



MOSQUITO MANAGEMENT PLAN

Part Lot 1 and Lots 2 and 3 South Yunderup Austin Cove, Phase 2

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1.0 INTRODUCTION

1.1 The Project

Part Lot 1 South Yunderup Road and Lots 2 and 3 Bens Road, South Yunderup is located near the eastern shoreline of the Peel Inlet and south of the Murray River in the locality of South Yunderup in the Shire of Murray (Figure 1).

The subject land comprises 526 ha that has historically been used for grazing livestock. Other activities that currently occur on site include bee keeping and a small scale palm cultivation operation on one lot.

Phase 2 of the proposed urban development of Austin Cove by Satterley Property Group (hereafter referred to as the site) is located in the south-western portion of the subject land and covers approximately 271 ha of Part Lot 1 and Lots 2 and 3 South Yunderup Road.

The site is bounded to the east and south by farming operations. The remaining area immediately west of the site is remnant vegetation and small wetlands, while further to the west, is the Peel Inlet. The Yunderup canals and Murray River are located north of the site.

1.2 Outline Development Plan

An Outline Development Plan (ODP) for Phase 2 has been prepared by project planners Chappell Lambert Everett (Figure 2), showing the proposed development within the site. The ODP illustrates a range of residential densities between R10 and R60, with linear Public Open Space (POS) areas separating pockets of residential areas from one another. A long linear lake approximately 1.4 km in length is proposed in the north-south aligned POS area in the eastern portion of the site.

A large Parks and Recreation reserve and Private Recreation reserve (under the Peel Region Scheme), consisting of remnant vegetation, wetlands and grazing pastures, separates Phase 2 from Phase 1, which lies to the north-west.

The development area (phase one and two) is zoned 'Special Development' under the provisions of the Shire of Murray Town Planning Scheme No 4. The 'Special Development' zone allows subdivision and development generally in accordance with an approved ODP. The current provisions of Schedule 7 of Scheme No 4, adopted through Amendment 115, set out specific provisions applying to the subject land with reference to the 1997 Murray Lakes Golf Course Estate Outline Development Plan.

Subsequently, Amendment 218 was initiated to remove the outdated provisions relating to the 1997 Murray Lakes Golf Course Estate ODP from the Shire of Murray Scheme and insert the necessary provisions to enable the Austin Cove ODP.

1.3 Mosquitoes and the Peel Region

The mosquito borne disease risk associated with the Peel Region and other coastal parts of Western Australia is widely acknowledged. The South Yunderup area within the Shire of Murray experiences significant levels of mosquito breeding and associated nuisance and health problems associated with mosquito borne disease during the spring, summer and autumn months. This is because the area is surrounded by the Peel Inlet, the Murray River and Yunderup canals, and numerous other smaller wetlands, all of which provide a suitable breeding habitat for populations of breeding mosquitoes. As South Yunderup's human population continues to increase, the nuisance and health problems associated with residential development in close proximity to mosquito breeding habitats are expected to worsen.

The site's proximity to the Peel Inlet, Murray River and Yunderup canals, and numerous smaller seasonal wetlands in the vicinity, as well as the proposed artificial lake within the site's POS area, means future residents of Austin Cove could be at risk of mosquito borne disease.

As a part of Amendment 218 and the Austin Cove ODP, a list of statutory provisions within Amendment 218 and the ODP were drafted to ensure effective management of the environmental impacts to the site, including mosquito management.

The specific scheme provision relating to the preparation of a Mosquito Management Plan is as follows:

Prior to subdivision approval, a Mosquito Management Plan shall be prepared to the satisfaction of the Shire of Murray, on advice from the DEC to identify mosquito nuisance, public health risks and management strategies.

Furthermore, the Austin Cove ODP outlines that the Mosquito Management Plan shall include but is not limited to the following:

- I. The identification and detailed description of known mosquito breeding sites and habitats on, and in the near vicinity of Austin Cove, Phase 2.
- II. A detailed analysis and description of methods to reduce and manage identified mosquito breeding sites and habitats on, and in the near vicinity of the subject land.
- III. Details of the built form response to mosquito nuisance and health risk.

- IV. Details of partnering arrangements agreed between the council and the developer for mosquito monitoring and control (including a 'Reporting Schedule' which incorporates a Sampling and Analysis Plan to specify the overall sampling collection, storage, analytical specification and reporting methodology) – such details to include description of strata reserve funding to ensure appropriate ongoing contributions.
- V. Details of a public health education program for future residents of Austin Cove, Phase 2.
- VI. Contingency measures to be implemented in the event that monitoring indicates that mosquito management is determined by the Council to be unsatisfactory.
- VII. Identification of responsibilities for implementing the Mosquito Management Plan.

This Mosquito Management Plan (MMP) aims to satisfy the above provision, and has been developed using as reference the EPA's *Guidance Statement for Management of Mosquitoes by Land Developers Guidance Statement No. 40* (EPA, 2000) and direct advice from the Shire of Murray.

I.4 Other Documentation

This MMP should be read in conjunction with the *Environmental Assessment Report Austin Cove Phase II* (RPS Bowman Bishaw Gorham, 2007) which has an extensive description of the site's existing environment, and the following management plans, which will be produced in support of the site's rezoning:

- Urban Water Management Strategy.
- Wetland Management Plan.
- Lake Management Plan.
- Conservation Area Management Plan.

2.0 MOSQUITO BREEDING IN THE EXISTING ENVIRONMENT

2.1 Surrounding Mosquito Breeding Sites

It is widely acknowledged that the critical factor in determining whether mosquitoes are likely to be a nuisance or health risk in a residential development is the presence of water, as mosquitoes require an aquatic environment to breed during their larval stage (Russell, 1999). Therefore, in order to determine the likely risk of mosquitoes breeding within the vicinity of the site, it is necessary to consider the locations of wetlands within the vicinity of the site.

The EPA's *Guidance Statement for Management of Mosquitoes by Land Developers* (2000) suggests that adult mosquito flight ranges as being up to 5 km in distance, and consequently these permanent water bodies are likely to influence the development.

2.1.1 Seasonal Wetlands

The site is located adjacent to seasonal wetlands that have the potential to serve as mosquito breeding areas (Figure 3). Examples of these seasonal wetlands are the network of drains traversing to the north of the site (excavated several decades ago to provide fill for the construction of the adjacent South Yunderup Road), and the naturally occurring seasonal dampland which lies within the Parks and Recreation Reserve to the north of the site. During extreme flood events, the Parks and Recreation reserve acts as a floodway for the Murray River to the Peel Inlet to the west. These wetlands generally contain water during the winter and spring months.

The seasonal nature of these wetlands means that, while they have the potential to serve as mosquito breeding sites, they are unlikely to pose as significant a risk as the permanent and much larger water bodies which occur at a greater distance from the site, and which are discussed below.

2.1.2 Permanent Wetlands

The Murray River and Yunderup canals are located approximately 1–2 km north of the site, with the Peel Inlet approximately 1 km to the east of the site (Figure 3). Both of these permanent water bodies provide an ideal habitat for mosquito breeding, particularly during the warmer summer months and when higher than usual tides are experienced. The higher tides serve to inundate riparian vegetation, providing ideal breeding habitats for mosquitoes and incubation habitats for mosquito larvae.

The Peel Inlet serves as the largest and most significant mosquito breeding site that may impact the Austin Cove development. This is because the Peel Inlet contains water year-round and presents an extensive area of water suitable for mosquito breeding. The fluctuation of tides in particular creates ideal circumstances for mosquitoes to breed within emergent shoreline vegetation. The seasonal wetlands adjacent to the site are by comparison much less significant in their capacity to serve as mosquito breeding grounds due to their smaller size and their seasonality of inundation.

2.2 Future Potential Mosquito Breeding Sites

If the design and management of the proposed development is not appropriate, the proposed artificial lake illustrated in the ODP has the potential to act as a mosquito breeding site. Although the area of water of this lake will be significantly smaller than the Peel Inlet, the long, linear design of the lake (approximately 1.4 km in length) will result in a long shoreline immediately adjacent to residential areas which, if incorrectly designed, constructed and vegetated, could provide a suitable mosquito breeding site.

3.0 MANAGEMENT TECHNIQUES EMPLOYED WITHIN AUSTIN COVE TO MINIMISE IMPACT OF MOSQUITOES

3.1 Introduction

The following section describes management techniques which will be employed in the development of Stage 2 Austin Cove to help minimise and manage the risks associated with mosquitoes breeding in the surrounding environment.

3.2 Vegetation Transport Corridors and Mosquito Buffers

Terrestrial vegetation planted around a water body can serve to function as a transportation corridor for mosquitoes seeking a blood-meal. The vegetation protects mosquitoes from predators and can act as a transport path. Although the majority of the Phase 2 site is surrounded by cleared land, a large tract of native vegetation serves to separate the site from the Peel Inlet to the west. This vegetated area could serve as a transport corridor for mosquitoes travelling eastwards from the Peel Inlet.

In order to disrupt the transport corridor, most residential lots within the development will be separated from surrounding vegetation by road. The lack of vegetation and provision of roads directly adjacent to individual residential lots will serve as a form of buffer to mosquitoes.

3.3 Alignment and Orientation

The street alignment of a residential subdivision can influence the extent to which mosquitoes can aggregate. Street alignments which are orientated in the direction of prevailing winds allow mosquitoes to be blown through the development without any obstructions. Obstructions to prevailing winds, such as cul-de-sacs, tend to limit the flushing effect of the wind which can in turn lead to pockets of mosquitoes forming. The majority of the Phase 2 Austin Cove development is aligned in an east–west direction, which will allow the prevailing summer sea breeze to blow through the development and flush-out any mosquitoes. Furthermore, there will be no cul-de-sacs and relatively few areas within the development which could act as pockets and trap mosquitoes. The alignment of the development to allow for the sea breeze flushing effect is critical as the summer sea breeze tends to peak in strength in the afternoon and evenings, which is the time when mosquito activity can peak and when humans are commonly outside and therefore likely to be bitten.

3.4 Street Lighting

Street lighting has the tendency to attract mosquitoes and result in mosquito aggregations. Consideration will be given within the development design to limiting street lighting along streets within the development which are not easily flushed with the sea breeze. The provision of additional lighting in non-residential areas can be used as a decoy to draw mosquitoes away from populated areas.

3.5 Drainage

Although based around the concept of on-site retention, drainage within the development will be designed to minimise the time period during which drainage run-off is stored, in order to reduce the likelihood of mosquitoes breeding in retained stormwater run-off. Drainage swales will be grassed and the retention time of stormwater from storm events is not expected to be of a sufficient time period for mosquito breeding and hatching to take place.

3.6 Artificial Lake Design

The artificial lake to be constructed at the site will support active and passive recreation, landscape, irrigation and urban water management functions (Figure 4) has the potential to act as a potential mosquito breeding area. To minimise the risk of this occurring the lake will be lined and design elements to reduce mosquito breeding will be incorporated.

The design elements to reduce potential mosquito breeding include a lake edge treatment that will consist mostly of hard walls/edges, with minimal provision of sandy beaches (hard edges are not suitable for mosquito breeding). To further assist in the control of mosquitoes, the area of water shaded by vegetation and other structures will be limited. Specifically, dense stands of emergent reeds and rushes where water circulation and movement of larval predators is inhibited will be avoided. Marginal and floating vegetation, and associated debris, which may harbour breeding mosquitoes, will also be avoided. Reeds and rushes will be planted in some areas to aid with water quality and overflow.

Such breeding areas can be readily reduced through maintenance procedures such as thinning of reeds and rushes, and removal of dead and dying vegetation. All of these actions improve water circulation and enables better access for natural predators to breeding areas, which will limit further nuisance populations of mosquitoes. Maintaining good water quality and minimising the risk of algal blooms will also serve to minimise the risk of midge breeding.

Research has also shown that water depths in excess of 40 cm have lower densities of mosquitoes and higher densities of predators. Design of the lake will take this research into consideration and provide lake edges with sufficient depths; however safety considerations also need to be taken into account and a shallow lake edge leading to deeper depths over an appropriate incline may need to be incorporated.

3.7 Public Education

Public education regarding the issues relating to mosquitoes in the area will be provided to all residents within the Austin Cove development. This educational material will explain the reasons why mosquitoes breed in the area, why there is a nuisance and health risk associated with the mosquitoes, methods for reducing potential breeding habitat and minimising the risk of mosquito attacks.

The methods for reducing the risks will include being aware of the seasonality and conditions which are likely to cause elevated risk levels and the need to avoid outdoor activities at certain times of the day during spring and summer unless adequately protected, appropriate protection (e.g. clothing, insect repellent), and adequate garden and outdoor area maintenance (plant pots and other garden items can create artificial water bodies for mosquitoes to breed).

This educational material will be provided to each land purchaser, and could also be delivered to each household at the beginning of the high risk season in spring.

This educational material will be developed in conjunction with the Shire of Murray and the Department of Health.

3.8 Notification on Title

All land purchasers within the Austin Cove development will be made aware of the risk from mosquito borne diseases associated with living in the Peel Region and specifically within Austin Cove by a notification on the title of all individual lots sold. All land purchasers will be provided with the education material described above at the point of sale of each individual lot.

4.0 PEEL CLAG SPRAYING PROGRAM AND SHIRE OF MURRAY/DEVELOPER PARTNERING ARRANGEMENT

4.1 Peel CLAG

The Shire of Murray is a member of the Peel CLAG (Contiguous Local Authority Group), which also includes the Shire of Waroona and the Cities of Mandurah and Rockingham. The Peel CLAG undertakes a helicopter-borne spraying program throughout the Peel/Harvey Region from September to May each year. The program averages approximately twenty spraying treatments per year, dependent on the conditions and mosquito severity of each summer. The treatment used is *Prolink Prosand* Mosquito Growth Inhibitor (the active ingredient being s-methoprene). *Prosand* works to inhibit the emergence of adult mosquitoes from the larval stage, and is not harmful to wildlife or humans. It is sprayed in granular form. The South Yunderup area, where Austin Cove is located, is targeted regularly during this spraying program.

In addition to the helicopter-borne spraying program, the Shire of Murray also employs a mosquito monitoring officer on a part-time basis. This officer undertakes monitoring within the Shire and also spot treatment where and when necessary.

4.2 Partnering Arrangement between Shire of Murray and Developer

Development of Austin Cove will increase the population within the South Yunderup area, which in turn creates a greater likelihood of mosquito-related problems. Therefore, as the developer of Austin Cove, the Satterley Property Group is willing to consider through negotiation a one-off/ongoing financial contribution to the Peel CLAG for its spraying program.

5.0 MOSQUITO MONITORING REQUIREMENTS

5.1 Monitoring Requirements

As discussed in previous sections, the water body most likely to contribute a significant nuisance and health risk to residents of Austin Cove is the Peel Inlet. The Murray River, Yunderup canals and other smaller seasonal wetlands in the vicinity of the site may also contribute to this risk. As a member of the Peel CLAG the Shire of Murray undertakes a mosquito spraying program which treats these water bodies. The developer of Austin Cove will accordingly contribute to this program. However, as an artificial lake of considerable length (approximately 2 km in length) is proposed for inclusion within POS of the site, the developer will also conduct its own mosquito monitoring and treatment program for the artificial lake within the development.

5.2 Monitoring Program

5.2.1 Sampling Locations

Upon completion of the artificial lake, an appropriate number of sampling sites will be selected in consultation with the Shire of Murray. Mosquito sampling sites are best chosen in areas sheltered from the wind and sun, such as under overhangs, beneath built structures, and amongst reeds. The total shoreline length of the lake is expected to be approximately 4 km, and on the basis of a sampling site for each 500 m of shoreline, it is intended that eight sampling sites will be sufficient. This number may be varied if it is found that the total number of sites has been over or under subscribed. Monitoring of drainage basins and Gross Pollutant Traps should also be undertaken to ensure no trapped/draining water outside of the lake, but within the POS area, is providing a mosquito breeding habitat. Figure 4 illustrates the artificial lake design and the suggested location of sampling points.

5.2.2 Sampling Method

The sampling will be completed by suitably qualified consultants engaged by the developer or the Shire of Murray. A sample is taken by quickly scooping water from the surface using a 250 mL long handled scoop, and counting and recording the number of mosquito larvae within each sample. Appendix I provides further detail on the sampling procedure.

As described in Appendix I, it is possible to calculate the number of mosquito larvae per square metre of water surface. However, as the selection of sampling locations within the wetlands will be based upon locations where mosquito larval populations are expected to be at their greatest, an extrapolation of the sample results across the whole lake would be misleading.

5.2.3 Sampling Frequency

During the critical mosquito breeding period of September–October, sampling will occur on a weekly basis. During the November–December period, sampling will occur on a fortnightly basis. From January–August, sampling will occur on a monthly basis.

As the water body progressively develops in an ecological sense (e.g. planting of emergent vegetation) it is likely the risk of mosquito and midge inhabitation will increase significantly. Therefore, at the completion of the initial twelve month monitoring period, it will be necessary to review the monitoring results and determine if any changes to the monitoring regime are required.

However, there should also be scope for an increase in the frequency (e.g. weekly) of monitoring in the event that a sudden change in environmental conditions (e.g. late spring/early summer rain and warm temperatures) occurs during this twelve month period.

5.2.4 Threshold for Remedial Action

The initial threshold for undertaking remedial action will be when two samples at adjacent locations results in greater than fifty living mosquito larvae per sample for two consecutive sampling events, or if a total of four samples in non-adjacent locations produce locations results in greater than fifty living mosquito larvae per sample for two consecutive sampling events. This threshold will be reassessed in consultation with the Shire of Murray after the first twelve months of monitoring and adjusted if necessary to accommodate specific site circumstances.

If the threshold is breached, the Shire of Murray will be contacted immediately and informed of the breach. Depending on the circumstances of the breach (i.e. where in the lake the breach occurred in and the type of habitat in which the breach occurred), agreement will be sought with the Shire as to which remedial action (described below) is the most appropriate to be undertaken.

5.3 Remedial Action

In the event that monitoring identifies a potential ongoing problem with respect to mosquito populations, remedial action will be undertaken. Options for remedial action include wetland maintenance, and/or biological and chemical control mechanisms, described below.

5.3.1 Wetland and Lake Maintenance and Modification

Larval monitoring may identify potential breeding locations within the water bodies that may generate nuisance populations of mosquitoes if not properly maintained. Such areas may include:

- Inadequately maintained gross pollutant traps or stormwater outlets adjacent to the lake that may have small areas of stagnant water trapped by accumulated litter and debris.
- Shallow margins along the edge of the lake which may require regrading or other modification to achieve greater depth, making them less attractive areas for larval breeding.
- Dense stands of reeds and rushes where water circulation and movement of larval predators is inhibited.
- Marginal and floating vegetation, and associated debris, which may harbour breeding mosquitoes.

Such areas can be readily eliminated through maintenance procedures such as cleaning of gross pollutant traps and stormwater outlets, thinning of reeds and rushes and removal of dead and decaying vegetation. All of these actions improve water circulation and enable better access of natural predators to breeding areas, which will limit further nuisance populations of mosquitoes.

In the event that multiple breaches occur as a result of lake design (e.g. too shallow lake margins) then the developer commits to modifying the lake in consultation with the Shire to eradicate the habitat which is causing the breaches.

5.3.2 Chemical Control

Chemical control measures may be required where larval and adult monitoring indicates the potential for heavy uncontrolled breeding, which may translate to large nuisance populations of mosquitoes. As previously described, this method is currently used by the Shire of Murray in the vicinity of the site.

Chemical control methods using pesticides can be quickly applied to achieve rapid results; however this method is not a long term solution and will only address the immediate problem.

Whilst chemicals will be applied if necessary to control the immediate potential for mosquito population explosion, investigations will also be conducted to determine the potential breeding sources.

The most appropriate chemical control method to use is *Prolink Prosand* Mosquito Growth Inhibitor (the active ingredient being s-methoprene). *Prosand* works to inhibit the emergence of adult mosquitoes from the larval stage, and is not harmful to wildlife or humans. Application of this control method would be done in conjunction with the Shire of Murray.

5.3.3 Biological Control

The maintenance of a healthy lake and wetland ecosystem will ensure that natural predators of mosquito larvae will be able to establish and reproduce. Such predators include dragonfly nymphs, and various beetle larvae.

Carnivorous fish are currently the only biological agents commercially available for practical use within wetlands (Russell, 1999). Whilst there is no intention to stock the lake with fish initially, it may be stocked at a later stage should nuisance populations of mosquitoes develop.

Consideration could also be given to the biological control of mosquitoes through the introduction of specific vegetation. Lemon grass, which acts as a natural mosquito repellent could be established in areas where people reside. This could be an option for areas further away from the lakes edge where saturated soils would be unlikely.

5.3.4 Passive Control Measures

A passive control measure which will be employed within highly used POS areas (e.g. barbeque and play areas) will be to minimise the amount of outdoor white lighting in the immediate vicinity of the water body, with more appropriate yellow spectrum lighting used instead.

Public education for residents of the Austin Cove development will be undertaken to encourage residents to minimise mosquito breeding conditions within their property, as plant pots and other garden items can create artificial water bodies for mosquitoes to breed.

5.4 Responsibility for Monitoring

The developer will retain responsibility for monitoring of mosquito populations within the artificial lake, and also for any required remedial actions, for a five year period.

Following this period, the responsibility for monitoring of mosquitoes and implementation of required remedial action will pass to the Shire of Murray.

6.0 CONCLUSIONS

Development of Stage 2 Austin Cove is proposed within the South Yunderup area. The influx of new residents as part of this development will create some associated risk of nuisance and health issues from substantial mosquito populations which breed in the surrounding area.

The existence of the Peel Inlet, Murray River, Yunderup canals, and the numerous seasonal wetlands within the vicinity of the site, as well as the artificial lake within Stage 2 Austin Cove, suggests mosquito related nuisance and health issues may be experienced.

This MMP identifies the most significant mosquito breeding habitats in the vicinity of Austin Cove, and describes the design and management measures to be undertaken to limit the risk of mosquito related nuisance and health issues. These measures include:

- The provision of mosquito buffers, through ensuring vegetation (which mosquitoes use as transportation corridors) does not immediately abut residential lots.
- Aligning the development in the direction of prevailing summer winds, allowing for any mosquitoes to be dispersed through the development without conglomerating in cul-de-sacs or pockets.
- Consideration being given to the location of street lighting, with some lighting being deliberately located away from the residential lots to act as a decoy to mosquito aggregation.
- Limiting periods of water retention in the drainage system, which could be used by mosquitoes as a breeding location.

This MMP also details the agreement between the developer and the Shire of Murray to make a financial contribution to the Peel CLAG, which undertakes a helicopter-borne spraying program throughout the Peel – Harvey Region from September to May each year. This MMP also prescribes an ongoing monitoring and contingency program for the artificial lake created within the POS area of Stage 2 Austin Cove. The responsibility for mosquito management in this artificial lake will be the developer's for a period of five years, at which time responsibility for all public infrastructures within the development will be handed over to the Shire of Murray.

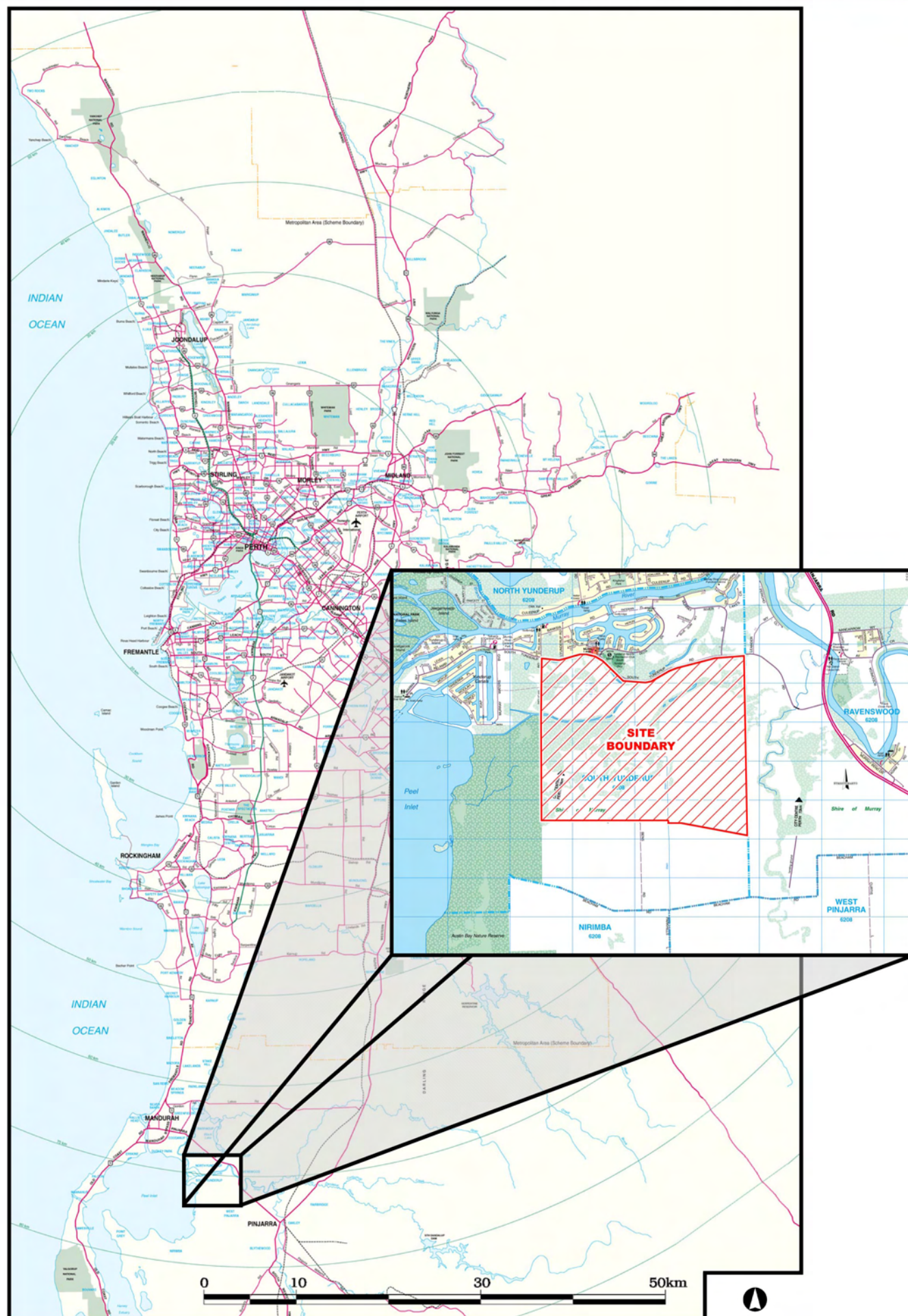
7.0 REFERENCES

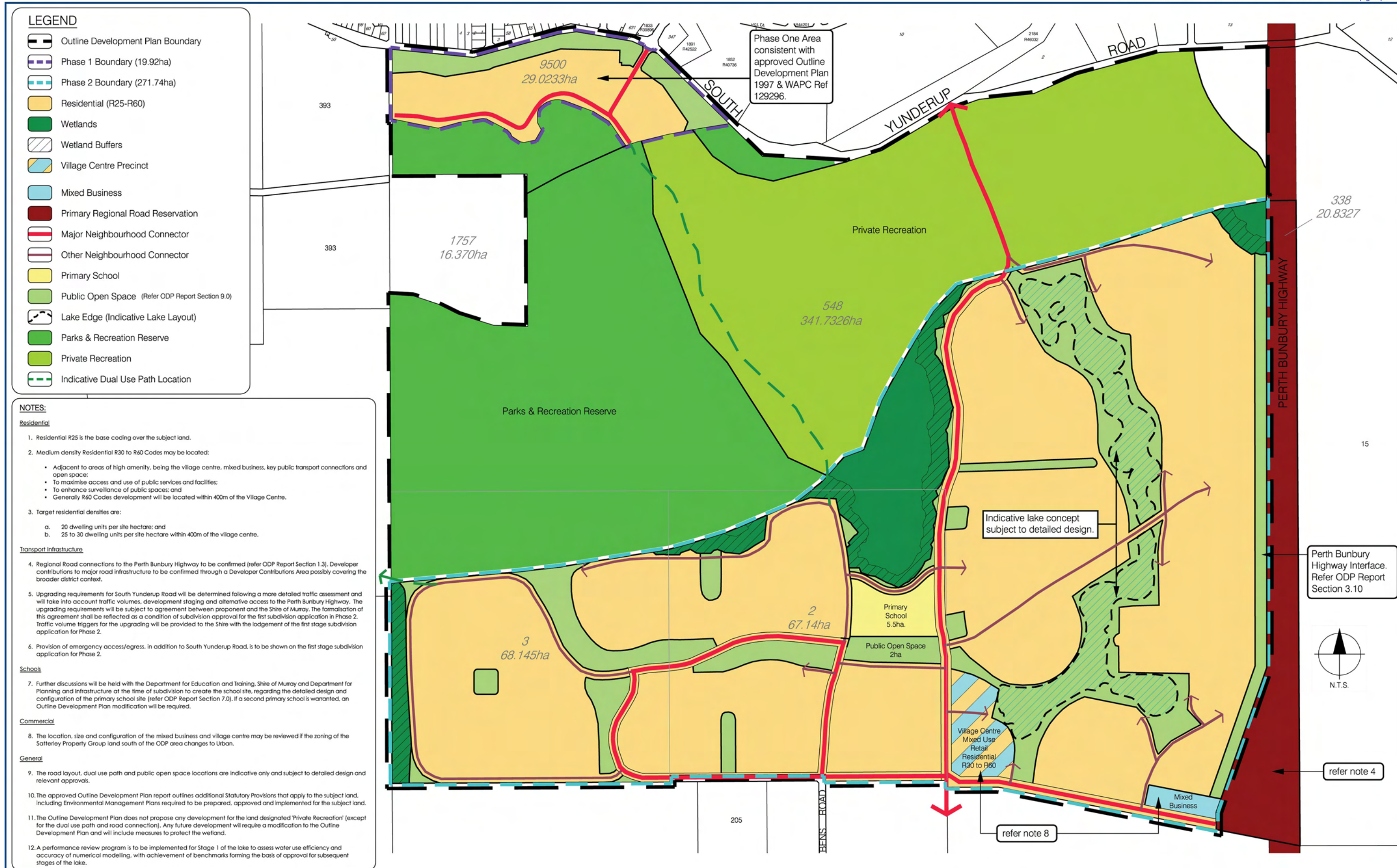
Environmental Protection Authority. 2000. *Guidance Statement for Management of Mosquitoes by Land Developers*. Guidance Statement No. 40. June, 2000.

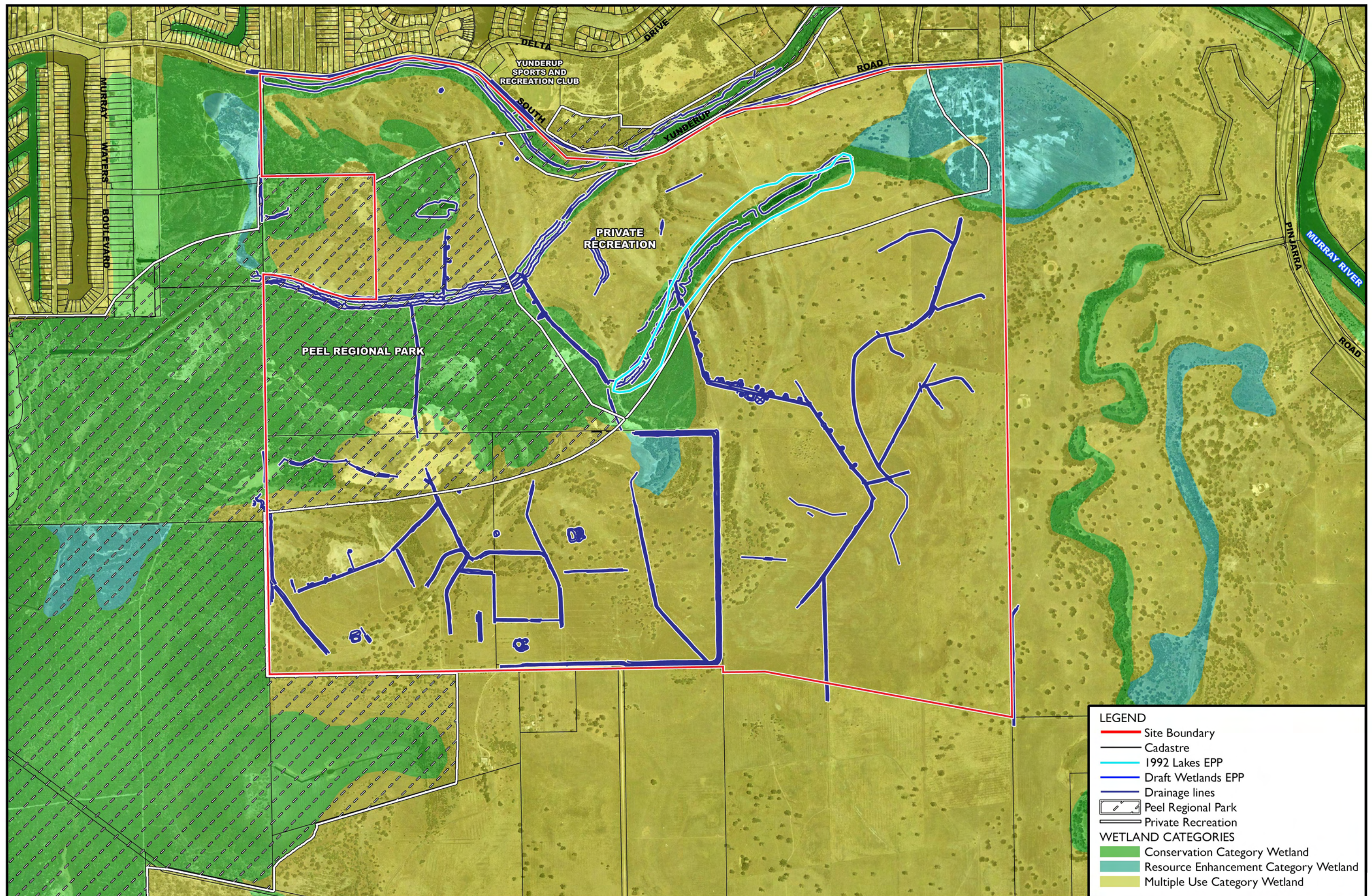
RPS Bowman Bishaw Gorham. 2007. *Environmental Assessment Report, Austin Cove Phase 2*. RPS Ref: L06373. Report prepared for Satterley Property Group.

Russell, R.C. 1999. Constructed wetlands and mosquitoes: Health hazards and management options – An Australian perspective. *Ecological Engineering*. 12. pp 107–124.

FIGURES

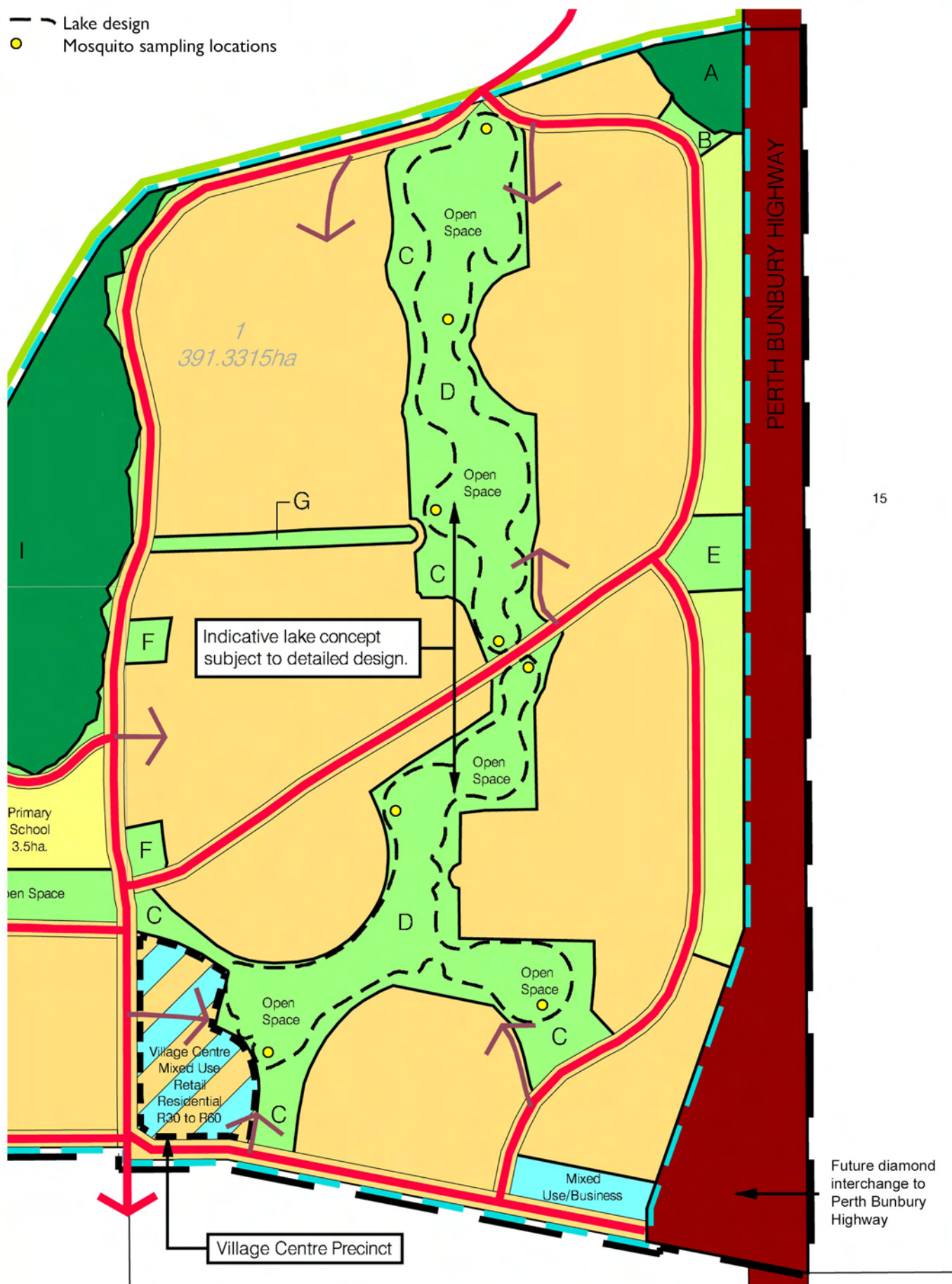






LEGEND

- Lake design
- Mosquito sampling locations



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APPENDIX I

Mosquito Sampling Procedures

APPENDIX I: MOSQUITO LARVAE SAMPLING AND ANALYSIS PROCEDURES

Sampling Procedure

Mosquito sampling sites are best chosen in areas sheltered from the wind and sun, such as under overhangs, beneath built structures, amongst reeds. The sampler must approach the sample location quietly and quickly, ensuring not to cast a shadow over the area of water to be sampled. Most mosquito larvae reside just below the water surface and they will quickly swim down through the water column if disturbed. If the sample is not taken adequately, the site must be allowed time for mosquito larvae to settle back at the surface before another sample is taken.

A sample is taken by quickly scooping water from the surface using a 250 mL long handled scoop. The water is allowed to settle then a count is taken of a) number of mosquito larvae alive; b) number of mosquito larvae dead; and c) number of adult mosquitoes alive or dead.

Analysis

If needed, the number of mosquito larvae per square metre of water surface can be calculated using the following formula:

N - Number of larvae in sample
S - Surface area of scoop cm^2 ($\pi \times \text{radius}^2$)

$$\text{Number of larvae per m}^2 = \frac{1000}{S} \times N$$

As the selection of mosquito sampling locations is judgemental (usually targeting preferred habitat types), it is not useful to extrapolate the per sample results out to represent a per metre squared value or a whole of wetland value. Different habitat types will support different numbers of mosquito larvae. For a more accurate representation, the calculation above should be done separately for samples within each homogeneous mosquito habitat.