GUIDELINES TO THE CONSERVATION AND MANAGEMENT

OF WETLANDS IN WESTERN AUSTRALIA

BULLETIN

DEPARTMENT OF CONSERVATION AND ENVIRONMENT
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DEPARTMENT OF CONSERVATION
AND ENVIRONMENT

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"The world's wetlands lie forlornly in the middle of the unfortunate, unnecessary, but so far unresolved conflict between productivity economic and productivity ecologic."

Allen, 1975.

FOREWORD

While Western Australia is endowed richly with many minerals such as iron ore, it is sadly impoverished in one of the simplest of minerals - pure water.

This water shortage has an immediate effect on the human population, because it can tend to limit industrial growth in the Pilbara and population growth in the South-West. Indeed, talk of summer water restrictions in the Perth metropolitan area is so common that, in this aspect at least, "conservation" is not regarded as a "dirty word" even by extreme advocates of growth and development.

The Environmental Protection Authority (EPA) has drawn attention to the consequential fact that "wetlands (lakes, swamps, rivers and estuaries) are among the scarcest resources in Western Australia." The Department of Conservation and Environment therefore gathered together a group of expert officers to form the "Wetlands Advisory Committee", so as to review and advise the EPA on the desirable allocation of wetland reserve resources and the adequacy of their management.

This committee has accumulated information on wetlands and given much valuable advice. Since both natural (e.g. seasonal) variations and man-made developments may cause significant changes in wetlands, it will take a considerable period of time and much more experience to produce a network of definitive cause-and-effect relations as an input to the adequate conservation and management of wetland resources.

However, sufficient Departmental experience has been gained that it has been possible to put together this booklet of guidelines to the conservation and management of wetlands, consistent with the EPA's desire for multiple-purpose usage where practicable.

Although we have statutory obligations regarding conservation and environmental protection we have no desire to impose one more set of "bureaucratic" controls on those who propose to use wetlands - whether for recreation, preservation of wildfowl or duck-shooting, land-fill garbage dumps or preservation of landscape aquatic vistas.

Thus this booklet has been prepared for general distribution, so that wetlands can be both preserved and managed by those immediately responsible for them. In a sense, these guidelines are not intended to enforce control as much as they are intended to assist responsible bodies, such as local authorities, in becoming more knowledgeable about the environmental implications and consequences of proposals presented to them.

There is little advantage to the private individual in buying a homesite with a scenic view over a lake or wetland if subsequent urban developments cause the lake to dry up!

There is little joy for a house-dweller or picnicker who finds that inappropriate upstream farming or foreshore activities have caused siltation of a formerly cleanly-flushed waterway, and changed it into a significant breeding site for mosquitoes.

Also, there will be little satisfaction for the duckshooter who fondly tells his son how many dozen ducks he used to be able to shoot each day when he was a boy, and how few there seem to be nowadays, - not understanding how his past actions were one vital element in the wetland ecological balance.

These "guidelines" are therefore intended to improve general understanding of wetland complexes, in the hope and expectation that an informed public will do the rest, in an unselfish manner and with a recognition of the importance of wetlands in our complex web of life.

Brian J. O'Brien

<u>DIRECTOR</u>

11 July, 1977.

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SECTION 1 INTRODUCTION

THE DEFINITION OF WETLANDS

There are many definitions of "wetlands" some of which are specific to certain geographical areas. In Western Australia wetlands have been defined by the Wetlands Advisory Committee (established by the Department of Conservation and Environment) as:

> "Areas of seasonally, intermittently or permanently waterlogged soils or inundated land, whether natural or otherwise, fresh or saline, e.g. waterlogged soils, ponds, billabongs, lakes, swamps, tidal flats, estuaries, rivers and their tributaries".

THE VALUE OF WETLANDS AND THEIR IMPORTANCE IN W.A.'S DEVELOPING ECONOMY.

Apart from their significant value as flora and fauna habitats and areas of scientific research and education, wetlands play important roles in water balance and drainage and in the maintenance of the quality of surface and ground water. A further increasingly important function of wetlands, especially in urbanised areas, is that of recreation, both active and passive. Activities such as boating, swimming, fishing, water skiing, crabbing, prawning and even new sports like hang-gliding require areas of open water, whilst other more passive pursuits such as picnicking, rambling, photography and barbecues do not necessarily demand waterside venues but are greatly enhanced by them. They can also provide a much-valued scenic and landscape feature. For instance, a recent study commissioned by the Department of Conservation and Environment (Swan and Canning Rivers Study, 1976) drew attention to the scenic attraction of the Swan River as reflected in the high number of people patronising regular and charter river ferry cruises.

Wetlands are thus an integral part of our Western Australian way of life comparable in importance with the Coastal Zone itself (EPA 1977).

Wetlands are resources worthy of respect and their exclusion from any short and long range resource planning in Western Australia's developing economy would lead to impoverishment of the Western Australian life style.

WETLANDS - THE DWINDLING RESOURCE

Historically, the attitude towards wetlands has been one of exploitation - for transportation, water supply, drainage, waste disposal, mining, agriculture and so on. They are filled in to provide sites for housing estates or industry and are frequently used as rubbish dumps. The largest losses have perhaps resulted from drainage of land for its conversion to agricultural uses, especially on fertile soils. Furthermore, various forms of recreation also exert pressure on wetland ecosystems, although not usually in an obtrusive manner.

The impact of exploitation on Western Australia's wetland resources is graphically emphasized by a 1964 estimate that 200,000 hectares of land representing 75% of the wetlands on the Swan Coastal Plain had been filled or drained. Of the remaining 65,000 hectares of wetlands, about 40% was potentially reclaimable using existing techniques (Riggert, 1974). Since 1964 an increasing population and a "development"-oriented economy have brought greater potential for pollution of wetlands and for the use of the water supplies (both surface and underground) which sustain them. Salination resulting from extensive clearing presents yet another threat.

The flora and fauna dependent on wetlands are also threatened by exploitation of their wetland habitats. The existence of about one hundred species of birds which depend on Australia's wetlands has been jeopardized, and many native species of animals have either perished or been reduced to critically low numbers as a result of our disregard for any wetland-users other than man (Riggert, 1974). For instance, in Western Australia, the known breeding habitats of the short-necked tortoise have been reduced to only two small swamps.

The loss of wetlands is not restricted to Western Australia. It is a world-wide problem.

In 1974 Australia signed the "Ramsar Convention" which required contracting parties to designate wetlands of international significance (within their territory) in terms of ecology, botany, zoology, limnology, or hydrology, and was one of the first countries to have done so when the Convention came into force on 21 December, 1975. Australia has already designated the Coberg Peninsula on the Northern Territory coastline under the terms of this Convention. Moreover, under the terms of an agreement with Japan, Australia is obliged to protect migratory birds and their habitats. This includes over twenty species of birds that depend on wetlands for their survival. Examples are certain species of egret, dotterel, plover, sandpiper and other migratory waders.

Australia, therefore, has an international responsibility to conserve and manage wetlands, as well as protecting them as an asset for its present and future generations.

SAVING OUR WETLANDS

Clearly, environmental management is an urgent priority if the developing social, economic, recreational, and conservation demands being made on our wetlands are to be met in a productive and sustainable way.

One important method of achieving this is through a greater public understanding of wetlands and their value. An example of this is the inclusion of environmental considerations in the earliest stages of engineering, economic and other feasibility studies for a development project, so that land-use development planning includes measures to preserve and where possible improve wetlands.

THE PURPOSE OF THE BOOKLET

The purpose of this booklet is therefore to:

- serve as an input into the education of the public. In this regard, Section 2 places particular emphasis on the factors which cause wetland degradation.
- provide some guidelines for planners, developers, local authorities and land-owners as to the desirable approach to land-use development to ensure protection of surviving wetlands. This is dealt with in Section 3 in which it is stressed that wetland preservation is dependent upon protecting both the quantity and quality of the water. This section also attempts to delineate some measures for integrating wetland conservation and management into the planning of development proposals e.g. for rural and urban subdivision, mining, sanitary landfill, and agriculture.

SECTION 2

THE FACTORS CAUSING DEGRADATION AND DESTRUCTION OF WETLANDS

Many of the major threats to our wetland resources result from a multitude of human activities. Such activities can affect the wetland feature either directly (e.g. the reclamation of a swamp for development purposes) or indirectly (e.g. the contamination of a swamp by pollutants leached from a rubbish tip remote from the wetland).

The greatest threats to wetlands in Western Australia (not necessarily always in this order of importance) are :

- 2.1 drainage and filling
- 2.2 pollution (including eutrophication)*
- 2.3 erosion
- 2.4 water level changes
- 2.5 salination
- 2.6 aesthetic disruption
- 2.7 aquatic (declared) weeds.

2.1 DRAINAGE AND FILLING

The largest losses of wetland areas have resulted from drainage for conversion to arable or other agricultural uses. Today many surviving wetlands which are part of agricultural holdings are endangered because of their farming potential.

Wetlands which occur in or near an urban situation often come under great demand for drainage and filling purposes for a number of reasons. Most often it may be considered that in

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* Eutrophication is the nutrient enrichment of waters. (see also 2.2 of this Section).

the short term the land could be put to more profitable use, by providing sites for housing estates, recreation, industry or tourism, or as a sanitary land-fill site for the disposal of wastes. Wetlands may also be mined, e.g. for peat, mineral sands, clay and diatomaceous earth. While controlled mining may be potentially beneficial to a wetland, land-fill is permanently destructive.

Already over 75% of the wetlands in the Swan Coastal Plain have been lost through drainage or filling and in the U.S.A., the U.S. Soil Conservation Service has estimated that about 36% of the Nation's wetlands have been drained (The Wildlife Society, Washington, 1971). These figures make it clear that, although each land reclamation scheme, argued in terms of its own objectives, may look relatively insignificant against the total wetlands area, the overall potential impact on the ecology of the area is enormous.

Where drainage or filling does not encompass an entire wetland, but is confined for instance to river flood plains or the margins of lakes, total destruction may not occur but the undesirable consequences are many :

- effects on the food chain, for example small animals which live in shallow water may be killed, thereby removing the food source for fish, which in turn reduces the food for birds and man;
- destruction of wildlife habitats;
- disturbance of mud and sand, bringing sediments into suspension, lowering of light penetration and hence photosynthesis and causing deoxygenation;
- disruption of local hydrology or drainage patterns.

2.2 POLLUTION

Pollution can be defined as any direct or indirect alteration of the physical, thermal, biological, or radioactive properties of any part of the environment. This may cause a condition which is hazardous or potentially hazardous to public health, safety or welfare, or to animals, birds, wildlife, fish or aquatic life, or to plants (Gilpin, 1976).

Pollutants may arise from point (or localised) sources, examples of which are industrial wastes, sewage effluents, effluents from agricultural processes, stormwater drains and livestock feedlots, mine wastes, discharges from watercraft and leachates from waste disposal sites, or diffuse sources such as agricultural and urban water catchments. The pollutants may be discharged directly into a wetland or they may contaminate it indirectly following percolation into the groundwater, or entry into streams in the wetland's catchment area.

The following table lists the major sources of pollution and the range of pollutants that could emanate from them:

SOURCE	POTENTIAL POLLUTANTS
Household effluent - sewerage and septic disposal systems	Disease-carrying organisms (e.g. bacteria and viruses). Nutrients (e.g. phosphorus and nitrogen). Other chemicals (e.g. fats, detergents, disinfectants, pesticides, weedicides).

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SOURCE	POTENTIAL POLLUTANTS
Waste disposal sites - sanitary landfill and liquid waste disposal sites - industrial effluent pits and lagoons - mine waste disposal sites	Leachates, including nutrients, acids, alkalis, heavy metals and other toxic substances depending on the nature of the wastes.
Agricultural run-off	Nutrients (e.g. fertilizers and animal wastes). Sediments. Agricultural chemicals (e.g. pesticides, herbicides and weedicides).
Recreation	Litter. Noise. Oil (e.g. from marine engines). Nutrients (e.g. fertilizers from lawns and gardens, watercraft discharges). Disease-carrying organisms (e.g. bacteria and viruses).
Land clearance in catchment areas.	Salt. Sediments
Mining - mine process or cooling water - mine tailings	Acid and alkaline wastes. Toxic substances (e.g. heavy metals and various chemicals). Sediments.
Urban run-off	Disease-carrying organisms (e.g. bacteria and viruses). Fuel and oil (e.g. from vehicles). Litter. Sediments. Nutrients (e.g. fertilizers from lawns and gardens). Tyre rubber. Metals, asbestos, cement. Toxic chemicals (especially in drains and outfalls).

These materials may alter the nutrient levels, biological oxygen demand (BOD)*, amount of suspended solids, levels of organic compounds and trace elements, acidity or alkalinity as indicated by pH measurements, salinity of the ground and surface water systems or add new toxic substances foreign to the receiving water body.

Thermal pollution, or alteration of the water temperature may also occur through the discharge of heated wastes or water from industrial processes.

Pollutants will directly or indirectly alter the physical, biological, thermal and other properties and hence the ecology of a wetland, although the degree of alteration will depend on the type and level of contamination and the original characteristics of the wetland. Such pollution is generally detrimental to the wetland.

Eutrophication is one effect pollutants can have on a body of water.

Eutrophication, or the nutrient enrichment of waters, results in the stimulation of an array of symptomatic changes including increased production of plants (algae and macrophytes), followed by deterioration of water quality and ultimately of fisheries. The word "eutrophication" is also frequently used to describe the effects of the process of nutrient enrichment when it occurs to excess in lakes and other waters.

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* Biological oxygen demand (BOD) is the weight of oxygen taken up mainly as a result of the oxidation of the constituents of a sample of water by biological action. The result gives some measure of the amount of biologically degradable organic material in polluted waters.

It is reasonable to assert, based on both overseas and Australian experience, that unless wetland catchment areas are managed in such a manner as to reduce the nutrient load entering the water body, eutrophication will cause a deterioration in wetland resources, particularly in urban and agricultural areas. Once a wetland has become eutrophic, it is extremely difficult to reverse the process, and even with good management recovery may take many years. Hence protection is most important and less expensive in the long term. (See Section 3). This is a classic case of prevention being better than cure.

2.3 SOIL EROSION

When rain falls on soil, its impact results in particles being detached from the soil complex and being transported by the water flow. This process may be accelerated by land clearing, disturbance of land forms e.g. by construction, mining, overgrazing, overstocking, trail bikes and off-road vehicles, droughts, floods or high winds. Apart from soil loss, the resulting problems include sedimentation or clogging of streams and lakes, increased turbidity or cloudiness of the water, increased costs of water clarification in water treatment plants, smothering of bottom-dwelling animals and plants, and killing of gill-breathing organisms such as fish and crustaceans, (e.g. prawns, crayfish). The sediments may carry large amounts of material, including organic debris, litter and nutrients with the potential to pollute wetland waters.

Erosion of the banks of rivers and lakes usually results from the disturbance of foreshore vegetation by human or stock activity. Watercraft can also cause significant erosion of the banks of wetlands by the action of the wash on the shoreline. This erosion also contributes sediments, as well as producing ugly scouring of the banks. It may even lead to a change in the course of a stream, and in downstream effects.

2.4 WATER LEVEL CHANGES

Many, but not all, wetlands of the south-west of W.A. are surface expressions of the shallow groundwater table (Allen, 1976). The water level in the wetlands rises as a result of rain falling directly on to the water body or its surrounding catchment area, (surface run-off), and by groundwater inflow stimulated by rainfall recharge in the surrounding area. Normally the water table drops over the summer period, leading to seasonal fluctuation in the wetland water levels.

The unconfined groundwaters of the Swan Coastal Plain are being exploited more and more to supplement Perth's water supply (Burton, 1976). Pumping of groundwater produces a "cone of depression" of the water table around the bores, and if pumping continues over a long period of time at a rate that cannot be fully made up from rainfall replenishment an overall regional lowering of the water table results. This lowering is superimposed on the normal seasonal fluctuations. Such a lowering of the water table could lead to the disappearance of some of the shallower lakes and swamps to the north and south of Perth, which are in the vicinity of productive bore fields.

A reduction in areas of open water would obviously mean the loss of water fowl habitats as well as losses in aesthetic, recreational and other amenities.

The lowering of the water table could also change plant communities including those supported by the wetlands, and as they are changed the fauna dependent on these plants will in turn be affected.

Conversely, land clearing and an increase in urban run-off tends to lead to a rise in the water table, and increased areas and depths of open water (Sanders, 1976).

2.5 SALINATION

Many of Western Australia's wetlands in the drier inland areas are naturally saline. They are part of a drainage system once integrated and functional at some time in geologic history, but now ineffective and acting as a sump in which the salts in solution in drainage water are concentrated by evaporation. Further, they are often the parts of the landscape where the local saline groundwaters, several times more concentrated in salinity than seawater, come to the surface or close to it.

With clearing of the natural vegetation to make way for farms, perennial, deep-rooting plants are replaced by shallow rooting annual crops and pastures, so that less water is transpired (i.e. drawn from the soil by the plants). As a consequence, the groundwaters rise, and flush salts previously stored in the soils. Thus, the saline areas increase in extent. Additionally, there is increased run-off and consequent flooding and water-logging of lower-lying land. Concentration of the salts in flood waters by evaporation can lead to soil salinity in these situations. The whole process results in increased quantities of salts being added to streams and rivers so that saline water moves downstream in the system, affecting rivers and associated wetlands which were formerly fresh. Notable examples of rivers affected in this way are the Swan, Avon and Blackwood (Peck & Hurle, 1973).

In intermediate rainfall areas (800 to 1,000 mm per annum) the same process may give rise to entirely new wetlands which may not be initially saline, generally in upland areas, e.g. the fresh water lakes and swamps of the sand plains both north of Meckering and near Brookton.

In the higher rainfall (> 1,000 mm per annum) areas of the Darling Range, while salination of wetlands is uncommon, particularly near the wetter western margin of the Range, clearing of the natural forest increases the salinity of the water in rivers and streams to some degree, as well as increasing the amount of run-off. Thus the wetlands of the coastal plains to which the streams drain may be seriously affected.

2.6 AESTHETIC DISRUPTION

The visually degrading effects that human activity can have on wetland areas are widely evident throughout Western Australia, especially on the Swan Coastal Plain. The extent of wetland exploitation is such that the aesthetic amenity or landscape value of only a limited number of wetlands remains unimpaired.

A multitude of activities, both uncontrolled and supervised, contribute towards degradation of the wetlands' scenic qualities.

Some examples of uncontrolled activities are :

- Littering and illegal dumping;
- Unchecked clearing, burning or grazing;
- Off-road vehicles (by disturbing vegetation and causing erosion);
- Power boating (by increasing turbidity through disturbing bottom sediments and by causing erosion of banks through their wash).

Additionally, official works and development programmes, such as sanitary landfill sites, construction of roadways, drainage undertakings (including river training) can impinge upon the wetlands' aesthetic appeal and hence the beauty of the landscape.

2.7 Aquatic (declared) Weeds

Certain noxious weeds have the capacity to propagate rapidly in wetland environments to the extent that control is difficult before ecological impoverishment of the wetland occurs. Furthermore, the control methods necessary in the event of heavy infestations, for instance blanket spraying, draining and raking could be severe enough to cause widespread damage to flora and fauna habitats. The weeds which cause greatest concern in this regard are Salvinia and Water hyacinth.

SECTION 3

GUIDELINES FOR THE PROTECTION OF WETLANDS

General Comments

Having set out in previous sections the technical aspects of the value of wetlands and their modification by man, it now becomes possible to set out guidelines for the protection of wetlands. For convenience these will be dealt with in the sequence adopted in Section 2. The philosophy from which these guidelines are derived is that the key to environmentally based planning is to integrate all facets of development with the natural environment. rather than to impose them upon it.

From this viewpoint wetland preservation requires not only protection of the wetland from physical disruption, such as by indiscriminate filling and drainage, but also protection of the quantity and quality of the water supply feeding it.

By sound management, it is often possible to go further, and to improve or enhance the value of the wetlands for one or more beneficial uses. For example a lake may have potential as a fishery, recreation area and wildlife habitat, but fail to fulfil this potential because the water quality has been degraded and it is supporting heavy blooms of unsightly and toxic algae. The upgrading of the lake's water quality would enhance all these beneficial uses, and would be of value to the community both economically and in terms of quality of life.

The degree of protection and management required depends on the nature and intensity of the surrounding land-use, and also on the characteristics of the wetland itself.

Where the wetland has important attributes, such as :

- presence of rare or restricted flora or fauna
- use by high numbers of migratory or native birds
- outstanding scenic quality
- forming an integral link in a system of waterways above and below ground
- size which dominates a regional watershed,

it should be totally preserved. No drainage, filling or other impact through development should be permitted.

Where the wetland has the potential to improve its contribution for wildlife, or for recreation, it should be preserved, and managed towards fulfilling this potential. This may involve some dredging to provide deeper areas of water for waterbirds or sport, filling to provide formal recreation areas on the banks or foreshore, and subsequent protection from impact such as pollution.

In order to achieve such preservation and management of wetlands, it is important that the value of any wetland be considered in the earliest stages of planning for any land-use development of the wetland itself, or the surrounding area. In this way, whether the development involves an individual farmer planning to drain a portion of his property, or a company or Government Department planning a large scale urban or other development, the areas most important for preservation can be assessed, and plans for their management can be incorporated in overall planning of the development. In most cases such environmentally based planning will not only help to preserve what remains of our limited wetland areas for the future, but will also enhance the development itself through maintaining an attractive landscape feature. In the case of urban, tourist and smallholding developments in particular, this could be of economic advantage to the developer.

The following guidelines are put forward as examples of how the major problems outlined in Section 2 can be prevented, by taking wetlands into account in the planning stages of any development. Where possible, means of overcoming or managing existing problems are also outlined. (For ease of reference, problems are dealt with in the same order as in Section 2.)

3.1 DRAINAGE AND FILLING

3.1.1 Agriculture

3.1.1.1 It is estimated that despite a diminishing supply of wetlands the present rate of agricultural development is likely to continue reclaiming wetlands by drainage at the rate of about 150 hectares per year alone in the area of land extending from the Moore River to the Blackwood River and inland a distance of some 80 kilometres (J. Malcolm, 1976 pers. comm.).

While recognising the added value to agriculture when wetlands are reclaimed it is preferred that the decision to drain should be based on the criteria already outlined (see General Comments above).

3.1.1.2 If reclamation by drainage (or filling) has to take place then every endeavour should be made to ensure that the integrity of valuable wildlife habitats is not threatened. This could be achieved by selective drainage and a system of gates and/or bunding to provide water to the habitat at the desirable level.

3.1.2 Urban Development

3.1.2.1 Residential or tourist developments which depend entirely on reclamation of wetlands should be opposed.

3.1.2.2 If there is no alternative to filling or draining part of a wetland area within a proposed development, care should be taken to ensure that the reclamation does not disrupt local drainage nor threaten valuable wildlife habitats, particularly of rare or endangered species of plants or animals.

3.1.2.3 Wetlands within areas proposed for urban development should be integrated into the development in order to achieve maximum beneficial use of their resources. For example, a wetland with value as a wildlife habitat could be preserved in public open space and utilised as an educational and passive recreation resource; a natural drainage depression could be developed for stormwater disposal (see 3.2.10); a degraded watercourse could be revitalized as an adventure playground to complement the more usual recreational facilities; part of a seasonal swamp could be deepened to provide permanent open water as a scenic and recreational attraction, as well as an improved area for water birds.

3.1.2.4 If a wetland is a major known mosquito-breeding site then this should be taken into account before consideration of locating residential development in close proximity to it. When the wetland has outstanding value as discussed in the general comments particularly as a wildlife habitat, then its preservation may be of greater value to the community at large than would the adjacent residential development which could create pressure for drainage, filling or other mosquito control measures all of which are destructive to wildlife. Filling of peripheral flats should not be permitted. If the wetland in a residential area is not of outstanding value, and is a potential source of mosquitoes, its development as "formal" parkland is favoured.

3.1.2.5 Where some filling is necessary, e.g. to improve the recreational potential, the following factors should be taken into account :

- nature of fill: only clean, non-polluting fill, such as clean sand, should be used (see 3.2).
- slope: for the following reasons, the gradient of the new bank or shore created by filling should be slight, preferably not more than 1 in 10:
  - to minimise erosion;
  - to maximise areas for the development of habitat diversity;

- to allow fauna access to and from the water, e.g. some tortoises must be able to climb out of the lake in order to find breeding sites.

- revegetation: re-establishment of foreshore and marginal vegetation (e.g. reeds) may be necessary to prevent erosion and restore visual attraction to the area.

3.1.3 Industrial Development

3.1.3.1 Industrial development relying entirely on reclamation of a wetland area should be opposed, unless the value to the community of the industry in question outweighs the recreational, social and other values of the wetland.

3.1.3.2 If filling is absolutely necessary the natural values of all the alternative sites should be carefully considered, so that areas which are of outstanding value to wildlife or the community are preserved.

3.1.4 Sanitary landfill

3.1.4.1 The use of wetlands, especially river foreshores, as sanitary landfill sites should be strongly opposed.

3.1.4.2 If there is absolutely no alternative, a site should be selected where the wetland :

- has no outstanding value for other purposes;
- is not essential for local drainage;
- is not connected hydrologically (e.g. by a stream) to other wetlands of higher biological or other value;
- is not situated in an area where groundwater is a source of domestic water supply;
- is not close to any wetland of high value as a wildlife habitat, or which is used as a source of drinking water or for water-contact forms of recreation (to prevent the spread of disease - causing bacteria to these wetlands, e.g. by birds).

3.1.4.3 The transmission of pollutants from sanitary landfill sites should be prevented - see 3.2.2.

3.2 POLLUTION

3.2.1 Household effluent

3.2.1.1 High density (residential, tourist), developments should be deep sewered and the wastes diverted away from wetland areas, to prevent pollution by nutrients, bacteria, viruses and chemicals.

3.2.1.2 Where deep sewerage is not practical because of economic or other factors, alternative means of sewage and "grey water" (from washing, etc.), disposal should be designed bearing in mind the need to protect the ground and surface water from contamination. This is particularly important when the groundwater is used as a domestic water supply, either via public or private bores, or where nearby wetlands are used for recreation or are valuable wildlife habitats. The role of excess nutrient input in causing deterioration of water quality, and hence wetland degradation, is stressed.

3.2.1.3 Where on-site effluent disposal is the only alternative, the existence of a suitable site for septic tanks and leach drains (in the context of height above the water table, set-back from water body, suitability of soils, etc. - see 3.2.1.4, 3.2.1.5) on each lot should be verified before development occurs. While obviously the effectiveness of septic effluent disposal systems would depend on local conditions (e.g. soil types, groundwater level etc.) it has been suggested by some overseas researchers that septic tanks are not satisfactory when the population is greater than one family per acre (Patterson et al., 1971).

3.2.1.4 Septic tanks and leach drains should be situated well above the expected highest level of the water table, to minimise the leaching or flushing of pollutants into the groundwater. Septic tanks should never be located in areas of high water table and must conform with public health regulations.

3.2.1.5 Septic tanks and leach drains should be set back at a sufficient distance from the wetland to minimise the transport of pollutants (in the soil or in the ground water flow) to the water body. Obviously it is extremely difficult to specify setbacks as the pollution potential depends on local conditions of soil types, topography, rainfall, water table level, and the density of the development. Clearly some guidelines in this regard would be desirable, and in fact Victoria has nominated setbacks for septic tanks from wetlands - 100 metres from shallow, small and poorly flushed lakes, 50 metres from large, deep lakes and 25 metres from major, minor and intermittent streams. In the absence of definitive data concerning transmission of sewage pollutants under local conditions, it is not possible to give firm guidelines as yet. (Research is being undertaken on Swan Coastal Plain soils to establish appropriate setback criteria and results will be made available when finalised). It should be noted, however, that chemicals (including nutrients) will travel far greater distances than bacteria, which are filtered out by soil particles. Therefore a setback which is sufficient to protect the water body from bacterial contamination is not necessarily sufficient to protect it from nutrient enrichment and consequent degradation.

3.2.1.6 Open areas between leach drains and the water body should be well-vegetated (by re-planting if necessary), as plants draw nutrients from the groundwater system, thus reducing the levels of such pollutants reaching the wetland.

3.2.1.7 Alternative means of household effluent disposal are often environmentally preferable to septic tanks in locations adjacent to wetlands, and the use of alternatives should be seriously investigated, particularly in areas of high water table. These alternatives include :

- enclosed effluent storage tanks (periodically emptied by a waste disposal contractor);
- electric or gas powered incineration toilets;
- composting toilets, e.g. "Bioloos".

These alternatives are particularly useful for situations where use is intermittent, such as holiday cottages.

3.2.2 Waste Disposal Sites - Domestic

Domestic waste disposal sites include sanitary landfills (rubble and household rubbish) and liquid waste sites (e.g. septic tank wastes). Household effluent has been dealt with under 3.2.1.

3.2.2.1 The choice of site for waste disposal is of extreme importance (see 3.1.4).

3.2.2.2 Pollution from waste disposal sites (whether wetland areas or not) arises by leaching of chemicals into groundwater, transport of chemicals and litter in surface runoff, and spread of bacteria from the site, e.g. by birds and other animals, (particularly sea gulls). The site should therefore be managed to prevent pollution, by :

- lining the bottom of the site with clay or other suitable impermeable material to prevent leaching;
- bunding and manipulation of drainage to prevent runoff from the site from entering natural drainage channels and hence wetlands;
- compacting (or pulverising) domestic wastes, to minimise surface area for leaching of chemicals;
- separate treatment of any noxious wastes;
- covering refuse at frequent intervals with sand to minimise leaching and avoid attracting sea gulls and other scavengers;

- fencing the site to prevent access by animals, particularly dogs and cats, capable of spreading disease.

3.2.3 Waste Disposal Sites - Industrial

3.2.3.1 The choice of site is again important:

- the criteria listed under 3.1.4 for selection of sites for sanitary landfill apply also to disposal of solid, non-toxic industrial wastes;
- ideally liquid industrial wastes should be treated, e.g. at a central treatment plant, before discharge, and diverted away from rivers, creeks and other wetland areas. This is particularly important if the wastes are high in nutrients or chemicals which are potential pollutants.

3.2.3.2 Where wastes are "ponded", whether or not in a wetland area, measures such as the following should be taken to prevent pollution of nearby ground and surface water:

- lining the bottom of the pond with clay or other suitable impermeable material to prevent leaching;
- bunding and manipulation of drainage to prevent run-off from the pond from entering natural drainage channels and hence wetlands.

3.2.3.3 The wastes should be prevented from becoming a hazard to wildlife, for instance waterfowl which may be attracted to areas which appear to be open water. It is acknowledged that complete fencing and netting is to date the only proven reliable albeit expensive method. Further research into alternative methods, such as light reflectors, is to be encouraged.

3.2.4 Waste Disposal Sites - Mining

Careful environmental assessment prior to detailed planning of mining projects results in the most effective control of mining pollution.

3.2.4.1 An effective waste management programme for operating mines would be necessary, and could include the following measures:

- the construction of suitably lined dams for waste water storage;
- in open-cut mining,the return of tailings to the mined out areas, where following consolidation and contouring they can be topsoiled and revegetated;
- the use of topographical depressions with impervious substratum for the construction of tailings dams;
- the design of waste dams should incorporate storage capacity to accommodate peak rainfall and to reduce the driving force in embankment slip ;

- the selection of stockpile sites away from the main natural drainage direction;
- the possible development of excavations for safe aquatic recreation.

3.2.4.2 Hazards from wastes from abandoned mines should be reduced, for example by:

- minimizing the flow of mine water into natural drainage by channel and dam lining;
- reshaping of waste dumps;
- covering of the reshaped dumps with layers of clay, rock and soil;
- revegetation of the area;
- further improvement in water quality may require the removal of contaminated stream and lake sediments and chemical treatment of all residual mine water;
- possible reprocessing if market values changed to make this viable.

3.2.5 Agriculture - Point Sources

A wide range of enterprises are involved and include animal feedlots, battery poultry sheds, and processing factories (e.g. dairy product processing, wool scouring, hide tanning and the slaughter of farm animals). The contribution to pollution of wetlands and associated groundwater systems varies with the process involved, the quantity of waste generated, the factory or feedlot location, and whether the wastes are subjected to treatment.

3.2.5.1 Point sources of pollution should be discouraged in areas of high water table, or high potential runoff. They should be sited on flat or gently undulating land, away from creeks, streams or other wetlands.

3.2.5.2 The nutrient output from these sources should be reduced, for example by:

- preventing water from outside feedlots from flowing through it, e.g. by pipes, levees, dykes, roofing, evaporation ponds for runoff;
- collection of feedlot runoff in retention ponds or settling basins before disposal;
- treatment of wastes e.g. biological oxidation in ponds;
- re-use, where possible, of the accumulated waste liquids and solids, e.g. by irrigation of wastes to recycle both water and fertilizer (not near wetlands).

3.2.6 <u>Agriculture - Diffuse Sources</u>

In controlling pollution of wetlands by agricultural runoff, the aim is to reduce the amount of nutrients (in the form of fertilizers and animal wastes), pesticides, weedicides, herbicides, and sediments reaching the water body.

3.2.6.1 Sedimentation of wetlands by soil particles carried in agricultural runoff should be controlled in accordance with the methods outlined in Section 3.3 (Erosion).

3.2.6.2 The widespread use of commercial fertilizers makes it necessary to modify agricultural practices to reduce nutrient enrichment and pollution of surface waters, for example by:

- careful determination of the amount and type of fertilizer required, in the light of nutrients already available in the soil, crop up-take, and climate;

- split application of fertilizer, or use of slow-release nitrogen fertilizer, in soils of high permeability to reduce loss through leaching;
- maintenance of organic content of soil, e.g. by ploughing under cereal straw;
- limiting over-irrigation;
- avoiding applying fertilizer to slopes subject to rapid run-off;
- recycling animal manures;
- maintenance of a well-vegetated non-fertilized "buffer zone" along creeks and around the foreshore of swamps and lakes, to remove some of the nutrients from the run-off water;
- controlling stock access. This can be achieved by pumping water from the wetland to watering facilities rather than allowing livestock on the foreshore.

3.2.6.3 The ecological effects of insecticides and herbicides on aquatic systems are still poorly documented. There is increasing evidence to justify the concern that ecological changes do occur particularly from their indiscriminate use. In this regard it is worthy of note that the U.K. Pesticide Safety Precautions Scheme has only approved eight weed control chemicals for use in or near water. These are 2-4 D (amine salt), maleic hydrazide and dalapon with or without paraquat for bankside vegetation control and chorthiamid, dichlokenil, diquat, paraquat, terbutryne and dalapon for aquatic vegetation.

Recent studies (Newbold, 1975) however, have concluded that most herbicides will cause declines of both fauna and flora over a short period of time. The long term effects are more difficult to assess.

It is therefore recommended that:

- when considering the use of chemicals for insect and weed control in or near wetlands the approach should be one of caution in the light of the lack of information of the possible effects on wetland ecosystems;
- the use of chemicals should be avoided whereever practical; if there are no alternatives, for instance for controlling noxious weeds, or mosquitos at human nuisance hazard levels, then the chemical chosen should if possible have a low persistence and be selective against the target pest or weed so that other components of the wetland habitat are not affected.

3.2.7 Recreation

The forms of recreation compatible with the type of wetland, and its other, or alternative, beneficial uses, should be carefully considered.

3.2.7.1 If the wetland is of high value, particularly as a wildlife habitat, it merits protection from the harmful impact of other activities. In this case recreational activity in and around the wetland should be restricted to passive, low-impact forms which are compatible with maintenance of high scenic value and a "sanctuary" for wildlife. Activities such as walking trails, "hides" for wildlife observation, photography, scientific study, may be acceptable. In some areas, for example water-fowl nesting sites, all human activity should be excluded. This is usually possible simply by providing access paths to other areas, rather than by direct exclusion.

3.2.7.2 If it is established that the most beneficial use of all or part of a wetland is recreation, perhaps in conjunction with other uses, (e.g. professional or amateur fishing) steps should be taken to reduce the pollution and other impact caused by recreational activity, for example by:

- the control of litter, by public education and the supply of ample strategically placed bins;
- the segregation, where possible, of sports or activities such as power boats which generate noise and other forms of disturbance from other more passive forms of activity. Highly active sports and recreational pursuits should be located in areas where the noise will cause least disturbance to wildlife and other people;
- boats, and particularly house-boats, should not be permitted to discharge toilet wastes into the water body. Disposal facilities

should be provided;

- foreshore areas to be formally developed e.g. as playing fields or park-land, should be maintained with minimum use of fertilizer and irrigation water which would add to the nutrient load of the wetland. One way of achieving this is to irrigate the foreshore with the lake (or river) water.

3.2.8 Land Clearance - see 3.2.6. (Agriculture diffuse sources of pollution), 3.3 (Erosion), and 3.5 (Salination).

3.2.9 Mining - see 3.2.4 (Waste Disposal Sites - Mining)and 3.3 (Erosion).

3.2.10 Urban Runoff

3.2.10.1 The pollution potential or urban stormwater runoff should be reduced, for example by:

- controlling the source of pollutants, e.g. animal excreta, illegal dumping, litter, construction work, fertilizer and pesticide application, accumulation of rubbish and debris;
- peak flow reduction - i.e. reduction in the overall volume and velocity of runoff, by minimizing infiltration of groundwater into the stormwater drainage system, by constructing porous pavements to reduce surface runoff, or the use of in-system storage, detention basins, or natural depressions to temporarily store excess peak flows.

- treatment of stormwater by screening to remove large debris, the use of detention basins, tanks or ponds, for settling or flotation (with or without chemical treatment), biological treatment, such as trickling filters, or "activated sludge", or by disinfection, usually in conjunction with screening, settling, or biological treatment.

3.2.10.2 Diversion of stormwater runoff away from wetlands particularly those of high natural value, is recommended. This could be achieved by discharge of stormwater to self-contained settling ponds, drainage sumps etc.

3.3 SOIL EROSION

3.3.1 Soil erosion in the wetland catchment, which would carry sediments and pollutants into the water body and alter drainage pattens, should be controlled, for example by:

- restricting clearing of vegetation, or re-establishment of vegetation cover, especially on slopes or high ground;
- mulching areas prone to erosion e.g. with straw to reduce the quantity of runoff;
- maintenance of a buffer zone of vegetation between cleared or cultivated areas and the wetland, to reduce runoff velocity;
- modification of slope effects by contouring or terracing;

- limiting stock numbers according to the carrying capacity of the area, to prevent overgrazing and removal of ground cover.

3.3.2 Erosion of the banks of the wetland itself should be controlled, for example by:

- protecting foreshore vegetation;
- limiting access points e.g. for recreational use or stock watering, and re-establishing ground cover in these cleared access areas;
- limiting the use of power boats on parts of rivers or lakes where the foreshore is prone to erosion, as the wash against the shore accelerates the process;
- re-establishing marginal vegetation e.g. reeds, in areas already subject to erosion.

3.4 WATER LEVEL CHANGES

Many Western Australian wetlands are ephemeral and dry-up in summer, but others, mostly in sandy terrain, are surface expressions of the water table and tend to retain water the year round although the level may fluctuate depending on previous seasons.

Intensive* groundwater abstraction in the vicinity of a wetland may affect groundwater flow to it.

* The degree of groundwater depression resulting from pumpage is dependent on aquifer conditions, but normally one or two bores would have little effect on regional water levels.

3.4.1 If an abstraction scheme must for developmental, engineering or economic reasons be established in a wetland area, then the value of the wetland should be assessed according to the criteria given at 3.1.4.2.

3.4.2 If the wetland has a value that necessitates its preservation (in some form), a number of engineering options should be considered, for example:

- The water level or volume of water in a wetland may be maintained by deepening;
- The borefield layout could be placed in such a manner as to minimize the effect of groundwater depression on the wetland;
- The pumping strategy of the borefield might be manipulated in such a manner as to minimize adverse effects;
- Some groundwater could be diverted from the borefield to the wetland to maintain water levels;
- The artificial maintenance of the wetland by the pumping in of collected storm runoff, (this option is practical in wetlands adjacent to urban areas and where water quality is not critical);
- The artificial maintenance by the re-use of treated effluents.

3.4.3 The options being engineering ones, the developers of groundwater resources should work in full consultation with those whose task it is to assess the environmental value of a wetland. The appropriate option or combination of options for any particular case is dependent on site and aquifer conditions, other engineering aspects and economic considerations.

3.5 SALINATION

The management of most wetlands depends on control of the catchments feeding water to them. In the case of salination, management depends on control over the extent of clearing and the ability to introduce rehabilitation programmes (e.g. re-vegetation) to reduce salination where this is already happening.

This may be relatively easily brought about in the higher rainfall areas where the catchments lie in State Forest or gazetted water control areas. However, the conservative management of the saline wetlands of the inland areas poses considerable problems since their catchments for the most part are farmlands in private ownership.

3.5.1 Land use development planning should take into account the potential salination consequences of clearing of native vegetation. The objective should be to develop a management programme that ensures the minimal release of salt into catchment areas and associated water systems whether they are in the immediate vicinity or remote from the proposed developments.

3.5.2 It is difficult to assess the potential salination consequences arising from clearing of vegetation in a particular area of land as many factors are involved. These include soil types, topography, rainfall and proximity to water systems. As a general guide, however, clearing of native vegetation should be avoided in catchment areas, particularly in deep lateritic zones, where salt storage is high.

3.5.3 If for economic reasons clearing has to proceed then due consideration should be given to schemes such as selective clearing, whereby the removal of vegetation is restricted to areas as distant as practical from water courses and to areas where salt storage is lowest, as well as to other techniques as they are proven in various regimes.

3.6 AESTHETIC DISRUPTION

3.6.1 The aesthetic environment of an area to be developed should be preserved, to the greatest degree possible, by integrating all facets of the development with the natural order. This could be achieved by, for example :

- the appropriate siting of construction according to the natural vegetation and contours of the land, to reduce its conspicuous facets;
- the preservation of as much as possible of the native vegetation, particularly around the foreshore of the wetland and in areas of high natural scenic value or with

special or unusual vegetation or other features, and if necessary enhancement of the vegetation by the planting of appropriate species;

- the prevention of erosion and breaking down the banks of the water body (see 3.3.2).
- the prevention of pollution of the water body and its surrounds, e.g. by litter, urban stormwater discharge (see 3.2.10), septic tank leachates (which could lead to unsightly deterioration of water quality, see 3.2.1), and waste disposal sites (see 3.2.2, 3.2.3, 3.2.4).

3.7 AQUATIC (DECLARED WEEDS)

In view of the potential adverse effects of aquatic weeds on wetlands it is imperative to include in wetland management programmes the undertaking of regular policing to ensure that any outbreak is curbed in its early stage. It is suggested that the Agricultural Protection Board's assistance be sought particularly in respect to wetlands of significantly high conservation value.

SECTION 4

CONCLUDING COMMENTS

The guidelines set out in this publication evolved from the experience and knowledge of many groups and individuals.

As numerous interacting factors must be assessed in the development of adequate conservation and management plans for wetlands, the guidelines are of necessity lengthy and complex. They will be updated as and when results are forthcoming from current and future research into wetland problems and from reader's comments which are welcomed.

In the meantime, this represents a single document which deals with all the elements of complex wetland management, and its importance, therefore, cannot be minimised.

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