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Winchester sub-catchment management plan

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WINCHESTER SUB-CATCHMENT MANAGEMENT PLAN

A Report to the Carnamah Land Conservation District
being one part of the Petan Creek
Catchment Management Plan

August, 1989

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SUMMARY AND RECOMMENDATIONS

The 590 Ha Winchester sub-catchment has no apparent external drainage. Groundwater levels are rising causing site specific problems. Wind erosion has severely affected some areas.

The objective of this report is to provide a sub-catchment management plan that is based on sustainable agricultural systems and a hydrological equilibrium. The recommendations aim to meet this objective in the long term.

Recommendations to achieve short term results are considered separately. These measures have relatively high installation and maintenance costs. They should be considered as interim management methods until the recommendations for long-term control become effective (perhaps 3 - 5 years after implementation).

The proposed sub-catchment management plan is based on the following long term recommendations:

- establish 45 Ha of tagasaste
- fence 37 Ha of remnant vegetation
- plant 5,270 trees for recharge control
- plant 8,600 trees for discharge control
- full establishment of the existing arboretum
- consider establishing a 4.5 Ha commercial plantation of *Banksia spp.*
- rehabilitate four gravel pits
- rehabilitate severe wind eroded areas
- pump dry the full lake
- construct earthworks for surface water control
- encourage optimum agricultural production
- implement the plan over a three-year period
- develop a monitoring scheme
Optimal drainage and pumping proposals for short-term results are:—

- excavate feeder drains to remove seepage water on north and south sides of Winchester East Road.

- install windmill(s) above a sump to remove seepage water

- excavate drains to control water in lakes west of the major lake

- install a culvert with control gates to manage the water level in the major lake

It is recommended that the full lake be pumped dry to establish the daily rate at which it refills before drainage and seepage pumping methods are installed.
1. **INTRODUCTION**

The Winchester sub-catchment is located 12 km south-east of Carnamah in the northern wheatbelt of Western Australia. The 590 Ha sub-catchment (Map 1) is within the Petan Creek catchment (43,300 Ha) which drains in a south-westerly direction to the drainage system south of the Yarra Yarra Lakes. The Winchester sub-catchment is characterized by having no apparent external drainage into the Petan Creek catchment.

Integrated property and catchment management plans are being prepared for the Petan Creek catchment. The aim of the planning process is to co-ordinate management strategies that are most suitable to reduce the land degradation processes that are causing major problems. The most significant problems have been identified as water run-off, flooding and regional salinity. The planning process is also expected to encourage improved land management resulting in increased agricultural productivity.

Five landholders have properties in the sub-catchment. Other land is managed by the Winchester Cemetery Committee for the Shires of Carnamah and Coorow. The area of each property is listed as follows:–

<table>
<thead>
<tr>
<th>Location</th>
<th>Area (Ha)</th>
<th>Percentage of Sub-Catchment (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>M1610</td>
<td>198</td>
<td>33.5</td>
</tr>
<tr>
<td>M1058 + M1215</td>
<td>165</td>
<td>27.8</td>
</tr>
<tr>
<td>M1309</td>
<td>118</td>
<td>19.9</td>
</tr>
<tr>
<td>M1792</td>
<td>97</td>
<td>16.4</td>
</tr>
<tr>
<td>Cemetery</td>
<td>14</td>
<td>2.4</td>
</tr>
<tr>
<td><strong>Total Area</strong></td>
<td><strong>592</strong></td>
<td></td>
</tr>
</tbody>
</table>
The Winchester sub-catchment is being considered intensively because of its internal drainage as well as specific management problems that occur there.

The major land management problems that have been identified are described as follows:

**Sandplain seepage** - a deep yellow sandplain soil type (DYS) occurs over 54.6% of the sub-catchment. Excess soil moisture recharges the unconfined aquifer. The hydraulic conductivity of these sands is relatively high (up to 30 m/day) so during months when rainfall is high, seepage water accumulated in lakes.

The main lake in the sub-catchment is a natural feature. However, since the landscape has been cleared for agriculture, an increased percentage of rainfall enters the unconfined aquifer such that seepage is now more extensive than it was when naturally vegetated. The additional seepage water is causing the groundwater level throughout the sub-catchment to rise.

**Increasing water and soil salinity** - the increased aquifer recharge since clearing natural vegetation has caused mobilization of salts stored in deep soil profiles. The additional salt input accumulates in the lake and is concentrated by evaporation. The direct effect is that the natural vegetation of the lakes (dominated by *Melaleuca spp.*) is very degraded.

Salinity has not affected an extensive area of the sub-catchment and is unlikely to do so because of the soil types and topography. However, the 10 Ha seepage site north of the Winchester East Road (Location M1059) is extending into agricultural land. Significantly, this seepage areas is a major contributor of saline water to the lake.

**Wind erosion** - the extensive areas of yellow sandplain are susceptible to wind erosion. Severe effects of wind erosion occur on 7.8 Ha (1.3% of the sub-catchment) on Location M1610.

Less obvious damage occurs more extensively across the area of deep yellow sands. The short term effects may be crop damage during a winds storm. The long term affects are a progressive decline in soil fertility.
Rising groundwater levels - the effects of rising groundwater levels since clearing have been pronounced by the cessation of ground water pumping directly west of the cemetery. The immediate effect is on the cemetery site which serves the Shires of Carnamah and Coorow.

A perceived effect was that the rising saline aquifer may intrude into the borefield south of the sub-catchment which supplements the Carnamah town water supply. Following consultation with Dr Adrian Peck (ROCKWATER PTY. LTD.), the risk of this occurring is not considered to be imminent.

This report aims to provide a comprehensive sub-catchment management plan that provides solution options for the four major land management problems. While short-term solutions to specific problems are considered, emphasis is attributed to developing sustained agriculture systems that reduce land degradation, solve the specific problems and improve farm productivity.

It is also anticipated that a rejuvenated lake environment adjacent to the cemetery is desirable.
2. **SUB-CATCHMENT DESCRIPTION**

The physical resources of the Petan Creek catchment will be described more fully in a subsequent report. The factors that are relevant to the four major land management problems in the Winchester sub-catchment are described here.

2.1 **Geology**

The geology of the sub-catchment is dominated by granite rocks (Archaen era) and chert (Proterozoic era) as shown in Figure 1. These formations are significant by the soils that are formed from them, and because they are probably deeply fractured which influences deep ground water aquifers.

![Geological Diagram]

**Figure 1** Geology of the Winchester Sub-Catchment
A major dolerite dyke occurs to the north-east of the Winchester Sub-catchment. Campbell Sandstone occurs to the west.

Deep yellow sand of aeolian origin covers much of the dominant bed rock to depths in excess of 9 meters. The topographical relationship between the sand profile and the underlying geology is the major determinant of ground water movement within the sub-catchment.

Gravel pits show the occurrence of a lateritized profile on Locations M1058 and M1215. Beneath the encrusted surface material, a deeply weathered pallid zone exists. The low permeable clays of this zone have considerable salt storage.

2.2 Land Management Units

The complexity of variable soil types has been reduced by considering land management units (LMU's). These are areas of relatively homogeneous soil characteristics considered at a scale that is relevant to land management. The distribution of five LMU's is shown in Figure 2. They are described as follows:-

DYS - deep yellow sand

The dominant LMU occurring over 54.6% of the sub-catchment. There is relatively high recharge to the unconfined ground water aquifer through this unit. The soil profiles are uniform textured but the clay content varies with topographical position. The pH of these soils is neutral but tending to be acid.

RSG - residual sand over clay

The soils of this LMU are remnant of the ancient lateric peneplain. They are characterized at the surface by a cemented duricrust or loose gravels above mottled clays. Recharge through these layers to the deep pallid zone clays is significant in mobilizing stored salts.

HRS - heavy red soils

Red coloured texture contrast (sandy loam over clay) soils occur on Location M1309. They are significant to the major land management problems by the run-off water that is contributed to the lake storage.
ALC - alluvial clay

The soils of this LMU are characterized by a deep clay horizon with very low permeability.

The orientation of this LMU suggest that it was formerly a drainage line from the sub-catchment to Petan Creek. Changes in roadside vegetation 450 meters north along Road No. 14 support this. It is possible that the internal drainage of the catchment has been caused during uplift along the Darling Fault Line which truncated the former drainage line.

During winter this unit remains waterlogged and is relatively unproductive.

SS - skeletal soils

Shallow (skeletal) soils usually occur adjacent, to, or in association with, areas of exposed parent material. They are either recently formed or are the remnant coarse fraction following illuviation of clays.

Within the sub-catchment, they occur in association with chert (SSc) and exposed laterite (SSL).

The significance of this soil type is the limited soil water storage capacity. The profile is rapidly saturated, after which, an increased percentage becomes run off.

The distribution of the five LMU's within the Winchester sub-catchment provide direction for the composition of management strategies for the major land problems.

2.3 Hydrology

2.3.1 Rainfall

The average annual rainfall for the sub-catchment is under 400mm with the extreme range being from 220 mm to over 700mm. The mean monthly rainfall recordings for Carnamah and Coorow are shown in Table 1.
Table 1 Mean Monthly Rainfall and Evaporation Statistics for Carnamah and Coorow (mm)

<table>
<thead>
<tr>
<th></th>
<th>J</th>
<th>F</th>
<th>M</th>
<th>A</th>
<th>M</th>
<th>J</th>
<th>J</th>
<th>A</th>
<th>S</th>
<th>O</th>
<th>N</th>
<th>D</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rainfall</td>
<td>11</td>
<td>15</td>
<td>22</td>
<td>24</td>
<td>52</td>
<td>83</td>
<td>71</td>
<td>54</td>
<td>29</td>
<td>18</td>
<td>10</td>
<td>9</td>
<td>398</td>
</tr>
<tr>
<td>(Carnamah)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rainfall</td>
<td>11</td>
<td>16</td>
<td>21</td>
<td>25</td>
<td>49</td>
<td>84</td>
<td>72</td>
<td>55</td>
<td>29</td>
<td>19</td>
<td>9</td>
<td>8</td>
<td>399</td>
</tr>
<tr>
<td>(Coorow)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Potential</td>
<td>400</td>
<td>340</td>
<td>300</td>
<td>200</td>
<td>130</td>
<td>80</td>
<td>75</td>
<td>100</td>
<td>130</td>
<td>220</td>
<td>270</td>
<td>370</td>
<td>2600</td>
</tr>
<tr>
<td>Evaporation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

The winter dominant rainfall (May - August) occurs when the vegetative biomass of cereal crops for the growing season is least. Because of the sandy texture of the dominant soil types, rainfall in excess of soil water storages moves downwards to the unconfined aquifers. As a result, the water levels of these aquifers vary in direct response to rainfall events.

2.3.2 Evaporation

The potential mean monthly evaporation statistics for the sub-catchment are shown in Table 1. The annual potential evaporation exceed the total annual rainfall. This suggests the potential for increasing water use when the evaporation rate is high (i.e. during summer months).

Evaporation rates from the open lake surface and from seepage areas is relatively high. The area of the lake is 3 Ha. If 75% of potential evaporation is assumed from May to December (1031 mm) then 3.09 x 10^4 Cu M of water is evaporated. The area of exposed seepage is approximately 7 Ha. If 30% of potential evaporation is assumed for all months (780 mm), then 5.46 x 10^4 Cu M is evaporated. This gives a conservative estimate of 8.55 x 10^4 Cu M of water evaporated from the areas of storage and discharge.

2.3.3 Aquifer Recharge

The amount of rainfall that is not evaporated, or does not become run off or through-flow, or is not increasing soil water storage becomes recharge to the ground water aquifers. The rate of recharge depends upon many factors. Different soil types have differing infiltration rates and water holding capacity. Coarse textured (sands and gravels) surface soils have relatively high infiltration
rates and low water holding capacity compared to finer textured soils (clays).

Where there are skeletal soils or bare rock adjacent to coarse textured soils, a significant percentage of rainfall becomes recharge.

Recharge rates also depend upon the type of vegetation cover. Shallow rooted cereal crops use a relatively small amount of the rainfall during the winter months as the crop biomass is not large. Rainfall in excess of requirements to saturate the soil moves beyond the root zone particularly in coarse textured soils.

The percentage of rainfall that becomes aquifer recharge is considered to be between 10% and 20%. The Deep Yellow Sand and Skeletal Soils LMU's which together increase recharge occur over 70.6% of the sub-catchment. However the rainfall is relatively low (i.e. low number of rainfall events where the soil moisture store exceeds saturation) so a recharge rate of 15% may provide a reasonable estimate.

Using this value, 60 mm of rainfall becomes recharge annually. Over this complete sub-catchment, 35.4 x 10^4 Cu M of recharge occurs.

To establish a hydraulic equilibrium, this amount of water must leave the sub-catchment by drainage or evaporation each year.

2.3.4 Areas of Seepage

Without a detailed hydrological survey it is difficult to be certain of ground water flow lines. By interpreting the geological features and surface topography, an estimate of what they may be can be made. These are shown in Map 3.

From this map, it can be seen that most seepage to the lake occurs from the north and from the south-east. The 10 Ha area north of Winchester East Road seeps visibly throughout the year. During most months, this seepage forms a stream that enters the lake via a culvert. Stream flow has been measured at 56 Cu M/day in August (1988), however, it is very variable. The salinity of this seepage was 3770 m S M⁻¹ (20,735 mg/lt) at this time.

Seepage south of the road is more extensive. It also forms a stream into the lake, however seepage also directly fills the lake from beneath the impounded water. The salinity of this seepage was measured to be 3820 m S M⁻¹ (21,065 mg/lt).
2.3.5 Water Storage in the Lake

The volume of the main lake when full is estimated to be 65,000 M$^3$ from a series of transects by boat to establish water depth. The lake has a relatively flat base. The water depth was generally about 100 cm, but in the center was a maximum of 117 cm.

Water samples were taken across the lake in August (1988). The salt concentration of the samples had a mean value of 6815 m S M$^{-1}$ (37,482 mg/lt) and had very little variation. From the volume and salt concentration, it can be calculated that the amount of salt currently in the lake is approximately 2,500 tonnes.

From the measurements of seepage stream flow (85 Cu M/day in August) it was very conservatively estimated that the annual contribution of water to the lake from this source alone is 1 x 10$^4$ Cu M. Assuming a salt concentration of 20,000 mg/lt, 200 tonnes of salt is contributed to the lake each year. A more realistic estimate is probably double this figure.

Considering the conservative estimate of a 200 tonne movement each year, this suggests that the total salt in the lake has accumulated over a period of about 12 years. It is clear that this is incorrect which further suggests that the lake may have a sub-surface outlet. This possibility adds uncertainty to calculations of the amount of aquifer recharge that should be utilized annually to achieve hydraulic equilibrium in the sub-catchment.

2.3.6 Petan Creek Flow Rates

Stream flow in the Petan Creek channel is rapidly responsive to rainfall events in current land management practices in the catchment. During winter months, the base flow is small.

The rate of streamflow in the channel was measured at the floodway on Road No. 14 when the four culverts were at maximum flow (25th August, 1988). The stream velocity through the culverts was 1.44 MS$^{-1}$. The rate of streamflow was calculated to be approximately 14,000 Cu M/day.

The salt concentration in the Petan Creek at this time was 3120 M S M$^{-1}$ (17,160 mg/lt). The amount of salt transported in the channel during peak flow was 240 tonnes/day.
2.4 Wildlife Habitat

While the lake environment is not unique to the district, it has value for wildlife even in its currently degraded state. The following list of bird species that occur there regularly (Table 2) provides an indication of the potential diversity of all that may be supported if the lacustrine environment were rehabilitated.

<table>
<thead>
<tr>
<th>Bird Species</th>
<th>Scientific Name</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>White-faced heron</td>
<td>Ardea novaehollandiae</td>
<td></td>
</tr>
<tr>
<td>Mountain duck</td>
<td>Tadorna tadornoides</td>
<td>(3 breeding pairs in 1989)</td>
</tr>
<tr>
<td>Black-shouldered kite</td>
<td>Elanus notatus</td>
<td></td>
</tr>
<tr>
<td>Australian goshawk</td>
<td>Accipiter fasciatus</td>
<td></td>
</tr>
<tr>
<td>Nankeen kestral</td>
<td>Falco cenchroides</td>
<td></td>
</tr>
<tr>
<td>Redcapped dotterel</td>
<td>Charadrius ruficapillus</td>
<td></td>
</tr>
<tr>
<td>Pied stilt</td>
<td>Himantopus himantopus</td>
<td></td>
</tr>
<tr>
<td>Crested pigeon</td>
<td>Ocyphaps laphotes</td>
<td></td>
</tr>
<tr>
<td>Galah</td>
<td>Cacatua roseicapilla</td>
<td></td>
</tr>
<tr>
<td>Corella</td>
<td>Cacatua tenuirostris</td>
<td></td>
</tr>
<tr>
<td>Twenty-eight parrot</td>
<td>Barnardius zonarius</td>
<td></td>
</tr>
<tr>
<td>White-backed swallow</td>
<td>Cheramoeca leucosternum</td>
<td></td>
</tr>
<tr>
<td>Welcome swallow</td>
<td>Hirundo neoxena</td>
<td></td>
</tr>
<tr>
<td>Australian pipit</td>
<td>Anthus novaeseelandiae</td>
<td></td>
</tr>
<tr>
<td>White-rumped minor</td>
<td>Manorina flavigula</td>
<td></td>
</tr>
<tr>
<td>Singing honeyeater</td>
<td>Lichenostomus virescens</td>
<td></td>
</tr>
<tr>
<td>Black-faced woodswallow</td>
<td>Artamus cinereus</td>
<td></td>
</tr>
<tr>
<td>Magpie lark</td>
<td>Grallina cyanoleuca</td>
<td></td>
</tr>
<tr>
<td>Australian raven</td>
<td>Corvus coronoides</td>
<td></td>
</tr>
</tbody>
</table>
3. APPROACH TO MANAGEMENT

The approach to solving three of the land management problems (increasing seepage, salinity and ground water levels) is dependent upon the discharge of a large volume of water from the sub-catchment. The fourth major land management problem (wind erosion) are considered while options for water discharge are evaluated. The potential aesthetic and wildlife values of the lake environment is also considered.

There are four general methods for discharging water from the Winchester sub-catchment. They are briefly evaluated.

3.1 Open Drainage

Several options for free-flow drainage to discharge water from the main lake into Petan Creek have been considered.

The first option was through the ALC land management unit on Location M1058, crossing Road No. 14 350 meters north of Winchester East Road, then to the Petan Creek parallel to the road. This option is not possible as the Petan Creek bed is 104 cm above the level of the full lake surface.

The second option is to drain to the Petan Creek along Winchester East road, a distance of 2.1 Km. The channel bed here is 176 cm below the full lake surface. With a very low grade on the drain (0.05%), the maximum amount by which the lake could be lowered is 71 cm (assuming no siltation problems in the drain).

The full lake level is 48 cm below ground level at the brick entrance to the cemetery. Assuming that the lake level is the ground water table level for adjacent areas, a 71 cm reduction in the lake level would lower the water table to only 119 cm below ground level at the entrance.

Considering also the depth of excavation required (up to 300 cm) and the problems caused by slumping and siltation, this option is not further considered.

3.2 Pumping

Pumping can be considered for two purposes;

- to empty the main lake so as to remove the salt storage,

- to discharge seepage water before it enters the lake
Pumping the Lake Water

To discharge the 65,000 Cu M of water (and 2,500 tonnes of salt), a 152 mm diameter pump, at 273 Cu M/Hr, would take ten days of continuous pumping. The cost of pump hire ($100/day) plus location would be approximately $1500.

The hire cost of pumping the lake will be increased because of the need to purchase additional flat hose. This additional cost may be $4,000. Alternatively, 100 mm polythene pipe may be purchased if lake pumping is to be repeated, however the cost of this pipe to be laid along the roadside to the Petan Creek is approximately $20,000.

This operation should only be undertaken when the Petan Creek has at least a base flow. The daily discharge rate by pumping would be approximately 6500 Cu M of water and 250 tonnes of salt. This saline water should be assured of complete discharge from Petan Creek.

Pumping Seepage Water

Total recharge to the sub-catchment is estimated to be 35.4 x 10^4 Cu M annually. Allowing for evaporation of lake and seepage water (8.55 x 10^4 Cu M), 26.85 x 10^4 Cu M of recharge water remains. Assuming that additional evaporate losses and transpiration by existing deep root vegetation accounts for a further 20% of recharge, 21.49 x 10^4 Cu M annually (i.e. 588 Cu M/day) remains to be discharged.

The rate at which water seeps into the lake system is unknown. Seepage water that becomes streamflow from north and south of Winchester East Road is approximately 56 M^3/day. Total seepage will be considerably higher, possible more than 500 M^3/day.

The rate of seepage into the main lake could be established by pumping the lake dry during winter, then measuring the time required for it to refill. This should be undertaken before deciding upon the method of seepage water pumping.

Two 4.3 M diameter (14 feet) windmills with 15.2 cm pumps will discharge 86 cu M/day. The installation of these mills will cost approximately $24,000.
A diesel motor-driven rotor pump could also deliver 200 Cu M/day. It could be installed and equipped, including an automatic timing switch, for $10,000. However, it is not recommended that a pump of this type be run continuously, so the discharge rate would be reduced. Regular maintenance would also be required.

Large solar pumps have a maximum discharge rate of only 25 Cu M/day.

3.3 Permanent Revegetation

Deep rooted permanent vegetation may utilize groundwater in both recharge and discharge positions in the landscape. In addition, large, upright vegetation with a relatively high leaf-area index intercepts approximately 20% of rainfall. This is evaporated before reaching the ground so the potential for recharge is reduced.

Some relevant revegetation options are considered.

Tagasaste

Tagasaste (Cytisus proliferus) is a legume that is becoming recognized as a useful fodder crop for sheep if regularly managed. Its water-use potential is not well documented but has been conservatively estimated to be 20 lt/stem/day for three years of growth (P. Scott, personal communication). At a density of 1000 stems per hectare, and considering reduced leaf area by grazing (i.e. assuming only 100 days effective transpiration), 2000 Cu M/ha could be utilized annually. This is the average approximate rate of 5.5 Cu M/day from each hectare established.

In addition to the benefits of water use and fodder supply, tagasaste can be used effectively to reduce the risk of wind erosion.

Tree Planting in Discharge Areas

Reclamation of sandplain seepages using trees has been successful for relatively small areas in the northern wheatbelt. By planting eucalyptus species in small areas above the area of seepage where the water table is at a depth of approximately 150 cm, then growth rates are rapid and survival rates are high so that the seepage may be controlled within five years.
The lakes formed in the Winchester sub-catchment are the result of very large and complex seepages. Tree plantings require strategic planning to be most effective for water usage and wind erosion control.

Trees planted above discharge areas can be expected to transpire about 50 lt/day for 200 days/year by 5 years of age. With a stem density of 500/Ha (5 x 4 meter spacing), 5000 Cu M is transpired annually (equivalent to 13.5 Cu M/day) from each hectare.

Suitable species should be selected after the management plan has been finalized so that they suit multiple purposes.

Tree Planting in Recharge Areas

Although trees are more difficult to establish and probably use less water in obvious recharge areas, revegetation there should still be seriously considered. In addition to transpiration, trees that intercept 20% of rainfall are reducing the potential for recharge.

It is particularly important to revegetate old gravel pits as these have been identified as major recharge zones. Deep ripping and fencing is required.

 Severely wind eroded areas should also be rehabilitated to reduced aquifer recharge.

Natural Regeneration

By fencing areas of remnant vegetation, regeneration will commence automatically. The value of this form of revegetation is that species which are adapted to survive in that environment will reproduce.

Rainfall interception is also relatively high for natural vegetation.

Banksia Plantation

The commercial potential for West Australian wildflowers has not yet been fully developed. In situations where relatively fresh water is seeping at the surface, there is opportunity to combine water usage with new commercial ventures.
The production of cut-flowers from \textit{Banksia} spp. is well suited to some areas of the Winchester sub-catchment.

3.4 Agronomic Control

The amount of water used by crops and pastures is linearly related to plant biomass. To maximize water use in the Deep Yellow Sandplain soils, a continuous cropping rotation of wheat and lupins is recommended.

It is common for an induced hardpan to occur in the DYS soils which impede crop root development. Deep ripping these soils has resulted in grain yield increases of 25 - 50%. The accompanying biomass increase will use substantially more water from the soil profile so reducing the potential for aquifer recharge.
4. MANAGEMENT PLAN RECOMMENDATIONS

The management plan for the Winchester sub-catchment integrates information about the natural resources and land management problems. The aim of the plan is to provide a sustainable agricultural ecosystem in the long term (i.e. more than five years after implementation) with the reduction of specific ground water problems.

Where there is potential to reduce ground water problems in the shorter term, the relevant options are further considered.

The sub-catchment management plan is represented as themes on three maps. Each of these themes is described for the five property locations and Shire roads that are involved. Recommendations are emphasized within the descriptions. Management priorities are provided in conclusion.

Theme 1 Tagasaste Establishment (Map 4)

Two areas where soil and water conditions are suitable for the establishment of tagasaste are shown.

M1309  -  15 Ha (P1)

M1610  -  30 Ha (P2)

45 Ha

Plantings should be in rows that follow contours at a density of approximately 1 - 2000 stems/Ha. Perennial pastures may be established between rows. In addition to annual grazing, the rows will require some form of pruning. Further information for establishment and management should be sought.

With this area planted, the 45,000 shrubs could conservatively utilize the equivalent of 248 Cu M/day of ground water (approximately 33% of total aquifer recharge).

Tagasaste planted at P2 would provide substantial protection from wind erosion.

Additional fencing is required on M1610 to isolate areas of severe wind erosion (approximately 870 M). On M1309, approximately 100 M of fencing is required.
Theme 2 Banksia Plantation (Map 4)

An area of 4.5 Ha on M1309 (B1) is well suited for growing banksias. The area is not currently suitable for crop production, due to a high water table. A plantation of banksias in conjunction with strategic tree planting will lower the water table and provide an opportunity for commerce.

Approximately 500 M of fencing is required.

One part of the Petan Creek catchment study is to investigate the feasibility of small-scale wildflower farming there. This information will be relevant to site B1.

Theme 3 Regeneration of Remnant Vegetation (Map 4)

Four major areas of remnant vegetation occur in the sub-catchment. They are described as follows:-

<table>
<thead>
<tr>
<th>Site</th>
<th>Location</th>
<th>Area (Ha)</th>
<th>Fencing Required (M)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RV 1</td>
<td>M1309</td>
<td>19</td>
<td>800</td>
</tr>
<tr>
<td>RV 2</td>
<td>M1058</td>
<td>10</td>
<td>1840</td>
</tr>
<tr>
<td>RV 3</td>
<td>M1058</td>
<td>4</td>
<td>410</td>
</tr>
<tr>
<td>RV 4</td>
<td>M1215</td>
<td>4*</td>
<td>330</td>
</tr>
</tbody>
</table>

* The total area of this patch is approximately 40 Ha for which 2700 M of fencing is required.

It is recommended that these areas be fenced with priority to reduce rainfall runoff and aquifer recharge from bare rock and very shallow soils.

Theme 4 Tree Planting to Reduce Recharge (Map 5)

Although aquifer recharge probably occurs over all of the sub-catchment except on areas of bare rock or seepage discharge, it is more important to have strategically located blocks of trees than to aim for uniform recharge control. The flow lines for ground water drainage (Map 3) provide a guide for strategic location. Recommended sites are described as follows:-
<table>
<thead>
<tr>
<th>Site</th>
<th>Location</th>
<th>No. Rows</th>
<th>No. Trees</th>
<th>Fencing Required* (M)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TR 1</td>
<td>M1792</td>
<td>4</td>
<td>200</td>
<td>540</td>
</tr>
<tr>
<td>TR 2</td>
<td>M1792</td>
<td>4</td>
<td>200</td>
<td>520</td>
</tr>
<tr>
<td>TR 3</td>
<td>M1792</td>
<td>4</td>
<td>440</td>
<td>590</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6</td>
<td>630</td>
<td>800</td>
</tr>
<tr>
<td>TR 4</td>
<td>M1610</td>
<td>10</td>
<td>500</td>
<td>410</td>
</tr>
<tr>
<td>TR 5</td>
<td>M1610</td>
<td>5</td>
<td>710</td>
<td>690</td>
</tr>
<tr>
<td>TR 6</td>
<td>M1309</td>
<td>20</td>
<td>640</td>
<td>320</td>
</tr>
<tr>
<td>TR 7</td>
<td>M1309</td>
<td>15</td>
<td>300</td>
<td>160</td>
</tr>
<tr>
<td>TR 8</td>
<td>M1058</td>
<td>4</td>
<td>190</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6</td>
<td>240</td>
<td>480</td>
</tr>
<tr>
<td>TR 9</td>
<td>M1058</td>
<td>4</td>
<td>185</td>
<td>270</td>
</tr>
<tr>
<td>TR10</td>
<td>M1058</td>
<td>2-8</td>
<td>556</td>
<td></td>
</tr>
<tr>
<td></td>
<td>M1610</td>
<td>1</td>
<td>140</td>
<td></td>
</tr>
<tr>
<td>TR11</td>
<td>M1215</td>
<td>4</td>
<td>340</td>
<td>440</td>
</tr>
</tbody>
</table>

* Assuming the plan is fully implemented.

If all recommended sites are planted, the 5270 trees would utilize the equivalent of 144 Cu M/day (approximately 20% of total aquifer recharge) with five years of growth.

In addition to water use, trees planted at sites TR 3, TR 5, TR 8, TR10 and TR11 will provide considerable benefit by reducing wind erosion within the sub-catchment.

**Theme 5 Tree Planting for Discharge Control** (Map 5)

Tree planting up slope of discharge areas is recommended with priority. The sites are described as follows:

<table>
<thead>
<tr>
<th>Site</th>
<th>Location</th>
<th>No. Rows</th>
<th>No. Trees</th>
<th>Fencing Required* (M)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TD 1</td>
<td>M1309</td>
<td>20</td>
<td>1600</td>
<td>310</td>
</tr>
<tr>
<td>TD 2</td>
<td>M1058</td>
<td>30</td>
<td>700</td>
<td>250</td>
</tr>
<tr>
<td>TD 3</td>
<td>CEMETERY</td>
<td></td>
<td>800</td>
<td></td>
</tr>
<tr>
<td>TD 4</td>
<td>M1058</td>
<td>65</td>
<td>4000</td>
<td></td>
</tr>
<tr>
<td>ARBORETUM</td>
<td>M1058</td>
<td></td>
<td>1500</td>
<td></td>
</tr>
</tbody>
</table>

If all recommended sites are planted, the 8600 trees would utilize the equivalent of 236 Cu M/day (approximately 32% of aquifer recharge) with five years of growth.

During 1988, approximately 100 trees of 10 different species were planted in the arboretum. There is adequate area to substantially increase the range of species evaluated there. It is suggested that commercial nurseries be invited to trial their recommended tree species at this site.
Melaleuca regeneration around the major lakes should be encouraged by management. Reduction of salinity levels, dispersal of seed and control of fires are the main requirements. This vegetation will also utilize some discharge water.

Theme 6 Gravel Pit Rehabilitation (Map 6)

Dis-used gravel pits accumulate surface water which infiltrates via preferred hydraulic pathways to become aquifer recharge. It is recommended that these be rehabilitated by earth works (to reduce ponding), deep ripping and planting trees or shrubs where possible. Four sites are described as follows:-

<table>
<thead>
<tr>
<th>Site</th>
<th>Location</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>GP 1</td>
<td>M1058</td>
<td>fencing required</td>
</tr>
<tr>
<td>GP 2</td>
<td>M1058</td>
<td>fenced within RV2</td>
</tr>
<tr>
<td>GP 3</td>
<td>M1058</td>
<td>fenced within RV2</td>
</tr>
<tr>
<td>GP 4</td>
<td>M1215</td>
<td>drain ponded water; fenced within RV4</td>
</tr>
</tbody>
</table>

Theme 7 Severe Wind Erosion Rehabilitation (Map 6)

Severe wind erosion has occurred at four sites in the sub-catchment. These areas should not be grazed or burnt. Cover crops of blue lupins or cereal rye should be established with high rates of fertilizer. Attempts to establish trees and shrubs there should follow. The sites are described as follows:-

<table>
<thead>
<tr>
<th>Site</th>
<th>Location</th>
<th>Area (Ha)</th>
<th>Fencing Required* (M)</th>
</tr>
</thead>
<tbody>
<tr>
<td>WE 1</td>
<td>M1610</td>
<td>1.3</td>
<td>370</td>
</tr>
<tr>
<td>WE 2</td>
<td>M1610</td>
<td>3.2</td>
<td>150</td>
</tr>
<tr>
<td>WE 3</td>
<td>M1610</td>
<td>3.0</td>
<td>900</td>
</tr>
<tr>
<td>WE 4</td>
<td>M1610</td>
<td>0.3</td>
<td>260</td>
</tr>
</tbody>
</table>

Theme 8 Earthworks (Map 6)

Some surface water control and seepage interception may be required. The recommended sites are described for each location as follows:-
two grader-built grade banks (G1, 220 M and G2, 450 M) should be constructed to prevent run off from the SS<sub>e</sub> unit entering the DYS unit and becoming aquifer recharge. Discharge from the banks can be safely accepted in the road drainage system.

two grader-built grade banks (G3, 250 M and G4, 200 M) should be constructed to drain into a grassed waterway (fencing is recommended). The ponding that occurs in the area recommended for the grassed waterway should be drained to the adjacent lake by a spoon drain (S1, 200 M).

The two lakes may be joined by redeveloping the existing drain (S2, 250 M). This should only occur if mechanical pumping from the sub-catchment is adopted.

one grader-built grade bank (G5, 600 M) should be constructed to discharge water from the sub-catchment. This will prevent water erosion damage that is occurring.

one grader-built grade bank (G6, 400 M) should be constructed to prevent runoff from the SS L unit from becoming aquifer recharge in the RSG unit.

Discharge to the road is acceptable if culvert CS is cleared of debris and maintained.

Theme 9 Optimize Agricultural Productivity

Further recharge can be avoided by having farm management systems that optimize crop and pasture growth in relation to each land management unit.

To facilitate this, one significant fence realignment is recommended on Location M1058 (S70 M).

It is recommended that all areas of the DYS unit to remain in a cropping rotation should be tested for an induced hardpan. If a hardpan exists, then deep ripping is recommended.
Optional Drainage Proposal

The recommendation for revegetation, earthworks and agronomic manipulation to control rising ground water levels may take 3 - 5 years before being effective. It may be desirable to provide control before this time.

A pump (windmill or diesel engine powered) could be installed above a sub-surface sump (approximately 45 Cu M capacity) at culvert C3 on the north side of Winchester East Road. A network of deep drains (shown on Map 6) could be excavated to intercept some seepage water. A total of 2410 meters of drainage is shown. A polythene discharge pipe could be laid on the ground surface to a culvert (C 1) on Road No. 14 (850 meters of pipe required), then to Petan Creek.

A pumping system would allow immediate revegetation of TD 4.

It should be emphasised that seepage into the major lake is complex and there is no certainty about the proportion of it that might be intercepted by the proposed drainage.

If the pumping and drainage option is adopted, it is recommended that the daily rate of refill to the lake by seepage be established. This may be done by pumping the full lake dry during winter.

It is recommended that test pits be excavated along the proposed drainage course.
5. IMPLEMENTATION STRATEGY

The average annual recharge to ground water aquifers in the Winchester sub-catchment is estimated to be 35.4 x 10^4 Cu M. Some uncertainty exists due to the fractured characteristics of the underlying bed rocks. There is some evidence suggesting that ground water may have a subterranean exit. It is also possible that ground water may be entering from elsewhere. Without further detailed knowledge, the proposed management plan assumes that recharge is as calculated.

The quantity of water discharged from ground water aquifers in the sub-catchment is estimated to be 8.55 x 10^4 Cu M annually. This leaves a nett balance of 26.85 x 10^4 Cu M of recharge water to be utilized or removed annually to achieve a hydrological equilibrium. Taken over a full year, the water utilization rate required is the equivalent of 735 Cu M/day.

To achieve this, full implementation of the proposed management plan will be required. Based on estimates of water utilization in Section 4, the annual aquifer recharge budget of the plan may be represented as follows:

<table>
<thead>
<tr>
<th>Theme</th>
<th>Estimated Daily Water Use (Cu M)</th>
<th>Percent of Net Recharge (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tagasaste</td>
<td>248</td>
<td>33</td>
</tr>
<tr>
<td>Recharge tree planting</td>
<td>144</td>
<td>20</td>
</tr>
<tr>
<td>Discharge</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tree planting</td>
<td>236</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>---</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td>628</td>
<td>85</td>
</tr>
</tbody>
</table>

The remaining 15% of recharge should be accounted for by the banksia plantation, regeneration of remnant vegetation, gravel pit rehabilitation, wind erosion site rehabilitation, earthworks and agronomic management.

The suggested drainage proposal should only be further considered if more expedient results are required than the 3 - 5 years period before evapotranspiration rates are substantially increased.

Table 3 provides initial guidelines for implementation considering priorities and management factors.
Table 3 Implementation Strategy for the Winchester Sub-catchment Management Plan

<table>
<thead>
<tr>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Establish Tagasaste</td>
<td>Establish banksia plantation</td>
<td>Establish trees and shrubs on We 1-4</td>
</tr>
<tr>
<td>Tree planting for:</td>
<td>Tree planting for:</td>
<td>Management for melaleucas</td>
</tr>
<tr>
<td>- TD 2</td>
<td>- TD 1</td>
<td></td>
</tr>
<tr>
<td>- TD 4</td>
<td>- TD 3</td>
<td></td>
</tr>
<tr>
<td>- TD 3</td>
<td>- TR 1</td>
<td></td>
</tr>
<tr>
<td>- TD 4</td>
<td>- TR 2</td>
<td></td>
</tr>
<tr>
<td>- TD 5</td>
<td>- TR 7</td>
<td></td>
</tr>
<tr>
<td>- TD 6</td>
<td>- TR 8</td>
<td></td>
</tr>
<tr>
<td>- TD10</td>
<td>- TR 9</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- TR11</td>
<td></td>
</tr>
</tbody>
</table>

Pump out full lake to remove salt

Cover crops for W.E. areas

Earthworks:-
- G 1-6
- S 1

Remnant vegetation fencing
- RV 1-4

Gravel pit rehabilitation
- GP 1-4

Test for hardpan in DYS

Deep ripping

As the proposed plan is implemented, it is recommended that a monitoring scheme be developed to allow the effects of the plan to be readily observed.