URRBRAE WETLAND

Urrbrae Wetland
Management Plan

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City of Mitcham

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Glossary

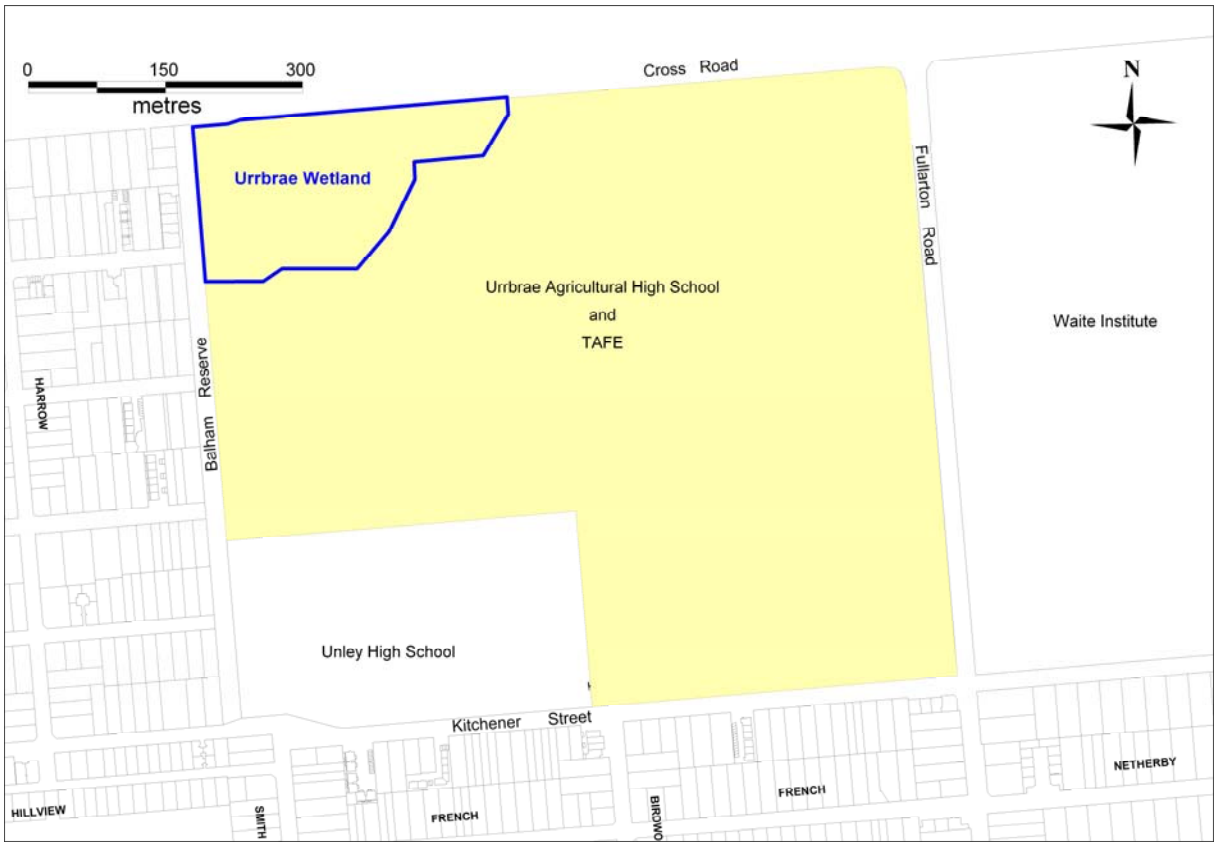
ASR	Aquifer Storage and Recovery
UAHS	Urrbrae Agricultural High School
PCWMB	Patawalonga Catchment Water Management Board
Megalitre (ML)	One million litres
mm	Millimetres
m	Metre
m^3	Cubic metres
ARI	Average Recurrence Interval
RL	Reduced level
L	Litre
L/sec	Litres per second
ECU	Electrical conductivity units, measured in microsiemens per centimeter (µs/cm). A measure of salinity (concentration of dissolved salts in solution)
TDS	Total dissolved solids, is a measure of salinity in milligrams per litre (mg/L)

1. Property

1.1 Location

Urrbrae Wetland is situated in the north-west of Urrbrae Agricultural High School (UAHS) and is bound by Cross Road and Balham Reserve (Figure 1.).

Figure 1. Location Map of Urrbrae Wetland



1.2 Title Information

The certificate of title obtained on 29 March 2004 shows that Urrbrae Wetland has been constructed in the north-western corner of allotment 10 (deposited plan 39536) in the area named Netherby, Hundred of Adelaide. The certificate of title is 5352/559 (Appendix A).

The registered proprietor in fee simple is the Minister for Education and Children's Services. There are no easements listed on the certificate of title for allotment 10.

2. Background, History and Status of Urrbrae Wetland

2.1 Background and Status

Urrbrae Agricultural High School was part of the land grant from Peter Waite to the State of South Australia for “boys to learn how to become farmers”.

According to the Minister for Education and Children’s Services, Hon. Robert Lucas MLC (1996), the land can not be sold, disposed, leased or encumbered for any purpose other than as a secondary school offering studies in agriculture. The certificate of title lists an exception for the Crown to have the right to “resume for road set forth in land grant Vol. 2198 Folio 61.”

The site of Urrbrae Wetland (Stage 1) was part of Peter Waite’s estate and used as farm land by UAHS until 1996. Land where the sedimentation basins (Stage 2) are now situated was utilised for grazing and cropping until 2003.

A broad overview of the Wetland's development is outlined in Section 2.5.

2.2 Easements

The certificate of title does not list any easements where the wetland development is situated (allotment 10).

SA Water issued an encumbrance notice in 1997 regarding the testing of a back-flow prevention device which was installed during Stage 1 of the Wetland.

2.3 Legislation and Agreements

Legislation that should be considered in the operation of Urrbrae Wetland include the:

- Local Government Act, 1999
- Environment Protection Act, 1993
- Development Act, 1993
- Metropolitan Drainage Act, 1935
- Natural Resources Management Act, 2004

The Waite Trust restricts the use of the land for agricultural education. However, this has been broadened to include environmental education in recognition of the role of farmers in sustainable land management.

Urrbrae Wetland was constructed under a licence agreement dated 16 July 1996, between the Minister for Education and Children’s Services and the City of Mitcham (Appendix B).

Another licence agreement between the Minister for Education and Children's Services and the City of Mitcham in 1997 (Appendix C), enables the City of Mitcham "to enter into and upon the land for a term of years for the purposes of maintaining the wetland and the Council's plant, equipment and appurtenances." The licence agreement terminates on 30 June 2019. Council has an option to renew the licence within three calendar months for a further 25 years, commencing on 1 July 2019.

In summary the Licence Agreement provides for:

The Council to:

- Maintain the wetland, all of its plant and equipment situated on the land, i.e. pumps, silt traps, piping, trash racks and boardwalks;
- Access the site.

The Minister to:

- Use the land for educational purposes within the spirit and in accordance with the provisions of the Waite Trust;
- Not interfere with or use any of the Council's plant and equipment on the land without prior written consent;
- Allow the Council access to the wetland;
- Maintain commercial property insurance (land and facilities);
- Maintain public risk insurance for the facility.

Both Council and the Minister to:

- Each pay 50% of the cost of effecting and maintaining insurance policies;
- Use and occupy the land and facilities at their own risk, and they shall each release the other party in the absence of default, neglect or omission by the other party;
- Indemnify and keep indemnified the other party from and against all claims, demands, actions, etc;
- Authorise any request, consent or notices in accordance with the Licence Agreement by the relevant representative of the party;
- Establish a Management Committee of two persons, one being the Principal of Urrbrae Agricultural High School and the other being Council's City Manager.

The Management Committee to have the following powers:

- To oversee and monitor the performance by the parties of their obligations under this agreement. The Management Committee may make recommendations to the parties as it sees fit;
- To meet as often as considered necessary, but at least once in each quarter;
- To appoint a person to carry out the secretarial requirements and duties of the Management Committee.

Disputes

- In the first instance, disputes between the two parties are to be referred to the Management Committee so it can make a recommendation to resolve the dispute;
- If the dispute is not resolved, then it shall be referred to the Minister for a final decision.

Termination of Agreement by the Minister if:

- Council is abolished pursuant to the provisions of the *Local Government Act*, *1934*;
- Council permits or suffers any breach or default in the due and punctual observance of its obligations, covenants or provisions under this agreement in which the Council has previously been given one calendar month's notice in writing of such breach or default.

2.4 Current Maintenance Operations

As set out in the licence agreement, Council maintains the wetland, its plant and equipment situated on the land. This includes the pumps, silt traps, piping, trash racks and boardwalks.

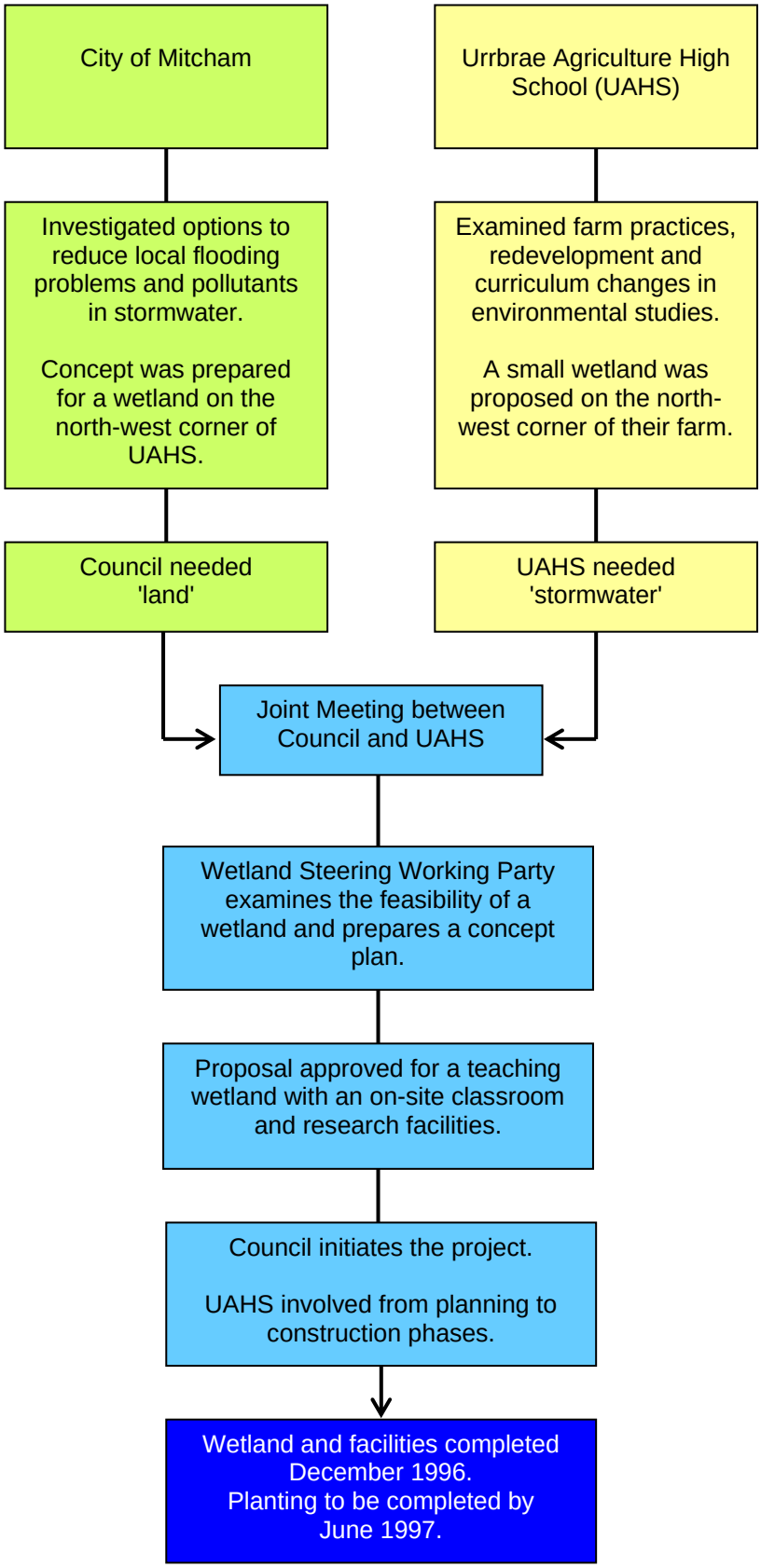
The Friends of Urrbrae Wetland play a key role in maintaining the Wetland through activities such as weed control, revegetation, watering plants and path maintenance. The Friends' contribution to the development and maintenance of the Wetland has been enormous.

2.5 Wetland Development

The early development of Urrbrae Wetland has been outlined in Appendix D in an attempt to document the challenges and drivers of this facility.

The circumstances that led to the development of Urrbrae Wetland (Stage 1) are summarised by Ciric (date unknown) in Figure 2. Although both parties (UAHS and Council) had different outcomes in mind (environmental education versus flood mitigation) a wetland resulted which has forged a strong, on-going partnership between the two stakeholders.

Figure 2. Developing the Wetland Concept



A key driver of the Wetland was the flooding problems along Cross Road which were highlighted by a Member of Parliament in 1992. A property on Cross Road had been flooded up to six times between 1973 and 1992.

UAHS also experienced flooding problems on its farm land where the main wetland is now situated. The School saw an opportunity to broaden its curriculum to include environmental studies with an on-site Learning Centre and wetland.

Some of the innovations at the Urrbrae Wetland listed by Ciric (date unknown - thought to be around 1999) include:

Projects

- First urban infill wetland;
- Teaching facility for primary and secondary schools;
- Classroom and research facilities;
- Wetland teaching areas including ephemeral wetlands;
- Boardwalks for student observation and sampling;
- Joint Management Committee (City of Mitcham and UAHS) oversees management over a 25 year term.

School

- Curriculum combines environmental studies and agriculture.

Farm Dam

- Provides top up water to maintain wetland pond level.

Sewage

- Trialing a wastewater recycling and vaporising unit.

Groundwater

- Council and the CSIRO Centre for Groundwater Studies collaborated on a joint project to measure changes in groundwater.

Projects initiated as a result of the wetland include:

1. Research and trials into aquifer storage and recovery (ASR) in sand aquifers by the CSIRO.
2. A proposed water recycling scheme within the catchment involving the CSIRO, University of Adelaide, UAHS, Unley High School, Patawalonga Catchment Water Management Board and the City of Mitcham.
3. Study into reusing debris collected from trash racks.
4. Indigenous plants established in and around the wetland are of local provenance. These can be harvested for other wetlands and watercourses.

5. Native fish breeding program (late 1990's) in conjunction with the South Australian Research and Development Institute (SARDI) and a native fish association.
6. Local schools involved in the planting program. Areas have also been allocated to schools for planting and field research.
7. Unemployment training program centred around revegetating the wetland.
8. The Friends of Urrbrae Wetland was established to involve the community in wetland education and native vegetation management.
9. Mosquito monitoring pilot study and management strategy.
10. Aquatic and terrestrial ecosystem monitoring program.
11. Sediment accumulation study in the main wetland pond.
12. Wetland Information Kit - about Urrbrae Wetland, including a field guide and activities on water monitoring, insect collections and creating a herbarium.
13. Stormwater pollution prevention survey and monitoring program.
14. Kid's Congress 1997 – facility used by local schools for field trips.
15. Construction works recorded and photographed to prepare a guide on constructing wetlands.

Note: some of the projects listed above have been completed or discontinued.

2.6 Financial History

Urrbrae Wetland (Stages 1 and 2) has been constructed with funding from the State Government's Stormwater Subsidy Scheme, Patawalonga Catchment Water Management Board and the City of Mitcham. Underpinning the project was the allocation of land by UAHS.

Construction and maintenance costs for Stages 1 and 2 up to November 2004 total $1,924,143 (Table 1). After receiving grants totaling $940,938, the project has incurred a nett cost of at least $983,205 to the City of Mitcham.

Table 1. Summary of Maintenance and Construction Costs (Stages 1 and 2).

Year	*Construction Costs ($)*	*Maintenance Costs ($)*	*Grants ($)*	*Comments*
1995/96	49,011	Not Available	0	Geotechnical testing, wetland design, tender process and preliminary works.
1996/97	1,112,022	Not Available	568,198	Construction Stage 1, cost: $1,034,652. This included Level 1 supervision, ASR trials ($15,000), sewer pumping system, landscaping, coordinator salary for school plantings, earthworks, Premier opening wetland, signage and educational material. $200,000 PCWMB: $200,000 grant. State Govt. Stormwater Subsidy Scheme: $368,198 grant.
1997/98	6,925	19,765	7,500	50% reimbursement from the State Govt. Stormwater Subsidy Scheme for ASR trials.
1998/99	176	21,479	1,100	50% reimbursement from the PCWMB for oil booms at the Cross Road inlet into the wetland.
1999/00	5,000	20,013	0	
2000/01	402	11,992	0	
2001/02	410	14,999	0	
2002/03	27,070	29,636	0	Stage 2: Consultant design of Stage 2 works and advance order of indigenous plants.
2003/04	492,845	47,898	364,140	Stage 2: new gross pollutant traps and sedimentation basins at each inlet into wetland. PCWMB: $110,000 grant. State Govt. Stormwater Subsidy Scheme grant $254,140.
2004/05	10,000	54,500	0	Stage 2: Cross Road inlet - connection to bypass drain.
Total	***1,703,861***	***220,282***	***940,938***	

3. Property Description

3.1 Physical Description

3.1.1 Topography

According to Golder Associates (1995), before the wetland was constructed the site had a gentle fall of about 1 in 60 towards the north-west. The ground also continued to rise at a similar slope toward the south-east for approximately one kilometre.

The Planning Statement by Kinhill Engineers Pty Ltd (1996) proposed constructing the main wetland (detention basin) predominantly beneath the natural surface level together with a low height mound along the north-western edge of the wetland. This would provide additional flood storage within the wetland basin.

Several islands for birds have been constructed, separated by water to deter predators. Maximum depth in the wetland is approximately three metres (Figure 3).

The sedimentation basins constructed in 2004 are relatively shallow having a maximum depth of 1.5-2 metres along Cross Road and up to one metre near Balham Reserve.

3.1.1.1 Geology

The Geological Map of Adelaide indicates that the site is underlain by Quaternary soils and sediments of the Adelaide Plains (Golder Associates, 1995).

3.1.1.2 Physiography

According to a map of the physiographic features of the Adelaide region in Taylor et al (1974, p 17), the UAHS site appears to be situated within the Brownhill Creek fan, on the upper outwash plain.

3.1.2 Soils

A geotechnical investigation was undertaken by Golder Associates in 1995, in which ten test pits were excavated to a depth of six metres. Groundwater was not encountered in any of the test pits.

The report refers to the Soil Association Map of the Adelaide Region produced by the Department of Mines and Energy which indicates that the soils in the area are likely to be Red Brown Earths (RB3). Black Earth profiles may also exist (Golder Associates, 1995).

According to Golder Associates (1995), the test pits revealed a general soil profile consisting of a layer of low to medium plasticity, sandy clay topsoil overlying a thin layer of high plasticity, fissured, red brown clay: the B horizon. This horizon overlaid interbedded sandy clays, some of which were calcareous with plasticity ranging from medium to very high. At around 5.0 metres depth many of the test pits encountered layers of clayey sands and clayey gravels. Clayey gravel occurred from 2.2 metres depth to the base of Test Pit 10 at the southern end of the site.

Much of the clay below the B Horizon was also fissured and contained pockets of sand and gravel indicating that there had been some alluvial deposition associated with the area. This suggests that ephemeral perched water tables or seepage may be present, particularly during periods of extended wet weather.

Soil testing revealed the presence of permeable zones within the area of the proposed wetland. Therefore, a clay liner was recommended to reduce seepage from the proposed basin. To construct the clay liner, it was considered appropriate to mix and compact the slightly dispersive and non-dispersive soils encountered in the test pits (Golder Associates, 1995).

According to Golder Associates (1995) chemical levels in the soil from 0.0 m - 0.2 m are either below laboratory detection levels or levels set by the South Australian Health Commission (SAHC) and the Australian and New Zealand Environment and Conservation Council (ANZECC).

An agronomist report from IMT & Associates (1995) analysed the topsoil for the presence of contaminants which may affect plant and aquatic life within the proposed wetland. Results were:

- pH values range from 5.3 (strongly acidic) to 6.5 (slightly acidic) with a mean pH of 5.8;
- Salinity and sodicity are not a problem;
- Nitrogen is extremely low, but the other major elements are available to various degrees and currently are not at toxic levels;
- Trace elements do not appear to be a major problem at this stage, although the level of boron is marginal;
- It is likely that aluminium may become toxic at [some] sites (pH of 5.3 and 5.5).

Soil tests indicated that the clay material was suitable to construct a clay liner and no serious problems existed.

3.1.3 Catchment

According to John Botting and Associates (1997) the area has a mean annual rainfall of 626 mm and mean evaporation of 1,400 mm.

The Cross Road and Kitchener Street catchments lie within the Patawalonga Catchment and have a combined area of approximately 445 hectares (Figure 4).

Two separate models estimated water runoff entering the wetland at 316 (Kinhill Engineers Pty Ltd) and 450 megalitres each year. The higher estimate by Armstrong and Clark (1999) referred to a long term average of 380 megalitres each year entering the Urrbrae Wetland and two megalitres each year lost to evaporation – transpiration.

Land uses within these catchments include residential, institutional, recreational and agriculture which influence the rate and amount of water runoff during rain events.

3.1.4 Infrastructure

The main components of Urrbrae Wetland include:

- Two trash racks: 14 netted bags in the Cross Road sedimentation basin and 10 netted bags in the Balham Reserve basin. In addition, 2 small racks/bags are installed alongside the main wetland's inlet (near Cross Road).

  There are 4 small, trash racks/bags in the original inlet near Balham Reserve but these were by-passed with the construction of the sedimentation basins and larger trash racks in 2003-04.
- Two sedimentation basins – receiving incoming stormwater;
- Permanent water body incorporating temporary storage;
- Three small ephemeral wetlands (water used to be pumped into them from the main pond);
- Synthetic lined dam ('Farm Dam') to provide top up water to the wetland;
- Learning Centre (log cabin construction);
- Timber boardwalks and viewing platforms;
- Septic tank effluent processing and vaporising appliance;
- Security fencing;
- Vehicle and pedestrian tracks – compacted gravel tracks for vehicles and visitors and, bare earth tracks around the main wetland.
- Pumps:
  - Floating pump – in Farm Dam which supplies stormwater water to the ASR well;
  - Return pump – set at 60 m below ground level in the ASR well. Water is pumped to the sand filters, then into a 5,000 gallon concrete storage tank.
  - Ballast pump – set in a concrete chamber near the Learning Centre, transfers water from the Farm Dam to the main wetland.
- Bores (Figure 5):
  - ASR bores (3) – immediately next to the Farm Dam on its south-western side;
  - Observation wells (two) – shallow wells to observe groundwater levels to monitor possible leakage from the clay liner. One well is situated next to the teaching facility, with the second well situated on the opposite side of the wetland near Balham Reserve.
- Pipework
- Landscaping and irrigation – a mains water line has been installed around the main wetland during Stage 1;
- Concrete rain water tank – for the Learning Centre;
- ASR Concrete water tank (5,000 gallons).

3.1.5 Adjacent Land Uses

Urrbrae Agricultural High School is situated within an institutional zone, alongside the Waite Institute on its eastern side (separated by Fullarton Road) and Unley High School on its south-western boundary.

An established residential zone surrounds UAHS along its northern, western and southern boundaries. Along the western boundary, Balham Reserve provides a narrow buffer between houses and the wetland.

3.2 Vegetation

3.2.1 Background

According to Kraehenbuehl (1996) citing Cockburn (1984), at the time of European settlement the 'Black Forest' extended along the western foothill suburbs of Burnside, Erindale, Beaumont, Glen Osmond south-west through Urrbrae, Malvern, Mitcham, Unley, Goodwood, Wayville, South Adelaide, Black Forest, Hyde Park, Clarence Park, Plympton, Edwardstown, St Marys, and terminated at the River Sturt near Marion.

The Black Forest is thought to have gained its name from the dark bark of the trees and the thick dark green foliage. Some of the plant species characteristic of it include: Grey Box *(Eucalyptus microcarpa),* South Australian Blue Gum *(Eucalyptus leucoxylon)*, Sweet Bursaria *(Bursaria spinosa)*, Native Lilac *(Hardenbergia violacea)*, Golden Wattle *(Acacia pycnantha)*, Kangaroo Thorn *(Acacia paradoxa)* and thick expanses of Kangaroo Grass *(Themeda triandra)* amongst other native grasses. Drooping Sheoak *(Allocasuarina verticillata)* and River Red Gum *(Eucalyptus camaldulensis)* also occurred in the Black Forest, with the latter concentrated along watercourses.

The site of UAHS would have contained a Grey Box woodland, evident from a photograph (page 68) of *Old House Urrbrae* in Kraehenbuehl's (1996) publication. The woodland would probably have been cleared for agriculture.

The land where the wetland has been constructed was previously used by UAHS for cropping and pastures. This was on a five year rotation of three years pasture and two years of cereal crops (deWet Jones, 1997). Along Cross Road, exotic pines were planted many years ago and now form a significant streetscape, although many are in decline and pose a number of issues to the wetland.

According to deWet Jones (1997), landscaping was undertaken to create an aesthetically pleasing and functional wetland. It was logical to recreate a pre-European landscape, typical of the area within the Black Forest. Therefore, all seed and cuttings for tubestock plantings are of local provenance.

3.2.2 Plant Species

More than 95 indigenous species have been planted as terrestrial and aquatic plantings to maximise diversity, habitats and serve as a resource (nursery) for other revegetation projects (Appendix E).

3.2.3 Relationship to other Vegetation

As the Black Forest was cleared for agriculture, timber and housing, few remnants remain today on the Adelaide Plains.

In the surrounding suburbs and Waite Institute, there are remnants such as River Red Gums *(Eucalyptus camaldulensis)*, Grey Box *(Eucalyptus microcarpa)* and native grasses.

The foothills behind the Waite Institute contain a remnant Grey Box woodland of local significance. Kraehenbuehl (1996) states that Brownhill Creek Recreation Park contains a River Red Gum woodland with minor stands of South Australian Blue Gum. These sites provide reference points for selecting suitable species for Urrbrae Wetland.

3.3 Water

Urrbrae Wetland was constructed to reduce the incidence of localised flooding whilst providing opportunities for an environmental curriculum at UAHS. The Wetland Committee's goal of improving the quality of stormwater for irrigation has resulted in research and development of international significance by the CSIRO.

3.3.1 Water Storage

Kinhill Engineers Pty Ltd (1995) state that there are two components of water storage (Stage 1):

a) Permanent Water Body – a true wetland water body sized for a ten day average retention period. (Vegetation within the water body provides the water quality improvement aspect of the development);

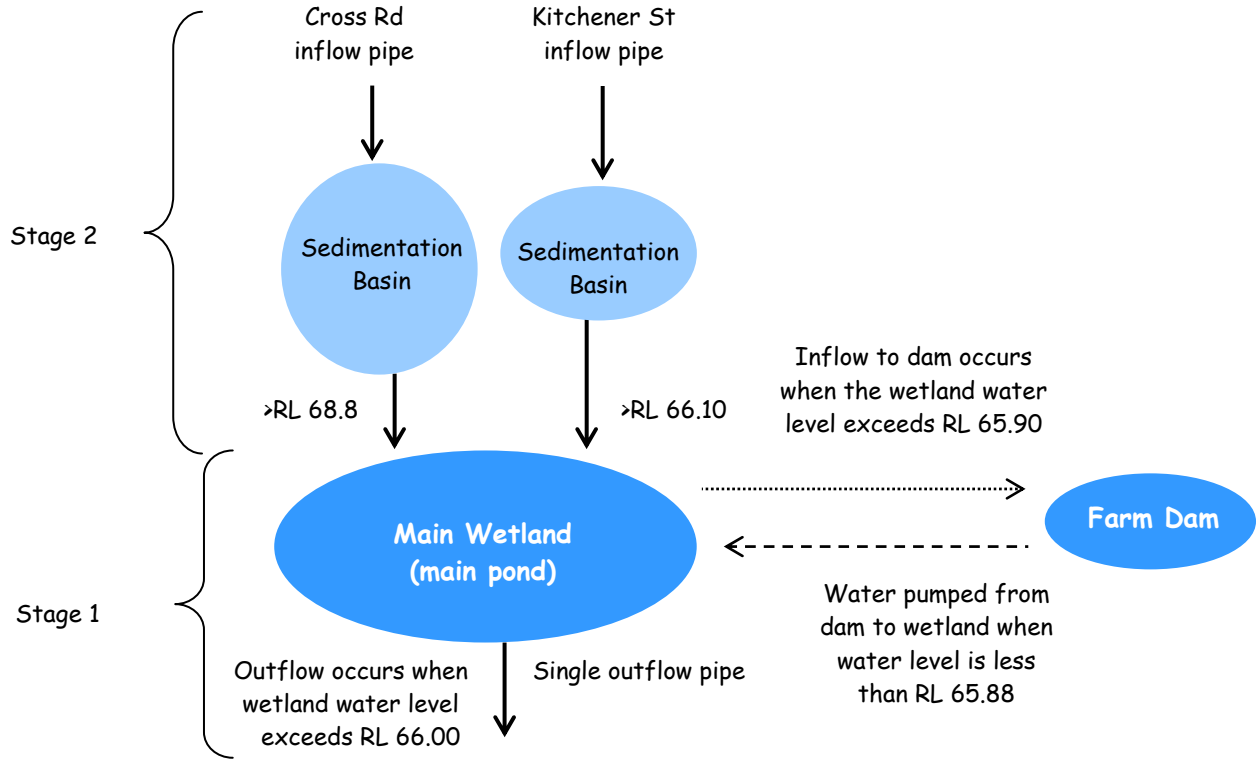
b) Temporary Water Storage – located above the permanent water body and provides for the attenuation of peak flows through the wetland for the five year Average Recurrence Interval (ARI) event. The duration of temporary ponding is short and consequently has little effect on stormwater quality. Flows exceeding the five year ARI (capacity of the upstream underground stormwater pipe system) would bypass the wetland.

Stage 1 has a volume of 13,000 m^3. For stormwater detention during a flood, the wetland has extra capacity of 14,600 m^3 (Kinhill Engineers Pty Ltd, 1997).

A Farm Dam with a synthetic liner has been constructed to provide 'top up' water to the main wetland/pond in periods of reduced rainfall, typically summer. It is critical to maintain the water levels in the main wetland/pond to prevent cracking of the clay liner (Figure 6). An external water system can be used to wet the clay liner if water levels drop in the main wetland and Farm Dam.

Detention times of incoming stormwater in Stage 1 are between 9-35 days in summer and 6-8 days in winter (Kinhill Engineers Pty Ltd, 1997). However, in a heavy rain event detention time may be less than 2-10 minutes (Dr. A. Hodson [Urrbrae Wetland] 2006, pers. comm.,).

Figure 6. Water Levels of Urrbrae Wetland (adapted from Kinhill Engineers Pty Ltd, 1997)



3.3.2 Water Quality

Water quality monitoring and assessment has been undertaken on an ad-hoc basis by various stakeholders including school groups, tertiary students and the Council. Results need to be interpreted with caution as major fluctuations in water quality can occur overnight, e.g. first flush results will be markedly different to later rain events (Dr A. Hodson [Urrbrae Wetland] 2004, pers. comm.,). Another early limitation has been the lack of established wetland vegetation and sediment from the redevelopment of UAHS.

An early assessment of Urrbrae Wetland by a University of Adelaide student (Mathews, 1997) found water quality to be characterised by:

- Low Phosphorus
- Low Nitrate
- High Colour
- High Dissolved oxygen
- Neutral pH
- Low Turbidity
- Low Conductivity
- Low Salinity

A number of invertebrates and macroinvertebrates were trapped (Table 2) and were dominated by one species of water snail in large numbers.

Table 2. Invertebrates and Macroinvertebrates Recorded, 1997.

Common Name	*Species Name*	*Number*
Water Snail	*Austropeplea tomentosa*	Abundant
Dragon-fly larvae	*Cardulidae sp.*	1
Damsel-fly larvae	*Coenagrionidae sp.*	1
Leech	*Richardsonianidae sp.*	1
Blood Worm	*Chironomidae sp.*	120 (Approximately)
Garden Worm		1

Captures made by school groups since that time indicate a seasonally fluctuating, but large, diversity of macroinvertebrates (Dr A. Hodson [Urrbrae Wetland] 2006, pers. comm.,).

3.3.3 Water Reuse Studies

Urrbrae Wetland has brought together a number of local water users, research scientists and government agencies to support investigations into stormwater capture and reuse. Aquifer storage and recovery (ASR) has been at the centre of these reuse projects.

Studies that have focused on water reuse at the Urrbrae Environs (including the Waite Institute, Unley High School and Urrbrae Agricultural High School) are listed below.

Urrbrae Environs Water Management Plan Stage 1 – Water Budget (*John Botting and Associates Pty Ltd, 1997*)

The report found that Urrbrae Wetland is considered the most suitable for treated stormwater as both collection and treatment have been addressed. However, the biggest concern is how the majority of run-off occurring in winter can be stored for use in summer.

Urrbrae Environs Water Management Plan, Stage 2A – Aquifer Injection Investigations* (John Botting and Associates Pty Ltd and Lisdon Associates, 1998*).

A feasibility study into constructing an ASR scheme at the Urrbrae Wetland using trial injection wells. Models were developed for annual stormwater inflow, storage and recovery for irrigation.

A trial ASR well was drilled over two days in July 1997 and reached 93.6 metres. The aquifer at this depth contains undifferentiated Tertiary sands which are believed to be of the Lower Port Willunga Formation. This aquifer is beneath Hindmarsh Clay and Carisbrooke sands.

The study concluded that:

- Low yield and low injection rates limit available water for irrigation (an injection rate of 2 L/sec is a key limiting factor);
- Uneconomical to proceed with large scale ASR;
- A smaller scale ASR scheme at the site is not economically feasible;
- Pre-treatment of stormwater is required before injecting to remove algal particles which cause blockages.

Funding for Stage 2A was met by the Urban Stormwater Drainage Subsidy Scheme, Patawalonga Catchment Water Management Board, University of Adelaide, CSIRO, Primary Industries SA, SARDI and City of Mitcham.

Urrbrae Environs Water Management Plan Stage 2B* (Armstrong and Clark, 1999*).

This study looked at the economic and hydraulic feasibility of using the wetland and associated infrastructure to supply water for irrigation of recreation areas at Unley High School and UAHS. An ASR scheme using existing bores formed the core of the system's feasibility (page 1).

Stage 1 of the study calculated irrigation for 6.43 hectares of ovals at UAHS and Unley High School. Details include:

- Applying 7,700 kL/month in summer (120 mm/month in summer);
- Irrigation season is from September-April. Total annual demand is 38 ML;
- Capital cost is $30,000 (pipe work from ponds to School) and operating costs of $8,800 per annum;
- A supply of 38 ML/annum the cost of delivered water is $0.30-$0.35/kL;
- 190 ML/annum of water would be available for irrigation under a best case scenario (diverting at least 50% of incoming water);
- 380 ML/annum 'best estimate' of long term average annual inflow to Urrbrae Wetland;
- Average annual evaporation – transpiration of 2 ML/annum;
- Modeling shows that 60% of inflows could be diverted for the supply of an ASR scheme (4.1 ML useable storage). Volumes exceeding 4.1 ML would overflow into the drain;
- Greatest economy for any given stage will be achieved when it can operate at its upper capacity;
- Native ground water salinity is approximately 1,200mg/L. Stormwater salinity is approximately 200mg/L. Therefore, the quality of water should be excellent.

Stage 3 – Well drilling and injection trials.

Injection trials continued up to 2001.

Water quality, specifically dissolved organic material and to a lesser degree sand, continued to block filters and pumps. Water quality is a major barrier to ASR at Urrbrae Wetland, resulting in very low injection and extraction rates.

Based upon these ASR trials in sand aquifers, a future ASR scheme would probably have a number of gravity fed wells with low injection and extraction rates. Irrigation water would be supplied to nearby UAHS and possibly Unley High School.

According to Dillon (2000), if the Urrbrae Wetland ASR project can not be made operational it will quarantine a very large part of the Adelaide metropolitan area from ASR opportunities.

Results from the drilling of Two Wells in the Upper Quaternary Aquifer at the Urrbrae Wetland Site **(Pavelic and Dilllon and Barry, 2005).**

Two shallow wells were drilled in the Upper Quaternary aquifer at the southern end of the Farm Dam in September 2005. The wells were found to be extremely heterogeneous and injection rates were considered too small for further trials.

Further research is likely to target the Tertiary sand aquifer at depths of 80-90 metres.

3.3.4 Water Infrastructure

Pipes

Stormwater enters the sedimentation basins through concrete pipes (1,050 mm diameter) from Cross Road (north eastern boundary) and Kitchener Street.

Water from the Cross Road sedimentation basin flows into the main wetland through a 1,500 mm diameter concrete pipe buried under the vehicle track.

Overflow from the wetland at RL 66.0 drains into existing concrete pipes (1,050 mm diameter) under Cross Road.

A mains water pipe nearly encircles the main wetland. The water meter is in the north-west corner near Cross Road/Balham Reserve and the main line terminates in the south-west corner of the wetland.

Gross Pollutant Traps/Trash Racks

The Planning Statement for the Wetland (Stage 1) specified underground gross pollutant traps at the end of both stormwater outlets which discharged into the main wetland. The structures included trash screens that would capture floating debris in low flows and a sediment trap to capture coarse particles. Fine particles would pass through the gross pollutant traps, depositing in the wetland and discharging with the overflow (Kinhill Engineers Pty Ltd, 1989).

Despite the preference for underground gross pollutant traps, ‘string bag’ type trash racks (four at each inlet) were installed due to their lower cost and educational value. Captured debris can easily be observed in above ground structures as compared to underground structures. The Patawalonga Catchment Water Management Board contributed $60,000 to the trash racks.

It appears that the string bag trash racks can effectively capture packaging litter and large debris, but their effectiveness declines with leaves and sediment. According to Urrbrae Wetland (2000), eucalyptus leaves are often pushed through the string net bags. Organic matter and sediment passing though the traps, are deposited in the wetland producing a black, highly organic substance that emits hydrogen sulfide (rotten egg smell), typical of anoxic and anaerobic conditions.

Knowledge of the characteristics and quantities of gross pollutants in the catchment has increased since the wetland was first constructed. Consequently, an emphasis is now on capturing organic pollutants such as sediment and leaves as opposed to packaging litter.

A review by BC Tonkins and Associates Pty Ltd in 1999 recommended the construction of sedimentation basins and expanded trash racks to increase removal efficiency and litter capture.

A hydraulic assessment of the inlets by BC Tonkins and Associates Pty Ltd (2000) listed two key problems of the original trash racks being: (i) insufficient capacity and, (ii) high energy/velocity inflows 'jetting' through the wetland.

To accommodate the larger trash racks and sedimentation basins in Stage 2, UAHS has made additional land available which was a significant constraint in Stage 1.

There are now two main trash racks with 14 bags near Cross Road and 10 bags near Balham Reserve, each measuring approximately 0.90 x 0.90 mm.

Stage 2 trash racks have a total collection area (not including bag capacity) of approximately 20 m^2 plus an additional 1 m^2 from the two original trash racks situated in the main wetland inlet. Therefore, the collection area is 5.7 times greater than Stage 1. However, overtopping of trash racks/bags continues during moderate to heavy rain events (Dr A. Hodson [Urrbrae Wetland] 2006, pers. comm.,).

Other improvements to the trash racks include larger (and more) energy dissipation blocks, silt weirs (approximately 300 mm high) and vehicle access to collect debris.

Sedimentation Basins

The purposes of the basins are to settle out sediment and trap litter in the stormwater before it flows into the main wetland.

The basins will be desilted periodically based upon accumulation data. To this end, they can be viewed as 'sacrificial' basins, to minimise impacts on the main wetland. Desilting the main wetland would be problematic since it can not be drained and dried as cracks would appear in the clay liner. To this end landscaping around the sedimentation basins took into account disturbances that will occur during desilting.

The sedimentation basins are constructed with trash racks immediately upstream. The basins consist of varying water depths to aid in settling out sediment as water velocity reduces.

During summer the basins contain small amounts of water between rain events, and may even dry out.

Farm Dam

A three megalitre dam, known as the Farm Dam, is next to the main wetland and has a high density polyethylene (HDPE) liner. This eliminates seepage and allows the dam to be drawn down to low levels without cracking. This was one of the reasons for drawing water directly from the dam during the ASR trials.

The purpose of the Farm Dam is to supply 'top up' water to the main wetland when its level drops below RL 65.88 metres (Figure 6). Conversely, when the wetland's water level exceeds RL 65.90 metres, water flows into the Farm Dam. Above RL 66.0 metres, water from the wetland is discharged into the existing Cross Road stormwater pipe network .

For ASR trials by the CSIRO, water is extracted from the Farm Dam and injected into the aquifer.

Water Re-use

The piggery at UAHS was originally allocated 600 L/day of 'wash down' water from the wetland, on the condition that it caused no unacceptable draw-down - affecting the clay liner and/or educational uses of the main wetland. A pump is situated on a headland of the wetland and was installed to transfer water to the piggery. However, it appears that pipework was never connected to enable this to occur.

Wash down water from the piggery does not enter the wetland for it is treated in aerobic digesters and aerating ponds before being used for irrigating the School's orchard.

Wells

During December 1996, two monitoring wells were drilled next to the wetland to detect possible seepage from the clay liner. (Dr Hodson, 1997). This was initiated by the CSIRO and formed part of the contract performance for the wetland's construction.

In 1997 an increase in water height was detected in the observation well adjacent to the Learning Centre, indicating a possible crack in the clay liner. However, this was attributed to a leaking pipe that was quickly repaired by the contractor. These wells were initially monitored by the CSIRO on a monthly basis, but as a result of finding no changes, monitoring intervals have increased.

John Botting and Associates Pty Ltd and Lisdon Associates (1998) report that a trial ASR well was drilled near the Farm Dam's south-west corner in July 1997. Within two days of drilling, a depth of 93.6 metres was achieved. The aquifer contains undifferentiated Tertiary sands which are believed to be of the Lower Port Willunga Formation and is beneath Hindmarsh Clay and Carisbrooke Sands. Salinity of water in the aquifer is approximately >1500mg/L TDS. Trials indicated that gravity injection into the aquifer was required at 2L/ sec, and extraction rates at 2-3.5L/sec.

3.4 Gross Pollutants

Identified pollutants entering Urrbrae Wetland are predominantly organic (leaves, sticks, bark, seeds) and inorganic (gravel, sand, clay) matter. Packaging litter is captured but is not a significant portion of the pollutants.

According to Urrbrae Wetland (2000) the volume of oil discharged into the wetland is estimated at 20 L/week and has increased markedly since 1998/1999.

A water quality and inflow management review of the wetland by BC Tonkins and Associates Pty Ltd (1999) reported that:

- The estimated ratio of sediment to organic matter is 1:1 at the Cross Road trash rack and 4:1 for the Kitchener Street trash rack;
- Lighter oils float in the water body. They tend to float near the water surface 1-2 days after a storm event;
- Lighter fractions gradually settle to the floor of the basins between storm events.

An investigation of the Urrbrae Wetland shortly after it was constructed, observed that the water colour was high, indicative of organic matter (Mathews, 1997).

With the original wetland (Stage 1), excess levels of organic matter entered the main pond causing anoxic and anaerobic conditions. This impacted upon the ecosystems within the pond and produced obvious hydrogen sulphide odours, offensive to visitors and neighbours. In 2003-04, sedimentation basins and larger trash racks were constructed with the aim of reducing this problem (Dr Hodson [pers. comm., 2006]).

3.5 Fauna

A comprehensive fauna survey has not been undertaken at the Wetland. However, 44 bird species have been recorded along with macroinvertebrates and microinvertebrates.

According to Dr Hodson (pers. comm., 2004) the presence and abundance of macroinvertebrates is variable, depending on the season. Larger populations occurred in the early days of the wetland, but have declined with the loss of bottom weeds in the main wetland. At the time of writing, the weed has not been able to re-establish as a consequence of high levels of organic matter in the stormwater. This is expected to improve with the new sedimentation ponds in Stage 2.

According to Dr Hodson (pers. comm., 2006) the wetland contains all but one type of organism shown on the KESAB Waterwatch identification sheets. The Urrbrae Wetland Learning Centre can provide further information on species lists.

4. Property Values

4.1 Significance of Vegetation and Habitat

Indigenous flora has been introduced through landscaping of the constructed wetland since 1997.

Indigenous plants used at Urrbrae Wetland are typical of species that occurred in the Black Forest (refer to Section 3.2.1), with some having conservation ratings. The plantings are a valuable resource for other revegetation projects.

The wetland provides a range of different habitats for flora and fauna to establish such as terrestrial zones, shallow and deep water, a permanent water body and islands. An extensive range of indigenous plant species has been established and has attracted a number of native water bird species.

The Wetland Manager's efforts to maintain a functioning ecosystem in the wetland has resulted in biological control of pests such as mosquitoes in the main wetland.

4.2 Landscape Values

The Urrbrae Wetland provides a unique water feature surrounded by native vegetation in an urban area. When visiting the wetland and its natural surrounds, it hardly seems possible that its situated next to Cross Road.

4.3 Educational Values

According to Dr Hodson (1994) with the growth of the Landcare movement and increased concern for environmental issues, UAHS considered how it might best respond. There was consensus that the School should broaden its emphasis from traditional agriculture to become a centre of excellence for the study of alternative agriculture and environmental studies/science. A small area for a functional wetland was expected to meet the developing curriculums.

Consultation within the School revealed a number of key issues that influenced the wetland's design:

- Mimic the natural environment;
- Protect the ecologically fragile wetland – fencing and controlled access;
- Boardwalks – access through the wetland;
- Constant water levels – to promote diversity of species;
- Diverse habitats – bogs, shallows and deep water;
- Reeds and sedge areas with some open water – with access to each area via boardwalks for student work;
- Learning Centre – next to the wetland, fitted with basic laboratory equipment;

- Expert Advisory Committee – appointed early;
- Executive Committee – formed with representation from TAFE and UAHS to manage use of the wetland.

Consultation across faculties revealed the diverse range of educational opportunities that a wetland could provide.

The educational values of Urrbrae Wetland have proved a major draw card with over 6,400 visitors each year. The wetland is particularly popular with primary and secondary schools as part of their environmental education lessons. Students from the University of Adelaide and Flinders University (i.e. social science, education, environmental science and landscape architecture) have visited the wetland on a regular basis as part of their course work. Some students have utilised the wetland for honours theses and other projects (Dr A. Hodson [Urrbrae Wetland] 2006, pers. comm.,).

According to Dr Hodson (pers. comm., 2004) the Learning Centre adjacent to the wetland has a well equipped laboratory, with microscopes, computers (used for identifying macroinvertebrates and teaching programs), reference books and basic water testing equipment.

Adult visitors to Urrbrae Wetland are asked for a gold coin donation and school children are charged $2.20 (incl. GST). Funds have been invested into teaching facilities and equipment for the Learning Centre.

4.4 Historic Values

Although the land on which the Urrbrae Wetland is situated belonged to Peter Waite, there is limited historical value attached to the site. The site was previously used for grazing and cropping for over one hundred years.

The Pine trees along Cross Road are thought to have been planted in 1922, along with those in the Waite Institute (Dr A. Hodson [Urrbrae Wetland] 2006, pers. comm., citing investigations by T. Tierney [UAHS]).

4.5 Scientific Values

Research and development in establishing an ASR scheme at Urrbrae Wetland in undifferentiated Tertiary sands is of international significance. Research and field trials have been undertaken by Dr Peter Dillon of the CSIRO and consultants with expertise in hydrology.

A workable ASR scheme at Urrbrae Wetland will mean that the sand trench aquifers along the foothills east of Adelaide are finally ‘unlocked.’ This would help to reduce our reliance on the River Murray and local reservoirs by utilising aquifer storage and recovery schemes.

Research and field trials have increased the knowledge base of scientists injecting stormwater and recovering it from sand aquifers. One of the problems to be overcome will be the removal of solids from the water (i.e. algae) which cause blockages between sand pores in the aquifer.

Secondary and tertiary students have used Urrbrae Wetland for a number of scientific studies into European wasps, water quality, stormwater management and re-use.

The wetland provides an accessible site in which students can investigate and report on urban stormwater issues in aquatic habitats.

4.6 Water Values

Stormwater and its management is the primary feature of Urrbrae Wetland. A permanent water body provides year round aquatic environments and combined with the new sedimentation basins, maximises flood mitigation and educational opportunities.

The Urrbrae Wetland serves the State as a practical demonstration of different facets of urban water management such as stormwater capture, pollutant removal (some), ASR and water conservation. It also demonstrates to the community the value of stormwater, and that it is a resource that can be used to reduce our reliance on traditional water sources.

5. Wetland Management Objectives

5.1 Educational Objectives

5.1.1 To provide educational opportunities on wetlands, biodiversity and water reuse to our community.

5.1.2 To provide opportunities for an environmental curriculum at the Urrbrae Educational Centre.

5.2 Environmental Objectives

5.2.1 To create and maintain a functioning wetland which contributes to improved water quality in the Patawalonga Catchment.

5.2.2 To capture, treat, store and reuse stormwater entering the wetland.

5.2.3 To comply with legislative and best practice environmental guidelines and requirements.

5.2.4 To protect and enhance indigenous flora, fauna and their habitats within Urrbrae Wetland.

5.3 Social Objectives

5.3.1 To reduce localised flooding from a 1 in 5 year flood event.

5.3.2 To raise community awareness of stormwater as a resource, water conservation and biodiversity.

5.3.3 To provide controlled access to Urrbrae Wetland for the education and enjoyment of our community.

5.3.4 To provide the community with a facility that provides linkages to pre-European landscapes and habitats.

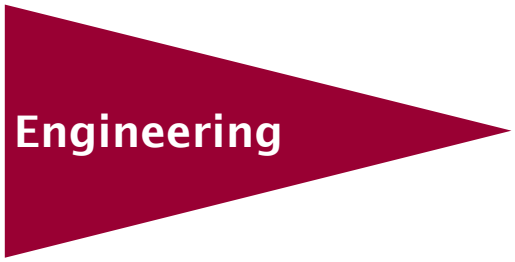
5.4 Economic Objectives

5.4.1 To mitigate downstream flooding, thereby minimising future funding for downstream drainage works.

5.4.2 To investigate alternative water supply opportunities for Urrbrae Agricultural High School to reduce potable water consumption.

5.4.3 To operate within budget allocations and employ best practice management techniques.

6. Management Issues and Strategies



6.1 Stormwater

Urrbrae Wetland receives the bulk of stormwater from concrete pipes underneath Cross Road and Kitchener Street. Small quantities of stormwater from the School grounds and to a lesser extent runoff from adjacent paddocks also enter the wetland/main pond.

Stage 1 of Urrbrae Wetland had both stormwater outlets discharging into the main pond. The high velocity of incoming stormwater resulted in on-going scouring problems around the trash racks.

Pre-treatment of stormwater did not occur due to budget pressures and the limited land area that was available for the development. Consequently, sediment and organic matter were quickly accumulating in the main pond. This reduced storage capacity for flood mitigation and impacted on the aquatic ecosystem that was being established.

Sedimentation basins and expanded trash racks were constructed in Stage 2. Both stormwater outlets now discharge into the basins and not the main pond. The basins were designed to reduce stormwater velocity, scouring and sediment entering the main pond. Indigenous vegetation has been planted in and around the basins. Aquatic plants can assist in reducing water velocity, settling out soil particles and absorbing nutrients.

As with Stage 1, water above RL 66.0 will be directed out of the main pond into the stormwater pipe system under Cross Road.

Strategy

6.1 (a) To improve the quality of stormwater entering the main pond by reducing its velocity, and increasing the capture of organic and inorganic matter.

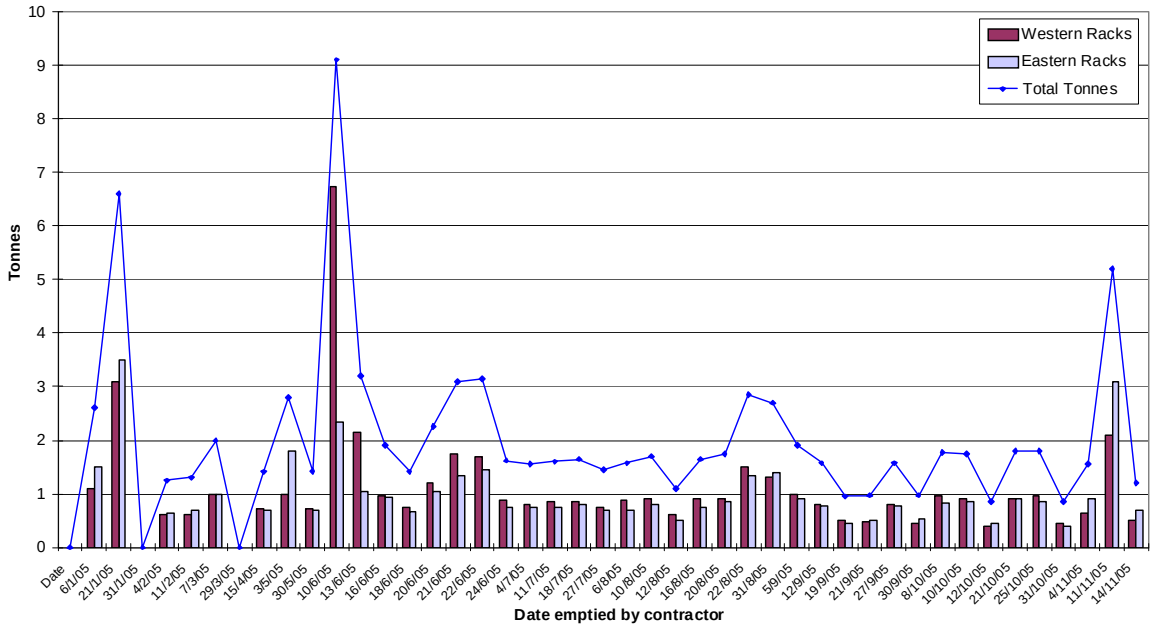
6.2 Trash Racks

Regular cleaning of the trash racks (bags) is essential to maximise capture of debris and minimise deposition into the main wetland. Cleaning involves emptying string bags and removing sediment from the concrete apron, silt weir and around energy dissipaters (concrete blocks). Vehicles are able to access the racks from the concrete ramps.

Currently, debris is disposed of at landfill due to suspected high levels of metals and hydrocarbons. However, the former Patawalonga Catchment Water Management Board has successfully trialed composting the debris as an alternative to dumping at landfill. The City of Mitcham may wish to investigate this further, to determine if composting is a feasible option.

Cleaning costs in 2004-2006 have escalated sharply since the new trash racks became operational. Cleaning data for 11.5 months (Figure 7) show relatively small quantities being collected during each visit. An estimated 89 tonnes of debris was removed, with a median quantity of 1.64 tonnes per visit. Greater efficiencies should be gained when the cleaning program is reviewed in line with catchment-wide standards and annual budget allocations.

Figure 7. Estimated Quantities of Debris Removed from Trash Racks, January 2005–mid-November 2005.



Note: **Western Racks** are along Cross Road and **Eastern Racks** are adjacent to Balham Reserve.

Strategy

6.2 (a) Regularly remove sediment and debris from trash racks to minimise deposition into basins and the main wetland.

6.2 (b) Promptly repair any damage to trash racks.

6.2 (c) Investigate alternatives to disposing of captured sediment and organic matter to landfill within Environment Protection Agency and Department of Human Services' guidelines.

6.3 Sedimentation Basins

The new sedimentation basins combined with expanded trash racks have been constructed to reduce sediment and organic matter accumulating in the main wetland (Section 6.4)

The surface water area of the Cross Road sedimentation basin at water level RL 68.80 is approximately 1,375 m^2 with a maximum depth of 1.5 m and 2.0 m for sediment deposition.

The basin receiving stormwater from Kitchener Street (near Balham Reserve) has a surface water area of approximately 406 m^2 at a water level RL 66.10, and a maximum water depth of 1.10 m.

Sediment removal will occur more frequently in the basins when compared with the main wetland. Therefore, landscaping of the basins has concentrated on hardy plant species that quickly establish or regenerate following disturbance.

Sediment removal should be undertaken during summer when basins dry out and excavators can gain access without sinking in mud. To enable this, stormwater will bypass the sedimentation basins and enter the main wetland.

If sediment is allowed to accumulate in the basins beyond 25-50 per cent of their capacity, the effectiveness of the basins will diminish and cause extra loading on the main wetland. Reducing the frequency of desilting the main wetland is an objective which will reduce maintenance costs, damage to the clay liner and habitat. Therefore, once capacity is reduced by 25 per cent desilting should be considered.

Strategy

6.3 (a)	Monitor sediment accumulation on an annual basis.
6.3 (b)	Consider desilting a sedimentation basin once its capacity has been reduced by 25 per cent.

6.4 Main Wetland

The detention basin or permanent water body constructed in 1996 is referred to as the ‘main wetland’ and ‘main pond.’

It is critical to maintain water levels above RL 65.88 to prevent cracking of the clay liner (300 mm thick) through swelling and shrinking. Once cracking of the liner occurs, its effectiveness will be reduced and may impact on groundwater levels. In the past, potential seepage through the clay liner was monitored from two observations wells.

A concern has been the accumulation of organic matter and sediment in the main wetland. According to BC Tonkins (1999) ‘organic loading’ is caused by the bypass of organic matter around the gross pollutant traps (Stage 1). Large quantities of decaying matter in sediments can decrease oxygen levels and lead to anoxic and anaerobic conditions - affecting plants and animals.

A study by BC Tonkins in 1999 concluded that sediment accumulation in the main wetland was below predicted levels for such basins, but further monitoring was required. Later in 2001, Tonkin Engineering & Science assessed a report on sediment accumulation in the main wetland by the Urrbrae Wetland Manager and students from UAHS. The report stated that there was approximately 1,200-2,400 m^3 of sediment (7-14 per cent of total wetland volume) which was significantly greater than that determined in 1999 investigations. Desilting is generally required when volume has been reduced by 20-30 per cent (Tonkin Engineering & Science, 2001). Desilting of the main wetland would need to be undertaken with care to avoid damaging the clay liner.

The possibility of desilting the main wetland remains but the frequency of taking this action has been extended with the construction of new sedimentation basins and trash racks (Stage 2). Whether desilting will be required remains to be seen and should be reviewed once capacity has reduced by 25 per cent.

Strategy

6.4 (a) Maintain water levels above RL 65.88 to minimise cracking of the clay liner.

6.4 (b) Monitor sediment accumulation on an annual basis to determine when desilting is required. Review management options once capacity has been reduced by 25 per cent.

6.4 (c) Consider desilting the main wetland once its capacity has been reduced by 25 per cent.

6.5 Farm Dam

The Farm Dam is approximately three megalitres in capacity and has a high density polyethylene (HDPE) liner to reduce seepage. This enables the water level in the dam to fluctuate widely in order to 'top up' the main wetland.

A sensor has been installed to turn on a pump when the water level in the main wetland is below RL 65.88. The opposite occurs when water reaches RL 65.90 in the main wetland, water is then gravity fed into the Farm Dam.

The Farm Dam is fenced around its perimeter, thereby separating it from the main wetland. This minimises unauthorised access as the lined banks are steep and slippery.

Water for injection into the aquifer, for an ASR project, should only be drawn from the Farm Dam. In summer draw down would frequently occur by one metre below the present level and occasionally by 1.5 metres (Armstrong and Clark, 1999).

Periodically the dam will need to be desilted to remove accumulated sediment and organic debris. The dam currently contains a large quantity of sediment and organic matter.

Sediment disposal should occur in consultation with the Environment Protection Agency and Department for Human Services as the sediment may contain elevated levels of pollutants. Disposal options may include land spreading, composting and dumping at landfill.

Care must be taken during maintenance operations to avoid damaging the polyethylene liner or dam. However, at some point the liner may need to be repaired or replaced as it may weaken through exposure to sunlight (ultraviolet radiation) and age.

Strategy

6.5 (a) Periodically desilt the synthetic lined dam (Farm Dam) and dispose of sediment in accordance with Environment Protection Agency and Department for Human Services guidelines.

6.5 (b) Periodically inspect the polyethylene liner for wear and replace or repair as required.

6.5 (c) Maintain the ballast pump and pipe work (between the Farm Dam and main wetland) to keep the water level above RL 65.88 in the main wetland.

6.6 Pumps

As listed in 3.1.4 there are three operational pumps:

- Floating pump (Farm Dam) - to lift water to the ASR tank;
- Return pump (submersible) – set at 60 metres below ground level in the ASR well;
- Ballast pump – set in a buried concrete tank near the Learning Centre to maintain minimum water levels in the main wetland.

The ballast pump and related equipment (i.e. pipe work) must be maintained for the main wetland to function correctly. It would be useful to document the details of all pumps for servicing and insurance.

Strategy

6.6 (a) Record the details of each pump (i.e. serial numbers and model) and place them on a maintenance program.

6.7 Bores

There are five bores on the Urrbrae Wetland site:

- Two observation wells to monitor seepage from the main wetland's clay liner were drilled in December 1996. One well is situated south-west of the Learning Centre and the other is on the western bank (Figure 5) of the wetland and are approximately 17 m deep. (Hodson, 1997).
- A bore for ASR was drilled to a depth of 93.6 m in 1997, and is situated in the south-west corner of the Farm Dam. Salinity of the ground water is approximately >1,500mg/L TDS. Problems encountered with the Tertiary sand aquifer include clogging of filter screens, sand pores and collapsing of the well which limits recharge and extraction rates. Gravity injection was required at 2L/ sec and withdraw at 2-3.5L/sec (John Botting and Associates Pty Ltd and Lisdon Associates, 1998). This bore is currently not operational and licences have lapsed.
- Two shallow bores approximately 25 m deep and 4.8 m apart, are drilled into the Quaternary Aquifer at the southern end of the Farm Dam. Groundwater is brackish and injection rates of around 0.1L/sec is considered too low to proceed with ASR trials in these wells (Pavelic et.al, 2005). Operating licences have been cancelled and would need to be reactivated at a later date on advice by the CSIRO.

The CSIRO will drill more bores next to the Farm Dam for further ASR trials into sand aquifers in both Adelaide, Melbourne and the Philippines.

Strategy

6.7 (a) Monitor observation wells for potential seepage from the main wetland.

6.8 Water Quality and Monitoring

When compiling this document, there were no water quality standards for stormwater (Ockenden, 2004).

In 2004 the Patawalonga Catchment Water Management Board let a two year contract for monitoring water, sediments and biota in five wetlands within the Patawalonga and Torrens Catchments. Urrbrae Wetland was included in this contract.

Sampling of water, sediments, wetland condition and some biota (macrophytes and significant macroinvertebrates) was undertaken twice each year - October/November and May/June (Table 3). However, sampling for microcrustacea, macroinvertebrates and fish was to be undertaken annually in late spring. Interpretation of data must be treated with caution due to intervals between sampling and the limited number of samples collected.

According to the Patawalonga Catchment Water Management Board (2003) the objectives of the program (described in detail in Appendix F) are to detect changes in:

- Water quality (inflow/outflow);
- Accumulated sediment;
- Nutrient and metal concentrations;
- Plant distribution;
- Phytoplankton species;
- Vertebrate and invertebrate species.

This program monitored each of the five wetlands as a functional unit, instead of a single focus on chemical analytes in the water column. Field data collected included water temperature, pH, Secchi depth, dissolved oxygen, and conductivity amongst other samples listed in Appendix F.

The standard Australian Rivers Assessment System (AusRivAS) sampling and processing protocols for South Australia was used for macroinvertebrates.

Testing for chemical analytes was to be undertaken using techniques for each analyte that provide a limit of detection no greater than the ANZECC (2000) guideline trigger level for protection of freshwater ecosystems. Chemical analysis was performed by a NATA accredited laboratory (Patawalonga Catchment Water Management Board, 2003).

In addition to the Board's contracted two year program, a monitoring program should be considered by the Urrbrae Wetland Management Committee to benchmark performance, fulfill annual reporting requirements and to guide management decisions.

Strategy

6.8 (a) Design and undertake a water monitoring program by qualified persons, ideally as part of a learning program.

Table 3. Water Monitoring Program

	Sampling & monitoring						
Analyte	Water	Sediment	Phyto-plankton	Wetland cond.	Biological	Micro-crustacea	Macro-invertebrates
Phytoplankton species present			■				
Abundance of potentially toxic Cyanobacteria			■				
Substrate composition				■			
Erosion &/or deposition				■			
Bank stability				■			
Riparian vegetation type & structure				■			
Significant vertebrates (fish, water birds, frogs, & mammals)					■		
Macrophytes (abundance_					■		
Microcrustacea – zooplankton (collection & identification)						■	
Macroinvertebrates (collection & identification)							■
Total Dissolved Solids	■						
Conductivity	■						
Filterable reactive phosphate	■						
Total phosphate	■	■					
Total oxides of nitrogen	■	■					
Total Kjeldahl nitrogen	■	■					
Ammonia	■	■					
Total Copper	■	■					
Total Lead	■	■					
Total Zinc	■	■					
Turbidity	■						
Faecal Coliforms	■						
Faecal Streptococci	■						
Chlorophyll a & b	■						
Total Organic Carbon	■	■					
Petroleum hydrocarbons	■	■					
Suspended solids	■						
Biochemical oxygen demand	■	■					
Sediment particle size		■					

6.9 Aquifer Storage and Recovery

Despite aquifer storage and recovery (ASR) trials at Urrbrae Wetland from 1997-2005, an operational ASR scheme has not been established.

The aquifer contains undifferentiated Tertiary sands which are believed to be of the Lower Port Willunga Formation. This aquifer is beneath the Hindmarsh Clay and Carisbrooke Sands (John Botting and Associates Pty Ltd and Lisdon Associates, 1998). Dr Hodson [Urrbrae Wetland] 2006, pers. comm.,) states that the fineness of the sands makes injection into this aquifer much more difficult than for fractured rock aquifers. The ASR trials demonstrated that:

> *Blockages develop between pore spaces of sand particles in the aquifer caused by organic substances in the stormwater. Collapse of the sand pack around the well screens occurs at low injection bracket extraction rates and sand clogs filters and pumps* (John Botting and Associates et al., 1998).

Trials indicate that the well can sustain a yield of 2.8L/sec from a pump setting at 60 metres (below top of casing). Gravity feed recharge is recommended at 2.5L/sec when the quality of pond water is satisfactory. At these low recharge and extraction rates, a single well ASR scheme at Urrbrae Wetland may not be viable when considering capital costs, maintenance costs and the current price of mains water. However the educational value of a working ASR project for visitors should not be ignored.

Pump out tests revealed that pond water remained in place in the aquifer for nearly ten months after injection at 300-320 ECU. Initial salinity levels in the aquifer were around 2,710 ECU/1,500 mg/L TDS.

As already stated in Section 6.7 the CSIRO are drilling more bores at Urrbrae Wetland for further ASR trails as part of an international research project. Hopefully, the trials will prove successful and unlock the sand aquifers for an operational scheme.

Strategy

6.9 (a) Maintain existing ASR infrastructure, plant and equipment in good working order.

6.9 (b) Continue to foster the partnership with the CSIRO.

6.9 (c) Establish an operational ASR project at the Urrbrae Wetland to reduce UAHS's dependency on mains water.

6.10 Indigenous Flora

Urrbrae Wetland has been landscaped with over 95 indigenous plant species. All plants have been collected under permit from seed or cuttings of local provenance. The collection areas include the lower Mitcham foothills, Southern Adelaide Plains, Belair National Park and the Lower Sturt River (Lane, 1996).

Seed collection and division of aquatic plants from Urrbrae Wetland can be utilised for revegetation projects around the wetland and possibly nearby watercourses. This activity should be monitored in respect to the City of Mitcham's and Urrbrae Agricultural High School's requirements.

Future plantings at Urrbrae Wetland should consider the following:

- Use of local provenance indigenous plants (or plant material) - collected locally where practicable;
- Minimise disturbance in areas which show signs of regeneration;
- High density plantings of native grasses, sedges and rushes to reduce weed competition;
- Use of hardy species in and around the sedimentation basins as they will be disturbed during desilting;
- Use of pioneering tree and shrub species in degraded areas. Consider using species that are taller than the weeds you are controlling;
- Where possible, for each tube stock planting use a tree sleeve, stakes and jute mat to maximise its chance of survival - do it right the first time!

Source tubestock from growers that:

1. Have current seed collection permits for the areas they are collecting from;
2. Grow quality plants (not root bound, leggy or haven't been sun-hardened);
3. Have quality assured hygiene practices to prevent the spread of *Phytophthora cinnamomi* (Pc).

Strategy	
6.10 (a)	Follow recommended guidelines and best practice methods for revegetating.

6.11 Weeds

Agricultural weeds are the most significant threats to establishing indigenous plants at Urrbrae Wetland. The site was once used for grazing and cropping which currently takes place in adjacent paddocks.

According to Kernick (2001) Wire Weed once dominated the site and could be seen in any direction. However, the Friends of Urrbrae Wetland, have worked very hard to bring it under control. The weeds for which significant progress has been made include:

- Wire weed;
- Salvation Jane;
- Fleabane;
- Plantain;
- Wild oats;
- Barley;
- Ash tree (*Fraxinus rotundifolia*);
- Briars;
- *Melaleuca* spp;
- Couch grass.

Pine oil has been used by the Friends as a herbicide on grassy and broad leaf plants with good success. Council arranges additional weed control in the form of brush cutting and spot spraying around the wetland's perimeter, sedimentation basins and areas nominated by the Friends.

On-going weed control is required, to combat weeds carried in stormwater, wind, by birds or from adjacent paddocks. It will never be a question of whether weed control is required, but simply a question of what level is required and what resources can be committed.

The construction of sedimentation basins has left large areas of bare earth and weeds have already established. In this situation, timed weed spraying followed by dense planting of indigenous plants, use of mulches and on-going weed control is recommended.

The Friends of Urrbrae Wetland have adopted a practice of targeting particular weeds, e.g. patrolling the water's edge for Briars, *Melaleucas*, Ash and Olive (Kernick, 2001).

The following techniques listed by Roche (2001) can be adopted for weed control at Urrbrae Wetland, particularly in areas of established native vegetation with understorey plants.

Brush cutting has been added to the list by the author.

- Hand Weeding
- Cut and Swab
- Weed brush
- Spot spraying
- Grubbing
- Brush cutting - target annual exotic grasses before they set seed in spring.

Strategy

6.11 (a) The City of Mitcham and Friends of Urrbrae Wetland to jointly control a range of weeds in and around the main wetland and sedimentation basins.

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6.11 (b) Undertake weed control to maintain native plants, aesthetics and reduce fuel loads along boundaries.

6.11 (c) Co-ordinate weed control with UAHS to reduce weed infestations from adjacent paddocks.

6.12 Fauna

When undertaking different works (i.e. desilting basins and weed control) it is important to consider indigenous flora and fauna that may be disturbed.

If a management action will significantly impact on a species, then implement measures to reduce such impacts. At times this may be unavoidable, but measures can be taken to minimise their effects.

Strategy

6.12 (a) Assess proposed works for their impacts on flora and fauna. Where impacts are likely or unavoidable, implement controls to minimise or eliminate them.

6.13 Pine Trees

The Pine trees along Cross Road, next to Urrbrae Wetland form a prominent streetscape. The species are *Pinus pinea* (Italian Stone Pine) and *Pinus halepensis* (Aleppo pine).

A site visit by the City of Mitcham's Arboricultralist, Andrew Wark and Urrbrae Wetland Manager, Dr Allin Hodson in September 2003 confirmed that many of the trees are in decline. The trees are shedding limbs and pose a safety hazard to visitors, pedestrians and passing vehicles along Cross Road. Trucks travelling west along Cross Road have hit overhanging limbs, whilst birds flying under the tree canopies have been killed by vehicles.

In response the following process is proposed to manage the risks posed (Wark, 2003):

1. Remove dead material from all Pines.
2. Remove potentially hazardous live limbs.
3. Assess the condition of all trees after pruning.
4. Identify any specimens for removal.
5. Submit appropriate development application(s).
6. Remove trees as per approval.
7. Monitor remaining trees and repeat steps 2 to 6 as required.

As Pine trees are removed due to poor health and structure, they should be replaced with suitable indigenous trees and shrubs - set further back from Cross Road. This will compliment the wetland's landscape and enable other vegetation to establish below their canopies.

Strategy	
6.13 (a)	Manage Pine trees in accordance with recommendations by City of Mitcham's Aboriculturalist to reduce safety hazards posed by the trees.
6.13 (b)	Any Pine trees that are removed will be replaced with indigenous trees and shrubs in keeping with the wetland landscape.

Site Issues

6.14 Security

Restricting unauthorised access to the Wetland was addressed in the joint use agreement between the City of Mitcham and the Department for Education and Children's Services. It is necessary to minimise public risk on the site, theft and vandalism of the Learning Centre (including the building, equipment, plants and animals).

Vandalism has been an intermittent problem over the years. The most serious incidents resulted in the chain link fence being cut and persons accessing the islands. Passing motorists have at times been the target of objects thrown from within the Wetland. Vandals have occasionally created a nuisance for residents along the western boundary by lighting fires and damaging property.

UAHS adopts a no tolerance attitude to vandalism on its property. Prosecution will follow any case of trespass and willful damage.

Measures taken to restrict access and minimise public risk include:

- Monitored security alarm in the Learning Centre;
- Sensor lighting around the Learning Centre;
- Security patrols each night;
- Liaison with Sturt Police. A key to the Wetland has been provided;
- Perimeter fencing - a 1.8 metre chain link fence surrounds the main wetland (Stage 1) and sedimentation basin adjacent to Balham Reserve. There is a 1.2 metre chain link fence along the Cross Road frontage of the adjacent sedimentation basin;
- Outside normal working hours, entry gates to the facility are only open when the site is attended by either the Wetland Manager, Friends Group, maintenance personnel or when an outside organisation has hired the Learning Centre;
- Guided Tours – schools arrange visits and lessons with the Wetland Manager. Staff involved with students still have responsibility for the safety and well being of their class. The Friends Group conduct open days for the public with specific guidelines to minimise impacts to the facility.

Strategy	
6.14 (a)	Maintain existing security measures with a view to improve them as required.

6.15 Public Use and Access

The public access Urrbrae Wetland through guided tours, workshops and student lessons to learn about a range of environmental topics. This fulfils the educational objectives for which the Minister for Education and Children's Services and UAHS allowed the wetland to be constructed.

Annual visitor rates are approximately 6,400 per annum. School tours account for approximately 5,000 visitors, followed by community groups with 1,000 visitors and 'off the street' visitors at 400 per annum. With an increasing interest in environmental education there is an escalating demand for 'field work' which the facility provides. This inevitably leads to an increased demand, and strain on wetland infrastructure.

Controlled public access to Urrbrae Wetland is considered necessary to minimise damage to plants, educational facilities and to maximise visitor safety.

Strategy	
6.15 (a)	Continue to offer public access to the Urrbrae Wetland through guided tours, workshops and student lessons.
6.15 (b)	Investigate options to improve facilities (i.e. paths) to handle an increase in visitor numbers and reduce impacts to revegetated areas.
6.15 (c)	Install interpretive signage around the wetland and sedimentation basins.

6.16 Fencing

The *Urrbrae Wetlands Early Works Planning Statement* (Kinhill Engineers Pty Ltd, 1995) stated that the entire wetland is to be fenced to control unauthorised access.

Controlled access is necessary to:

- Satisfy risk management issues of the Minister for Education and Children's Services and the City of Mitcham;
- Reduce impacts to wetland habitats;

- Reduce the likelihood of theft and vandalism to the facility and its teaching and operational equipment;
- Protect fauna from predators (i.e. cats and dogs);
- Control access to the open water body which can pose a risk.

Access is restricted to the main wetland and sedimentation basins by a 1.8 m and 1.2 m chain link fence. A burglar alarm is fitted to the Learning Centre which houses computers, books and laboratory equipment.

On several occasions the Patawalonga Catchment Water Management Board has requested changes to the Cross Road fence in order to improve aesthetics and public access. The Management Committee approves in principal a fencing upgrade provided the integrity of the Minister's land is preserved on its existing boundaries and external funding is forthcoming to meet the cost of a fencing upgrade.

Strategy

6.16 (a) Investigate options to improve site management and visitor access.

6.17 Paths

Access around the main wetland is by unmade paths and has resulted in some damage to plants, particularly where paths are not well defined. In winter, these paths become muddy and slippery. Mud clinging to shoes is tracked into the Learning Centre.

To accommodate visitors of all ages, paths should be hard surfaced whilst having a natural appearance. This can be achieved by using rubble mixed with cement which has been used successfully near the Learning Centre.

Limited wheelchair access is restricted to boardwalks and the Learning Centre. The remainder of the facility is in a state replicating the natural environment, and is not suitable to wheel chair access.

Strategy

6.17 (a) Construct hard surface paths around the main wetland using compacted road metal mixed with cement.

6.18 Car Parks and Vehicle Tracks

Car parking is provided in front of the Learning Centre and near the Cross Road entrance. The latter is used by buses when transporting students. There are a number of improvements which can be made to the car parks, and include:

- Provide dedicated bus parking along Cross Road;
- Improve the approach to Cross Road - currently too steep for buses;
- Increase the number of visitor parking places along Cross Road;
- Provide disabled parking bays next to the Learning Centre.

Signage could also be installed to limit vehicle speeds, warn drivers of pedestrians, entry/ exit points, and indicate the location of car parks. Signage design and placement should not create an eyesore and detract from the facility.

Vehicle tracks are constructed of road metal. The main vehicle track starts near Cross Road, leading to a small car park next to the Learning Centre. The same track branches off leading to the trash racks in the sedimentation basins.

Previously, heavy equipment used to clean the trash racks has damaged the track during winter. Therefore, maintenance of these tracks should be undertaken which may require grading with additions of road metal. In some areas reconstruction of the track may be required to accommodate heavy vehicles and to re-divert surface water.

Access along the boundaries of the main wetland should be maintained for emergency vehicles.

Strategy

6.18 (a)	Review vehicle movement, car parking and pedestrian movements with a view to redesigning the Cross Road entrance and, installing appropriate signs.
6.18 (b)	Maintenance of vehicle tracks is required and may include grading, additions of road metal and diverting surface water.
6.18 (c)	Maintain emergency service vehicle access along the boundaries of the main wetland.

6.19 Boardwalks

Boardwalks are an integral part of the educational aspect of the Wetland. The boardwalks enable students to collect water, sediment and biota samples from a range of habitats and depths.

There are approximately 138 metres of boardwalks and jetties around the main wetland. Maintenance issues include repairing mesh panels, fixing protruding nails, re-fixing boards and cleaning bird faeces from posts. Moreover, with age, rotting or damaged timber will need to be replaced. Regular inspections of the boardwalk should identify any areas needing repair.

Strategy

6.19 (a) Maintain boardwalks and jetties in a safe and tidy condition, fit for use by students, visitors and maintenance staff.

6.19 (b) Discourage ducks from sitting on posts by installing pointed caps.

6.20 Fire

In preparation for the fire danger season, grass height along the Wetland's boundaries is reduced to approximately 100 mm in October to November each year. This also improves the facility's appearance from vantage points on Cross Road and Balham Reserve.

The Learning Centre aims to comply with the fire and evacuation requirements of the Department for Education and Children's Services. Fire fighting equipment is regularly serviced and maintained.

Strategy

6.20 (a) Ensure fuel breaks along the Wetland's boundaries are in place during the fire danger season each year.

6.20 (b) Fire and evacuation safety requirements (including equipment) meet standards prescribed by the Department for Education and Children's Services, relevant Australian Occupational Health and Safety standards and codes.

6.21 Oil Discharge

Occasionally, waste oil illegally dumped into upstream waterways combined with surface oil deposits on roads within the catchment finds its way into the main wetland.

Illegal dumping of oil causes the most damage and was a problem during ASR trials. Therefore, a temporary oil boom was installed.

It is difficult to combat illegal dumping but greater community awareness and strategies to reduce the need for illegal dumping would be worthwhile.

Strategy

6.21 (a) Educate the local community in stormwater pollution prevention and promote oil drop off facilities for residents.

6.22 Partnerships

Urrbrae Wetland is a result of strong partnerships forged during the planning, construction and operational phases (Table 4).

Some partnerships were for a brief period due to the nature of a task, but others are long term and should be maintained. A case in point is the research to develop an operational ASR project with the CSIRO.

Table 4. Partnerships

Organisation	Comment
Minister of Education and UAHS	Provided land; employs Wetland Manager; joint use agreement outlines relationship; member of Urrbrae Wetland Management Committee. Benefits – an environmental education centre for schools in South Australia; Reduce consumption of mains water (economic and environmental benefits) through ASR.
City of Mitcham	Part funding of wetland construction (Stages 1 and 2); maintains wetland; Joint use agreement outlines relationship; member of Urrbrae Wetland Management Committee. Benefits – flood mitigation for nearby houses; working with the community.
Friends of Urrbrae Wetland	Assists in the maintenance of the Wetland and community education; observer at Urrbrae Wetland Management Committee meetings. Benefits – volunteering and helping the community manage an important asset; community awareness and education; maintaining revegetated areas.

Table 4. Partnerships (cont…)

Organisation	Comment
Patawalonga Catchment Water Management Board (now - the *Adelaide and Mount Lofty Ranges Natural Resources Management Board*).	Provided funding for the Wetland's construction (Stage 1 & 2), ASR research; technical input into designs; catchment wide project to clean up the Patawalonga. Benefits - following their charter; improving water quality in the catchment; flood mitigation; community participation in catchment management and education; stormwater reuse; ASR reduces mains water consumption and discharge of stormwater into the Patawalonga and Gulf St Vincent; publicity; established demonstration site.
State Government: Stormwater Subsidy Scheme	Provided funding for the Wetland's construction (Stages 1 and 2); ASR research funding. Benefits - reduced pressure on stormwater pipes under Cross Road; State Govt. is committed to reducing flooding and improving water quality in the catchment.
CSIRO Centre for Groundwater Studies	ASR research and development into Tertiary sands; funding contribution to research trials. Benefits - research; attract research funding; improve knowledge of Tertiary sand aquifers; unlock Tertiary sand aquifers for ASR.
Adelaide University, Unley High School, CSIRO	Funding contribution and input into ASR project. Benefits - research and potential user of ASR; reduce consumption of mains water (economic and environmental benefits).
Residents	Benefits - flood mitigation; aesthetics of the Wetland and its natural environment in a developed area.
Visitors	Includes students, clubs and general public; provide gold coin donations; learn about stormwater management, wetlands and ecosystems. Benefits - environmental education centre within metropolitan Adelaide.

Table 4. Partnerships (cont…)

Organisation	Comment
Consultants and contractors – engineering, geotechnical, landscape, water modeling and construction	Commissioned by City of Mitcham for the planning, design, supervision and construction, of Urrbrae Wetland Stages 1 and 2; hydrological modeling for stormwater reuse schemes; ASR trials; investigations into the functioning of the main wetland. Benefits – commercial (fee for service); Intellectual property.
Onga Pumps	Donated pumps. Benefits – promoting products.
SARDI	Assisted in introducing native fish into the main wetland. Benefits – research and increasing native fish populations.

6.23 Funding Strategies

The owner and leaseholder of Urrbrae Wetland (Minister for Education / UAHS and the City of Mitcham) have been successful in attracting substantial funding for the Wetland's construction (Stages 1 and 2), ASR research and, development and staffing of the Learning Centre.

Main sources of external funding have been the:

- State Government's stormwater subsidy scheme, administered by Transport SA;
- Patawalonga Catchment Water Management Board;
- Urrbrae Environs (University of Adelaide, CSIRO and Unley High School).

Strategy

6.23 (a) Seek funding from external bodies to further develop water conservation, quality and reuse opportunities.

6.24 Promotion and Marketing

The promotion and marketing of Urrbrae Wetland's achievements and attributes is important in attracting visitors, sponsorship and funding partners.

The Wetland has a number of unique attributes which can be packaged and capitalised on by sponsors and funding partners:

- Location: extensive main road frontage;
- Educational wetland;
- Wetland Manager's technical expertise;
- Adjoining farm land can reuse stormwater;
- ASR research by CSIRO on the site;
- Attractive landscape that is well maintained.

A marketing strategy may be developed by the Urrbrae Wetland Management Committee to attract sponsors and visitors. However, the Management Committee must consider the level of visitor numbers the Wetland can reasonably manage, against the impact of visitors and the primary purpose of the facility.

Strategy

6.24 (a) The Urrbrae Wetland Management Committee should determine appropriate visitor numbers for the facility, balancing their likely impacts against the aims and objectives of the Wetland.

6.24 (b) Develop and distribute marketing material suitable for attracting additional funding.

6.25 Community Education

Urrbrae Wetland has proved to be an important environmental education resource for South Australians of all ages – primary school children to senior citizens.

Community education has taken the form of guided tours (on request), three open days each year, interpretive displays, information packs, water quality testing ('Waterwatch') planting days, research assignments and, primary and secondary school lessons.

As with schools, groups from the broader community may access the Wetland by making prior arrangements or visiting during open days. This maximises the educational experience of the visitor, and minimises damage to the Wetland.

To maintain the educational facility, unrestricted access is simply not a feasible option. (see Sections 6.16). The small size of the site limits visitation rates which currently run at 1,500 each year for non students.

The Wetland fills a niche in environmental education for both primary and secondary school students. School base visitors run at approximately 5,000 students each year. It is reaching a point where one person can not adequately service the demand as bookings for visits and lessons increase.

The Learning Centre is currently equipped for macroinvertebrate and water quality studies. This enables students to not only tour the Wetland and appreciate the natural environment, but also have hands-on experience in data collection, analysis and interpreting observations or results. Important subjects of the educational program are water conservation, state of the River Murray, ASR and future water needs of South Australia.

To improve visitor education, interpretive signs should be installed describing the treatment of stormwater, pollutants, wetland construction, flora, fauna and observation wells. This would also provide visitors with an option for self-guided tours - when the facility is open.

Readily accessible information for people inquiring about the Wetland could be improved, particularly by way of information sheets held at the Council offices. In the early years of the Wetland, many technical information sheets were developed. This information can be revised and displayed on Council's and/or Urrbrae Agricultural High School internet site.

Strategy

6.25 (a)	Continue providing relevant education to specific groups such as primary and secondary students.
6.25 (b)	Enable self guided tours by providing interpretive signs along trails.
6.25 (c)	Provide information sheets on Urrbrae Wetland for distribution at Council Offices and other locations.
6.25 (d)	Urrbrae Wetland should have a presence on the internet from which the community can access useful information, e.g. information sheets, management plan, upcoming events and water quality testing data.

Summary of Strategies

Strategy No.	Strategy	Priority
6.1 (a)	To improve the quality of stormwater entering the main pond by reducing its velocity, and increasing the capture of organic and inorganic matter.	Highly Desired
6.2 (a)	Regularly remove sediment and debris from trash racks to minimise deposition into basins and the main wetland.	Critical
6.2 (b)	Promptly repair any damage to trash racks.	Critical
6.2 (c)	Investigate alternatives to disposing of captured sediment and organic matter to landfill within Environment Protection Agency and Department of Human Services' guidelines.	Highly Desired
6.2 (d)	Review the trash rack cleaning program to improve efficiencies and reduce costs.	Critical
6.3 (a)	Monitor sediment accumulation on an annual basis (sedimentation basin)	Highly Desired
6.3 (b)	Consider desilting a sedimentation basin once its capacity has been reduced by 25 per cent.	Critical
6.4 (a)	Maintain water levels above RL 65.88 to minimise cracking of the clay liner (main wetland).	Critical
6.4 (b)	Monitor sediment accumulation on an annual basis to determine when desilting is required. Review management options once capacity has been reduced by 25 per cent (main wetland).	Highly Desired
6.4 (c)	Consider desilting the main wetland once its capacity has been reduced by 25 per cent.	Highly Desired
6.5 (a)	Periodically desilt the synthetic lined dam and dispose of sediment in accordance with Environment Protection Agency and Department for Human Services guidelines.	Critical
6.5 (b)	Periodically inspect the polyethylene liner for wear and replace when required.	Critical
6.5 (c)	Maintain the ballast pump and pipe work (between the Farm Dam and main wetland) to keep the water level above RL 65.88 in the main wetland.	Critical
6.6 (a)	Record the details of each pump (i.e. serial numbers and model) and place them on a maintenance program.	Highly Desired
6.7 (a)	Monitor observation wells for potential seepage from the main wetland.	Highly Desired

Summary of Strategies (cont…)

Strategy No	Strategy	Priority
6.8 (a)	Design and undertake a water monitoring program by qualified persons, ideally as part of a learning program.	Highly desired
6.9 (a)	Maintain existing ASR infrastructure, plant and equipment in good working order.	Highly Desired
6.9 (b)	Continue to foster the partnership with the CSIRO.	Highly Desired
6.9 (c)	Establish an operational ASR project at the Urrbrae Wetland to reduce UAHS's dependency on mains water.	Highly Desired
6.10 (a)	Follow recommended guidelines and best practice methods for revegetating	Highly Desired
6.11 (a)	The City of Mitcham and Friends of Urrbrae Wetland to jointly control a range of weeds in and around the main wetland and sedimentation basins.	Highly Desired
6.11 (b)	Undertake weed control to maintain native plants, aesthetics and reduce fuel loads along boundaries.	Highly Desired
6.11 (c)	Co-ordinate weed control with UAHS to reduce weed infestations from adjacent paddocks.	Highly Desired
6.12 (a)	Assess proposed works for their impacts on flora and fauna. Where impacts are likely or unavoidable, implement controls to minimise or eliminate them.	Critical
6.13 (a)	Manage Pine trees in accordance with recommendations by City of Mitcham's Aboriculturalist to reduce safety hazards posed by the trees.	Critical
6.13 (b)	Any Pine trees that are removed will be replaced with indigenous trees and shrubs in keeping with the wetland landscape	Highly Desired
6.14 (a)	Maintain existing security measures with a view to improve them as required.	Highly Desired
6.15 (a)	Continue to offer the public access to the Urrbrae Wetland through guided tours, workshops and student lessons.	Highly Desired
6.15 (b)	Investigate options to improve facilities (i.e. paths) to handle an increase in visitor numbers and reduce impacts to revegetated areas	Highly Desired
6.15 (c)	Install interpretive signage around the wetland and sedimentation basins.	Highly Desired
6.16 (a)	Investigate fencing options to improve site management and visitor access.	Desired
6.17 (a)	Construct hard surface paths around the main wetland using compacted road metal mixed with cement.	Highly Desired

Summary of Strategies (cont…)

Strategy No.	Strategy	Priority
6.18 (a)	Review vehicle movement, car parking and pedestrian movements with a view to redesigning the Cross Road entrance and, installing appropriate signs.	Desired
6.18 (b)	Maintenance of vehicle tracks is required and may include grading, additions of road metal and diverting surface water.	Highly Desired
6.18 (c)	Maintain emergency service vehicle access along the boundaries of the main wetland.	Critical
6.19 (a)	Maintain boardwalks and jetties in a safe and tidy condition, fit for use by students, visitors and maintenance staff.	Critical
6.19 (b)	Discourage ducks from sitting on posts by installing pointed caps.	Highly Desired
6.20 (a)	Ensure fuel breaks along the Wetland's boundaries are in place during the fire danger season each year.	Critical
6.20 (b)	Fire and evacuation safety requirements (including equipment) meet standards prescribed by the Department for Education and Children's Services, relevant Australian Occupational Health and Safety standards and codes.	Critical
6.21 (a)	Educate the local community in stormwater pollution prevention and promote oil drop off facilities for residents.	Desired
6.23 (a)	Seek funding from external bodies to further develop water conservation, quality and reuse opportunities.	Highly Desired
6.24 (a)	The Urrbrae Wetland Management Committee should determine appropriate visitor numbers for the facility, balancing their likely impacts against the aims and objectives of the Wetland.	Critical
6.24 (b)	Develop and distribute marketing material suitable for attracting additional funding.	Highly Desired
6.25 (a)	Continue providing relevant education to specific groups such as primary and secondary students.	Highly Desired
6.25 (b)	Enable self guided tours by providing interpretive signs along trails.	Highly Desired
6.25 (c)	Provide information sheets on Urrbrae Wetland for distribution at Council Offices and other locations.	Highly Desired
6.25 (d)	Urrbrae Wetland should have a presence on the internet from which the community can access useful information, e.g. information sheets, management plan, upcoming events and water quality testing data.	Highly Desired

7. Implementation of Strategies

7.1 Management Zones

The Friends of Urrbrae Wetland have divided Stage 1 (main pond and Farm Dam) into 24 management zones. A further six zones have been created following Stage 2 (sedimentation basins) - see Figures 8 and 9.

The zones are mainly based upon on-ground features such as internal roads, fences, and ephemeral or terrestrial areas. The concept of creating zones will assist in recording and managing on-ground activities.

7.2 Management Committee

The Urrbrae Wetland Management Committee is well placed to oversee and review implementation of this management plan.

Monthly meetings provide an opportunity to resolve issues that may arise. Actions specified in the management plan can be standing agenda items for these meetings.

7.3 Monitoring, Evaluation and Review

Some actions will be easy to monitor and evaluate such as brush cutting fuel breaks, whilst others require a scientific approach to evaluate the success of an action such as sediment accumulation in the main wetland.

Besides monitoring water quality and sediment accumulation, vegetation monitoring can also take place. Suitable methods may include:

- Photo-points – monitoring vegetation change and erosion control;
- Vegetation Surveys – transects and quadrats.

Periodic review of actions can occur at Committee meetings by evaluating outcomes of each action, provided sufficient information is available. Therefore, sound practices can be repeated (or improved) and mistakes not multiplied.

Outcomes of the evaluation may be to alter actions for the coming year, re-prioritise actions and make changes to the management plan.

It is advisable to review this management plan in five years.

7.4 Resourcing

Roles and responsibilities for each organisation involved in the management of Urrbrae Wetland should be clearly defined to maximise efficiencies, outcomes and maintain good working relationships.

Following consultation with stakeholders involved in maintaining the Wetland, a summary of their roles and responsibilities are listed below in Table 5.

Table 5. Roles and Responsibilities of Stakeholders.

Stakeholder	Roles and Responsibilities
Minister for Education and Children's Services and UAHS	• Owner of the land; • Member of the Management Committee; • Develop and provide educational programs; • Monitoring programs as part of the school curriculum; • Maintain the Learning Centre and associated equipment (e.g. microscopes and computers) and watercraft; • Pay 50% of insurance costs; • Liaise with TAFE lecturers regarding the use of the wetland for environmental studies.
City of Mitcham	• Owner of the plant and equipment; • Member of the Management Committee; • Maintain the wetlands (plant and equipment including trash racks); • Initial landscaping of wetland and basins; • Brush cutting fuel breaks; • Emptying trash racks; • Maintenance of internal roads; • Supervision of Friends of Urrbrae Wetland; • Pay 50% of insurance costs.
Friends of Urrbrae Wetland	• Identifying and documenting native plants; • Weeding and pruning; • Mulching and planting; • Minor repairs; • Conduct tours of the site for interested groups. Note: Friends have agreed to undertake weed control around the sedimentation basins (Stage 2) with the support of the City of Mitcham using contractors for weed spraying, brushcutting and mulching.
TAFE (School of Horticulture)	• Periodic involvement; • Weeding (sedimentation basins, Stage 2); • Mulching and planting (sedimentation basins); • Monitoring programs as part of their curriculum.

7.5 Implementation Guide

The process by which this plan should be adopted and implemented is outlined below in Table 6.

Table 6. Implementation Guide.

Task	Issue	Duration and Status
Consultation of first draft plan (internal)	Review feedback from the Urrbrae Wetland Management Committee and modify the first draft where appropriate.	Completed
Consultation of final draft plan (internal)	Review feedback from the Urrbrae Wetland Management Committee and finalise the plan.	Completed
Council and UAHS adopt management plan	Management plan is adopted by Council and UAHS. Actions are endorsed.	Short term
Plan implementation	Management Committee to implement actions	Ongoing
Monitoring	Establish monitoring programs, i.e. gross pollutants, flora, fauna, sediment and water quality.	Medium term, ongoing
Evaluate and review	Annually review implementation of strategies and monitoring results.	Ongoing
Review plan	Plan should be updated to include new strategies, and actions.	5 year intervals (due 2011/12)

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