EVALUATION OF METROPOLITAN WETLANDS IMPACTED BY MAIN ROADS DEPARTMENT DEVELOPMENTS

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1.0 INTRODUCTION

Since European settlement, much of the wetland resource in and around the metropolitan area of Perth has disappeared. The remaining wetlands are under increasing pressure because of expanding urban and rural development reaching into areas previously undeveloped.

Some of the pressures on the remaining wetlands include:

* pollution due to excess nutrients from agriculture and domestic gardens;
* hydrocarbons and heavy metal pollution from industry and automobiles;
* a changing water table level through excessive drawdown on the ground water, resulting in the lowering of the water table or the raising of the water table, as a result of the increasing stormwater runoff into wetlands;
* filling for various purposes; and
* recreational pressures.

The expansion of roadworks in and around wetlands has the potential to have a negative impact on wetlands. If a road goes through a wetland or its fringe, it will impact directly through filling the wetland, altering the hydrology and destroying vegetation and fauna. During construction, increasing noise and dust levels can disrupt wildlife and cause increased turbidity of the water body.

Indirectly, the closeness of roads to wetlands may impact as a result of:

* increased water runoff entering the wetland from the road;
* the runoff carrying pollution from cars and other vehicles, including hydrocarbons, lead and other heavy metals, as well as pollution from accidental spills (SPCC, 1987);
* traffic noise and light disrupting the wildlife;
* roads acting as a physical barrier to movement of wildlife; and
* increasing human access and their associated pressures.

Increasingly, wetland protection is becoming an important issue with governments, government authorities and the general public. The events surrounding the building of Farrington Road in 1982 highlighted both this increasing public concern about the impact roadworks can have on wetlands. Responding to this concern the Environmental Protection Authority produced two reports on the impact of roads and roadworks on wetlands (Environmental Protection Authority 1985 a&b) and subsequent to this, the "Draft Guidelines for Wetland Conservation in the Perth Metropolitan Area" (Environmental Protection Authority, 1986). A revised

version of this document is currently being produced (Environmental Protection Authority, in press).

One of the recommendations from the second of these reports on the impact of roads on wetlands was:

> "The wetlands identified in this study as potentially affected by roads and roadworks be individually assessed so that priority for conservation is given to those wetlands which have a current or potential conservation value." (Environmental Protection Authority, 1985b)

In response to this recommendation, the Main Roads Department (MRD) commissioned the School of Biological and Environmental Sciences at Murdoch University to carry out this study. The aims of this study are:

* to identify and map all wetlands where either existing MRD road reserves contain wetlands or where proposed MRD roads have reserves containing wetlands;
* to evaluate those wetlands to determine their conservation values using the method recommended by the Environmental Protection Authority; and
* to provide a ranking of importance of these wetlands, based on the Environmental Protection Authority evaluation method within their suggested management categories.

This report presents the results of the study. Section 2 gives the background to the study, including a brief discussion of the study area, a description of the nature of the wetlands in the metropolitan area and a description of the wetland classification. Section 3 describes the experimental methods, and the final section, Section 4, presents the results of the study and a discussion of their implications. Appendix 2 which includes maps of the wetlands identified and evaluated in this study is presented as a separate document to the main report.

2.0 BACKGROUND- THE STUDY AREA AND ITS WETLANDS

2.1 Geomorphology

As Figure 1 indicates, the Perth Metropolitan area, as defined by the Metropolitan Region Scheme, lies largely on the Swan Coastal Plain.

The Coastal Plain is largely made up of a series of three ancient sand dune systems extending from the foot of the scarp to the Indian Ocean, increasing in age the closer to the Darling Scarp (Figure 2). The most recent system, the Quindalup Dunes, are composed of mobile sands and are located nearest the coast, most notable of which are the Rockingham Peninsula, Woodman's Point and the white sands around Whitfords. The next system is the Spearwood Dune system, highlighted by limestone outcrops and their distinctive yellow sand. The third and most eastern of the dune systems is the Bassendean Dune system. This is the oldest of the three systems. Erosion has reduced this system to gentle undulations and caused the soils to be well leached and typically grey and very sandy.

The Pinjarra Plain lies close to the scarp where the dunes are overlain with alluvial deposits from the rivers that flow off the scarp, most notably the Serpentine River. The resulting sandplains are typically flat and have a higher clay content than the sand dunes they cover, holding surface water for much longer (Semeniuk 1987).

FIGURE 1: Study area and Swan Coastal Plain.

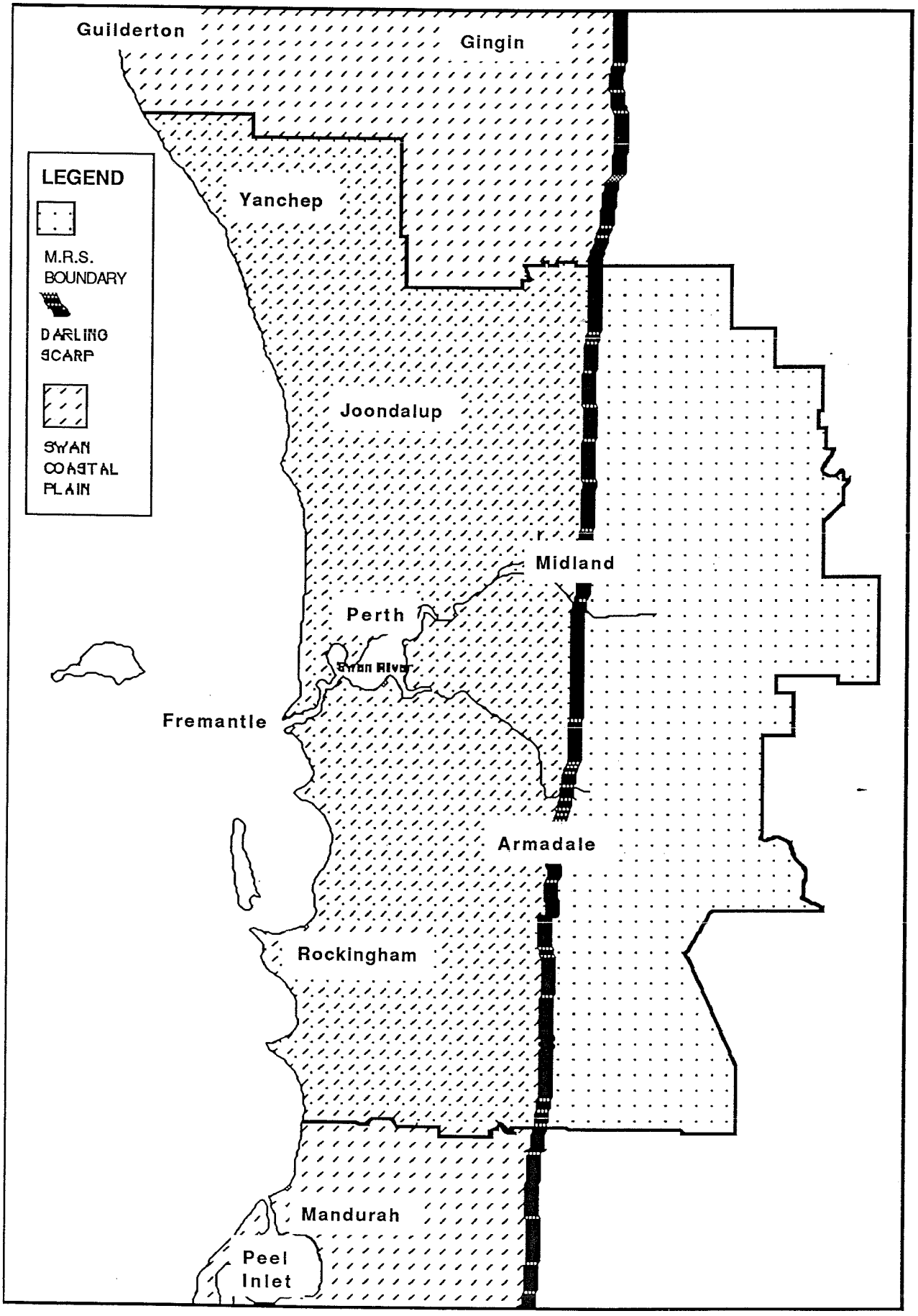
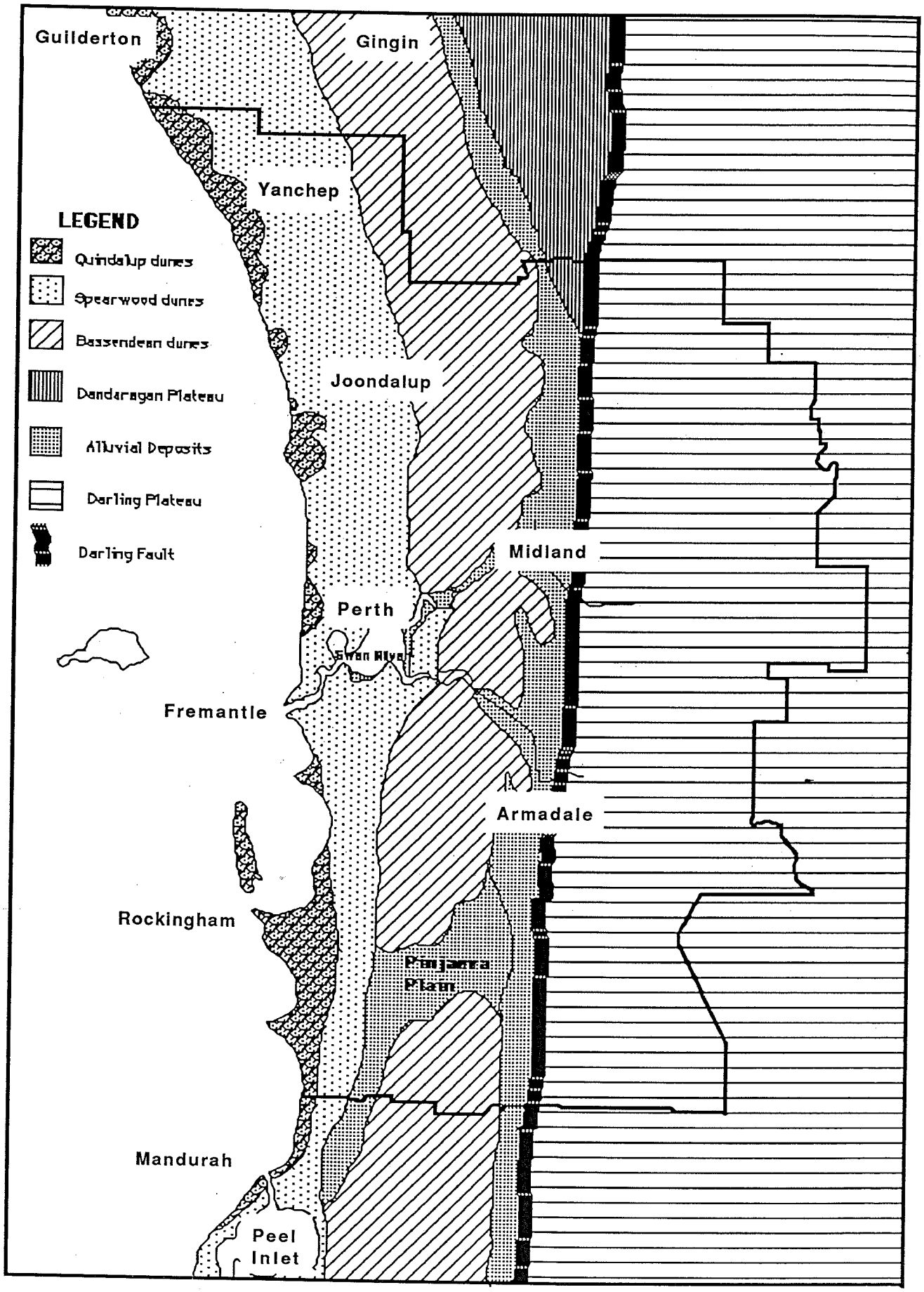


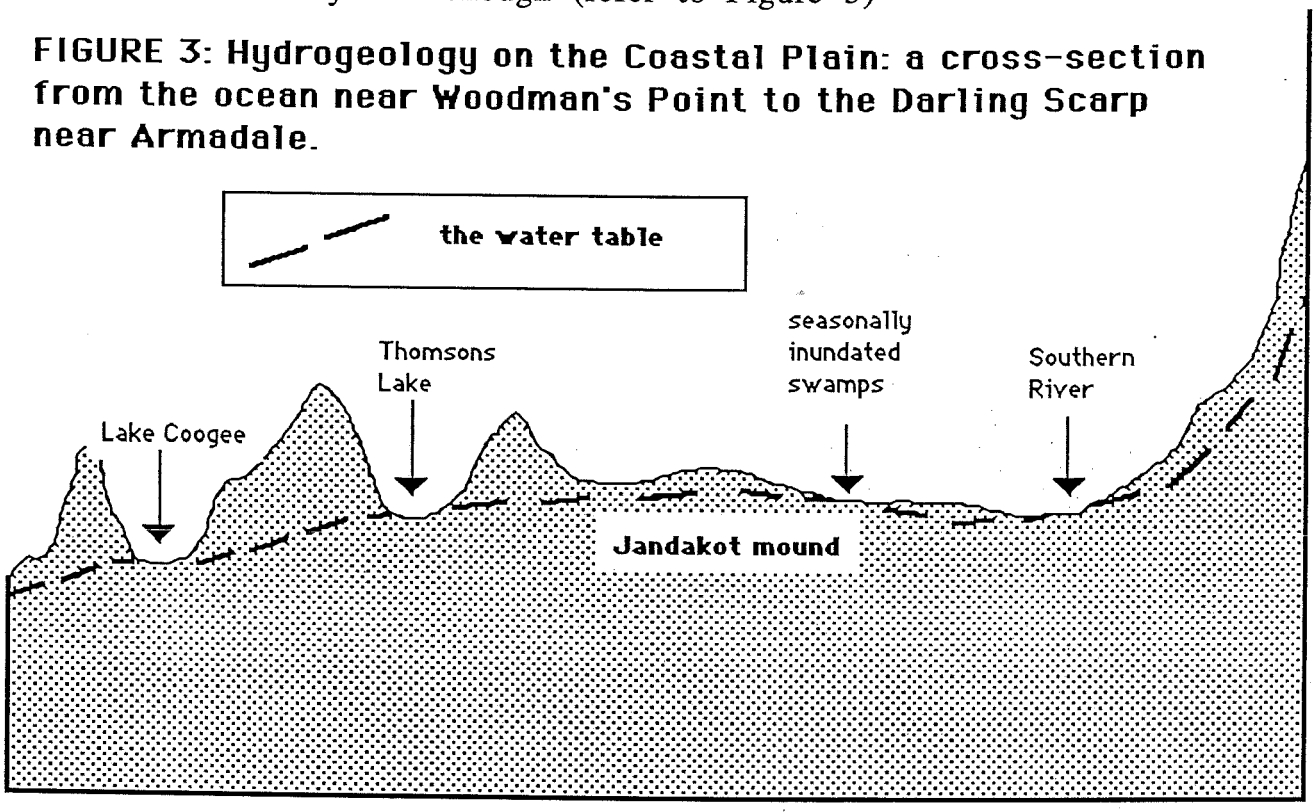
FIGURE 2: Geology of the study area



2.2 Hydrology and the Coastal Plain Wetlands

Coastal Plain wetlands are surface expressions of an unconfined aquifer that underlies the whole plain. Wetlands on the coastal plain are formed when the water table is exposed at the surface where the swales between the dunes are sufficiently low enough (refer to Figure 3)

FIGURE 3: Hydrogeology on the Coastal Plain: a cross-section from the ocean near Woodman's Point to the Darling Scarp near Armadale.



2.3 Wetland definition

Wetlands as defined by the Environmental Protection Authority(1986) are:

> "lands permanently or temporarily under water or waterlogged; temporary wetlands must have surface water or waterlogging of sufficient frequency and/or duration to affect the biota and/or the soils. The occurrence at least sometimes of hydrophytic vegetation or use by water birds are necessary attributes"

This definition is applied in this report

2.4 Wetland types

Semeniuk(1987) has developed a classification system to help characterise the nature of the wetland resource which is specifically designed for the wetlands on the Coastal Plain and Scarp. This classification system is applied in this study.

Seven primary wetland types were identified by Semeniuk using a combination of wetland form, that is, a description of the wetland shape and

water permanence. The three types of wetland shape used were basins, channels and flats and the three types of water permanence applied were permanently inundated, seasonally inundated and seasonally waterlogged.

Therefore the seven primary wetlands types are:

* LAKE - permanently inundated basin;
* SUMPLAND - seasonally inundated basin;
* DAMPLAND - seasonally waterlogged basin;
* FLOODPLAIN - seasonally inundated flat;
* PALUSPLAIN - seasonally waterlogged flat;
* RIVER - permanently inundated channel; and
* CREEK - seasonally inundated channel.

The surface water of the first five types, the basins and flats, moves slowly across the wetland in response to the aquifer movement and surface forces, notably wind. Such wetlands are called LENTIC, whereas the channel wetlands typically have more rapidly flowing water and are known as LOTIC wetlands. This study is confined to lentic wetlands and from hereon the term wetland should be read as meaning lentic wetlands only on the Coastal Plain.

This classification system has proved to be very useful in describing the unique nature of wetlands in and around Perth, but some confusion has arisen because of the generally "accepted" meaning of the terms "lake" and "swamp". Lakes are typically seen as wetlands dominated by vast areas of open water, whether the water is permanent or seasonal. However, the definition of lake by Semenuik (1986), ignores vegetation cover and only uses water permanence. Consequently, a wetland like Lake Kogolup is defined as a sumpland by Semeniuk and not a lake as the name suggests. The term swamp refers to wetlands dominated by emergent vegetation, notably reeds and paperbarks which can be permanent or seasonal. However, the term is not used at all by Semenuik and is thus not used in this report.

3.0 METHODS

3.1. Mapping Wetlands

The wetlands of the Coastal Plain from Gingin to Mandurah have been mapped using 1:25 000 topographical maps as a base, and produced as either overlays or in digital form by Semenuik for the Western Australia Water Authority and the Department of Land Administration.

In this study, copies of these overlays were placed over the corresponding 1: 25 000 topographical maps. Much of the data on these maps is dated, in particular, information on roads. In addition, the scale of these maps is too large for practical reporting purposes (40 maps are needed to cover the study area). Further, the eastern extremes of the metropolitan area are not covered by 1: 25 000 maps, making it difficult to produce consistent reporting methods.

The base maps chosen for this study were 1:50 000 Metropolitan Region Scheme maps produced by the Department of Urban Development and Planning. These maps contain up-to-date information, including some proposed main roads and planned extensions to existing highways and freeways. This information was further updated using the most recent MRD data and hand drawn onto the base maps.

Wetlands potentially affected by main roads were located by matching their location on the 1:25 000 wetland maps with the location of roads on the base maps. These wetlands were drawn on overlays rather than directly onto the base maps.

The base maps and overlays were photo-reduced to A3 size (with permission) and are included as Appendix 2 of this report.

3.2. Evaluating Wetlands

3.2.1 Background

The Environmental Protection Authority's Bulletin "Draft Guidelines for Wetland Protection in the Metropolitan Area" proposed a method to evaluate wetlands on the Swan Coastal Plain (Environmental Protection Authority,1986). In 1988, Murdoch University carried out a pilot study of this method in the Shire of Serpentine-Jarrahdale (Western Australian Water Authority, 1990). As a result of that study, and further deliberation by the Environmental Protection Authority, a modified version of the evaluation method was proposed (Environmental Protection Authority in press).

This revised method was further trialled in 1989 in another Murdoch study (Murdoch,1990). This study found that some additional modifications were

necessary. The modified version of the evaluation method was used in this study and is explained in more detail below.

3.2.2 The method applied in this study

The wetland evaluation method of the Environmental Protection Authority places wetlands into one of five management categories - High Conservation (H), Conservation (C), Open Space (O), Resource Enhancement (E) and Multiple Use (M). Wetlands are recognised to have two broad types of values: natural value and human use value. A wetland's management category is determined by the extent of their value on these two scales.

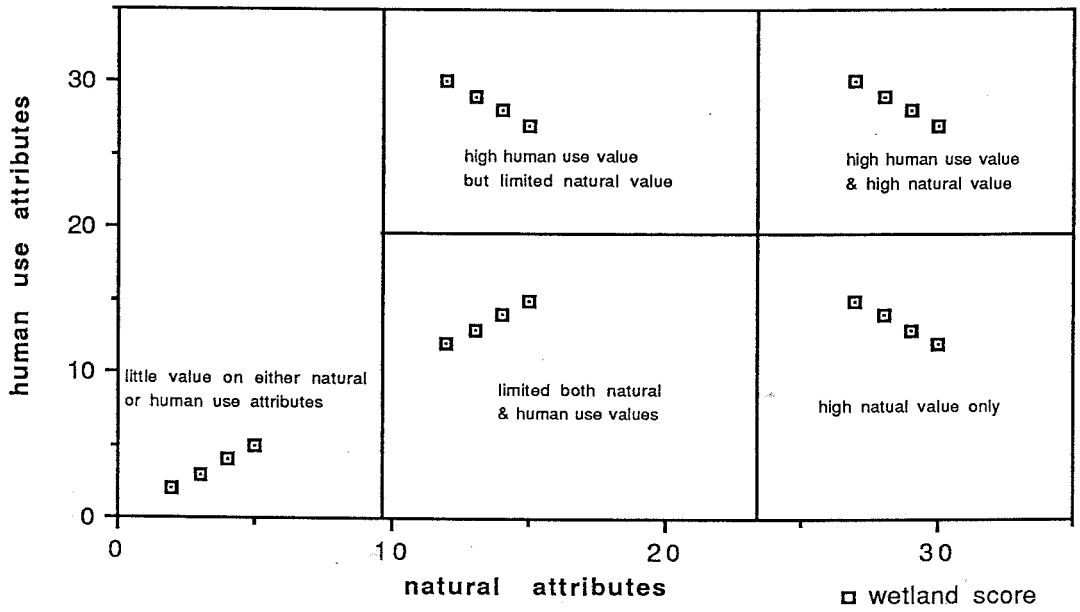
* Wetlands categorised for HIGH CONSERVATION (H) have both high natural and human use value.
* Wetlands categorised for CONSERVATION (C) have high natural value but limited human use value.
* Wetlands categorised for OPEN SPACE (O) have limited natural value but high human use value.
* Wetlands categorised for RESOURCE ENHANCEMENT (E) have limited human use and natural value.
* Wetlands categorised for MULTIPLE USE (M) have little human use and natural value.

The evaluation method allocates two scores to a wetlands, one score for each human use and natural value. A two dimensional graph is then drawn using the two values as the axes. The scores each wetland receives are then used to locate it on the graph where it fits into one of the management categories. Figure 4 shows how this process works. In practice, the the delineation between the management categories on the graph, known as cut-offs are not thin line boundaries as shown in figure 4. Rather, they are imprecise areas, so a degree of subjectivity is introduced in drawing the final boundaries for the cut-offs (as discussed in the results).

To evaluate a wetland using this method involves completing a questionnaire and allocating scores for each question. Questions are answered by refering to aerial photographs, topographical maps and the Metropolitan Region Scheme maps. There are two sections to the questionnaire, one for natural attributes and one for human use attributes. The scores for each question within each section are totalled to give a single score for both human use and natural values.

The full questionnaire as proposed by the Environmental Protection Authority (Environmental Protection Authority, in press) and how to score each question is given as Appendix 1. Also included in Appendix 1 is a field sheet developed for the Gingin study. This sheet summarises the questionnaire and is generally easier to use than the questionnaire proposed by the Environmental Protection Authority.

FIGURE 4: Allocation of Wetlands to Management Categories



3.3 Amendments Evaluation Method

Experience from the Gingin study (Murdoch, 1990b) indicated that:

* three questions needed to be amended; and
* a clear distinction was needed between wetlands with well defined boundaries and wetlands with poorly defined boundaries.

3.3.1 Amended questions

1. Habitat types - some habitat types were identified that did not fall into those proposed in the original evaluation. To overcome this shortfall, the extra types of habitats were added to the questionnaire.

2. Drainage - the catchment area of wetlands was used as part of the scoring procedure. However, this was unable to be used on the Coastal Plain because the contour information from the topographical maps was not precise enough to indicate drainage basins on the scale required. Secondly, because these wetlands are largely groundwater fed, their actual catchment includes a large section of the coastal plain to the east of the wetland and possibly part of the Scarp. A modified version of the scoring method was applied to this question by only noting the absence or presence of drains and, if they were present, whether they fed into or out of the wetland.

3. Potential effectiveness as a conservation unit - experience had shown that the data for this question was difficult to obtain, and when it was available, often produced false results. As a result this question was removed and the cut-offs for the management categories changed accordingly to take this into account.

3.3.2 Distinguishing Wetland Boundaries

The wetlands found on the Bassendean Dune System, the alluvial Pinjarra Plain and the flood plains of the major rivers have poorly defined boundaries, particularly if they have been significantly modified. To standardise the results, and to ensure the evaluation system compared similar types of wetlands, the following wetlands were taken to have poorly defined boundaries:

* damplands on the Bassendean Dune System;
* palusplains, usually found on the Pinjarra sandplains; and
* floodplains.

All remaining wetlands in this study were taken to have well defined boundaries.

Wetlands with poorly defined boundaries typically are in basins or on flats where the vegetation changes from wetland to dryland in an ill-defined region. The gradient of the land is very slight making this transition difficult to see. Wetlands with well defined boundaries, on the other hand, have a much steeper gradient producing a clear distinction between wetland and dryland vegetation.

4.0 RESULTS

4.1 Management Categories

As shown in Section 2.2, wetlands can be placed into management categories based on their position on a two dimensional graph using the natural attributes and human use attributes as the two axes. However, the cut-offs as recommended by the Environmental Protection Authority were modified in this study because of the changes made to the questionnaire (see Section 3.3)

Figures 5 and 6 below show the graphs for the two types of wetlands and the amended cut-offs applied in this study. Figure 5 shows the results for wetlands with well defined boundaries and Figure 6 for wetlands with poorly defined boundaries. The numbers on the graph refer to the codes used for mapping the wetlands; these codes are explained later.

FIGURE 5: Evaluation of Wetlands with Well Defined Boundaries

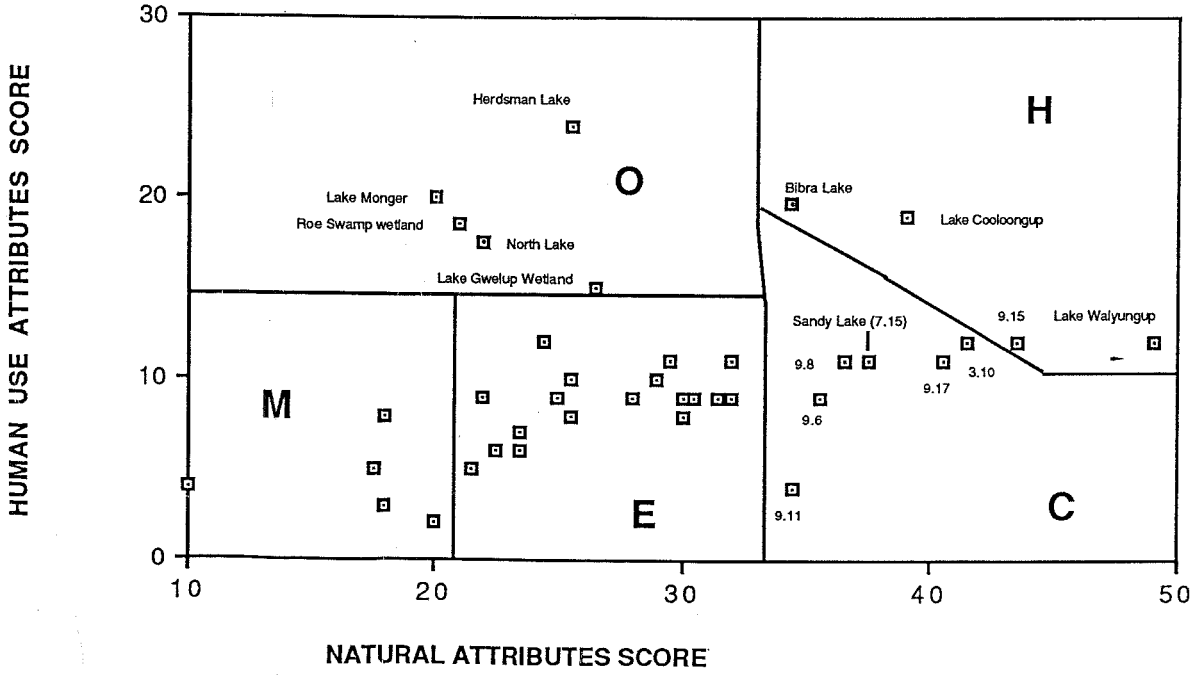
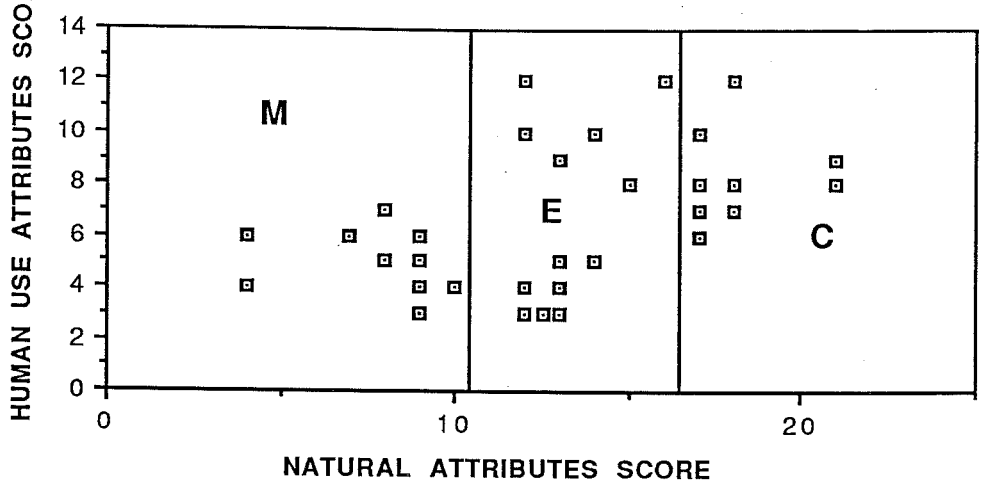


FIGURE 6: Management Categories for Wetlands with Poorly Defined Boundaries



The remaining parts of this section give a more detailed discussion of the results.

4.2 Results Summary

A total of 80 wetlands were identified as either being directly affected by existing roads or are likely to be affected by proposed roads and extensions. These wetlands can be summarised as:

* 39 wetlands have well defined boundaries and 41 had poorly defined boundaries;
* 21 wetlands were on existing roads and/or road reserves and 59 wetlands were on proposed roads or proposed extensions to existing roads;
* 4 wetlands were placed in the High Conservation management category, 16 in Conservation, 5 in Open Space, 35 in Resource Enhancement, and 20 in Multiple Use.

These results are summarised in Table 1.

It is possible that some of the wetlands identified as being on road reserves for proposed new roads or extensions to existing roads might not be on these reserves ultimately. There was also some potential for error when transposing information from maps to the base maps, notably from the wetland maps (different scale and old information) and from the various maps showing the planned roads (different scale). To ensure that all wetlands were included, this study adopted the procedure that any wetlands on the edge of a reserve were included on the reserve and evaluated.

Nearly three times as many wetlands have been identified on proposed roads compared to existing roads. This might suggest that either past

roadworks practices have destroyed wetlands completely or that existing roads are now in areas with a higher proportion of wetlands. A combination of these factors is most likely the reason. For example, in the past, wetlands were seen as negative aspects of our environment and, as a result, it was not uncommon for them to be destroyed either by filling or draining. Similarly, until recently, most of the metropolitan area was concentrated near the coast on the Quindalup and Spearwood Dune systems, or in the Scarp and foothills, areas largely free of wetlands. However, the recent rapid expansion of urban development into the Bassendean Dune system, with its many wetlands, has led to a significant increase in the number of wetlands at risk.

Table 1: Summary Of Results

Management Category	Number of Wetlands with well defined boundaries	Number of Wetlands with poorly defined boundaries	Total num -ber
high conservation	4	0	4
conservation	6	10	16
open space	5	0	5
resource enhancement	18	17	35
multiple use	6	14	20
TOTAL	39	41	80
status of road			
existing roads	11	11	22
proposed roads	28	30	53
TOTAL	39	41	80

4.3 Wetlands Potentially Affected by Specific Roads

Table 2 below lists the main roads, either existing or proposed, within the metropolitan area which either affect wetlands now or are likely to effect wetlands if built. The columns from left to right show the road status and name, management categories and the wetland boundary type. The last two columns also shows how many of each wetland type are affected or could be affected by the road.

The most noticeable aspect of this table is the possible impact that the proposed extension to the Kwinana Freeway could have on important wetlands. That is, one wetland categorised as High Conservation and ten wetlands categorised as Conservation. These wetlands are discussed later in more detail in Section 4.6, although it is clear that careful management of the roadworks is needed to ensure that the values of these wetlands are not diminished.

TABLE 2: WETLANDS TYPES IMPACTED UPON BY SPECIFIC ROADS

Road Status	Road Name	Management Category	Wetland Boundary Type
1. existing			
	Forrest Road	4 x M	4 x poorly defined
	Great Northern highway	1 x C; 2 x E	3 x poorly defined
	Mandurah Road	2 x H; 1 x E	3 x well defined
	Mitchell Freeway	1 x E; 3 x M	3 x well defined
			1 x poorly defined
	Roe Highway	1 x M	1 x poorly defined
	Tonkin Highway	1 x E; 2 x M	1 x poorly defined
			2 x well defined
	Whitfords Ave	1 x E	1 x well defined
	both Northern Perimeter & Tonkin H/ways	1 x C	1 x poorly defined
	Farrington Road	1 x O	1 x well defined
total wetlands		**21**	**21**
2. proposed			
	Cockburn Road	2 x E	2 x well defined
	Hills Spine Road	1 x C	1 x poorly defined
	Kwinana Freeway	1 x H; 10 x C	17 x well defined
		13 x E; 5 x M	12 x poorly defined
	Mitchell Freeway off-ramp and widening	1 x O	1 x well defined
	Northern Perimeter Highway	2 x C; 5 x E	3 x well defined
		4 x M	8 x poorly defined
	Redcliffe-Bushmead Freeway	1 x E; 1 x M	2 x poorly defined
	Roe Highway	1 x H,1 x C; 1 x O	2 x poorly defined
		1 x E; 1 x M	3 x well defined
	Stephenson Highway	1 x O; 1 x E	2 x well defined
	Swan River Drive	1 x E	1 x poorly defined
	Tonkin Highway	1 x E; 3 x M	4 x poorly defined
total wetland		**59**	**59**

4.4 Specific Wetland Details

This section provides more details of the specific wetlands that are or could be impacted upon by Main Roads Department roads. Table 3 summarises this information.

Column one is the wetland code where the first digit refers to the map number, and the second number represents the wetland number for the particular map sheet. Column two is the wetland name, if it is known, and column three is the type of boundary identified for each wetland. Column four represents the natural attribute score for the wetland and column five gives the human use score. The last column is the management category identified for each wetland.

Wetlands are ordered initially by management category, and within these categories by wetland boundary definition.

TABLE 3: SUMMARY OF WETLAND EVALUATION

Included are the scores for natural attributes and human use attributes, and the management category given to each wetland.

WETLAND CODE	WETLAND NAME	WETLAND BOUNDARY TYPE	NATURAL ATT SCORE	HUMAN USE ATT SCORE	MANAGEMENT CATEGORY
7,22	Lake Cooloongup	well defined	39	19	H
9,1	Lake Walyungup	well defined	49	12	H
9,15		well defined	43.5	12	H
5,20	Bibra Lake	well defined	33	20	H
3,10		well defined	41.5	12	C
7,15		well defined	37.5	11	C
9,11		well defined	34.5	4	C
9,17		well defined	40.5	11	C
9,6		well defined	35.5	9	C
9,8		well defined	36.5	11	C
3,12		poorly defined	21	8	C
3,17		poorly defined	21	9	C
3,9		poorly defined	17	10	C
4,1		poorly defined	18	8	C
5,15		poorly defined	18	12	C
7,17		poorly defined	17	8	C
7,2		poorly defined	17	6	C
7,5		poorly defined	17	6	C
9,14		poorly defined	18	7	C
7,11		poorly defined	17	7	C
5,1	Gwelup wetland	well defined	26.5	15	O
5,17	Roe Swamp wetland	well defined	21	18.5	O
5,18	Lake Monger	well defined	20	20	O
5,6	Herdsman Lake	well defined	25.5	24	O
5,19	North Lake	well defined	21	17	O
3,1	Wallaburnup swamp	well defined	24.5	12	E
3,14		well defined	25.5	10	E
3,2	Careniup Swamp	well defined	22.5	6	E
3,3		well defined	23.5	7	E
5,13		well defined	28	9	E
5,5		well defined	21.5	5	E
7,13		well defined	23.5	6	E
7,19	Folly Pool	well defined	29	10	E
7,20		well defined	30.5	9	E
7,21		well defined	22	9	E
9,10		well defined	30	8	E
9,12		well defined	32	11	E
9,16		well defined	25.5	8	E
9,2		well defined	31.5	9	E
9,4		well defined	30	9	E
9,5		well defined	25	9	E
9,7		well defined	32	9	E
9,9		well defined	29.5	11	E
3,11		poorly defined	12	4	E
3,4		poorly defined	12	10	E
3,5		poorly defined	16	12	E
3,8		poorly defined	14	5	E
5,10		poorly defined	12.5	3	E
5,8		poorly defined	15	8	E
7,12		poorly defined	13	9	E
7,16		poorly defined	12	12	E
7,4		poorly defined	12	3	E
7,6		poorly defined	13	3	E
3,15		poorly defined	13	4	E

WETLAND CODE	WETLAND NAME	WETLAND BOUNDARY TYPE	NATURAL ATT SCORE	HUMAN USE ATT SCORE	MANAGEMENT CATEGORY
3,16		poorly defined	13	3	E
3,18		poorly defined	13	5	E
3,19		poorly defined	13	3	E
3,20		poorly defined	13	5	E
5,16		poorly defined	14	10	E
5,12		well defined	17.5	5	M
5,3		well defined	18	3	M
5,4		well defined	10	4	M
5,7		well defined	18	3	M
7,1		well defined	20	2	M
9,3	Maramanup Pool	well defined	18	8	M
3,13		poorly defined	10	4	M
3,6		poorly defined	9	3	M
3,7		poorly defined	9	3	M
5,11		poorly defined	7	6	M
5,2		poorly defined	9	4	M
5,9		poorly defined	4	6	M
7,10		poorly defined	4	4	M
7,14		poorly defined	8	5	M
7,7		poorly defined	9	6	M
7,18		poorly defined	9	5	M
7,3		poorly defined	10	4	M
7,8		poorly defined	9	3	M
7,9		poorly defined	9	3	M
9,13		poorly defined	8	7	M

4.5 Wetland Ranking

One of the aims of this study was to place all affected wetlands into management categories, as well as, identify an order of priority for each of these wetlands within the categories. However, two problems arise. Firstly, the evaluation method has only been designed to place wetlands into management categories; and secondly, there is no mechanism to compare wetlands that need separate evaluation procedures.

The following solution was devised for the first problem. Wetlands within the Conservation category are valued mainly because of their natural attributes and were therefore ranked on their natural attributes score only. Wetlands in the other groups were valued because of both human use and natural values and were ranked based on the COMBINED score of both attributes.

In wildlife evaluation it is only possible to compare like systems as it is inappropriate, for example, to compare desert ecosystems to species rich ecosystems like rainforests. This principle also applies on the smaller scale when comparing wetlands of different types. The Environmental Protection Authority has recognised this by having separate evaluation systems for wetlands with well defined boundaries and those with poorly defined boundaries.

It was decided, therefore, to provide two lists of wetlands showing rankings - one list for each broad type of wetland. None of the three scoring mechanisms (natural attributes score, human use attributes score and total score) can be used to compare wetlands between each broad wetland type.

However, it should be stressed again that this evaluation method is not designed for this type of exercise, and the ranking given below should be seen as PRELIMINARY only.

Table 4 below summarises the preliminary ranking of the wetlands. The table is divided into five sections, one for each management category. The wetlands are ranked in decreasing order as defined above. Wetlands with well defined boundaries are listed first, but it should not be implied that these wetlands are of more value than those with poorly defined boundaries.

TABLE 4: PRELIMINARY RANKING OF WETLANDS WITHIN EACH MANAGEMENT CATEGORY

1. HIGH CONSERVATION

Wetland code	Wetland name definition	Boundary att type	Nat cat score	H/U cat score	Man score	Total
9,1	Lake Walyungup	well defined	49	12	H	61
7,22	Lake Cooloongup	well defined	39	19	H	58
9,15		well defined	43.5	12	H	55.5
5,20	Bibra Lake	well defined	33	20	H	53

2. CONSERVATION

Wetland code	Wetland name definition	Boundary att type	Nat cat score	H/U cat score	Man score	Total
3,10		well defined	41.5	12	C	53.5
9,17		well defined	40.5	11	C	51.5
7,15		well defined	37.5	11	C	48.5
9,8		well defined	36.5	11	C	47.5
9,6		well defined	35.5	9	C	44.5
9,11		well defined	34.5	4	C	38.5
3,17		poorly defined	21	9	C	30
3,12		poorly defined	21	8	C	29
4,1		poorly defined	18	8	C	26
9,14		poorly defined	18	7	C	25
5,15		poorly defined	18	12	C	30
3,9		poorly defined	17	10	C	27
7,11		poorly defined	17	7	C	24
7,17		poorly defined	17	8	C	25
7,2		poorly defined	17	6	C	23
7,5		poorly defined	17	6	C	23

3.OPEN SPACE

Wetland code	Wetland name	Boundary definition type	Nat att score	H/U cat score	Man cat	Total score
5,6	Herdsman Lake	well defined	25.5	24	O	49.5
5,1	Gwelup wetland	well defined	26.5	15	O	41.5
5,18	Lake Monger	well defined	20	20	O	40
5,17	Roe Swamp wetland	well defined	21	18.5	O	39.5
5,19	North Lake	well defined	21	17	O	38

4. RESOURCE ENHANCEMENT

Wetland code	Wetland name	Boundary definition type	Nat att score	H/U cat score	Man cat	Total score
9,12		well defined	32	11	R	43
9,7		well defined	32	9	R	41
9,2		well defined	31.5	9	R	40.5
9,9		well defined	29.5	11	R	40.5
7,20		well defined	30.5	9	R	39.5
9,4		well defined	30	9	R	39
7,19	Folly Pool	well defined	29	10	R	39
9,10		well defined	30	8	R	38
5,13		well defined	28	9	R	37
3,1	Wallaburnup swamp	well defined	24.5	12	R	36.5
3,14		well defined	25.5	10	R	35.5
9,5		well defined	25	9	R	34
9,16		well defined	25.5	8	R	33.5
7,21		well defined	22	9	R	31
3,3		well defined	23.5	7	R	30.5
7,13		well defined	23.5	6	R	29.5
3,2	Careniup Swamp	well defined	22.5	6	R	28.5
5,5		well defined	21.5	5	R	26.5
3,5		poorly defined	16	12	R	28
5,16		poorly defined	14	10	R	24
7,16		poorly defined	12	12	R	24
5,8		poorly defined	15	8	R	23
7,12		poorly defined	13	9	R	22
3,4		poorly defined	12	10	R	22
5,14		poorly defined	14	5	R	19
3,8		poorly defined	14	5	R	19
3,18		poorly defined	13	5	R	18
3,20		poorly defined	13	5	R	18
3,15		poorly defined	13	4	R	17
3,16		poorly defined	13	3	R	16
3,19		poorly defined	13	3	R	16
7,6		poorly defined	13	3	R	16
3,11		poorly defined	12	4	R	16
5,10		poorly defined	12.5	3	R	15.5
7,4		poorly defined	12	3	R	15

5. MULTIPLE USE

Wetland code	Wetland name	Boundary definition type	Nat att score	H/U cat score	Man cat	Total score
9,3	Maramanup Pool	well defined	18	8	M	26
5,12		well defined	17.5	5	M	22.5
7,1		well defined	20	2	M	22
5,3		well defined	18	3	M	21
5,7		well defined	18	3	M	21
5,4		well defined	10	4	M	14
7,7		poorly defined	9	6	M	15
9,13		poorly defined	8	7	M	15
7,3		poorly defined	10	4	M	14
3,13		poorly defined	10	4	M	14
7,18		poorly defined	9	5	M	14
5,2		poorly defined	9	4	M	13
7,14		poorly defined	8	5	M	13
5,11		poorly defined	7	6	M	13
7,8		poorly defined	9	3	M	12
3,6		poorly defined	9	3	M	12
3,7		poorly defined	9	3	M	12
7,9		poorly defined	9	3	M	12
5,9		poorly defined	4	6	M	10
7,10		poorly defined	4	4	M	8

4.6 Specific Wetlands

4.6.1 Introduction

In the following section, the most notable wetlands are identified and described according to their placement in management categories.

HIGH CONSERVATION

Wetland 7.22, Lake Cooloongup, well defined boundary, natural attributes score - 39, human use attributes score - 19

Wetland 9.1, Lake Walyungup, well defined boundary, natural attributes score - 49, human use attributes score - 12

Wetland 9.15, well defined boundary, natural attributes score - 43.5, human use attributes score 12

Wetland 5.20, well defined boundary, natural attributes score - 33, human use attributes score - 20

The first two wetlands are adjacent to the old Mandurah Road. They have been evaluated previously by the Environmental Protection Authority (1986), receiving the same evaluation. The third wetland is an almost pristine well defined dampland in the middle of privately owned bushland. This wetland is well protected, only slightly degraded in one area, and has a wide diversity of habitat types. It is an excellent example of this type of wetland, and well worth preserving in its current state.

Bibra Lake had been previously evaluated as a "Conservation" wetland by the EPA (EPA in press). But since the time of the field work that lead to that scoring there have been modifications to the Lake, improving its value as recreation resource (Middle, 1988, detailed the social value of this wetland). These changes are enough to change it management category to High Conservation.

CONSERVATION

Wetland 3,10, well defined boundary, natural attributes score - 41.5, human use attributes score - 12
Wetland 7,15, well defined boundary, natural attributes score - 37.5, human use attributes score - 11
Wetland 9,11, well defined boundary, natural attributes score - 34.5, human use attributes score - 4
Wetland 9,17, well defined boundary, natural attributes score - 40.5, human use attributes score - 11
Wetland 9,6, well defined boundary, natural attributes score - 35.5, human use attributes score - 9
Wetland 9,8, well defined boundary, natural attributes score - 36.5, human use attributes score - 11
Wetland 3,12, poorly defined boundary, natural attributes score - 21, human use attributes score - 8
Wetland 3,17, poorly defined boundary, natural attributes score - 21, human use attributes score - 9
Wetland 3,9, poorly defined boundary, natural attributes score - 17, human use attributes score - 10
Wetland 4,1, poorly defined boundary, natural attributes score - 18, human use attributes score - 8
Wetland 5,15, poorly defined boundary, natural attributes score - 18, human use attributes score - 12
Wetland 7,17, poorly defined boundary, natural attributes score - 17, human use attributes score - 8
Wetland 7,2, poorly defined boundary, natural attributes score - 17, human use attributes score - 6
Wetland 7,5, poorly defined boundary, natural attributes score - 17, human use attributes score - 6
Wetland 9,14, poorly defined boundary, natural attributes score - 18, human use attributes score - 7
Wetland 7,11, poorly defined boundary, natural attributes score - 17, human use attributes score - 7

Most of these wetlands are in an excellent condition, with only minimal degradation. One exception, however, is wetland 9.11. This wetland scores highly mainly because it is well buffered, has no drains into it and no noticeable water quality problems. However, the wetland proper is low in diversity, being badly degraded, but showing signs of regeneration. This regeneration is a result of either the wetland having once been cleared or to a changed hydrology pattern because of the surrounding pine plantation. As a wetland it is not a good example but its value will increase if allowed to regenerate.

Two other wetlands, 9.6 and 9.8 are located within the same pine plantation as 9.11, but are in much better condition, with higher habitat diversity.

Wetland 9.17 has special value as it is one of only a few wetlands in a relatively pristine state found on alluvial floodplain soils around Perth.

Wetland 3.9 is an extensive dampland with different sections showing varying states of degradation. Some sections have been cleared for horse grazing and industry, while the south western section is regenerating after a bush fire. The most natural section, which is a good example of this type of wetland, is the section between the industry and the east of Beechboro Road, part of which forms the interchange for the Tonkin and Northern Perimeter Highways. It is possible that roadworks and post construction management could be carried out in a manner that retains much of the natural integrity of this section of the dampland within the road reserve.

Wetland 3.10 is a small sumpland just south of wetland 3.9. This wetland is in a relatively deep basin, well protected by surrounding bush and shows a high diversity, including some extensive beds of *Baumea* species. There is no *Typha* present in this and the wetland is small enough to be managed in a way that retains most of its current natural attributes.

Wetland 5.15 is a partly degraded section of the Canning River floodplain. The floodplain is largely covered by *Eucalyptus rudis* over degraded grassland with a paperbark fringe to the river. It scores highly, primarily because the soil type is alluvial - a rare wetland soil type. Access to the river is limited because of the trees and grasses. With careful management, the grasslands could be replaced with native shrubs and herbs.

Wetland 7.2 is a dampland with both degraded and near pristine sections. The Kwinana Freeway extension works have reached this wetland and part of the natural area has already been destroyed by roadworks. However, between the roadworks and the road reserve boundaries, to the northeast of the road, is an unaffected section which is an excellent example of a dampland, being a cross-section through the basin. This dampland shows the full range of habitat types, from the fringe with scattered paperbarks over low scrub less than 0.5m, through to thickets of *Astartea* species up to

2.5m in the deepest part. All attempts should be made to manage this wetland section to retain this diversity. This wetland may also provide an excellent educational opportunity as a result of its potential for easy access.

Wetland 7.11 is a distinct dampland, still largely in it natural state. It contains mostly impenetrable *Astartea* species over 2.5m, with the western section cleared for a State Energy Commission of Western Australia (SECWA) power line. The Freeway is planned to align just east of the SECWA reserve. A similar management policy as suggested for wetland 7.2 should be adopted.

Wetland 7.17 is in two sections. The section north of Mortimer is in an excellent condition with an extensive and, apparently, undisturbed bed of sedges. This is very rare in and around Perth. The southern section is largely regenerating paperbarks over grazed land. The northern section is on the Freeway road reserve. All attempts should be made to keep the actual roadworks on the west side of the reserve and to protect this section of the wetland.

Wetland 7.5 is degraded in parts. However, but the southeastern section, known as Russell Road Swamp which is dissected by Barfield Road, is still relatively pristine. The Freeway extensions may cut through the eastern edge of this section. It is possible, however, to align the road to the east of the reserve to avoid any more damage to the wetland and retain part of it within the reserve and protected from further degradation.

Wetland 9.14 is largely a degraded floodplain section of the Serpentine River. These wetland types are considered rare, although the only part of this wetland of any natural value is a small basin within the floodplain in the tip of the northwest "finger". In this section, on the eastern part of the freeway reserve, there are large *Eucalyptus rudis* trees over thickets to 2m high. It may be easy to align the Freeway to miss this wetland and still keep it protected within the reserve.

OPEN SPACE

5.18, Lake Monger wetland, well defined boundary, natural attributes score - 20, human use attributes score - 20.

5.1, Lake Gwelup and surrounding wetland, well defined boundary, natural attributes score - 26.5, human use attributes score - 15

5.17, Roe Swamp and surrounding wetland, well defined boundary, natural attributes score - 21, human use attributes score - 18.5

5.6, Herdsman Lake, well defined boundary, natural attributes score - 25.5, human use attributes score - 24

5.19, North Lake, well defined boundary, natural attributes score - 21, human use attributes score - 17

Lake Monger, while not scoring the highest in this study on human use value, is possibly the most important wetland for recreation in Perth. A study by Middle (1988) suggested that nearly 1 in 8 people in Perth visit the Lake throughout the year with 81 000 people making 320 000 visits during a six month period over summer.

The most important aspects of this lake were the open water, the wildlife, the path around the lake, the grassed areas and the various facilities. The implication for the MRD with regard to the proposed widening of Mitchell freeway, is that it will need to be done in a way that does not diminish the value of these attributes. If the widening takes place on the Lake Monger side of the road, it is likely that some of the lake will be filled in and the path on that side destroyed. The MRD may have to demonstrate that such works will, once construction is finished, improve the quality of the facilities and environment on this badly degraded side of the Lake.

Lake Gwelup proper is unaffected by proposed road works. The degraded sumpland to the east is where the road works will take place. These roadworks would be expected to have minimal impact on the Lake section of the wetland.

Both Roe Swamp and Herdsman Lake are more likely to be directly affected by roadworks, and careful management will be needed to maintain their high human use values.

North Lake has been the centre of previous controversy regarding road works, as outlined in the introduction (Farrington Road). This wetland forms part of the proposed Beeliar Regional Park, and is an important summer refuge for many waterbirds. The bushland to the east is also an an important habitat for other fauna.

OTHER WETLANDS

All of the remaining wetlands have limited natural and human use attributes and have no attributes needing further comment.

5.0 MANAGEMENT CATEGORIES AND THE IMPLICATIONS FOR MAIN ROAD WORKS

5.1 Introduction

EPA Bulletin 374 gives broad guidelines for management for wetlands in each management category. These guidelines will be discussed in the following sections in relation to main road works.

5.2 High Conservation

The objectives for managing these wetlands are;

* the wetland attributes, in particular, the natural attributes should be actively managed to maintain and enhance their values; and
* if there is no management plan for these wetlands one should be developed as a matter of urgency.

Clearly, the MRD has a responsibility to construct and manage its roads in ways that do not affect such wetlands. The two Rockingham wetlands (Walyungup and Cooloongup) are near an existing road. Care should be taken to avoid runoff from this road entering these wetlands.

Similarly, the MRD should ensure that the High Conservation wetland - number 9.15- will not be adversely impacted upon by the proposed extensions to the Kwinana freeway. This may require the extensions avoiding the wetland altogether.

5.3 Conservation Wetlands

The management objective for these wetlands is to maintain and enhance their natural attributes and functions. Most of these wetlands (14 out of 16) are in the paths of proposed roads. These wetlands have a high natural attributes value and will need to be isolated from roadworks and road impacts if their values are to be maintained. Every effort should be made to divert roadworks away from these wetlands and to ensure that the roads do not impact on the wetlands.

5.4 Open Space Wetlands

The management objective for these wetlands is to protect the human use attributes without diminishing their natural attributes. All these wetlands identified in this report are in the path of proposed roadworks. The proposed road works will, therefore, need to ensure that they do not diminish the human use attributes of the wetlands into this category. This

can best be achieved by referral to the database, provided with this report, which outlines these values.

5.5 Resource Enhancement Wetlands

The management objective for these wetlands is to maintain their existing functions. It is likely that proposed roadworks in and around these wetlands can take place if managed carefully to ensure no loss of function occurs as a result of the roadworks. It will require that their existing values are determined (refer to the full data on the wetlands in the data base), and road works planned accordingly.

5.6 Multiple Use Wetlands

It is possible that these degraded wetlands can undergo substantial alteration. It would be desirable, however, that a management programme be implemented, following road construction, that could rehabilitate part or all of the wetland so as to enhance some of its natural or human use values. For example, if a wetland is used as a drain, it can be landscaped so as to provide a pleasant recreational resource for nearby residents. It might also be possible to build islands and include reeds and paperbarks to provide wildlife habitats that complement the water.

6.0 CONCLUSION

Over recent years, wetlands have taken on a much greater value as their natural and human use functions are realised. This has meant that proposed developments which may impact upon wetlands should be assessed before they are permitted to proceed. Accordingly, this report has identified, mapped, evaluated and provided a ranking of importance within each management category for wetlands existing in MRD road reserves or for wetlands where proposed MRD roads have reserves containing them.

This report has also provided a brief description of the impacts caused by existing roads or potential impacts caused by proposed MRD developments. As well, management policies have been suggested to avoid such impacts where they may lead to deleterious effects upon wetlands classified into high conservation, conservation or open space management categories.

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SPCC (1987). Pollution Control manual for Urban Stormwater: Draft State Pollution Control Commission, NSW.

APPENDIX 1 Simplified field sheet for evaluating wetlands

A - INSTRUCTIONS ON HOW TO COMPLETE THE INFORMATION & SCORING SHEETS.

This sheet has been designed for easy usage and processing. The instructions below should be read prior to using the sheet.

1. The sheet is divided into two vertical sections: data collection (left hand side of the sheet) and scoring and comments (the right hand side).

2. Some of the parts are contained within boxes, either single or double boxes. The sections within the SINGLE boxes can be completed by referring to maps, aerial photography, System 6 Red Book and local Government information, without the need for field checking.

The sections within DOUBLE boxes should be completed separately from the rest of the data collection. The double box for question B2 should be completed once all the data is recorded on habitat types for all wetlands. Question C2 is on historical and archaeological sites, and is best completed as a separate part of the study, considering all the wetlands at the same time.

3.The sheet headed "Lentic Wetland Information & Scoring Sheet" refers to LENTIC wetlands on the Coastal Plain, whereas the sheet headed "Lotic Wetland Information & Scoring Sheet " is to be used for rivers and creeks.

4. The lentic sheet can be used for lentic wetland with or without well defined boundaries. If the wetland has a well defined boundary ALL questions should be answered. If the wetland has a poorly defined boundary only those questions marked with an ✠ should be answered .

5. Do not fill out the scoring section until after all of the wetlands in the study area have had the data collected and entered on the sheets.

LENTIC WETLAND INFORMATION & SCORING SHEET

A. RESOURCE DATA

LAKE NAME _____
WELL DEFINE OR POORLY DEFINED BOUNDARY _____

DATE VISITED _____ FIELD WORKER _____

ID No __ (basin 6 Perth, 7 Moore) _ _ _ _ _ (easting) _ _ _ _ _ _ _ (northing)

QUESTION SCORE

B. NATURAL ATTRIBUTES

✿1. ENVIRONMENTAL GEOLOGY CLASSIFICATION

Geology _ _ _ Soil type _ _ _ Distribution restricted? Y/N

✿2. ADJACENT WETLANDS

1. How many wetlands are there within 2 Km? _____

2. Refer to section E below on number of habitats types.
How many habitat types in THIS wetlands are not found in the wetlands within 2kms of this one?_____

3. DROUGHT REFUGE SCORE

Is this wetlands one of those listed in the Appendix?
If so what score is allocated to it? _____

4. WETLAND SIZE

What is the area of the wetland? _____
Tick the corresponding box for wetland size. Between:
0-10 ha ☐ 10-25 ☐ 25-50 ☐ 50-100 ☐ >100 ☐

✿5. HABITAT TYPES

No of habitat zones are visible from the aerial photo? _____

Tick the appropriate boxes for habitat types are present.
(a). EMERGENT VEGETATION

large paperbarks in dense clumps (>2.5m tall) ☐
large E. rudis in dense clumps (>2.5m tall) ☐
thickets of Astartea or Melaleuca (~2.5m tall) ☐
thickets of *Leptospermum* or *Kunzea* (~1.5 m tall) ☐
paperbark fringe ☐ sedge fringe (eg baumea, juncea) ☐
rush fringe (eg typha) ☐ samphire or salt-marsh ☐
extensive beds of sedges ☐ extensive beds of rushes ☐
scattered "islands" of rushes or sedges ☐

(b). OTHER HABITAT

flooded grasslands in winter/spring ☐
mud flats or seasonally dry open water ☐
islands - natural/man-made ☐ fringing non-wetland bush ☐
shallow perm open water present (<0.5m) ☐
deep permanent open water present (>0.5m) ☐
scattered paperbarks ☐ scattered rushes ☐

6. AREA OF EMERGENT VEGETATION

What is the area of emergent vegetation _____
Calculate AREA OF EMERGENT VEGETATION x 100
AREA OF WETLAND
Tick the appropriate box for this calculation

40 - 60 ☐ 30 - 40 & 60 - 70 ☐
20 - 30 & 70 - 80 ☐ 10 - 20 & 80 - 90 ☐
<10 & >90 ☐

7. ADVERSE WATER QUALITY

Have any of the following been observed/recorded by fieldworker or locals

Algal blooms (free-floating) ☐ Algal mats (filamentous) ☐
High nutrient levels ☐ Pollution slicks ☐
Botulism recorded ☐

✿8. DRAINAGE

Are there any drains coming in or out? CIRCLE CORRECT RESPONSE **Drains in/drains out/No drains**
If drains come into the wetland what is the catchment area for that/those drains? _____ha

9. ADJACENT NUTRIENT SOURCE

Note the presence of any of the following:
Landfill into wetland ☐ septic tanks within 100m ☐
seasonally fertilized lawns or grazing areas ☐
agric development with high nutrient loss ☐
type _____

10. AREA OF WETLAND MODIFIED

Area of wetland + 50m buffer _____
area filled or dredged _____
area cleared/paved/grassed/cultivated or grazed _____
area badly weed invaded _____
area urbanised _____
Total area modified _____
Calculate TOTAL AREA MODIFIED x 100
AREA OF WETLAND + BUFFER
Tick the appropriate box based on that calculation

0 - 10% ☐ 11 - 20 ☐ 21 - 30 ☐
31 - 40 ☐ >40% ☐

✿ only for wetlands with poorly defined boundaries -
Area of wetland within property boundary _____ha
area of wetland modified as above _____ ha

11. POTENTIAL EFFECTIVENESS AS CONSERVATION UNIT

Wetland area (from above) _____
Calculate the "Cadastral" area ie the area of land that is a reserve containing the wetland, and/or area of private land allocated to the wetland by the landowner(s)_____

12. NATIVE VEGETATION BUFFER

What length of the perimeter of the wetland has a 50m vegetation buffer? _____m
What is the total perimeter of the wetland? _____m

C. HUMAN USE

1. AESTHETICS

Record any of the following aspects related to aesthetics:

- Little if any artificial noise ☐
- Some artificial noise noticeable ☐
- Steep ridge visible as part of scenery ☐
- Views of water from ridge ☐
- Wetland is a lake & open water easy to view ☐
- Understorey intact ☐
- Some intrusion of the view by nearby buildings ☐
- An area exists where few people visit ☐

2. HISTORICAL/ARCHEOLOGICAL COMPONENTS

Note the presence of any of the following

Aboriginal site ☐ pioneer relics ☐
national trust centre ☐ national estate listing ☐

3. SECURITY OF WETLAND

TOT No OWNERS _____
USING THE CODES BELOW LIST THE OWNERS TYPES
OWNER 1 _____; OWNER 2 _____; OWNER 3 _____;

PO - private; LA - local authority; VA vested res or SPC land; CL - vac crown land. MAJOR OWNER_____

RESERVE CLASS AND NUMBER __ __ __ __ __
RESERVE PURPOSE:
(a) in full _____
(b) summary: Tick the appropriate box for ownership type:

- A Class reserve -for Conservation/recreation ☐
- PAR MRS owned by local authority or Govern Dept ☐
- Other vested reserve ☐
- Other reserve - unvested or System 6 recreation ☐
- Other or private ☐

SYSTEM 6 RECOMMENDATION No __ __ __ __ MRS ZONE __ __
__ (use codes below) PAR - parks & recreation; PUB - public purposes; RRL - rural; FST State Forest; IND - industry & special industry; TRS - transport - road and railway; URB - urban, urban deferred, civic and cultural

4. PROTECTION GROUPS

Are there active protection groups for this wetland? Yes/No
If yes give the details below.
NAME(S) _____

CONTACT PERSON(S)_____

_____

ADDRESS(ES) _____

_____

_____

PHONE No(s) _____

5. PASSIVE RECREATION

Is the wetland used or has facilities for the following - tick the appropriate box(es)?

nature study/bird watching ☐ education (school < 500m) ☐
picnic/barbecue facilities ☐ recognized tourist venue ☐
conservation of flora ☐ conservation of fauna ☐
recognized research site ☐ protection/preservation-other ☐

6. ACTIVE RECREATION

Is the wetland used or has facilities for the following - tick the appropriate box(es)?

walking/cycling (path) ☐ horse riding ☐ trail bikes ☐
playground ☐ oval ☐ other _____ ☐

7. OTHER HUMAN USES

Is wetland used for any of the following - tick box(es)?

agriculture ☐ mining leases exist on wetland ☐
existing/proposed service corridors (roads, SEC) ☐
water supply ☐ proposed urban/housing ☐
private purposes other than above ☐

ANY COMMENTS

_____

_____