

# ALDINGA ARTS ECOVILLAGE STORMWATER PONDS

## *REHABILITATION REPORT: - ASSESSMENT AND RECOMMENDATIONS*

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## SUMMARY

The eight ponds that form part of the stormwater drainage system of the Aldinga Ecovillage development are generally regarded as unsatisfactory, in regard to the following issues:

Most ponds are very slow to fill, and some may not fill at all in a dry year, It is reported that the clay liners in the ponds may be ineffective, so that the ponds do not hold water well, The visual appearance of the ponds is very poor; some are devoid of plantings, others are weed infested, some ponds have exposed clay banks, and none are regarded as having appropriate wetland vegetation, The ponds have been fenced as a supposed safety measure; the need for this fencing is questioned.

Much of the drainage system that carries runoff to the ponds consists of grassed and rock lined swales; it is considered that these may be contributing to the poor performance of the ponds, by allowing water to soak into the soil, so reducing the amount of water reaching the ponds.

In this report, the factors affecting and contributing to the poor performance and appearance of the ponds has been assessed, and recommendations have been provided to improve both performance and appearance. Comment has also been provided in the report in relation to appropriate wetland species selection and planting of the ponds, mosquitoes, and the opportunity to harvest stormwater from the site.

The amount of runoff that the village site produces in an average year has been estimated, and this has been compared to the size (water volume) of the ponds. Several factors are considered to be affecting the poor performance of the stormwater ponds:

The catchments that generate runoff into the ponds are very low yielding. That is, the proportion of rainfall that falls on the catchments that is actually converted into runoff that reaches and flows into the ponds is very small.

The water volume of the ponds is large in relation to their catchment yield, and hence for much of the year, particularly when rainfall is low, insufficient water to fill the ponds and to maintain water levels for a good part of the year.

The extensive system of grassed swales are likely to be contributing to a reduction in the amount of runoff reaching the ponds, through seepage into the underlying soil.

The principal recommendations made in the report are summarised as follows:

The static water volume of possibly six of the existing ponds should be reduced by partial filling with soil. This will enable the ponds to fill more quickly with the available runoff.

The effectiveness of the clay liners to minimise seepage losses and hold water should be assessed. If found to be ineffective, then reworking or replacement of the liners should be implemented, so that the water losses from the ponds due to seepage is minimised.

The banks of the ponds should be regraded to batters not steeper than 1:5, and covered with topsoil.

It will be desirable to remove all weeds and bulrush (*Typha* spp) from the ponds, and replant with selected aquatic/wetland species, to establish a dense cover of vegetation. This should follow filling of the ponds to reduce their volume, and regrading and topsoiling of banks.

The installation of low flow / trickle flow pipes under or parallel to selected swales can be considered, to reduce infiltration losses from the swales and increase the amount of water delivered into the ponds.

The regrading of banks and establishing aquatic/wetland vegetation in the ponds will reduce and minimise any safety hazard associated with the ponds. This will ensure that the ponds conform to normal accepted practice in relation to safety, and will enable the fences to be removed, if this is considered desirable.

The development of a secondary water supply for the village, which could involve the harvesting of stormwater from the village ponds or the use of treated effluent from the village, is a complex issue and outside the scope of this study.

It may be that the best opportunity to make harvested stormwater available for use in the village may be as part of a much larger scheme, in conjunction with or in partnership with future developers or Council.



## **INTRODUCTION**

In this report, the factors that affect the filling of the Aldinga Ecovillage stormwater ponds and their ability to retain water are assessed, and recommendations made to improve their performance.

Safety issues and the removal of the existing pond fencing are discussed and recommendations made. Pond vegetation, weeds, and the establishment of suitable aquatic/wetland planting are also discussed, and comment provided on mosquitoes in ponds.

General comment has also been provided on the opportunities for water harvesting from the stormwater ponds, but any detailed assessment of this issue is considered to be outside the scope of this report.

## **VILLAGE STORMWATER DRAINAGE SYSTEM AND DETENTION PONDS**

Unlike the usual urban residential development, the drainage system of the Aldinga Ecovillage development uses mainly grassed swale drains and stormwater detention ponds, instead of kerb and gutter and pipe drains.

As shown in Figure 1, stormwater swales convey runoff from the development into a series of detention ponds, labelled as Ponds A to H.

The ponds have been designed simply to control the rate at which stormwater is discharged from the overall site. Once a pond has filled to its static water level, water above this level begins to discharge via an outlet pipe fitted with an orifice plate to control the flow rate. A high level spillway allows larger inflows to discharge without overtopping the banks surrounding the pond.

Once full, each pond then stores excess runoff, which is discharged slowly to the next pond, so that peak flows are detained for a short period within the series of ponds, and the final discharge rate from the site at the three outlet points is much reduced.

The design and layout of the ponds is simple, with straight, relatively steep batters. Unlike most urban wetlands, these ponds have not been designed specifically as wetlands to provide amenity, to improve water quality, or to create wetland habitat.

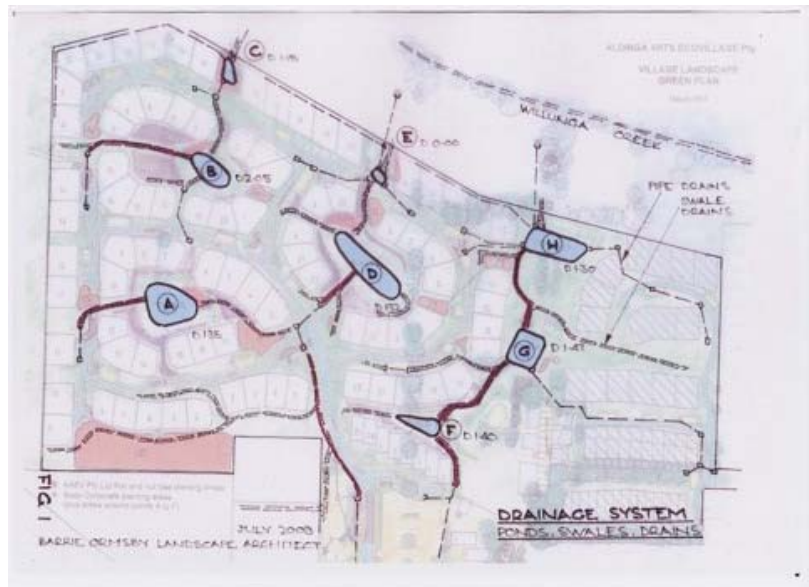
The design/construction drawings show that the ponds were to be constructed with a compacted clay liner to water level, then covered with topsoil, to ensure that they would hold water. The clay liner in most ponds does not appear to have been covered with topsoil, as evident in some ponds by exposed clay

banks.

**FIGURE 1**

**CATCHMENT YIELDS**

The amount of runoff into the ponds on an annual basis can be estimated, using annual rainfall data and a runoff coefficient. The estimated runoff can then be compared to the size (volume) of the individual ponds, to assess if the available runoff is adequate to sustain the ponds.



**3.1 Annual Rainfall**

Rainfall records are available for the Aldinga Post Office for the period 1894 to 1991, but none since that date. In that period, the mean (average) rainfall was 501 mm, and the median 483 mm.

Rainfall has also been recorded at Willunga (approx 7 km east of Aldinga) since 1862, but from 1998, records are only complete for the years 2000, 2004 and 2005.

It would be useful to know what rainfall trends have been evident in the area in say the last 10 years, given that rainfall in recent years has generally been below average. To this end, available rainfall data for several stations are shown in the Table below. Also shown in the Table are rainfall totals recorded at the Ecovillage for the period 2006 to 2008. (Noarlunga is about 14 km north of Aldinga,

**TABLE 1: Rainfall - Years 2000 to 2008**

YEAR	Noarlunga	Aldinga PO (1894 to 1991)	Willunga	Aldinga Ecovillage
2000	-	-	729	-
2001	588	-	-	-
2002	390	-	-	-
2003	615	-	-	-
2004	450	-	599	-
2005	504	-	764	-
2006	243	-	-	240
2007	424	-	-	490

2008	328	-	-	360
<b>Mean</b>	<b>443</b>	<b>501.3</b>	<b>649.6</b>	<b>363</b>

If the mean rainfall for Aldinga PO is approx 500 mm, then the record from the Ecovillage site indicates that the year 2007 was about average, while 2006 and 2008 were well below average. This can be compared with the data from Noarlunga, which shows that these two years were also the lowest in the 8 years of available recordings. The Noarlunga data also indicates that the last three years were below the average for the preceding 5 years.

For the purposes of calculating potential runoff from the Aldinga Ecovillage site, an average annual rainfall of 475 mm has been adopted. This is slightly below the long-term average of 501 mm for the Aldinga PO, but possibly better reflects rainfall trends at the present time.

The record for the Village also shows that the years 2006 and 2008 were well below average, which may account in part for the ponds not generally filling well.

### **3.2 Runoff Coefficient**

The runoff coefficient is the percentage or proportion of rain falling on a site that is converted to runoff.

Only part of the rainfall falling onto a residential site is converted to runoff, the remainder is 'lost' due to infiltration into the soil, localised ponding, evaporation, wetting of vegetation and pavements, etc. If the ground is very dry, more rain will soak into the soil; conversely, when the soil is saturated, much more of the rain falling on a site will be converted into runoff.

The Aldinga Ecovillage is unique in its form of development, with un-kerbed and narrow street pavements, a high percentage of open space, and with mainly grassed and rock-lined swales carrying runoff into a series of stormwater detention ponds.

In estimating runoff from the village site, a runoff coefficient of 0.10 has been adopted. This is based on the following:

The village is a low density development, with relatively large allotments, most without direct stormwater connections, and a high percentage of open space, At the present time, many allotments are vacant,

Streets have narrow pavements, without kerb and gutters, so that runoff from the sealed surfaces is discharged onto grassed verges and into grassed swale drains, A mainly surface drainage system of overland flows and grassed swale drains, which maximises the interception and retention of surface flows and allows considerable losses by infiltration into the soils to occur (this is exacerbated under dry conditions and in years of low rainfall).

The runoff coefficients generally adopted for conventional residential developments vary from 0.25 to 0.50, depending on the size of allotment and corresponding density, and the proportion of impervious surfaces. A figure of 0.25 is usual for typical older residential areas, while recent developments with smaller allotments and larger buildings may be 0.50 or higher. A coefficient of 0.10 as adopted for this site is more akin to that applied to a rural catchment.

The condition of the catchment has a significant effect on runoff. When soils are dry and possibly cracked, the amount of runoff and the rate at which surface water is absorbed is very much increased. Light rain and a dry catchment is unlikely to result in much runoff reaching the ponds. When the catchment and the soils are saturated after persistent rain, then the amount lost to the soil will be reduced and the runoff into the ponds will be increased.

### 3.4 Catchment Yields and Pond Sizes

A theoretical annual discharge or catchment yield has been calculated for the individual catchment for each pond, using the average annual rainfall, the adopted runoff coefficient, and the area of each. (Catchment areas have been scaled from a catchment plan provided)

As shown in Figure 1, the swale drains and pond form three separate systems, with ponds in series, with Ponds C, E and H being terminal ponds discharging off the site to Willunga Creek.

The upper pond in each system will receive inflow from its catchment, while the next pond in each system will receive any overflow from the pond above it, plus runoff from its own catchment.

The following Table 2 shows the estimated total annual catchment yield, pond volume, the total annual overflow from each pond, and the total overflow or discharge from the final pond.

**TABLE 2: Pond Volumes, Annual Runoff Yield, etc.**

POND	Pond Vol. (m <sup>3</sup> )	Pond Depth (m)	C'mnt Area (m <sup>2</sup> )	Annual Yield (to pond) (m <sup>3</sup> )	Yield to Pond Vol Ratio	Over-flow (from pond) (m <sup>3</sup> )
A	986	1.35	10,850	515	0.5	0
D	820	1.32	50,010	2375	2.9	1555
E	0	0.00	12,065	575	-	2130*
B	525	2.05	15,285	725	1.4	200
C	53	0.90	12,355	585	11.0	730*
F	210	1.40	11,065	525	2.5	315
G	610	1.47	30,735	1460	2.4	1165
H	677	1.30	29,775	1415	2.1	1903*

<b>Totals</b>	3880		=SUM(AB OVE) 172,140	=SUM(AB OVE) 8175	2.1	
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**Notes:**

Pond volume and depth from construction drawings (Connell Wagner Feb 2002)

"Annual Yield" is calculated using a runoff coefficient of 0.10 and an average rainfall of 475 mm/year.

\* Indicates total annual volume discharged from ponds E, C, and H to Willunga Creek; that is, surplus water available for reuse after filling of ponds.

Note that Pond D receives some additional runoff from Port Road (catchment area not known), Pond G receives additional runoff from Carter Street (catchment area not known)

Note that the overflow volume shown is the volume after each pond has filled, and this surplus volume is then transferred to the next pond. In practice, some water would be lost between ponds as water flows in the connecting grass swales.

#### 4.0 POND SIZE

In comparing the existing pond size with the estimated (annual average) runoff (as per Table 2), it is necessary to establish what would be regarded as the 'normal' size of a stormwater wetland in relation to its catchment area and estimated runoff.

##### 4.1 Wetland Sizing – Common Practice

Most urban wetlands have water quality improvement as a desired outcome. A common method or 'rule of thumb' for sizing wetlands to achieve the desired water quality performance is the "10 day detention time" volume. The average daily winter runoff is calculated for the catchment, and then multiplied by 10 to derive the required or desirable (minimum) volume for the wetland.

Generally, using this method or other established wetland design guidelines to size a wetland generally assures that runoff from the catchment will fill the wetland relatively early after the autumn 'break', and it will remain full throughout winter and into spring.

##### 4.2 Village Ponds

If this calculation is carried out for the village site catchment, using an average annual rainfall of 475 mm and a coefficient of 0.10, the calculated desirable '10 day' volume for the combined ponds would be 310 m<sup>3</sup>.

This can be compared to the actual as-designed static volume of the nine

ponds in the village site of 3,880 m<sup>3</sup> (refer Table 2), which is 12.5 times larger than the calculated '10 day' volume of 310 m<sup>3</sup>. The result is that the ponds require much more rainfall to occur before the ponds can fill, than would otherwise be the case if the ponds had been sized and designed using current wetland design guidelines.

As the column "Yield to Pond Vol Ratio" in Table 2 demonstrates, the ponds, except for Ponds E and C, are very much over-sized for their calculated annual catchment yields.

The result of this 'oversizing' is that the ponds are very slow to fill from autumn and winter rainfall, and the length of time that the ponds remain full may be very limited. Any summer rainfall and storms, which are often very significant in maintaining water levels in urban wetlands during summer, will have a very limited effect in maintaining water levels or refilling the ponds.

This poor performance of the ponds is exacerbated in a year when rainfall is below average and the soils of the catchments are much dryer than normal, and so in-site losses (seepage into the soil, etc) are much higher.

This provides a likely explanation for the poor water level performance of the ponds. This would be particularly evident in years with below average rainfall.

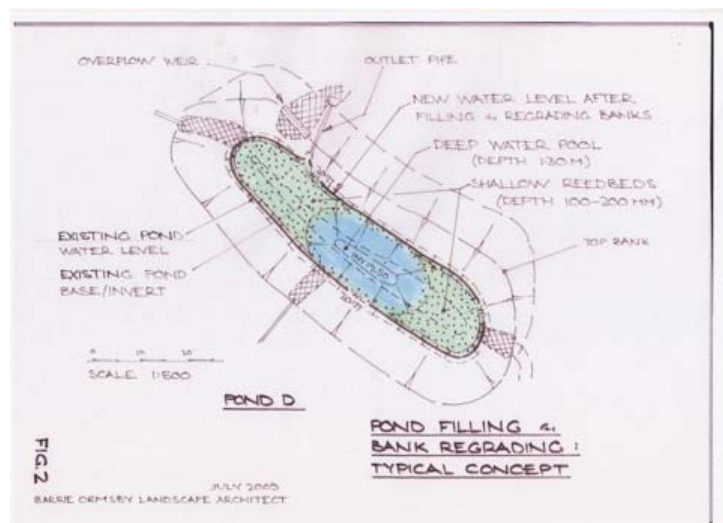
The only possible and practical means to improve the filling of the ponds are:  
Decrease the volume of the ponds,  
Increase the catchment area feeding runoff to the ponds.

The partial filling of the ponds with soil to reduce their static water volume would enable the ponds to fill following a much smaller amount of rainfall, and would appear to be the most practical means to achieve a pond system that holds water for a good part of the year.

Figure 2, as a typical example, provides an illustration of the partial filling of a pond to reduce its static water volume – an area of deep water is retained, and the remainder is filled to a depth that would create areas of shallow reedbed habitat.

## FIGURE 2

In this typical configuration, the shallow areas in the ponds would dry out early in the season, depending on late spring/early summer rainfall, while the deeper pool, with a depth of 1.20 to 1.30 m, should retain some water throughout summer. (Evaporation from a wetland in summer is generally



in the order of 0.75 m). However, a small amount of runoff from a summer rain event would be able to raise the water level significantly in the smaller pool.

It may be possible to divert additional stormwater into the village site from Port Road, but this would presumably require works to channel water into the existing village drainage network. It may be worthwhile to discuss this option with Council, but any benefit may be limited.

#### **4.3 Recommendations:**

Filling of selected ponds be carried out to reduce their static water volume, so that the ponds can fill more quickly with the available runoff.

Discussions be held with the City of Onkaparinga to determine if it is practical to divert any stormwater from areas around the village site into the village ponds.

#### **5.0 POND CLAY LINERS**

A clay liner in a pond or wetland is intended to act as an impermeable layer, preventing loss of water by seepage into the underlying, more permeable soils. However, if the clay dries out, it can shrink and crack, reducing its effectiveness. A cover of soil over the clay, as well as providing a growing medium for pond vegetation, is used to minimise drying of the clay, and so preserve its function.

The design drawings for the ponds show a 300 mm thick compacted clay liner to pond water level, with a cover of 300 mm of soil.

It has been reported that the ponds do not hold water very well, and it is also suggested that the clay liner was not constructed and installed according to design. It would also appear that the soil cover over the clay was not provided, leaving the clay exposed, and so subject to drying and cracking, as well as erosion, which would reduce its effectiveness.

Initially, it may be possible to check if the ponds are leaking by placing a marked or graduated stake in the water, and observing the drop in water level over a period of several days or a week without rainfall or any inflow to the ponds. The loss in water level due to evaporation to the atmosphere can be measured in a large open container, placed in the open. The evaporation loss can then be subtracted from the drop in water level as measured in the ponds, to obtain the loss in water due to seepage.

If it is suspected that the ponds are not holding water, then it will be necessary for the liners in the ponds to be examined and tested to determine what action is necessary to improve their performance.

If the liners are found to be inadequate, then some form of remedial works may be necessary and justified. This would entail the installation of a new liner, or an upgrade and reworking of the existing liner.

This could be either:

Installation of a geosynthetic clay liner (Bentofix) or a plastic membrane within

the existing pond, and cover this with a minimum of 300 mm of suitable soil, to both protect the liner and to provide a growing media for aquatic/wetland plants.

Reconstruct and extend the existing compacted clay liner to a level above the outlet pipes, sourcing and importing additional clay if necessary, and cover this with 300 mm of soil to both protect the clay and prevent drying out, and to provide soil for aquatic/wetland plants.

#### ***5.1 Recommendation:***

The clay liners in the ponds should be examined and tested to determine their effectiveness to hold water without significant loss from seepage.

If found to be inadequate, then consideration be given to either installing a new liner (either a geosynthetic clay liner or a plastic membrane) or reworking the existing compacted clay liner. The liner must then be covered by a minimum of 300 mm of soil, to provide physical protection against damage and drying of the clay, and to provide a growing media for plants.

### **SWALE DRAINS**

Grassed and rock-lined swale drains have been used extensively throughout the development to collect and convey stormwater to and from the various detention ponds.

Swale drains are a low-cost and environmentally beneficial means to carry stormwater in many sites, in comparison to conventional underground drainage pipes. They allow some water to soak into the soil, thus recharging soil moisture, and silt and some pollutants can be filtered out as water flows through the grass cover in the swale.

The extensive use of swales in this development, and the relatively small catchments feeding into each swale, means that the potential loss of water through seepage into the soil can be considerable, particularly following summer when soils will be very dry, and even in winter after periods without rain, when the soil has had an opportunity to dry out to some degree.

Some swales have been lined with loose rock (riprap); the seepage loss from these would be increased, compared to a grassed swale.

While the recharge of soil moisture is beneficial for the landscape and overall environment of the development, the end result is that there can be a significant reduction in the volume of water actually reaching and flowing into the stormwater ponds. This will be particularly marked in a dry, below average rainfall year, when the soils of the swales have had very little opportunity to become saturated, and so will absorb a larger proportion of the runoff entering the swales, whenever rain does fall.

If the loss of water through seepage in the swales is considered detrimental to the pond system, and this loss is not offset by the other environmental benefits of the swale system, then the installation of a trickle flow pipe system under or parallel to the swales could be considered.

A trickle flow pipe system would collect and carry small flows directly to the ponds that would otherwise be lost through seepage in the swales.

The priority for installation of trickle flow drains would be for swales that carry overflow from one pond to the next, and that collect water from points where a significant amount of runoff, such as from an area of hard surface, enters a swale drain. Some swales would probably not justify the cost of installation, such as where the only runoff is from areas of natural grass surface.

Swales considered to have some priority for the installation of trickle flow drains are shown red in Figure 1.

These could consist of small diameter pipes, such as 100 mm uPVC stormwater pipe, at a shallow depth below the surface, with small grates at intervals along the inverts of the swales to allow water to be diverted into the pipes.

Under heavy intense rain, the swales would continue to carry the bulk of the runoff to the receiving ponds as before.

One disadvantage of a trickle flow pipe system is that water flowing in these pipes is not subject to the filtration and cleansing that flows in the swales are subject to, and so the water entering the ponds would be of a lower quality. However, given the low density and nature of the development, the quality of the runoff is not likely to be a major concern.

### ***6.1 Recommendations:***

If the loss of runoff in the swales is considered sufficiently detrimental to the performance of the pond system, then the installation of small diameter trickle flow drains under selected swale drains be considered, possibly after other works to rehabilitate the ponds have been completed.

## **POND FENCING AND SAFETY**

The existing ponds have been fenced with swimming pool type safety fences. These were installed originally for insurance purposes, but it is understood that these are no longer a requirement of the insurance company.

The fences are visually intrusive, and alienate and isolate the ponds, which should be focal points in the landscape of the open space of the village, from the overall landscape.

The ponds were designed and presumably constructed with batters of 1:4. The static water depth of the ponds varies from 0.90 m to a maximum of 2.05 m.

It would also appear that the ponds were not topsoiled as the construction drawings required. The resulting slippery and muddy exposed clay on the banks is both hazardous and unsightly. Any exposed clay should be covered with soil to minimise this hazard, and to allow the successful establishment of wetland vegetation.

Constructed urban stormwater wetlands are not normally fenced, except around features such as gross pollutant traps and sedimentation ponds, which are often concrete structures, may have steep batters, and may contain a depth of unconsolidated silt (and are often unsightly).

Generally, urban wetlands, if designed and constructed according to accepted guidelines, are regarded as not being hazardous. Batters are generally relatively flat (1:5 or flatter), which means that any deep water is some distance from the water edge. Water edges are normally densely vegetated with aquatic plants, which act as a barrier and a discouragement to deliberate entry into the water, as well as providing a firm footing and handholds for anyone wading or falling into the water. Water velocities within wetlands are normally very low, which eliminates the possibility of a person or child being swept away by fast flowing water.

It is recommended that the pond batters be regraded to a slope of 1:5 or flatter, the banks be topsoiled and aquatic/wetland plants be established, before any fencing is removed. This work should be done in conjunction with the recommended filling of the ponds to reduce their static water volume and any rehabilitation the clay lining.

This would ensure that the pond batters comply with accepted wetland design standards, and so should be acceptable in relation to safety issues. However, it is suggested that fences not be removed until regrading of the banks has been carried out, regardless of insurance company requirements.

### ***7.1 Recommendations:***

It is recommended that the banks of the ponds be regraded to a batter of not steeper than 1:5, topsoiling be carried out and plantings be fully established, before fences are removed.

## **POND VEGETATION AND PLANTING**

Some of the ponds are virtually devoid of vegetation, some have some established wetland plants, and some are infested with weeds and bulrush.

Bulrush (*Typha* species), although a native plant, is totally unsuitable in a small

wetland or pond, as it is invasive and will quickly dominate and suppress all other vegetation, creating a monoculture with low biodiversity and poor appearance.

Every effort should be made to eradicate this plant from ponds in which it is present. This is best achieved by careful spraying with a Glyphosate herbicide "Roundup Bioactive", when the plant is actively growing, preferably when water levels are low.

Repeated cutting of the plants below water level is another method used to control bulrush. It could also be removed by excavation as part of any earthworks necessary to reduce pond volumes, restore clay liners, or regrade the banks of the ponds.

Many of the ponds have dense cover of couch grass, which is able to survive being flooded for long periods of time. The only practical method of eradicating couch (other than excavation and complete removal of the soil) is repeated spraying with a Glyphosate herbicide during the active growing season. This is a non-selective herbicide, and all other plants will be killed as well.

In any pond that has serious infestations of weeds, it may be necessary and desirable to start any replanting with a "clean slate", by killing off and removing all existing vegetation, including any desirable plants. This will enable replanting to be carried out into a site as weed-free as possible.

The objective then would be to establish a dense cover of the desired species that will be able to compete with and suppress any weeds that may subsequently invade.

### **8.1 Species Selection**

The following species are considered suitable for planting the ponds. Tall or aggressive species should be avoided, as these are unsuitable for small ponds or wetlands.

The species listed are mainly locally occurring plants, but a few would occur in the higher rainfall areas to the east, and are included to provide biodiversity and visual interest.

Spreading Species:

*Baumea juncea*  
*Bolboschoenus caldwellii*  
*Carex bichenoviana*  
*Centella cordifolia*  
*Eleocharis acuta*  
*Hydrocotyle verticillata*  
*Lythrum hyssopifolia*  
*Marsilea drummondii*  
*Schoenoplectus pungens*

Clumping/tussock growth habit:

*Carex appressa*  
*Cyperus gymnocaulis*  
*Cyperus vaginatus*  
*Gahnia filum*  
*Isolepis nodosa*  
*Juncus bufonius*  
*Juncus kraussii*  
*Juncus pauciflorus*  
*Juncus sarophorus*

Submergent Species:

*Myriophyllum crispata*  
*Myriophyllum verrocosum*  
*Triglochin procera*

## **8.2 Recommendations:**

The establishment of suitable aquatic/wetland plants in the ponds is an essential part of the upgrading of the ponds, and should be carried out as an integrated package of works to rehabilitate each pond.

## **MOSQUITOES**

A well-established wetland does not normally contribute to a mosquito problem in an urban area, as the natural predators of a wetland ecosystem control and prevent mosquito larvae from surviving to maturity.

Mosquitoes can breed occasionally in ephemeral wetlands, particularly immediately following the first filling after being dry. Once natural predators have established later in the season, larvae would normally be controlled.

The measures recommended elsewhere in this report to ensure that the ponds maintain water levels and so increase their permanency, such as partial filling to reduce their static water volume while retaining water depth, and utilising runoff from other catchments, will assist to maintain the wetland ecosystems that will help to reduce any potential for mosquitoes to breed successfully.

The introduction of suitable native fish species to ponds that have permanent water can also assist in controlling mosquito larvae in those ponds, and could be considered in the longer term.

## **WATER HARVESTING**

Other than providing general comment, the assessment of the feasibility of harvesting stormwater or the reuse of treated effluent as a secondary water supply in the village, is outside the scope of this report.

The development of a secondary, non-potable water supply for the village would reduce the demand on the reticulated mains supply, and possibly enable the community to become more self-sufficient. This would also require the installation of a reticulation system to deliver that water to users. For this to be economically viable, it is considered that a reliable, year-round supply would be essential.

Two options to provide a secondary water supply for the village could be considered:

Stormwater harvested from the village drainage system, and,  
Treated effluent, sourced from the village sewage system.

### **10.1 Stormwater Harvesting Options**

Direct use of water from a pond or wetland during summer is generally considered undesirable, as this lowers the water level in the pond at a time when

inflow is very infrequent or unlikely, and evaporation losses are at a maximum. This would affect the appearance of the waterbody, reduce its value as habitat, and possibly leading to it drying out.

Harvesting of winter stormwater for use in summer generally requires some form of storage, which may include:

Surface storage dams (subject to evaporation losses, unless covered, but relatively low cost if a suitable area is available)

Storage tanks (surface or underground, usually only appropriate for low volume systems, or where some water can be harvested during summer to maintain a supply)

Aquifer injection and storage (can be very high cost, requires permit/ approvals from various authorities, ongoing monitoring and water quality compliance requirements for injection, etc)

## **10.2 Available Stormwater Resource**

Table 2 provides an estimate of the (calculated) overall yield in an average rainfall year from the individual catchments within the Ecovillage site, as well as an estimated surplus or overflow after all ponds have filled. This surplus or overflow is what would be available for harvesting.

The volume of water leaving the site in an average year is estimated at about 4,700 m<sup>3</sup> or 4,700 Kilolitres.

However, in a dry year, such as 2006 when the total rainfall for the year was about half of the average, the estimated surplus is estimated to be not more than about 1,000 m<sup>3</sup>, but may possibly be much less, due to increased losses within the catchments resulting from dry soils, etc.

It would be expected that the catchment yields would increase as vacant allotments are developed, and this will have a significant impact on the water available for harvesting. The diversion of additional stormwater from outside the site, if feasible, would also add to the available resource.

If the recommendations to reduce the static water volumes of the ponds were carried out, the amount of water available for harvesting would also be increased, possibly to about 6,100 m<sup>3</sup> in an average year.

Given the small size of the site and the low yield of runoff, it may be that the best opportunity to make harvested stormwater available for use in the village may be as part of a much larger scheme, in conjunction with or partnership with future developers or Council.

## **10.3 Sewage Effluent**

Sewage effluent, treated to a suitable standard (Class A), would provide an alternative supply of secondary, non-potable water for use for irrigation of gardens and landscape, or selected domestic use (eg, toilet flushing).

Sewage effluent could be used as a stand-alone secondary water supply, or supplemented with harvested stormwater when this was available.

Treated effluent has the advantage of being available year round, and would probably only require a minimal storage capacity, able to cope with short-term demand variability, to be viable.

**10.4 Recommendations:**

If the development of a secondary or supplementary water supply for the village were to be considered, then the first step would be a detailed resource assessment and feasibility study.

*Barrie Ormsby*

BARRIE ORMSBY LANDSCAPE ARCHITECT

3 August 2009

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