer width and details of mitigation and management measures to reduce impacts to fisheries resources	Section 3, 6

2. Site Characteristics

Site characteristics have been identified through field investigations and a desktop analysis of mapping and aerial photography (Figure 2.1). The site characteristics are discussed in greater detail in the following sections.

2.1 Land Use

The site is currently used for cattle grazing with a vacant house, several sheds and cattle yards in the western area of the site remaining. Between approximately 1970 and 2002 a large portion of the site was a commercial pine plantation and prior to that the site was used for grazing and crop growing. Lot 2 has remained vegetated with indigenous flora.

Dumping of household waste, bark and several motor vehicles has occurred in discrete areas of the site, particularly in an area off Nolan Drive. The site is generally surrounded by rural, rural residential and residential areas. Several parcels of vacant land abut the site along the southern and eastern boundaries.

2.2 Land Form, Waterways and Drainage

The site is gently sloping with typical elevations between 1.5m and 5m Australian Height Datum (AHD). Areas along the southern and western boundaries form hillocks of up to 14m and 17.5m AHD.

The Caboolture River forms the northern site boundary. Within the site are one natural waterway (Raft Creek) and several constructed channels. Raft Creek enters the site approximately 600m to the east of the southwestern site corner and flows in a northeast direction towards the Caboolture River. The largest constructed channel is in the northern section of the site and begins in an adjoining property to the west of the site. It traverses the site in an east-northeast direction and joins the Caboolture River.

A large proportion of the site lies below the Q100 flood level. Q100 levels vary across the site from 3 to 5.5m AHD. There are four relatively large raised areas above Q100 (Table 2.1), which comprises approximately 30% of the site and are considered suitable for development. Isolated minor areas above Q100 also occur, but are considered impractical for development.

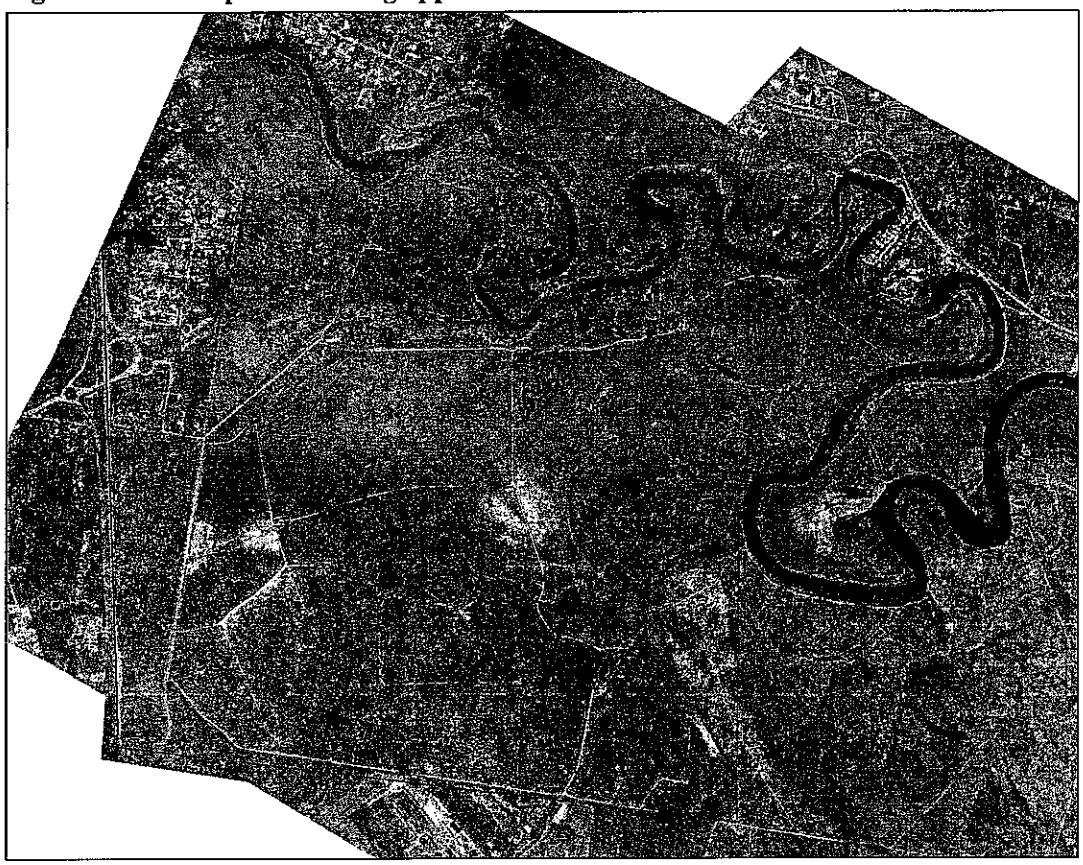
Table 2.1: Areas above Q100

Area	Location	Size (ha)
A	Projects eastwards from the western site boundary; closest area above Q100 to the Caboolture River.	4.50
B	Along western site boundary, projecting northeast	103.83
C	Projecting northwards from southern boundary	12.41
D	Eastern site boundary	33.30
Total		**154.03**

Existing (and proposed) stormwater runoff is generally conveyed by overland flow into the waterways on site and then flows to the Caboolture River. Due to relatively flat topography, low lying areas (especially in the east, southeast and south of the site adjacent to waterways) are poorly drained with minor ponding of water occurring after significant rainfall events.

Low lying areas closer to the Caboolture River are inundated during high tides. This is evidenced by the presence of marine vegetation within these areas which consists of tidal mangroves and saltmarsh communities.

Figure 2.1: Aerial photo showing approximate site boundaries



2.3 Flooding

Investigations into flooding of the Caboolture River and its tributaries were undertaken for Council in 1994, by Australian Water Engineering Pty Ltd (AWE). As part of that work, computer models of the Caboolture River catchment and floodplain were constructed and used to predict design flood levels throughout the area. The model of the Caboolture River floodplain was constructed using surveyed cross sections of the floodplain, originally surveyed by Caboolture Shire Council (CSC).

For the area downstream of the Bruce Highway, the cross section spacing utilised in the previous modelling was typically in the order of 500 metres. The results obtained from the previous modelling were used to provide Council with an assessment of the likely extent of flooding throughout the lower reaches of the Caboolture River system. Flood mapping throughout this area was based on Council's 1:5000 scale topographic mapping, which has a contour interval of one metre. The quoted accuracy of this topographic mapping is 0.5 metres.

The previous 1994 flood modelling has provided an acceptable basis for the determination of broad scale flood level prediction and broad scale flood inundation mapping.

Preliminary flooding information for the proposed development has been determined by Parsons Brinkerhoff, and involved the following tasks:

- Modelling of the 100 year, 50 year and 10 year flood surfaces was undertaken for the site, using the flood levels calculated during the previous 1994 flood modelling. These models were prepared by constructing triangulated networks (TINS) for each flood event, using a series of water level planes, the levels of which were based on the previous flood modelling;
- The boundary of the flood inundation over the site was then created by intersecting the models of the flood surface with the ground surface. Flood inundation boundaries were created for the 100 year, 50 year and 10 year design flood events;
- Preliminary investigations into possible compensatory earthworks for the site have been completed, based on maintaining existing condition flood storage volumes over the site. These investigations have involved creating two extended fill pads at the 100 year flood level. The fill pads are intended to extend beyond the existing 100 year flood inundation line on the site. The fill batter has been assumed to be a maximum of 1:6. Three areas of compensatory excavation are proposed for the lower lying areas of the site, thereby offsetting the lost flood storage due to the fill pad. The excavated surface has been designed to be free draining, with a maximum depth below the surrounding natural ground surface of 1.0 metre, with a minimum excavated surface elevation of RL 2.4 metres AHD and with a maximum cut batter of 1:6. The excavated level of 2.4 m AHD is based on acid sulfate soil considerations.

The results of these storage calculations are summarised in Table 2.2.

Table 2.2: Preliminary flood storage calculations

	100 year flood storage volume m^3	50 year flood storage volume m^3	10 year flood storage volume m^3
Existing ground surface	6906129	6159420	4463307
Proposed filled surface	6913249	6211162	4589671
Difference (absolute)	7120	51742	126364
Difference (percentage)	0.10	0.84	2.83

From the flood storage volumes quoted in Table 2.1, it is evident that (in their current form) the proposed earthworks for the site will result in a small gain in flood storage over the site for the 100 year, 50 year and 10 year ARI events.

The detailed report provided by Parsons Brinkerhoff is provided in Appendix F of this report.

2.4 Receiving Water Quality

Water quality data for fives sites within the section of the Caboolture River adjacent to the site was available from the *Caboolture Region Water Quality Study 1999-2001* (Counihan *et al* 2002). Sources of data for the study were Caboolture Shire Council's Environmental Monitoring Program for site CAB-8, and the Environmental Protection Agency's (EPA) state-wide water quality monitoring program for sites Cab-9.5, Cab-11.4, Cab-13.4 and Cab-15.1. Monitoring occurred between October 2000 and September 2001. Table 2.3 provides a summary of the water quality results. The sites are in order from upstream to downstream, with CAB-9.5 the most downstream site.

Table 2.3: Summary of water quality study results

Parameter	Rating[1] for Each Site				
	Cab-9.5	CAB-8	Cab-11.4	Cab-13.4	Cab-15.1
pH	Good	Good	Good	Good	Good
Conductivity	Good	Good	Good	Good	Good
Dissolved oxygen	Good	Poor	Moderate	Moderate	Poor
Turbidity	Moderate	Poor	Good	Moderate	Good
Secchi Depth	Good	Insufficient Data	Good	Good	Good
Oxidised Nitrogen	Poor	Moderate	Poor	Poor	Poor
Ammonia	Poor	Poor	Poor	Poor	Poor
Total Nitrogen (N)	Poor	Insufficient Data	Poor	Poor	Poor
Total Phosphorus (P)	Poor	Insufficient Data	Poor	Poor	Poor
Chlorophyll a	Moderate	Insufficient Data	Moderate	Moderate	Poor
Organic N	Poor	Insufficient Data	Poor	Poor	Poor
Filterable Reactive Phosphorus (FRP)	Moderate	Insufficient Data	Moderate	Moderate	Poor
Overall	**Poor**	**Poor**	**Poor**	**Poor**	**Poor**

[1]Compared with regional reference values for the protection of aquatic ecosystems developed by the EPA (2001) and national faecal coliform guidelines for primary and secondary contact recreation developed by ANZECC and ARMCANZ (2000).

The results indicate that overall the water quality of the Caboolture River adjacent to the site is poor. This is primarily a result of a combination of poor concentrations of dissolved oxygen, turbidity and nutrients (Counihan *et al* 2002).

The SEQ Environmental Health Monitoring Program, 2002 Report Card for Caboolture River estuary indicates a value of 'C', with reduced levels for dissolved oxygen, elevated levels of biological nutrient processing, elevated levels of phytoplankton and total nitrogen (TN), and high sewage nitrogen signals (Coastal CRC, 2002).

2.5 Soils

Soil testing at 18 test locations indicates that all soil on site has medium to thick (0.1m-0.6m) A-horizon depths consisting of sandy loam texture and light clay to light-medium clay subsoil texture (Landloch 2003). Table 2.4 provides details of the three soil types identified on site.

Table 2.4: Summary soil descriptions[1]

Soil Group	Soil A	Soil B[2]	Soil C
Location	Crests and upper slopes of rises 0.5 – 1%	Crests and upper to mid slopes of rises, usually 0.5-4% but some slopes up to 10%	Lower slopes of rises 4-8%
Concept	Red massive soil with sandy loam surface	Deep yellow massive soil with sandy loam surface	Deep grey poorly drained soil with sandy loam surface
Australian Soil Classification	Red Kandosol	Yellow and Brown Kandosols	Deep grey poorly drained soil with sandy loam surface
Great Soil Group	Red earth	Yellow earth (minor yellow podsolic soils)	Gleyed podsolic soil
pH	6.0-6.5 on surface 6.0 below	6.0-7.0 on surface 5.5-6.0 below	5.5-6.0 on surface 5.0-5.5 below
Permeability	Moderately permeable	Moderately permeable	Slowly permeable
Drainage	Well drained to moderately well drained	Imperfectly drained	Poorly drained
Water holding capacity	Moderate	Low to moderate	Low to moderate

1. Source: Landloch, 2003
2. A variant of Soil B (labelled BV) was identified. Refer to Landloch Pty Ltd (August 2003) for further information.

2.5.1 Agricultural Land

An Agricultural Land Suitability Assessment was conducted by Landloch Pty Ltd during 2003. The report is contained in Appendix B. Soil samples were taken from 18 sites contained within the 100 year flood line. Table 2.5 notes the agricultural land class for each soil group.

Table 2.5: Agricultural land classes for each soil group[1]

Soil Group	Approx. Size (ha)	Soil Group Limitations	Agricultural land class
Soil A	5	▪ Low Plant Available Water Capacity (PAWC) ▪ Low nutrient status and retention capacity ▪ May have toxic nutrient effects in subsoil	Class A – Crop land with none to moderate limitations.
Soil B	30	▪ Low PAWC ▪ Low nutrient status and retention capacity ▪ May have toxic nutrient affects in subsoil ▪ Imperfect internal drainage ▪ Water erosion hazard	Class A - Crop land with none to moderate limitations; and Class B – Limited crop land regarded as marginal cropping land with severe limitations.
Soil C		▪ Low PAWC in upper profile ▪ Low nutrient status and retention capacity ▪ May have toxic nutrient affects in subsoil ▪ Poor internal drainage ▪ Water erosion hazard	Class C – Pasture land unsuitable for continuous cultivation.

1. Source: Landloch, 2003

The results indicate that 35ha (an area of 28ha and another of 7ha) of the site can be considered as good quality agricultural land. However, given several other limitations agriculture is not considered a beneficial land use for the site. Those limitations are:

- slow internal drainage;
- low plant available water;
- low initial nutrient reserves;
- low nutrient retention capacity;
- low subsoil pH;
- potential water erosion hazards;
- size;
- discontinuity of area; and
- incompatible adjacent land uses.

2.5.2 Acid Sulfate Soils (ASS)

Douglas Partners conducted an ASS and Geotechnical Investigation of the site between July 2003 and August 2003, with field investigations conducted over the 1, 2 and 3 July 2003 (Appendix D). The areas investigated were restricted to potential fill source areas (refer to Figure 3.1). In total, 20 test pits were excavated to a depth of 2.5m below surface levels and soil samples taken from each.

Each sample was field screened for pH and peroxide pH. Visual inspection and pH screening of drains and creeks for acid drainage signs was also undertaken, and indicated that the natural waterway on site is impacted by ASS, with a water pH of 5.2 and the presence of iron stains. The drains within the site do not appear to be affected by ASS, with only very minor iron scum visual and water pH between 6.9 and 7.8.

Laboratory testing indicates that either low or moderate ASS levels were present in all samples. The Total Actual Acidity and Oxidisable Sulfur level in 8 of the 20 test pits exceeded the QASSIT Action Criteria between 0.5m and 2.0m below surface level.

2.5.3 Geotechnical

To obtain an indication of soil suitability for filling purposes (Refer to Drawing 1 in Appendix B), standard compaction and Californian Bearing Ratio (CBR) tests were conducted on 4 samples from select areas on site. Results indicate the silty clay material within 3 of the 4 samples is a potential fill source. The variable CBR results (3% to 6%) indicate potential variability of plasticity and reactivity across the site, which may result in the requirement to source alternative fill material for areas with potentially stringent engineering/building construction requirements (eg roads and building pads). If required, this will be further addressed during detailed design.

Additional testing of the potential fill source areas and the areas to be filled will be conducted at a later stage to ensure these areas are suitable. The testing of the fill source areas will specifically involve examining the following characteristics: the plasticity; the reactivity under shrink-swell behaviour; and the strength reduction during wetting. Testing of areas to be filled will entail assessment of the suitability of these areas under fill induced loads.

2.6 Contaminated Land

Lot 10 on RP902079 is included on the Environmental Protection Agency's (EPA) Environmental Management Register (EMR) but not on the Contaminated Land Register (CLR). The notifiable activity that was undertaken on site was storage of petroleum product and/or oil. Lot 2 on RP902075 is not register on either the EMR or CLR.

Douglas Partners undertook a Site Contamination investigation between July 2003 and August 2003, with field investigations conducted on the 1, 2 and 3 July 2003 (Appendix D). A number of potential sources/areas of contamination were identified, limited to Lot 10, including:

- A cattle dip;
- Underground fuel storage tank, bowser and vent;
- Aboveground storage tank;
- Chemical store;
- Surface waste disposal area; and
- Pine plantation areas sprayed with herbicides.

A total of 37 test pits were excavated and soils samples taken from each. The test pits were located to target potential areas of contamination. The results indicate that soil contamination is isolated to the immediate area surrounding the underground fuel storage tank and bowser. This equates to approximately 10-20m^3 of affected soil or 0.02% (1ha) of the site. The contamination level identified was above the EPA's Environmental Investigation Levels but below the health-based threshold for commercial/industrial and residential sites. Additional sampling around the dip will be undertaken to ensure that area is not contaminated.

As a result of the contamination finding, a Remedial Action Plan and Site Management Plan were prepared by Douglas Partners. Remedial actions to be carried out, as identified in the plan will consist of the following:

- Removal of the underground fuel storage tank, bowser and vent pipe – excavated and disposed off-site;
- Removal of petroleum hydrocarbon affected soil – validated, excavated and bio-remediated on-site or disposed off-site; and
- Removal of any soil found to be contaminated as a result of the further testing – excavated and disposed off-site.

An application will be made to the EPA for a Section 424 Disposal Permit before any off-site disposal of contaminated soil. The Site Contamination Investigation, Site Management Plan and Remediation Action Plan were forwarded to the EPA on 19 February 2004 for assessment. EPA has issued a Concurrence Agency response which will require that a suitability statement be prepared prior to any disposal permit being issued..

2.7 Flora and Fauna

Yurrah Pty Ltd (2003) conducted an ecological assessment of the site during April 2003 and June 2004. This report is included in full in Appendix E.

2.7.1 Flora

Field investigations determine 88 native flora species are present on site, none of which is significant at Commonwealth or State level. Fifty-one introduced species or weeds were observed.

Eight vegetation communities were identified, of which 6 communities (4 remnant and 2 non-remnant) are comprised of indigenous species. The native vegetation is generally located in the low lying areas of the site, including drainage lines, freshwater swamps, tidal creeks and banks of the Caboolture River. Table 2.6 below describes the vegetation communities on site that can be classified as Regional Ecosystems (REs).

Table 2.6: REs identified on site

Vegetation Community	Regional Ecosystem Equivalent to	*Vegetation Management Act 1994* Status
Paperbark swamp (*Melaleuca quinqueneriva)*	RE12.3.5	Of concern
Bribie Island Pine Woodland (*Callitris columellaris)*	RE12.2.5	Of concern
Tidal Mangrove/Swamp Oak	RE12.3.5	Not of Concern
Tidal saltmarsh	RE12.1.2	Not of Concern

As indicated in Table 2.6, two of the REs have a *Vegetation Management Act 1994* status of "Of Concern". RE12.3.5 is associated with lower lying areas in the south of the site and is present over approximately 20.5ha of the site. RE12.2.5 covers a minor area (0.334ha) of freshwater swamp in the southeast corner of the site. In total, the "Of Concern" vegetation covers approximately 20.84ha.

A non-remnant community of open Eucalypt forest/woodland with *Eucalypt tereticornis* (Blue gum) and other species is in mid-stage regrowth. It is consistent with RE12.5.2, which has a *Vegetation Management Act 1994* status of "Endangered".

2.7.2 Fauna

The following were identified on site:

- 63 bird species;
- 13 mammal species (of which 1 species is introduced);
- 5 reptile species; and
- 4 amphibians species (of which 1 species is introduced).

No significant fauna species listed under the *Nature Conservation Act 1992* or the *Environment Protection and Biodiversity Conservation Act 1999* were identified on site.

2.7.3 Values

Overall the flora and fauna values of the site are low to medium. Yurrah Pty Ptd assessed the main ecological values of the site as associated with the waterways (drainage paths and Caboolture River) and recommended retention of the vegetation on these areas and provision of suitable buffers to protect ecological values. The riparian and tidal vegetation along Caboolture River provides the only faunal connectivity.

3. Site Constraints and Opportunities

Following an appraisal of existing site conditions, key environmental constraints and opportunities for development layout and stormwater management were identified (Figure 3.1, Figure 3.2).

Figure 3.1: Development Constraints Identified On site

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Figure 3.2: Overland Flowpaths

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3.1 Key Design Constraints

Table 3.1 identifies the constraints considered in site layout planning and stormwater management design.

Table 3.1: Site Constraints

Constraints	Description
Low lying nature of site	▪ Most of the site is below 100 year ARI flood contour and any development within these areas will require filling, with compensatory excavation from within the site. ▪ The major prerequisites for winning of fill material in the flood plain are no adverse environmental impacts, no reduction in flood storage capacity and no increase in flood levels.
ASS	▪ Parts of the site have been identified as containing moderate levels of ASS which will require appropriate treatment and management during development activities and appropriate rehabilitation/remediation following earthworks. The level of treatment required has been identified in the Preliminary ASS investigation (prepared by Douglas Partners) as 'very high' (as defined by DNRME requirements), due to the large volume of material required to be excavated for use in filling of the site. Stormwater flows in exposed areas subject to ASS also need to be managed to minimise the risk of mobilisation of acidic material or acid leachate from the site to the Caboolture River.
Fisheries/waterways buffering	▪ To provide protection and management of fisheries resources, Department of Primary Industries (DPI) guidelines suggest a 100m buffer between any tidal lands (taken at the site as the area containing tidal/marine vegetation communities) and development and the developed area (Figure 4.1). They also suggest a buffer of 50 metres to freshwaters. DPI may consider a reduced buffer if it is appropriate to the development and its management strategies (Bavins *et al*, 2000). Council requirements are for a 100m buffer to tidal waterways, and 40m to freshwater.

Stormwater	▪ The applicability of structural stormwater quality best management practices (SQBMPs) is constrained by:
	  ▪ The limited infiltration capacity of the sub-strata assumed from preliminary geotechnical assessments. As such, the attenuation of water quality within the subsoils through local infiltration would also be limited;
	  ▪ The low lying nature of the site; and
	  ▪ Sensitive ecological areas (waterways and REs).

Significant and tidal vegetation	▪ The paperbark vegetation of the freshwater swamps is classified as being 'Of concern', as is small remnant of Bribie Island Pine beach forest. These areas are afforded protection under the *Vegetation Management Act 1999* and State Coastal Management Plan. Ecological values in these areas are generally to be conserved within the development by their exclusion from the developable area above the Q100 flood level. The balance of site vegetation is regarded as being non-remnant, and is therefore not classified under this system. ▪ Any proposed development involving clearing of tidal vegetation requires approval from DPI.

3.2 Key Design Opportunities

Table 3.2 describes the opportunities for the site that have been identified. The opportunities include those Caboolture Shire Council noted should be maximised (Information Request, 16 August 2002, Section 3.2).

Table 3.2: Site Opportunities

Opportunities	Description
Aquatic or riparian habitat retention and creation.	▪ Opportunity to locate development areas and fill source areas in substantially cleared parts of the site. ▪ Saline and/or freshwater wetlands could be created in lowland parts of the site to provide stormwater detention during peak flows. Will additionally enhance the landscape and recreation values of the site.
Protection of fisheries and other ecological values associated with waterways.	▪ Incorporation of suitable buffering to protect ecological values in waterways onsite (Raft Creek) and in Caboolture River adjacent to the site. ▪ Avoidance of development activities (including proposed excavation areas) within the mapped extent of tidal vegetation onsite.
Water conservation and Stormwater recycling	▪ Use of rainwater tanks and porous paving to reduce the quantity of runoff leaving the site.
Water quality treatment	▪ Use of Water Sensitive Urban Design (WSUD) in treating stormwater quality within the development prior to discharge. ▪ Retention and use of existing natural drainage paths to provide for nutrient stripping and control of flow intensity
Pollution minimisation	▪ 'At source' control of pollutants (eg site specific measures), to target stormwater management and potential contaminants from individual sites within the development (to be determined at detailed design).
Rehabilitation and revegetation	▪ Rehabilitation and revegetation of currently degraded areas on site and areas from which fill will be sourced.

3.3 Suitability of buffer distances

Table 3.3 identifies the proposed extent of buffering to waterways and fisheries resources, as required by DPI and Council.

Table 3.3: Buffer distances between waterways and development footprint

Waterway	Proposed Minimum Buffer Distance (m)	DPI Buffer Requirements (m)	Caboolture Shire Council's Buffer Requirements (m)
Caboolture River	100	100	100
Estuarine Areas	30	100	100
Freshwater Streams	15	50	40

Although the proposed minimum buffer extents are in some areas less than the Council and DPI requirements, the proposed final developed area and proposed areas for excavation for fill only approach the proposed (reduced) buffers in a few locations. However rehabilitation of the open areas in the remainder of the site is expected to ultimately provide a significantly greater actual buffer area.

Additionally, within the completed development, greater opportunities are to be provided for protection of fisheries/waterway values through stormwater management, revegetation and rehabilitation of degraded portions of the site. The approaches to minimisation and management of potential environmental impacts are discussed in the subsequent sections of this report.

4. Development Concept

4.1 Development Areas and Stages

There are three areas proposed for development, shown on the proposed development plan in Figure 4.1.

As indicated, the intent is to develop the site in two stages. The first stage will predominantly involve developing the areas currently above the Q100 flood level. The second stage will involve developing all of Area A and parts of the site which will require filling (i.e. areas below Q100) (Figure 4.2).

4.2 Preliminary Fill Calculations

Table 4.1 provides indicative calculations of the extent of fill required for development, to achieve suitable flood immunity.

Table 4.1: Estimated Excavation and Fill calculations

Excavation	
Southern excavation	30,400 m^3
Centre excavation	44,400m^3
Northern excavation	224,000m^3
Fill	
Southern fill platform	449,600m^3
Northern fill platform	11,000m^3

The preliminary calculations undertaken by Parsons Brinkerhoff identify that there is sufficient material available on site to meet filling requirements for staged development of the site (to achieve development above the Q100 line), in keeping with Council's requirement for balanced cut and fill within the floodplain.

Figure 4.1: Indicative Structure Plan

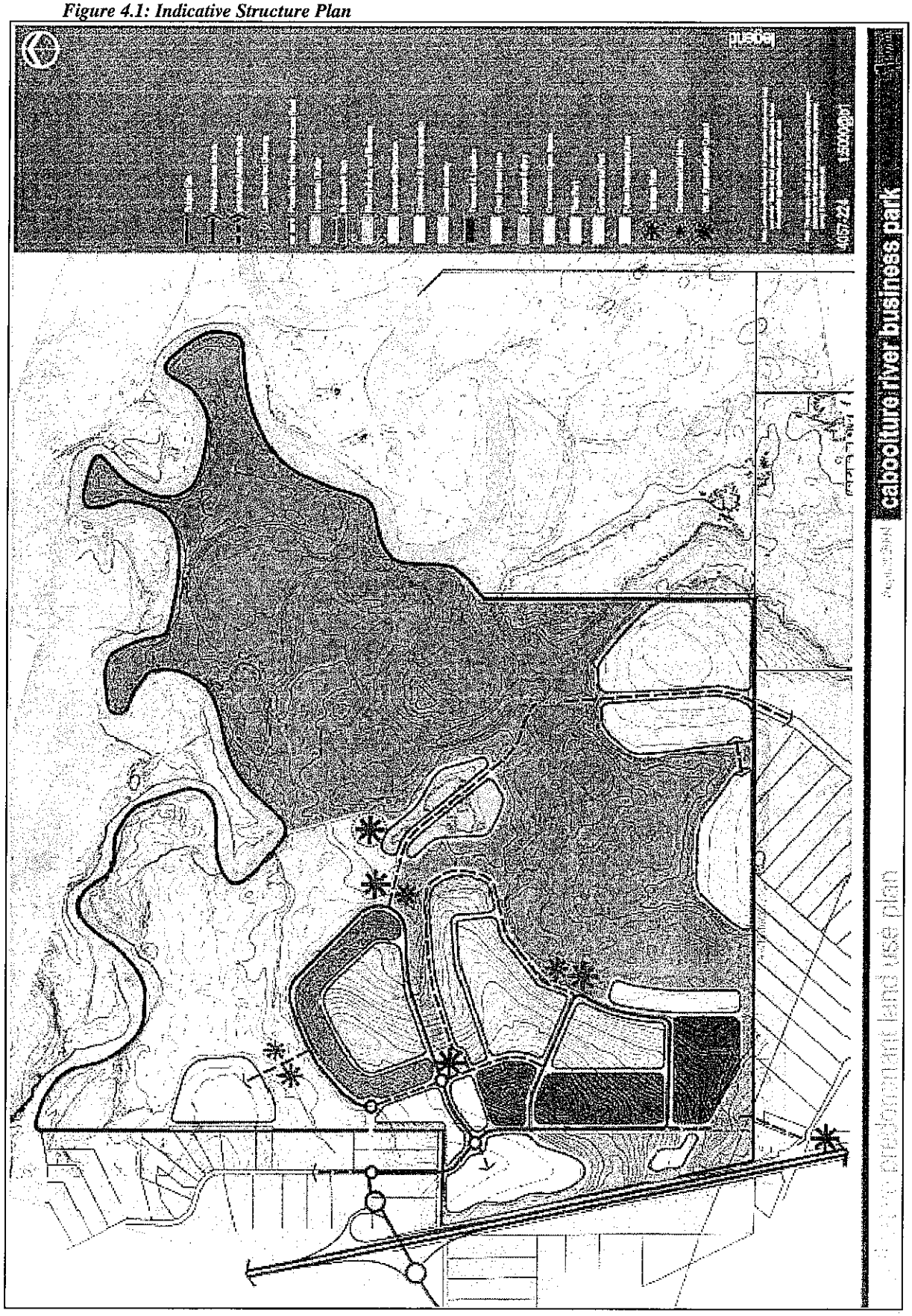

Figure 4.2: Proposed Stage 1 / Stage 2 Developable areas

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5. Environmental Risks – Water Management

A qualitative environmental risk assessment has been undertaken to identify the level of effort required to reduce and manage potential impacts related to water quality (as a major constraint) within the development. The risk assessment technique used generally follows the methodology identified in the *Australian Standard for Risk Management* (AS/NZS 4360:1999), provided in Appendix A, which includes a description of the ratings system used.

A number of risks related to environmental management during the development of the site have been identified, all with the potential to result in environmental harm. Table 5.1 identifies the environmental risks associated with water management which are considered applicable to the proposed development.

Table 5.1: Environmental Risks associated with water management

Risk Aspect	Likelihood	Consequence Rating	Risk Level	Potential Mitigation
Impacts to environmental values in receiving waters from contaminated stormwater: • Litter; • Sediment; • Nutrients; • pH; • Other contaminants, e.g. surfactants hydrocarbons, and heavy metals.	D	3	M	• Treatment of all stormwater through the proposed system before discharge to receiving waterway. • Separate the treatment train into "regional" trains rather than end of pipe systems • Source prevention in industrial areas, including bunded areas, hardstand areas with catchment systems, oil and water separators for refuelling areas and spill management procedures.
Stormwater system is insufficient for capacity of runoff generated.	E	3	M	• Reduce stormwater runoff and peak flows: • Stormwater system designed with high by-pass threshold and overflow control • Stormwater capture and porous pavements to reduce peak discharge
High velocity water causing erosion and sediment deposition in receiving waters.	C	2	M	▪ Use of a dispersion device such as a gravel delta on release points ▪ Multiple stormwater release points ▪ Use of a detention basin prior to, or as

Risk Aspect	Likelihood	Consequence Rating	Risk Level	Potential Mitigation
				part of the first stage of the stormwater management system so as to limit storm water peak flows. • Use of source controls such as rain water collection and porous paving to limit peak flows.
Potential for mobilisation of acid leachate in stormwater discharging from exposed ASS areas.	C	4	E	• Implementation of the Acid Sulfate Soil management plan during construction and operational phases.
Mortality of existing and/or rehabilitated native vegetation as a result of contaminated stormwater runoff: Pollutants- ❑ Excessive nutrients in runoff; ❑ Clogging through excess sediment; ❑ Physico-chemical contaminants (eg heavy metals, hydrocarbons); ❑ Acid leachate	E	2	L	• The stormwater system to be designed to treat any stormwater to a suitable level (for WQOs) in the receiving waterway. • Individual sites to implement site based stormwater management appropriate to the type and scale of industry. • Contaminated stormwater to be directed away form sensitive vegetation.
Creation of opportunities for mosquito breeding in surface water ponding on site.	B	3	H	• Open water and water storages to be kept to a minimum. • Other site based management/treatment as required (see below -Section 8)
Improper maintenance of stormwater/water quality management infrastructure resulting in the inability of the system to adequately manage stormwater.	D	4	H	• Use of stormwater management structures that will require low maintenance over the design life while still maintaining maximum efficiency • A maintenance plan for the development to the relevant local authority. • Placing storm water treatment structures within property boundaries, therefore placing the emphasis

Risk Aspect	Likelihood	Consequence Rating	Risk Level	Potential Mitigation
				on property owner maintenance.
Plant mortality in stormwater infrastructure (potentially caused by choking by weeds & excess nutrient/pollutant loading) - Pollutants- ❑ N and P ❑ Sediment ❑ Heavy metals	C	3	H	• Use of appropriate stormwater management to reduce nutrient loads. • If possible, establish partnership with a local community greening group for revegetation/maintaining natural vegetation condition in stormwater features.

6. Stormwater Management

Caboolture Shire Council currently has no generic guidelines for stormwater management (Hansen 2003, *pers comm.*). For this site Caboolture Shire Council has requested as a minimum the following information:

1. *"The identification of flowpaths over the site. Consideration should be given to the principles of water sensitive urban design and the incorporation of natural drainage paths within the ultimate development.*
2. *The characteristics and quality of the area or waterway to which stormwater from this development will be released.*
3. *Technologies, structures or practices that will be employed to prevent contamination of stormwater, and to mitigate the impact of stormwater discharge at each progressive stage of the proposal, and for the continued occupation of the development"*
   (section 3.1 of Information Request, 16 August 2002)

The characteristics and water quality of the Caboolture River (the receiving water) have been identified in Section 2.3. From the results of sampling adjacent to the site it was determined that water quality in this section of the Caboolture River is poor.

Through cessation of existing agricultural activities, reducing opportunities for illegal dumping on the site (through the site being developed), and incorporation of appropriate stormwater management within the development, the proposed development should result in a net improvement to water quality entering the Caboolture River estuary.

6.1 Receiving Water Quality Objectives

6.1.1 Target Pollutants

Table 6.1 lists the pollutants which are likely to be generated on site, and are most likely to be of concern with regards to stormwater management and discharge water quality.

Table 6.1 - Pollutants Most Likely to be of Concern

Pollutant	Development Phase	
	Construction	Operation
Litter	✓	✓
Sediment	✓	✓
Hydrocarbons	✓	possibly
Toxic materials	✓	✓
pH Altering Substances	✓	possibly
Nutrients (nitrogen and phosphorus)		✓
Pathogens (bacteria, viruses and other microbes)		possibly
Heavy metals (often associated with fine sediment)		possibly
Surfactants		possibly
Thermal Pollution		✓

Note:
1. Source: Brisbane City Council Subdivision and Development Guidelines (BCC, 2000a).
2. Shading denotes key pollutants to be targeted for trapping during the operational phase (BCC, 2000a).

3. Key heavy metals include arsenic, cadmium, chromium, copper, nickel, lead and zinc (Source: BCC, 2000a).

A set of indicative environmental values and WQOs applicable to the development have been derived from relevant Regional, State and National guidelines.

6.1.2 Environmental Values

Environmental values were identified for Caboolture River as part of the South East Queensland Regional Water Quality Management Strategy (SEQRWQMS) (Waterways Partnership, 2001). The values which have been determined to be relevant to the tidal estuary are:

- ***High value***: secondary recreation, visual recreation, cultural heritage, aquaculture, drinking water;
- ***Moderate to high***: human consumer;
- ***Moderate value***: aquatic ecosystem, wildlife habitat, irrigation, stock water, farm supply, oystering;
- ***Low value***: Primary recreation, industrial use.

These environmental values have been adopted for determining WQOs for the site.

6.1.3 Water Quality Objectives

The environmental values above indicate a preference towards recreation. However, in order to provide for recognition of the potential for impacts on ecological values, WQOs associated with aquatic ecology have been adopted as they are more stringent, and as such will automatically provide for greater protection of other identified waterway values.

Table 6.2 sets out the relevant WQOs for Caboolture River associated with aquatic ecosystems, based on relevant Australian (ANZECC, 2000) and Queensland (draft) guidelines (EPA, 2001). The site will be primarily industrial with some commercial, which will mean that heavy metals, hydrocarbon and similar pollutants may be present in stormwater runoff.

Table 6.2: Summary of applicable WQOs for the site

Pollutant	WQO[1]
Litter	No anthropogenic material greater than 5mm in any dimension[2]
Total suspended solids (TSS)	30 mg/L[2]
Total phosphorus (TP)	0.06 mg/L
Total nitrogen (TN)	0.45 mg/L
Faecal coliforms	1000 cfu/100mL
Aluminium	0.027 mg/L
Arsenic	0.001mg/L
Cadmium	0.06 ug/L
Chromium	0.001mg/L
Copper	0.001mg/L
Nickel	0.008 mg/L
Lead	0.001mg/L
Zinc	0.0024mg/L

Note:
1. Source: ANZECC (2000) default trigger values for the protection of aquatic ecosystems in Southeast Australian estuarine systems, unless otherwise stated.
2. Source: EPA (2001) Draft Queensland Water Quality Guideline for east coast mid-estuarine reaches (no value provided by ANZECC 2000).

6.2 Stormwater Treatment Measures

It is not possible to fully determine the specifications of the entire stormwater system until detailed design of the proposed internal development layout occurs, and specific nature of activities to take place is fully determined. However, the main objective of the stormwater management system is to provide a thorough and integrated approach to stormwater management through the use of a treatment train. Table 6.3 identifies the proposed elements in the stormwater management system, with the following hierarchy to be implemented to achieve the identified WQOs:

1. Minimisation of runoff through source controls;
2. Capture and reuse of stormwater;
3. Treatment of pollutants from industries onsite;
4. Treatment while in transit;
5. Reduction of peak discharges; and
6. The use of end of pipe system such as wetlands for final treatment.

Table 6.3: Overview of Stormwater Management Measures

Potential Treatment Measure	Purpose
Onsite rain water collection and Porous paving	❑ Potential to provide a supplementary water supply for the development. ❑ Reduction in the peak discharge during storm events. ❑ Minimisation of the amount of storm water that has to be treated.
Onsite treatment and spill control	❑ Containment of any site specific spills and/or contaminants from entering the main system.
Swales and/or Bio-retention along the roads and edge of development.	❑ To treat and remove particulates and excess nutrients (nitrogen & phosphorus) in stormwater prior to discharge. ❑ Provision for overland/natural flow paths for transport of stormwater.
Detention Basin (subject to detailed design)	❑ Reductions in peak discharge during a storm event to allow downstream stormwater treatment mechanisms (e.g. wetlands) to work efficiently.
Artificial Wetland (subject to detailed design)	❑ Reductions in levels of nutrients and total suspended solids in stormwater prior to discharge.

As the proposed development is to be located on high (filled) land and surrounded by flood plains and swamp areas, the achievement of adequate and appropriate stormwater management will represent an important design requirement. The aim of the stormwater management system will be to capture and treat stormwater at its source, including a provision that any facility located within the development will have any necessary (site specific) treatment measures which are suitable for the particular type of operation. The result of this requirement will be that any stormwater released from individual operations should already be subject to treatment for site specific contaminants.

Standard swales in isolation are unlikely to provide sufficient treatment. The installation of bio-retention trenches beneath the swales to filter captured runoff will provide a secondary treatment measure, with increased capacity for removal of stormwater contaminants prior to discharge. Vegetated buffers planted along edges of the swale system will also provide

enhanced initial treatment, thereby increasing the efficiency of stormwater treatment measures.

6.3 Preliminary MUSIC Modelling

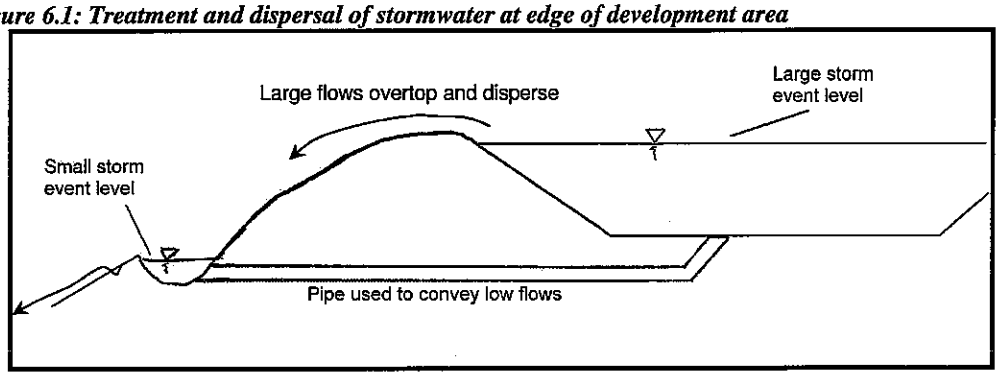
Preliminary MUSIC modelling was undertaken to identify and assess possible treatment measures and size requirements for the proposed development. The design and modelling of the stormwater system has been carried out in reverse - while the required WQOs were known, detailed design of the development has not yet been carried out, so in modelling various potential solutions, the size of the treatment train (eg length of swales & biofilters and types of treatment mechanisms) has been altered to achieve the required WQO. For the modelling the following assumptions were made;

1. Two arbitrary areas were used (based on the preliminary design for stage one of the development); and
2. Each treatment train was modelled, while varying the extent and scale of treatment mechanisms.

Two options for the stormwater system were investigated. The first option involves the use of standard swale and bio filtration system alongside roads, parkland, or similar areas. The other option is more specific for the site. As the area proposed for development is on a hill above flood plains, treatment is based on the idea of using a combination of swales and a piped system to transport the water to the top banks of the batters.

Stormwater in smaller events would be captured initially in the upper drain, and be conveyed via the pipe to a shallow spoon drain just below the top of the fill batter, where it would overtop the drain to disperse via sheetflow or natural evaporation. In larger storm events, water would be captured in the upper drain faster than it could flow through the pipe system. As the drain filled, water will overtop the top of bank, and flow down the batters and into the natural waterways and flow paths of the flood plain (Figure 6.1).

Figure 6.1: Treatment and dispersal of stormwater at edge of development area



6.3.1 Option 1- Swale and Bio Filtration

The first stormwater treatment option involves the use of bio-filtration/swale system along roads, parkland and other open spaces. This system was modelled upon a standard Type 1 swale as per the *Water Sensitive Road Design Guidelines*, produced by Brisbane City Council, June 2003. The two areas modelled were set at 103 hectares and 4.5 hectares, based on preliminary estimates of the proposed developable areas. The swale size and storage properties were modelled with increasing areas and the treatment efficacies recorded. Due to the large number of low flow conditions, a flow based sub-sample was used to help make the statistics more realistic. The results of the small and large source nodes are shown in Figures 6.2 and 6.3.

Figure 6.2: Small Area Treatment Efficiencies

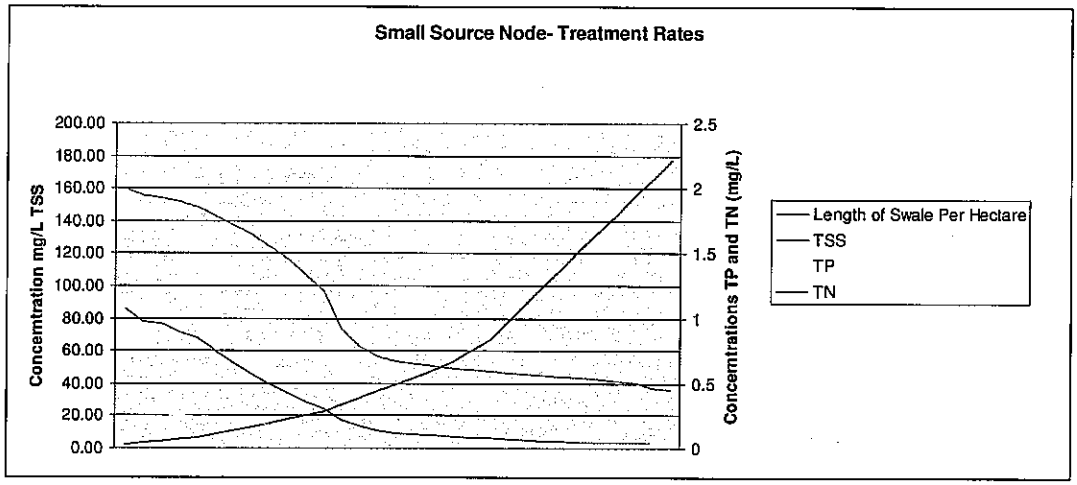
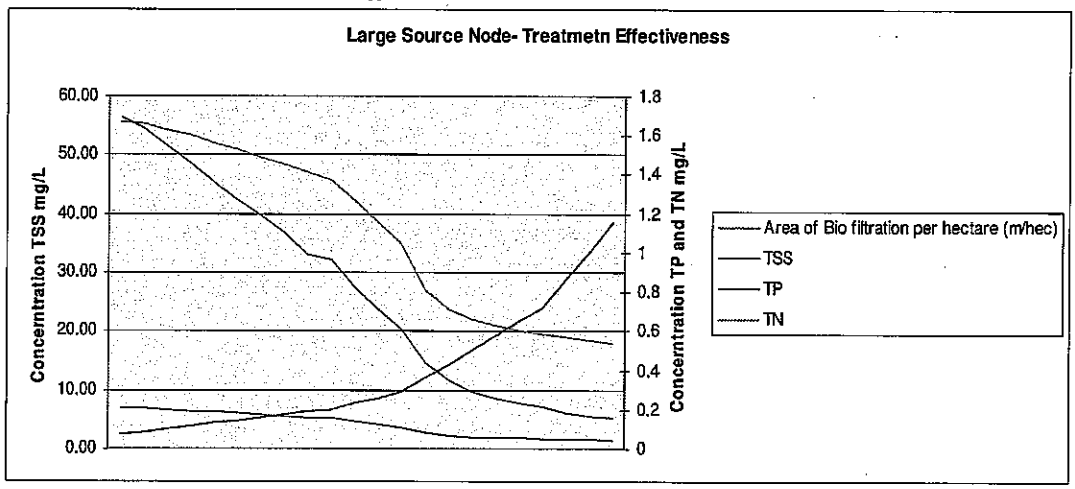


Figure 6.3: Large Area treatment Efficiencies



As illustrated in the graphs above, the concentrations of TSS, TP and TN decrease in proportion to increases in the biofiltration area. From analysis of the raw data it was determined that for the small source node, just over 800m of swale/biofiltration is required in order to meet the WQOs for the site. Table 6.4 shows the areas of bio filtration that are required to meet each WQO.

The modelling indicated that just over 4000m of swale and bio filtration is required to treat the large source node (103 hectares) to the required level (Table 6.4). It should be noted that this is a very conservative approach to MUSIC modelling and it should be possible to provide less treatment within the development while still attaining the required WQO. More rigorous modelling of the stormwater system should be undertaken once more detailed design is carried out for the proposed development. It can be seen that it is quite easy to attain the required values for TSS and TP, while the greater proportion of the treatment system is required to achieve adequate reduction in TN.

Table 6.4: Required treatment lengths to meet specific WQO's for Option 1

Parameter	WQO	Small source node treatment area required	Length Of bio-filtration per Hectare (small source node)	Large source node treatment area required	Length Of bio-filtration per Hectare (large source node)
TSS	30	Approx 85m	18.8m	Approx 750m	7.28
TP	0.06	180m	40m	Approx 1825m	17.71
TN	0.45	Approx 800m	177.7m	4000m +	38.8m +

The modelling results show that on average, 177.7 m of biofiltration is required for the small areas and over 38m per hectare would be required for the large areas. This difference in the required treatment areas is quite noticeable, and could be explained by a number of reasons, including the choice of sub-sample bound used for generation of statistical values (within the model), and also the generation of both flows and pollutant concentrations. Once a final design and layout has be developed it will be possible to run a more detailed MUSIC model which will give a clearer and more accurate indication of the possible treatment mechanisms and their respective efficiencies.

6.3.2 Option 2- Swale Collection and Dispersion for Overland Flow (Buffer)

The second option uses a piped stormwater network within the development and a swale system around the perimeter of the development foot print. This design incorporates the natural channel flows and overland flows that already exist with the site. For modelling purposes the swale length was assumed to be 3400m (which is a conservative estimate of the possible length around the eastern side of the lots). For the system to work properly and efficiently, the water must be treated in the swale and then dispersed over the batter of the development in sheet flow before rejoining the natural overland flow paths. For this to occur, a dispersion system must be used to disperse the water over the top of the slope (as per Figure 6.1).

The modelling was completed using the same sized catchments as for Option 1. The total swale length for each was 768m and 3400m. From the modelling the following results were gained (Table 6.5)

Table 6.5: Required treatment lengths to meet specific WQOs for Option 2

Parameter	WQO	Pollutant Concentration for small source node	Pollutant load for small source node	Pollutant Concentration for large source node	Pollutant load for large source node
TSS	30	13.6 mg/L	621 kg/yr	13.6 mg/L	55500 kg/yr
TP	0.06	0.143 mg/L	6.22 kg/yr	0.143 mg/L	252 kg/yr
TN	0.45	1.68 mg/L	77 kg/yr	1.68 mg/L	2550 kg/yr

In most cases it can be seen that the values are unable to reach the required WQO. This is due to a parameter in the model which, for each treatment node, sets a baseline value for pollutant concentrations in water exiting that treatment node. This baseline value does not necessarily reflect the actual level of treatment which may be achieved. As is the case for Option 1, when a detailed development layout has been confirmed the final treatment options can be modelled and an appropriate solution for stormwater management and treatment identified.

7. Soil and Earthworks Management

The proposal to develop the site will potentially require significant amounts of earthworks, with the potential to impact adversely on environmental values on and around the site if not properly managed.

Specifically, parts of the site have been identified as impacted by Acid Sulfate Soils (ASS), and the proposal to source fill material from in the floodplain of the Caboolture River has implications for water quality management and protection of the Caboolture River. Any earthworks will need to be undertaken in an appropriate manner to minimise and/or mitigate the potential impacts of ASS, with suitable procedural and on-ground controls in place. Exposed areas of soil will also need to be managed and rehabilitated such that the potential for erosion and mobilisation of exposed soils and sediments as a result of stormwater flows is minimised.

7.1 Management of Acid Sulfate Soils

The ASS Investigation undertaken by Douglas Partners identified the site as requiring an 'extra high' level of treatment for ASS, and based on the ASS action criteria identified in the *Queensland Acid Sulfate Soil Technical Manual - Soil Management Guidelines, November 2002* (Dear et al., 2002). Subsequently, an ASS Management Plan (Appendix F) has been prepared for the site consistent with QASSIT requirements. The ASS Management Plan identifies specific soil management measures to minimise or prevent the risk of adverse impacts from exposed areas of acid sulfate soils. The management options and recommendations are generally consistent with the principles of ASS management identified in the *Soil Management Guidelines*, as follows:

1. The disturbance of ASS is to be avoided wherever possible.
2. Where a disturbance of ASS is unavoidable, preferred management strategies in order of preference are:
   - Avoidance or minimisation of disturbance;
   - Neutralisation.
3. Works will be performed in accordance with ***best practice environmental management*** (when it has been demonstrated that the potential impacts of works involving ASS are manageable), to ensure that the potential short and long term environmental impacts are minimised.
4. The material being disturbed (including *in situ* ASS) and any potentially contaminated waters associated with ASS disturbance, must be considered in developing a management plan for ASS and/or in complying with the ***general environmental duty*** under the *Environmental Protection Act 1994.*
5. Receiving marine, estuarine, brackish or fresh waters are not to be used as a primary means of diluting and/or neutralising ASS or associated contaminated waters.
6. Stockpiling of untreated ASS above the permanent groundwater table with (or without) containment will not occur.
7. The following issues will be considered when formulating ASS environmental management strategies:
   - the sensitivity and environmental values of the receiving environment;
   - whether groundwaters and/or surface waters are likely to be directly or indirectly affected;
   - the heterogeneity, geochemical and textural properties of soils on-site; and
   - the management and planning strategies of Local Government and/or State Government.

The ASS Management Plan for the development includes provision for ongoing management and monitoring of the impacts of any ASS disturbed during development, including monitoring of the success of any treatment measures for a period (specified in the plan) following completion of the project. The management plan identifies information including construction schedules, environmental management procedures, and mitigation measures to deal specifically with risks from disturbed areas of ASS (Table 7.1), and the program of any works in identified areas of ASS will be prepared and carried out such the extent of disturbance (and potential for impacts) is limited, and can be relatively easily managed.

A qualitative environmental risk assessment has been undertaken to identify the level of effort required to reduce and manage potential impacts related to ASS within the development. The risk assessment technique used generally follows the methodology identified in the *Australian Standard for Risk Management* (AS/NZS 4360:1999), provided in Appendix A.

Table 7.1: Potential Risks associated with Management of ASS

Possible Risks	Likelihood Rating	Consequence Rating	Level of Risk	Treatment Method
Acid Sulfate Soils	A	4	E	❑ An ASS study and analysis has been undertaken to clearly define the extents of the ASS within the site. ❑ Where ASS material is disturbed during construction, use of suitable management and/or mitigation will be required to address any potential risks. ❑ Provisions for appropriate treatment and storage of any identified ASS material to be used in filling will be required, so as to limit the potential for exposure and mobilisation of acid material. ❑ Wherever possible, earthworks should not be undertaken in known areas of potential of actual ASS. ❑ The extent and duration of soil disturbance in areas of identified ASS/PASS should be minimised. ❑ To prevent the risk of de-watering of existing areas of ASS, stormwater management infrastructure should be designed to protect & maintain existing groundwater flows, incorporating natural infiltration and overland flow post construction.

7.2 Excavation

The excavation of material for use in filling has the potential to expose identified areas of ASS, with resultant adverse impacts to water quality and vegetation from acid leachate and mobilisation of soil metals (iron, aluminium). Table 7.2 identifies those aspects of soil excavation which may result in the potential for adverse impacts, and broad mitigation measures to address them.

Table 7.2: Potential impacts from excavation and mitigation/management measures

Aspect	Potential Impact(s)	Mitigation and Management Measures
Disturbance and exposure of ASS to oxidising conditions, and resultant release of acid leachate.	Reduced water quality in receiving waters through: • Reduced pH (increased acidity) • Increased mobilisation of metals (iron, aluminium) Impacts on fisheries/habitat values in Caboolture River: • Increased risk of fish mortality • Increased possibility of *Lyngbya* (algal) blooms in Moreton Bay/Caboolture River estuary.	• Staging of works to minimise the extent and duration of soil exposure during earthworks. • Appropriate treatment and management of acid sulfate soil conditions encountered during works. • Capture and treatment of any leachate from exposed areas of ASS. • Separation and/ or diversion of stormwater from disturbed areas of ASS to minimise potential acid leachate production and export. • Stabilisation (including treatment with lime) and revegetation of disturbed areas and borrow pits (Impacted by ASS) following earthworks.

7.3 Filling

Two options for sourcing the required quantities of fill are:

Option 1: Source fill material from onsite (preferred); or
Option 2: Importation of fill material from off site.

All filling of areas below the Q100 flood level will utilise material sourced from within the floodplain to achieve the required balanced cut and fill. Irrespective of the source of fill, improper management of exposed soils during construction may result in increased risk of sediment transport and contamination of runoff. Excavation of material from flood plains may represent an unsuitable risk of adverse impacts from ASS, or alternatively, the costs of management and mitigation of ASS may be restrictive, necessitating importation of fill material from off site. Additionally, Council or other site restrictions may result in insufficient fill being able to be won onsite, necessitating importation of fill. Depending on the source and nature of imported fill, there is the potential for importation of weed/pest species to the site.

Table 7.3 identifies aspects associated with filling activities and the potential impacts, and broad mitigation measures to address those impacts, while Table 7.4 identifies the degree of environmental risk associated with excavation and filling activities.

Table 7.3: Potential impacts from filling and mitigation/management measures

Aspect	Potential Impact(s)	Mitigation and Management Measures
Erosion and mobilisation of soil material (slippage, scouring) during earthworks and/or construction.	Increased transport of sediment to receiving waters.	• Use of erosion and sediment control measures. • Minimising extent and duration of exposed soil during construction.
Pest species in imported fill	Introduction of weed and/or pest species (eg Red Imported Fire Ants – RIFA) in imported fill.	• Controls on source and quality of fill material
Exposure of any ASS material in fill material won on site.	Increased risk of export of acid leachate from the site.	• Treatment of any fill which includes ASS material. • Stabilisation & revegetation of exposed soil areas as soon as practicable.

Table 7.4: Rating of risks from activities and specific treatment methods

Ref	Possible Risks	Likelihood Rating	Consequence Rating	Level of Risk	Treatment Method
1.	*Land slippage*	E	4	H	❑ Minimise the risk of land slippage through appropriate engineering and stabilisation of earthworks as soon as practicable. ❑ Minimise and/or manage the extent and duration of earth works taking place at any one time to ensure risk of soil slippage is avoided.
2.	*Scouring*	B	*3*	H	❑ Vegetation or other suitable means is to be used to stabilise exposed slopes or other areas that may be prone to scouring ❑ Stormwater controls are to be incorporated to minimise runoff down exposed steep gradients or constructed batters.
3.	*Fire ants & weed species*	D	3	M	❑ Ensure any imported fill is sourced from areas not within any RIFA controlled area. ❑ Ensure adherence to DPI requirements and procedures to prevent potential spread of fire ants. ❑ Ensure any imported fill material does not contain visible traces of weed species
4.	*ASS*	A	4	E	❑ Provisions for appropriate treatment and storage of any identified ASS material to be used in filling will be required, so as to limit the potential for exposure and mobilisation of acidic material/creation of acid leachate.

7.4 Rehabilitation of Exposed Soil areas

There is a range of options available for rehabilitation of soil areas exposed during construction, as identified in Table 7.5 below. The most effective response will be the use of effective management during works, and prompt stabilisation of exposed soil areas following construction.

Temporary stabilisation of exposed batters can be achieved relatively easily by placement of geotextile (or similar) and mulch during (or immediately following) construction, or landscaping of exposed banks with grass and larger vegetation as soon as possible after disturbance. The effectiveness of measures to stabilise exposed soil areas will be augmented by effective stormwater management to prevent stormwater from flowing unhindered down exposed batters in high quantities or at high velocities. Suitable measures may include detention of stormwater to reduce peak flows, diversion drains/bunds, grassing of slopes, and rock or grassed swales to manage flow velocities.

Table 7.5: Suggested measures for rehabilitation of exposed soil areas during construction

Measure	Outcome	How delivered
Geotextile or similar on exposed slopes	❑ Stabilisation of exposed batters on steeper gradients	❑ Cover exposed slopes with geotextile prior to replanting to minimise potential for soil mobilisation.
Re-vegetation of disturbed areas	❑ Stabilisation of exposed batters ❑ Increased soil stability during vegetation establishment.	❑ Placing both grass and larger vegetation on the banks as soon after disturbance as possible, allows the soil to be held together. ❑ Reduced water velocity during storm events. ❑ Reduced erosive potential.
Stormwater management	❑ Stormwater flows diverted from exposed soil areas	❑ Diversion bunds and or channels placed at top of exposed soil batters, to divert stormwater from exposed soil areas and minimise potential for erosion.

7.5 Rehabilitation of (Fill) Borrow Pits

It has been identified that in order to achieve the preferred development options, a substantial amount of fill will be required (see also Section 4.2 and Figure 4.1), which is intended to be sourced from excavation of material on site wherever possible from within the flood plain. The site investigation has identified the likelihood of ASS material being encountered during earthworks, which if managed appropriately and in accordance with the ASS Management Plan, should not represent an impediment to the re-establishment of vegetation in disturbed areas, and the subsequent protection (and potential enhancement) of ecological values.

The ASS *Remediation Guidelines for the Management of Coastal Floodplains in NSW*, (Tulau, M.J., 2000) identifies the following suggested approaches to rehabilitation of coastal lowland areas which have been impacted upon by ASS:

- Placement of 150mm topsoil and appropriate ASS Management;
- Use of sedges and similar native plant varieties, which are able to accept soil pH of 5.5;
- Use of grasses (green couch/marine couch) for ground cover; and
- Ensure that the site is well drained, particularly during establishment.

Effective rehabilitation of disturbed areas will contribute to the effectiveness of stormwater management, through providing suitable areas for natural polishing and nutrient uptake (in conjunction with onsite treatment for gross pollutants). Rehabilitation will also provide for re-establishment of a variety of habitats, suitable for fauna species identified in the ecological assessment as present or likely to be present on site, and similar to what might be expected to occur as natural revegetation took place. Lower areas closer to waterways (Area A – See Figure 7.1) are intended to have a grass/sedge character, progressing through to riparian vegetation types similar to the existing Swamp-oak communities. Higher parts, in the central portion of the fill areas (Area B – see Figure 7.1) are intended to display a more mixed grass and open Eucalypt character.

Figure 7.1 identifies areas which are to be rehabilitated. Detailed rehabilitation plans have not yet been prepared (these are to be done during detailed design for subsequent approvals processes), however, an indicative planting list has been prepared (Table 7.6), based on endemic vegetation species identified on site in the Ecological Assessment Report (Appendix D). Rehabilitation of exposed soil areas should occur as soon as practicable following any ASS or earthworks management measures, with a suitable maintenance/establishment period to ensure that rehabilitation measures are successful. Rehabilitation should take place under the guidance and direction of a qualified ecological or landscape consultant. The suggested rehabilitation schedule is identified in Table 7.7.

Table 7.6: Suggested plant species for use in rehabilitation (endemic unless marked *)

Species Name	Common Name	Growth form	Area to be used in (see Figure 6.1)
Corymbia intermedia	Pink bloodwood	Canopy Tree	A & B
Eucalyptus racemosa	Scribbly gum	Canopy Tree	B
Eucalyptus siderophloia	Grey ironbark	Canopy Tree	B
Eucalyptus tereticornis *	Forest red gum	Canopy Tree	A
Lophostemon suavolens	Swamp box	Canopy Tree	A
Acacia concurrens	Black wattle	Small tree	B
Acacia fimbriata	Brisbane wattle	Small tree	B
Acacia leiocalyx	Black wattle	Small tree	B
Acacia podalyriifolia	Silver wattle	Small tree	B
Alphitonia excelsa	Soapwood	Small tree	B
Allocasuarina littoralis	She-oak	Small tree	A & B
Glochidon ferdinandii	Cheese tree	Small tree	A & B
Glochidon sumatranum	Glochidon	Small tree	A & B
Leptospermum polygalifolium	Teatree	Shrub	A & B
Melaleuca nodosa	Prickly leafed paperbark	Shrub	A & B
Trema aspera	Poison peach	Shrub	B
Goodenia rotundifolia		Herb	B
Pimelia linifolia	Riceflower	Herb	B
Cymbopogon refractus	Barbed wire grass	Clumping	B
Entolasia stricta	Wiry panic	Clumping	B
Lepidosperma laterale	Variable swordedge	Clumping	A & B
Lomandra longifolia	Tall matrush	Clumping	A & B
Lomandra multiflora	Many flowered matrush	Clumping	B
Lomandra lystrix *		Clumping	A & B
Themeda triandra	Kangaroo grass	Clumping	B
Thysanotus tuberosus	Native iris	Clumping	B
Tricoryne elatior	Tricoryne	Clumping	B
Pteridium esculentum	Bracken fern	Fern	B
Baumea articulata	Jointed twigrush	Aquatic	A & B
Cyperus exaltatus	Giant sedge	Aquatic	A & B
Juncus usitatus	Common rush	Aquatic	A & B
Lepironia articulata	Grey rush	Aquatic	A & B

Table 7.7: Proposed ASS rehabilitation schedule

Rehabilitation Item	Required Establishment/Maintenance	Required timeframe
Treatment of PASS/ASS	▪ Treat exposed areas with a suitable neutralising agent (e.g. Aglime - CaCO3) in accordance with liming rates identified for 'very high treatment' in the QASSIT Guidelines. ▪ Soil management to be undertaken as per Preliminary ASS Management Plan prepared by Douglas Partners (and any subsequent detailed revision).	As soon as practicable after disturbance, and prior to any substantial rain event.
Stabilisation of exposed soil	▪ Stabilisation of exposed soil and fill batters with geotextile fabric or similar. ▪ Revegetation of excavated areas with native grasses or similar. ▪ Revegetation and landscaping of fill batters.	As soon as practicable after disturbance, and prior to any substantial rain event.
Rehabilitation	▪ Revegetation with native plant species from the list above, to provide for reestablishment of natural and/or habitat values.	Ongoing – following successful treatment and soil stabilisation.

Figure 7.1: Fill source areas to be rehabilitated

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8. Mosquito Management

A separate Mosquito Management Plan has been provided which provides details of specific management mechanisms to be applied to minimise the impact of mosquitoes within the proposed development. Broadly, the methods applied to the management of mosquitoes are consistent with the relevant Queensland State Government documents relating to mosquito management, namely:

- *Guidelines to minimise mosquito and biting midge problems in new development areas,* produced by Queensland Health, 2002; and
- *Mosquito Code of Practice for Queensland,* produced by the Local Government Association of Queensland, 2002.

Proposed initiatives for mosquito management within the development include:

- Earthworks design to avoid creation of artificial ponds which may be likely to provide opportunities for mosquito breeding onsite;
- Ensure the site is free draining to minimise surface ponding of water which may provide for opportunistic breeding;
- Control of potential mosquito breeding through habitat modification and minimised opportunities for onsite breeding in preference to reliance on chemical control; and
- Avoiding the creation of large areas of heavy vegetation onsite which may provide mosquito harbourage and movement corridors from identified breeding areas near the Caboolture River into the development.

9. Conclusions

The analysis has identified a number of potential aspects of the proposed development which may impact on environmental values in and around the site. However, it is envisaged that potential impacts can be adequately and appropriately managed during development activities. The most significant aspects of the development with the potential to result in environmental impacts, and the proposed mechanisms to manage them are identified in Table 9.1

Table 9.1: Summary of Potential Impacts and Proposed Mitigation

Potential Impact	Proposed Mitigation	Impact Following Mitigation
Impacts on flood storage capacity in the Caboolture River Floodplain from excavation and filling.	Excavation and filling has been designed to be in balance to ensure no loss of flood storage in the flood plain.	Nil
Impacts on identified 'Of Concern' and 'Endangered' regional ecosystem.	No development activities are proposed in areas of State significance Regional Ecosystem identified on site.	Low
Impacts on waterway values	Provision of minimum 100m to Caboolture River, 30m to other tidal areas and 15m to freshwaters.	Low
	However, stormwater will be managed to ensure discharge water quality is consistent with the protection of water quality values in the Caboolture River.	Low
Adverse impacts on biodiversity/habitat values within the site	Habitat values within the site are currently degraded. The proposed development retains significant areas of potential habitat in the portion of the site below the Q100 flood level. Opportunities have been identified for rehabilitation of areas to be exploited for fill material. Rehabilitation will utilise endemic native vegetation species wherever possible. It is expected that appropriate rehabilitation within the floodplain will provide for enhanced habitat value.	Low
Exposure of acid sulfate soils during excavation for fill.	A Preliminary ASS Management Plan for the development has been prepared. All areas of ASS/PASS exposed during construction activities will be managed in accordance with the ASS Management Plan and QASSIT Guidelines.	Low
Impacts from Mosquitos	Mosquitoes have been identified by Caboolture Shire Council as a potential problem for the site. A Mosquito Management Plan has been prepared which is consistent with relevant Government Guidelines produced by QLD Health and the Local Government Association of QLD. Management initiatives will be supplemented by additional information to promote awareness of mosquito issues in contractors and/or staff working onsite during construction and operational phases of the development.	Low

10. References

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Appendix A - Risk Assessment Methodology

General Definition of Risk

For this project the risk associated with an event that may cause environmental impacts is defined as the product of:

- The likelihood of an untoward impact resulting from that event occurring (likelihood of impact); and
- The severity of the consequences when the event occurs (consequence rating).

Likelihood of a Risk Event

The likelihood of a risk event represents the probability of that event occurring. The likelihood of a risk event for each risk scenario has been selected from Table A1.

Table A1: Qualitative Measures of Likelihood from AS 4360

Rating	Category	Description
A	Almost certain	Will almost certainly occur once a year.
B	Likely	Is likely to occur once per 1 – 2 years
C	Possible	Moderate chance of occurrence with a frequency between once per 5 years and once per 10 years
D	Unlikely	Unlikely to occur with a frequency of once per 20 years
E	Rare	Extremely unlikely to occur, eg. greater than once per 100 years

Consequence Rating

The consequence rating reflects the severity of the environmental consequence if an overflow event took place as a result one or more of the trigger events occurring. The rating does not include an assessment of whether or not the event will occur, as this is included in the likelihood of impact. In determining the consequence rating, it is assumed that the event has occurred. Hence, only the severity of the event's effect is being assessed for the given area of influence of the overflow.

The severity of risk will depend upon the geographical extent of ecosystems exposed to the event and the magnitude of the effects. The measures of consequence are detailed in Table A2.

Table A2: Description of measures of Consequences of an Event Occurring from AS 4360

Rating	Category	Description
1	Insignificant	No significant off-site impact; low cost
2	Minor	Minor on-site impact, very minor offsite impact; moderate cost
3	Moderate	Moderate on-site impact with some detrimental effects, minor offsite impacts with limited detrimental impacts; moderate cost
4	Major	Off-site impacts with major detrimental effects; high cost
5	Catastrophic	Toxic release off-site with substantial detrimental effects; very high cost

Note: Cost refers to potential remedial works/repair of potential harm.

Risk Rating

Table A3 is the risk analysis matrix used to derive the risk rating for each risk scenario given the identified likelihood of impact and consequence rating. The matrix was is from the *Australian and New Zealand Standard 4360 - Risk Management.*

Table A.3: AS 4360 Qualitative Risk Analysis Matrices

	Consequences				
Likelihood	**Insignificant 1**	**Minor 2**	**Moderate 3**	**Major 4**	**Catastrophic 5**
A (almost certain)	H	H	E	E	E
B (likely)	M	H	H	E	E
C (possible)	L	M	H	E	E
D (unlikely)	L	L	M	H	E
E (rare)	L	L	M	H	H

Notes

E = Extreme risk; detailed research and management planning required.
H = High risk; senior management attention – substantial site specific controls required.
M = Moderate risk; management responsibility must be specified.
L = Low risk; manage by routine procedures.

The focus with risk assessment is management. When interpreting a risk analysis, it is important to consider both the probability and consequences in order to place the real risk in perspective. In particular, where the probability of an event is rare and the consequences of that event are catastrophic, the risk may be described as "high" warranting a closer examination. Equally appropriate responses may include additional safety features to reduce the potential consequences to an acceptable level or a change in management practices.

Appendix B: Agricultural Land Suitability Assessment Report – Landloch Pty Ltd, 2003

Appendix C: Acid Sulfate Soils Investigation and Report – Douglas Partners Pty Ltd, 2003

Appendix D: Contaminated Soils Investigation and Management Plan – Douglas Partners Pty Ltd, 2003.

Appendix E: Ecological Assessment Report – Yurrah Pty Ltd, 2004.

Appendix F: Flood Study and Report – Parsons Brinkerhoff, 2004

Appendix G: Preliminary ASS Management Plan – Douglas Partners Pty Ltd, 2004.