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Shire of Wanneroo – a Study of Land Resources and planning considerations

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Disclaimer

The contents of this report were based on the best available information at the time of publication. It is based in part on various assumptions and predictions. Conditions may change over time and conclusions should be interpreted in the light of the latest information available.

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Preface

A land resource study of all rural and undeveloped coastal land within the Perth Metropolitan Region is being undertaken by the Division of Resource Management in recognition of the inevitable pressure on those areas for land use change as population increases. This report addresses both coastal and rural land use because the Department is not only concerned with assisting agricultural productivity, but is also responsible under the Soil and Land Conservation Act (1945—82) for mitigation of the effects of land degradation throughout the State.

The land resource study involves a systematic mapping programme for the Darling Scarp and Foothills region. However, for the bulk of the Metropolitan Rural Area the study will involve the collation and interpretation of existing data, with 'new' land resource mapping being undertaken when specific requests justify it.

This technical report is one of a series of interim documents which aims at collating material which would normally remain within departmental letters and files as specific advisory material relating to individual requests for information. It should be noted that the map units employed in this report do not correspond exactly with those used in the previous report in this series (Shire of Rockingham — Technical Report No. 44). It is intended within the next few years, to bring all metropolitan land resource survey data together under a uniform system of map unit nomenclature and publish a Department of Agriculture Technical Bulletin describing the rural land resources and their capabilities for future use.

NOTE: Copies of maps associated with this report may have been replaced by microfiche reductions. Dyaline copies of map sheets are available upon request to the Division of Resource Management, Department of Agriculture.

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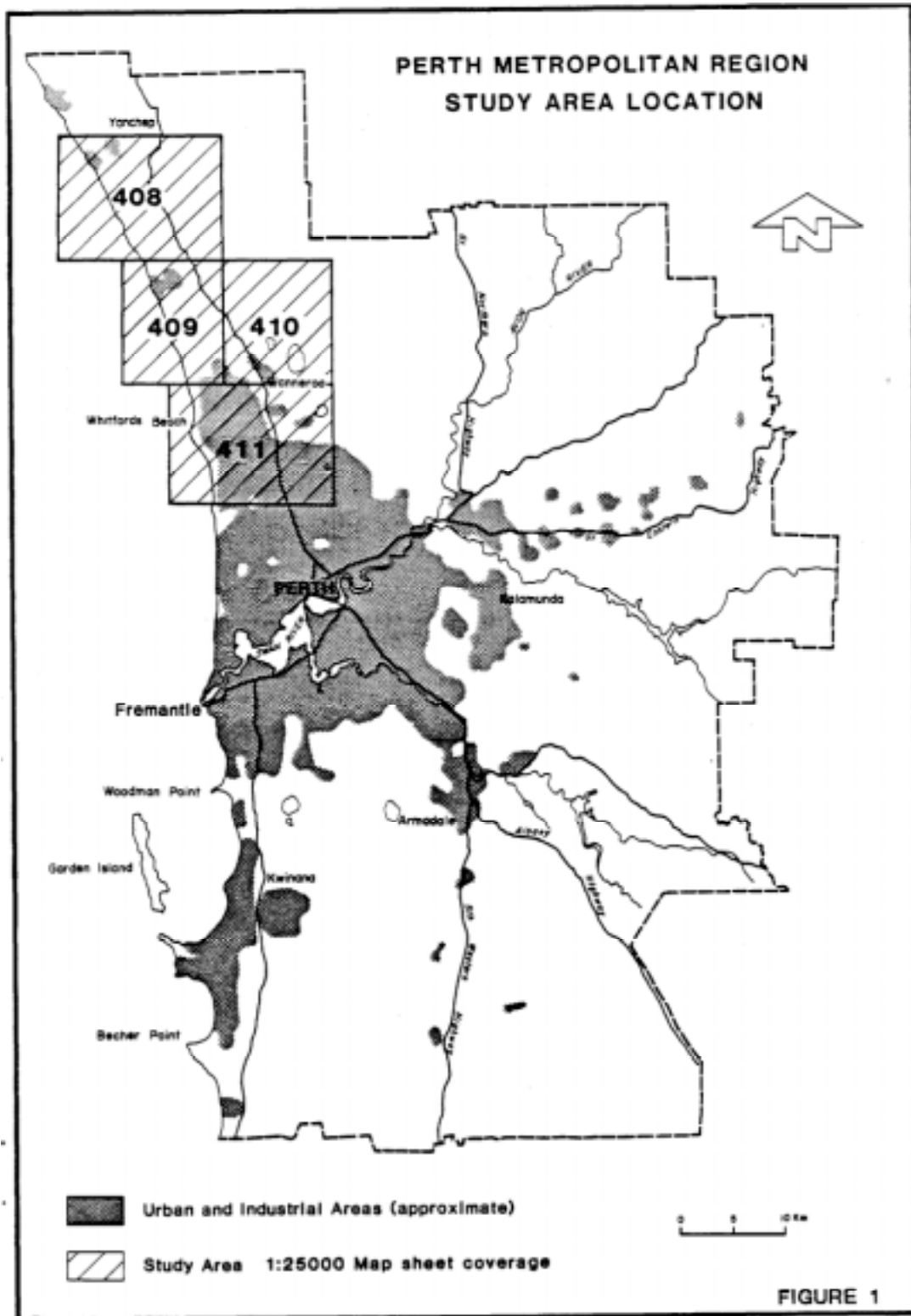
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1. Introduction

The Division of Resource Management is able to assist regional land use planning through the provision of mapped information on the nature and distribution of land resources. These maps deal principally with soils and landforms and their capability for various land uses. On the coastal plain of the Perth Metropolitan region where pressures for land use change are continual, the Division conducts resource mapping and interpretive work in relation to specific requests from local government authorities or State Government departments involved in planning.

In relation to this report a request was received from the Shire of Wanneroo in 1977 for a land resource study to aid planning for future development of the Shire. At approximately the same time CSIRO were conducting a geomorphology and soils, study* of the area west of Wanneroo Road. The study reported herein surveyed, in 1979, 'the remainder of the Shire east of Wanneroo Road across to the State forest as far north as Yanchep National Park. The maps prepared included the CSIRO mapping of the coastal side of the Department's survey to provide a more complete coverage and to facilitate greater use of the mapping. Information from the 1979 survey has been provided at various times in unpublished form to the State Planning Commission, private consultants and to the Shire of Wanneroo. The location of the study area is shown in Figure 1.

* McArthur, W.M. and Bartle, G.A. (1980)



2. Regional Planning – General Considerations

2.1 *Capability of Land and Land Degradation Hazards*

All land developments within the Shire should aim to be sympathetic to the natural landform and soil conditions, afford protection to sensitive wetland and coastal dune areas, and retain as far as practical the natural vegetative cover. To assist this objective a series of four land resource maps at 1:25000 scale accompany this report. These provide a framework for the consideration of natural site constraints and opportunities for future land use which are detailed further in section 3. Note that the assessments of horticultural potential herein are based on landform and soil characteristics only and that water availability cannot be similarly mapped in this study. Water availability must be determined on a site by site basis and within declared groundwater control areas extraction permits must be obtained from the Water Authority of Western Australia.

The effects of or potential for land degradation in most areas can be minimized through a consideration of basic soil conservation principles and the nature of the land resource itself during any development. Exceptions are the areas of unstable Quindalup dunes (Q4 and Qu) which require a considerable management input if they are to be used at all. Development guidelines for small rural lots are given in appendix 1.

2.2 *Protection of Good Quality Agricultural Land*

2.2.1 Market gardening

The market gardens within the Shire of Wanneroo are of regional significance to the Perth Metropolitan area due to a number of factors listed below:

1. Low transport costs and travel time (for perishable items) compared to other rural areas.
2. Availability of labour.
3. Aesthetic factors, to 'break up' urbanized stretches.
4. General availability of suitable groundwater (providing expansion is strictly monitored to avoid excessive water extraction in any localised areas).
5. Area is free from frost and extremes of summer heat.

Due to these factors, market gardening should be encouraged within the Shire's rural planning strategy. In support of this, recommendation 8.12 of the Rural Small— Holdings Policy Study (1977), commissioned by the Town Planning Department and the MRPA, stated that the market gardening areas of Wanneroo should be preserved for that use wherever underground water availability allows.

The planning strategy preferred by the Department of Agriculture for areas with high horticultural potential is for those areas to retain the flexibility of a 'rural' zoning and have gardens develop sporadically, interspersed with other rural land uses requiring less water. The demand on underground water should therefore not be excessive in any one area and the possibility of salinization of supply through an indrawing of the coastal salt/fresh water interface should be reduced.

It is possible that the relocation of the Perth Markets from the central city to Canning Vale may result in an increased trend towards larger sized horticultural properties developing for the export market rather than the local market. However any further developments requiring large amounts of water will have to be assessed on a case by case basis by the Western Australian Water Authority.

2.3 Maintenance of water quality

Due to the importance of groundwater resources for irrigation use and possible domestic and industrial consumption, great care should be taken to avoid their pollution. In addition, the maintenance of the coastal lakes and wetland areas as biological and recreational resources is dependent on water quality which relates to activities on adjacent land. Nutrients and pollutants from agricultural fertilizers or from industrial or residential wastes may be detrimental to these areas. Consideration needs to be given to the ability of soils to accept and purify liquid wastes when required, and to the need for buffer zones separating conflicting land uses from water bodies and their recharge areas.

2.4 Subdivisions and special rural zone development

To prevent speculative subdivision and alienation of rural land from potentially productive agricultural uses, a policy of staged development of subdivision for Special Rural Zones should be required. Subdivision should be permitted only after a certain occupancy or development level is achieved within existing small rural lots.

Within the Shire of Wanneroo most areas, excepting units Q4 and Qu, are generally capable of supporting subdivision and small lot residential development (lots generally greater than 1.5 ha) providing due consideration is given to buffer zones from adjacent waterbodies and to the specific development factors discussed in appendix 1.

Although quite capable of subdivision, it is generally desirable to resist pressure for subdivision in these rural areas in order to ensure that the demand is not speculative and that bona fide rural land users are not adversely affected by increasing land values and rates. Maintenance of larger sizes also retains flexibility for future planning of rural areas.

2.5 Coastal foreshores

Due to their susceptibility to erosion by wind and water action, and their inherent

instability, coastal foreshores require careful management and environmentally sensitive planning if they are to be used for any use other than conservation. The Coastal Development Committee of the State Planning Commission have adopted a 100 year planning horizon for the coast. Therefore where the coast is eroding, the minimum foreshore reserve is the annual rate x 100. It is necessary therefore that any proposed developments in these areas are examined individually and that land resource mapping of a more detailed scale and nature than that presented here, is used as a basis for environmental impact assessment. It is recommended that foreshore management plans be prepared in consultation with the Department of Conservation and Environment, and the Department of Agriculture (Soil Conservation Service).

3. Description of Land Resources and Specific Planning Considerations

Development of the soils of the Swan coastal plain is described by McArthur and Bettenay (1974) and the soil associations described and delineated by Bettenay, McArthur and Hingston (1960). Within the study area the soil associations encountered are the Quindalup, Cottesloe, Karrakatta and Bassendean associations. The Quindalup association consists of dune formations of pale cream coloured calcareous sands of the most recent coastal aeolian deposits. Further inland the Cottesloe association is characterised by aeolianite limestone outcropping on the soil surface. This aeolianite is present under the Karrakatta association but beneath greater depths of yellow sand in dunes. The Cottesloe and Karrakatta associations together form the Spearwood Dune System which is intermediate in age and position between the coastal Quindalup dunes and the Bassendean Dune System. Occurring inland to the west of the Spearwood's Karrakatta soils, the Bassendean association consists of grey sand in dunes of low relief, many swamps and intervening a flat area with shallow depth to groundwater.

3.1 Quindalup Dune System

This is a coastal dune formation of unconsolidated Holocene aeolian deposits (Safety Bay Sand), occurring to the west of the Spearwood Dunes. The major formations are moderately inclined to steep—sided, complex parabolic dunes. Active foredune ridges also occur adjacent to the coast. The dominant soils are rapidly drained, uniform pale calcareous sands with minimal profile development. CSIRO have recognized four different ages of dunes and within the undulating landscape seven discrete mapping units have been identified as follows:

- Q1 The oldest phase. Dunes or remnants with low relief; soils have organic staining to about 30 cm, overlying pale brown sand and with indefinite cementation below one metre.
- Q2 The second phase. A complex pattern of dunes with moderate relief; soils have organic staining to about 20 cm, passing into pale brown sand; some cementation below one metre.
- Q3 The third phase. Steep irregular dunes with high relief; soils consist of loose sand with little surface organic staining and incipient cementation at depth.
- Q4 The youngest phase. Steep irregular dunes of loose pale. brown sand with no soil profile development.
- Qu Presently unstable sand.
- Qp Undulating landscapes with deep calcareous sands overlying limestone; soils have dark grey—brown sand to about 50 cm and then pale brown sand; remnants of hummocks are often present.

Qs Undulating landscape with shallow calcareous sand over limestone and much rock outcrop.

McArthur and Bartle (1980) report that the original vegetation of the older dunes has been much modified by clearing and grazing but probably consisted of a low heath of *Melaleuca* spp., *Acacia* spp., matted together with *Hardenbergia comptoniana*, *Cassylia glabella* and *Hemiandra pungeris*. On the younger dunes they report a vegetation typified by such pioneer species as *Lepidosperma gladiatum*, *Helichrysum cordatum*, *Tetraqonia decumbens*, *Scaevola* spp. and *Myoporum insulare*, all of which have specialized leaf morphology to combat the harsh hot dry exposed conditions.

Planning considerations:

1. These areas are in demand mainly for beachside urban developments, rather than for any hobby farming or agricultural uses. Their use for the latter is severely restricted by the low water holding capacity of soils, groundwater salinity, unfavourable microclimatic conditions and high general susceptibility of vegetation and soils to degradation.
2. Areas of current erosional instability within the Shire are largely restricted to the Quindalup Dunes in the immediate coastal zone where the youngest phase (Q4) has been disturbed. Dunes which have become unstable often cover areas far in excess of their original extent and are shown on the accompanying maps as unit Qu. Areas of Quindalup dunes which are currently stable owe that stability to their vegetative cover which is highly susceptible to damage from people pressure (mainly vehicular and pedestrian traffic). To reduce the risk of erosion it is recommended that pedestrian access through frontal dunes to the beach is restricted to narrow fenced paths and that any vehicle parking areas behind these be paved.

3.2 Spearwood Dune System

The Spearwood system has a core of sandy aeolianite with a capping of secondary limestone overlain by yellow brown siliceous sands with weak podzol development. The system has an undulating surface, with some higher ridges and hills, and hollows representing dune swales. Differential wind erosion has resulted in some areas being stripped of sand to expose the limestone capping or pinnacles. Flat to gently undulating areas within or fringing the Spearwood system represent hind dune flats. The sands may develop a leached grey surface horizon of variable depth and can integrate with soils of the Bassendean system.

Six discrete mapping units have been identified as follows:

Ss Extensive areas of bare limestone and shallow yellow brown siliceous sands over limestone.

- Si Complex area adjacent to Ss, with variable depths of brown sands and sporadic limestone outcrop.
- Ky Karrakatta sand (yellow phase). Grey—brown sandy surface passing into bright yellow siliceous sand and often with limestone within two metres.
- Kg Karrakatta sand (grey phase). Grey sandy surface, a very light grey sub-surface, and pale yellow sand within one metre; limestone occurs at depth.
- Sk Spearwood sand. Gently sloping to steep irregular banks of depressions; associated with a line of swamps from Lake Coolelal to Loch McNess. Soils have a brown sandy surface over bright yellow—brown sand with limestone often within one metre; much limestone outcrop.
- Sg Beonaddy sand. Flat topography often surrounding lakes and swamps in floors of depressions; very dark grey sandy surface over very light grey sand which sometimes has brown mottling. Watertable often occurs within one metre.

The deep sandy areas of the Spearwood system which overlie limestone at depth and have the greatest horticultural potential are the Karrakatta sands. These develop a grey surfaced phase to the eastern side of the Spearwood system and this is recognized as a phase distinct from the brown surfaced phase. However there is no sharp boundary between the two and there is a continuum of gradation from one phase to the other. The differences are also found between crests of dunes and the hollows between. Where the grey phase is present on the crest, the depth to yellow sand will increase down the slopes of the dunes. Often the crests may consist of the brown phase but change gradually to the grey phase in the hollows. This variation and the gradual nature of the change from one phase to another has necessitated the representation of the boundary between the two as a dotted line reflecting its arbitrary nature. It would be possible to find examples of each phase present in the mapped unit of the other.

Along with the change in colouring from the brown to the grey phase there is a slight change in particle size. This is very small and is in the order of 2 per cent clay + silt content for the grey phase soil surface, and 4 per cent clay + silt for the brown phase. Similarly the fine sand fraction will change from about 6 per cent to perhaps 12 per cent in the brown phase. These differences represent a small change in water—holding capacity of the soil which reflects a marginal difference in desirability for horticulture. Sands occurring close to out—cropping limestone (units S] and Sk) often have higher proportions of the finer particles, in particular fine sand, suggesting they have received the products of more recent weathering of the limestone.

The vegetation is variable within the Spearwood Dunes. Within the yellow phase of Karrakatta sands (Ky) the natural vegetation consists of a low open forest of *Eucalyptus marginata*, *E. calophylla* and *E. gomphocephala* with an understorey of *Banksia menziessi*, *B. attenuata* and *Allo Casuarina fraseriana* (McArthur and Bartle 1980). In the grey sand phase areas (Kg) there may be a higher incidence of *Banksia attenuata* but *Eucalyptus* spp. when present, are less vigorous. Within the remaining units

vegetation varies considerably with water status and includes *Melaleuca* spp. and *Eucalyptus rudis* in wetter areas.

Planning considerations:

1. The Spearwood dunes contain areas which are in demand for rural residential and hobby farm uses as well as for dryland farming and irrigated market gardening.
2. The lower flatter areas unit S4a, and to a lesser extent unit S2a, are particularly suited for market gardening purposes due to favourable climatic, topographic, and soil drainage conditions. The area is free of climatic extremes and the sandy soils are generally free of limestone, are deep, easy to work, freely draining and have groundwater at reasonable shallow depth. Although the soils have a low inherent fertility and water holding capacity their location is sufficiently close to metropolitan markets to make high fertilizer and groundwater usage an economic proposition.
3. Most areas of the Spearwood dunes are capable of supporting either urban or rural—residential development. The risk of erosion under most established rural residential, urban, or agricultural land uses within the Spearwood system is minor. The limestone is an adequate foundation for most structures and, with compaction, the sands are also suitable. For rural—residential densities no problems are envisaged for on—site effluent disposal with the exception of areas proximal to the coastal lakes and swamps. To ensure recharge is not inhibited or polluted it is desirable that any residential development be seweraged in these localities.
4. Limestone outcrop within Ss units is extensive and poses a significant limitation to any agricultural activities beyond rough grazing. The limestone in this unit may also pose some limitation upon residential use (although not as severe as that for agriculture) due to difficulties for on site effluent disposal and house construction. Adjacent slopes, units Sk and Sl also contain limestone patches but these are often relatively easily removed should the land use require it.

3.3 Bassendean Dune System

This system consists of low to very low relief Pleistocene sand dunes, intervening swamps and gently undulating sand plain. Within the dunes (3d) the deep grey sands may become pale yellow with depth (usually < 1.5 m) and are marginally coarser and more leached than the sands of the Spearwood system. In the low lying areas (Sw) adjacent to swamps (Sw) the watertable is relatively shallow in winter being between only one to two metres of the surface. Drainage here is often restricted by an iron/organic hardpan. The scattered rounded shallow lakes and swamps contain water, coloured brown by organic material, of low salinity and high acidity.

Four mapping units have been identified here as follows:

- Bd Low relief dunes with deep grey siliceous sands.
- Sw Flat topography often surrounding swamps; bleached grey sands over an iron/organic hardpan, usually at less than 1 m depth; watertable is shallow during winter.
- Sw Swamps; permanent and seasonally inundated.
- L Lakes and fens.

Vegetation within the dunes (Bd) consists mainly of *Banksia attenuata* and *B. merizziessi* with jarrah, *Casuarina* spp. and *B. ilicifolium* occurring as low woodland.

Within the flatter low lying areas (Bw) jarrah and *Banksia* spp. also occur but are usually taller than those in Bd. Within the swamp areas the vegetation varies from sedges or rushes to areas with large *Melaleuca preissiana* trees.

Planning considerations:

1. Although flatter areas of the Spearwood dunes have traditionally been preferred for market gardening, the low inherent fertility and low water holding status of both Spearwood and Bassendean System soils are similar. Given sufficient irrigation and fertilizer the better drained areas of Bassendean (units Bd, 3w) can be used for market gardening.
2. There is potential for wind erosion of the dry loose sands, particularly within unit Sd if areas are denuded of vegetative cover by overgrazing or clearing.
3. Seasonally inundated swamps within the Bassendean system are often too wet for market gardening but some are useful as summer pastures for grazing.
4. Given sufficient compaction, soils of unit Bd provide a good housing foundation base and are sufficiently deep to permit on site effluent disposal. Seasonal watertable levels within unit Bw are likely to require house construction on sand pads and limit the use of on—site effluent disposal systems.

4. Land Use Potential

Based upon the description of land resources and planning considerations in the previous section, the land use potential of rural areas of the Shire are classified here into five major groupings as follows:

4.1 *Residential/Conservation*

(Areas with very limited agricultural potential) — all Q units

Existing urbanization to the south of the study area shows that the Quindalup Dunes are generally capable of supporting that use providing due care is taken to minimise movement of sand by wind and water during development. It is important to recognize that certain areas are more susceptible to erosion or instability problems (units Q4, Qu) and that special management, sometimes including total conservation/preservation, may be required.

Due to alkaline soil conditions, susceptibility to erosion and wind damage, and the probability of saline ground water supplies, the soils of the Quindalup Dunes have very limited agricultural potential.

4.2 *Quarrying*

(Areas with very limited agricultural potential) — Unit Ss

There are large areas of limestone which have a very thin cover of sand and which are effectively of no horticultural value at all. Limestone occurs at or very close to the surface. The areas have been the sites of limestone quarries in the past and will continue to be a major source of limestone for the metropolitan area.

4.3 *Mixed limestone and sand areas*

(Area with patchy horticultural potential) — Units Sk & Si

This group includes outcropping or shallow limestone but there are areas of deeper sands (Ky + Kg) suitable for horticulture scattered throughout. Unit Sk is found around the lakes (associated with the karst formation), adjoining the limestone zones and unit Si occurs as areas of more shallow limestone amongst the deep Karrakatta sands (ky + Kg).

In the past these areas have been much used for market gardening, particularly in the Spearwood area. Considerable labour is required to clear the limestone where it outcrops but the tendency in the past for high amounts of family labour to be employed in the market garden industry has enabled these areas to be developed. In the future, with labour less readily available, with more sophisticated technology and larger properties necessary for more modern techniques, these areas will be far less

acceptable compared to the deep sands.

4.4 Swamps

(Area with summer grazing potential) — Unit Sw

Areas mapped as swamps vary considerably in size and nature. Depth to watertables vary, both in summer and winter, and dictate the potential use of the areas. Market gardeners have used the drier parts of swamps for summer cropping, taking advantage of the more fertile organic soils and the shallow watertables.

Swamps can provide useful summer grazing for horses, in particular. Production is not high or of great value but the green pasture at that time of year is of advantage if easily available. Equestrian activities are increasing in this area and there is potential for greater development of swamps as summer pastures.

Drainage schemes have been carried out to extend the period that the swamps can be utilised for horticulture and pastures. These schemes seek to reduce winter watertables. In summer, shallow watertables are an advantage and lowering of them could have a deleterious effect on their productivity. It is difficult to estimate the significance of this, as summer pastures are not of great value in terms of production and the use of swamps for horticulture has been less important since irrigation became general practice. A large part of Lake Pinjar has potential for pasture, it is little developed at present but some landholders have prepared significant areas of summer pasture.

4.5 Deep sands

(Areas with highest horticultural potential) — Units Ky, Kg, Sg, 3d, Sw

These soils have been traditionally used for market gardening because of their depth, ease of working, free drainage and also the presence of good quality groundwater at reasonably shallow depths. In the past, yellow sands (Ky) have been preferred, market gardeners believing they were best. More recently however, market gardeners are moving onto the adjacent grey sands to the east (Kg) and into the Bassendean dune system (Bd, Bw). The grey sands (Kg) and the Bassendean soils (Bd, Bw) have similar gross physical characteristics and water—holding—capacity, but are slightly more acidic, more leached and more susceptible to water repellency than the yellow sands. These soils are also useful for market gardening since the necessary adjustments to management techniques are relatively minor and the costs involved are usually more than compensated for by lower land prices compared to the yellow sands of the Spearwood dunes. The land price differential is presumably related to proximity to the coast and residential land use appeal.

Four different soils have been included in this grouping, the deep Karrakatta sands (yellow and grey phases Ky, Kg) and the grey sands found around swamps in the Spearwood System (Sg) with the Bassendean dunes (Bd) and the areas of Bassendean sands with shallow watertables (Bw). All can be utilized similarly for market gardening, if

good quality groundwater is available for irrigation. Control of groundwater extraction is the responsibility of the Water Authority of Western Australia.

East of Wanneroo road there are large areas of these soils as far north as a line roughly connecting Wanneroo race track and the northern tip of Lake Joondalup. Further areas of Karrakatta sand (Ky, Kg) also occur north of Wesco Road adjacent to the State forest.

Along the eastern edge of the shire are areas of Bassendean sands which have some potential for market gardening. Generally these sands have been utilised by Forests Department for pine plantations.

5. Future Rural Land Use Needs

5.1 *Equestrian*

The expansion in equestrian activities will probably increase the demand for irrigated and summer pastures and for hay. The rate of expansion is difficult to estimate but utility of margins to swamps and Lake Pinjar could well increase as more summer pastures are sought. Karrakatta sands are being used for growing Lucerne to cut as hay. This would probably expand to meet increased demand but there is sufficient demand at present to absorb production from a further 400 ha of Lucerne, although this expansion in production would produce a decrease in price. If this expansion did occur it would not be confined to the Wanneroo area but probably be spread over all presently producing areas. Lucerne requires roughly 1.5 metres of water as irrigation over a year.

There is a small amount of permanent pasture irrigated for horse grazing but nowhere near the area involved in Swan and Serpentine—Jarrahdale Shires. This may well increase in the future as more properties are developed for horses.

5.2 *Market gardening*

For many years urban expansion has pushed market gardening further out from the city, mainly north and south parallel to the coast. Market gardeners have chosen the yellow sands which they have been used to but in recent years more have moved towards the grey sands of the Bassendean type. Much of the Gnangara area would be suitable for market gardening, both on the basis of soils and groundwater supply.

Wanneroo Shire ranks with Cockburn and Manjimup as one of the three most important areas for vegetable production in the state. Although not as important as Cockburn at the present time, it would have greater potential for expansion in the future in terms of suitable areas available.

High land prices are to some extent limiting the development of Wanneroo Shire for market gardening. There have been significant developments in recent years in the Gingin area where land is much cheaper. It is thus difficult to predict the exact area of land that will be required in Wanneroo.

Calculations, based on the assumption that the population of W.A. will be 2 million by the end of this century, have estimated that an additional 630 ha of land will be required for irrigated market gardening close to Perth by the year 2000 AD. Of this total some will be distributed south of Perth, some into areas such as Gingin, with a proportion expanding into Wanneroo Shire. A reasonable figure to consider for Wanneroo could be 200 ha — that should not be an under—estimate.

The amount of water required by the various market gardening crops will vary very much with time and length of growing season. Market gardeners often apply double the daily evaporation rate on vegetables over periods of heat stress or for germination of seeds.

Crops follow closely after each other and so irrigation would be applied to most of the cropped area over the summer period. The most useful figure for irrigation application would be 1.5 metres as the annual water input into market gardens generally. This figure takes into account the variety of crops and different growing periods.

If market gardening expanded in the Gnangara area by 200 ha, about 3 million cubic metres of extra water would be required for irrigation. This represents the amount that might be applied; presumably a significant proportion of this water would be returned to the groundwater along with leached fertilizers.

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Appendix 1. Development Guidelines for Small Rural Lots

The following aspects of conservation land use should be considered for small lot developments.

- provision of adequate water supply
 - subdivision design
 - lot sizes
 - access
 - development envelopes and set—back distances
 - fire management
 - stocking limitations
 - vegetation protection and
 - effluent disposal ability
- (i) Water Supply: Where a reticulated water scheme is not available, it is recommended that the developer provide a reliable and adequate water supply for each lot. The subsequent costs of bore sinking or dam construction could be apportioned amongst all lots within a Special Rural Zone development before sale.

Where bore water is to be used, the Western Australian Water Authority should be contacted to ascertain any permit requirements and water extraction restrictions.

- (ii) Subdivision design: Subdivision should be planned in a manner that will enable each block to be developed and managed in a practical and feasible way. For example, the location of boundaries on natural features such as drainage lines, ridges or contours ensures practical access both to and within the lot, to building sites and water supply points as well as for fire management. Boundaries diagonal to slopes or along intermittent flow lines are not recommended.
- (iii) Lot sizes: These should be related to the practical needs of the land use and the natural attributes of the land in each case. Small lot sizes and closely spaced property boundaries may create difficulties for design and maintenance of soil conservation measures. They may also limit options for effluent disposal.

As a general rule for hobby farm situations, larger lot sizes will be required for steeper sites because:

- of stock feed requirements, due to the lower carrying capacity of steep slopes and the limited potential for fodder cropping
- erosion of stock tracks and firebreaks has to be prevented

- there must be adequate scope for safe access to building and yard sites and
- the capacity of the soil to handle effluent wastes is often lower

For commercial market gardening situations, lot sizes will be determined by water availability and the need to rotate land for disease control purposes. As a general recommendation the Department of Agriculture maintains that for newly establishing commercially viable market gardens a minimum of 20 ha is desirable. This figure relates to a perceived trend towards large gardens which are more suitable for mechanized operations.

- (iv) Access: The planned alignment, construction and maintenance of subdivisional roads and internal tracks should consider existing landforms, water supply points, fire management needs and the proposed land uses. Specific attention may be required for:
- location,
 - road grade,
 - surface material,
 - surface drainage,
 - table—drains,
 - relief culverts,
 - drainage line crossings,
 - road batters,
 - topsoil management,
 - revegetation, and
 - maintenance.
- (v) Development envelopes and set—back distances: In order to limit site disturbance to the most capable areas within a rural—residential lot, all buildings and traffic circulation areas may need to be contained with an envelope defined by measurement to the lot boundaries. All lots should therefore be designed around adequate building envelopes. Clearing outside that envelope should be restricted to that required only for access and fire control. A general recommended set—back distance from boundaries and streams is 20 m. Boundary set—backs may, however, need to be varied where topography and block shape dictate.
- (vi) Fire management: Fuel reductions, firebreaks and fire trails may be required as part of a fire management strategy. These may pose erosion hazards and require appropriate erosion control measures. See comments on ‘access’ for specific areas of attention.

- (vii) **Stocking limitations:** In many small hobby farm situations land holders are prepared to hand—feed animals more than would be practical under general farming situations and hence high stocking levels are common. To prevent overgrazing and subsequent erosion of topsoil it may be necessary to ensure that suitable summer grazing or housing facilities for stock are available to reduce stock impact on well—grazed paddocks.

In larger farming situations where hand feeding is minimal, the number of stock should be limited in accordance with the land's carrying capacity. The carrying capacity is the ability of pastures to carry grazing animals, and is usually expressed as the number of dry sheep that can be run on a year—round basis with minimal hand feeding.

Stocked at its carrying capacity, a pasture sustains grazing animals in a healthy condition, without the land being denuded of ground cover, particularly towards the end of summer. The carrying capacity of pastures is usually sustained only by regular applications of the correct fertiliser.

Advice on fertilizer requirements and carrying capacities for specific soil and land types is readily available from the Metropolitan Office of the Department of Agriculture.

- (viii) **Retention and protection of natural vegetation:** In general, subdivision design should mean minimal disturbance to existing natural vegetation and drainage systems. It may be desirable for Council to incorporate specific vegetation protection measures within Special Rural Zones where land use and soil conditions pose an erosion hazard.
- (ix) **Effluent disposal ability:** In most Special Rural Zones disposal of septic effluent will be provided through on—site septic tanks and soil absorption fields. Special design considerations will be required to ensure efficient septic effluent disposal in seasonally waterlogged areas, or those with either shallow soils or very slow subsoil permeabilities. Effluent absorption fields should also be kept well back from drainage lines to minimise risk of pollution. For specific set—back distances from drainage lines, underlying watertables and suitable soil permabilities, the Department of Health should be consulted.