DWLBC REPORT

Volumetric Conversion in the South East of South Australia: Calculation of Specialised Production Requirements

2006/31

Government of South Australia
Department of Water, Land and Biodiversity Conservation

Volumetric Conversion in the South East of South Australia: Calculation of Specialised Production Requirements

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Resource Allocation
Department of Water, Land and Biodiversity Conservation

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Department of Water, Land and Biodiversity Conservation

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FOREWORD

South Australia's unique and precious natural resources are fundamental to the economic and social wellbeing of the State. It is critical that these resources are managed in a sustainable manner to safeguard them both for current users and for future generations.

The Department of Water, Land and Biodiversity Conservation (DWLBC) strives to ensure that our natural resources are managed so that they are available for all users, including the environment.

In order for us to best manage these natural resources it is imperative that we have a sound knowledge of their condition and how they are likely to respond to management changes. DWLBC scientific and technical staff continues to improve this knowledge through undertaking investigations, technical reviews and resource modelling.

The Volumetric Conversion Project was a four-year project initiated in 2002 to facilitate the process of converting the existing area based water licences in the South East of South Australia to licences with a volumetric basis for allocation. The conversion approach was developed following a comprehensive community consultation process, using the best available science and extensive field data.

The conversion approach will be implemented through the review of Water Allocation Plans for the Padthaway, Tatiara and Lower Limestone Coast Prescribed Wells Areas that is being conducted by the South East Natural Resource Management Board. The reviewed Water Allocation Plans will define the arrangements for the issue of new volumetric allocations, taking into account the recommendations of this report, the sustainability of the resource and input from the stakeholder community.

Rob Freeman
CHIEF EXECUTIVE
DEPARTMENT OF WATER, LAND AND BIODIVERSITY CONSERVATION

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ASSOCIATED REPORTS

Carruthers, R 2006, *Volumetric Conversion in the South East of South Australia: Community Consultation Processes,* DWLBC Report 2006/33, Government of South Australia, through Department of Water, Land and Biodiversity Conservation, Mount Gambier.

Carruthers, R, Latcham, B & Pudney, S 2006, *Volumetric Conversion in the South East of South Australia: Summary of the Conversion Model and Associated Conversion Rates,* DWLBC Report 2006/29, Government of South Australia, through Department of Water, Land and Biodiversity Conservation, Mount Gambier.

Carruthers, R, Skewes, M, Latcham, B & Pudney, S 2006, *Volumetric Conversion in the South East of South Australia: Calculation of the Crop Adjustment Factor,* DWLBC Report 2006/32, Government of South Australia, through Department of Water, Land and Biodiversity Conservation, Mount Gambier.

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Skewes, M 2006, *Definition of Net Irrigation Requirements in the South East of South Australia,* Report to Department of Water Land and Biodiversity Conservation, Irrigated Crop Management Service, Rural Solutions SA, Primary Industries and Resources South Australia.

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EXECUTIVE SUMMARY

The Base Component of the proposed volumetric conversion model accounts for water that is used for crop growth processes, the Delivery Component accounts for water that is 'lost' during the application process. In certain crop production systems it is necessary to use water for other activities. In these instances the base and delivery components will not provide enough water to allow a reasonably efficient irrigator to continue their current practices. As this is one of the principles of conversion it is necessary to develop a methodology for calculating how much water is required for these activities and include it as a component in the conversion model.

Specialised production requirements (SPR) include:

1. Water that is necessarily applied as a part of the crop production process that does not contribute to crop water use and is not included in the delivery component (e.g. to prevent soil drift or to protect against frost damage)
2. Water that is required in addition to base allocation due to significant changes in the crop production system (as recognised by FAO 56). For example Maximum Production Pasture.

This report summarises the methodology used to calculate volumetric allocations for the processes that have been identified as 'Specialised Production Requirements'. Table 1 details the crop production processes that are entitled to a 'Specialised Production Requirement' and the associated volumetric allocation (see App. A for allocation listed by management area).

Table 1. Summary of Specialised Production Requirements and Volumetric Allocations

Crop	Process for which additional water is required	Allocation Volume (ML)
Fruit Trees (Apples)	Cooling for prevention of sunburn, cooling to aid the development of red pigment	0.39
Onions	Prevention of soil drift, establishment of a post harvest cover crop	1.10* 1.47^
Potatoes	Prevention of soil drift, inter-mound losses, harvest (in ground storage, cooling, bruising), establishment of a post harvest cover crop	1.35* 1.70^
Vines	Prevention of frost damage	1.55
Olives	Salt leaching	0.28
Subterranean - Cover Seed	Establishment of a post harvest cover crop	0.31* 0.38^
Maximum Production Pasture	Increased net irrigation requirement due to significant changes in pasture management systems (as recognised by FAO 56).	0.97–4.56# 0.6–2.87

* South: Management areas within Climatic Bands 1A–3A. Climatic bands are described in Skewes (2006)

^ North: Management areas within Climatic Bands 4A–9A. Climatic bands are described in Skewes (2006)

Depending on management area and irrigation system type – see App. A)

1. INTRODUCTION

1.1 GENERAL INTRODUCTION

The Volumetric Conversion Project was initiated in 2002 to facilitate the process of converting 2500 area based water licences in the South East of South Australia to licences with volumetric allocations.

The volumetric conversion process will be implemented through the review of Water Allocation Plans, due for finalisation in late 2006. Over the past four years the Project has developed a model that describes the proposed process for conversion using an iterative process of consultation and amendment with input from the stakeholder community.

The proposed conversion model is shown below (Fig. 1). All licensees will receive a Base Allocation and a Delivery Component. The Base Allocation provides for crop irrigation requirements (Skewes 2006). Some licensees may also be eligible for a Crop Adjustment Factor that provides additional Base Allocation for licensees where, due to initial calculation problems, the existing area based system does not provide adequate allocation.

The Delivery Component is the volume of water needed in excess of the crop irrigation requirements to account for irrigation system losses (evaporation losses, deep drainage etc.). In certain crop production systems it is necessary to use water for other activities, this water will be provided through the Specialised Production Requirements model component. The Bridging volume is an additional temporary water allocation designed to give irrigators who are currently pumping in excess of their new volumetric allocation time to adjust to the new system. The Specialised Production Requirement and Bridging Volume model components may be available on application, subject to meeting eligibility criteria.

This report describes the methodology used to calculate the volumetric allocations for ‘Specialised Production Requirements’ (shaded portion of Fig. 1). Other reports (listed in ‘Associated Reports’) detail the calculation of the base allocation, delivery component and bridging Volume. A report has also been published on the community consultation processes used in this project.

1.2 INTRODUCTION TO SPECIALISED PRODUCTION REQUIREMENTS

Specialised production requirements (SPR) include:

1. Water that is necessarily applied as a part of the crop production process that does not contribute to crop water use and is not included in the delivery component (e.g. to prevent soil drift or to protect against frost damage).
2. Water that is required in addition to base allocation due to significant changes in the crop production system (as recognised by FAO 56). For example Maximum Production Pasture.

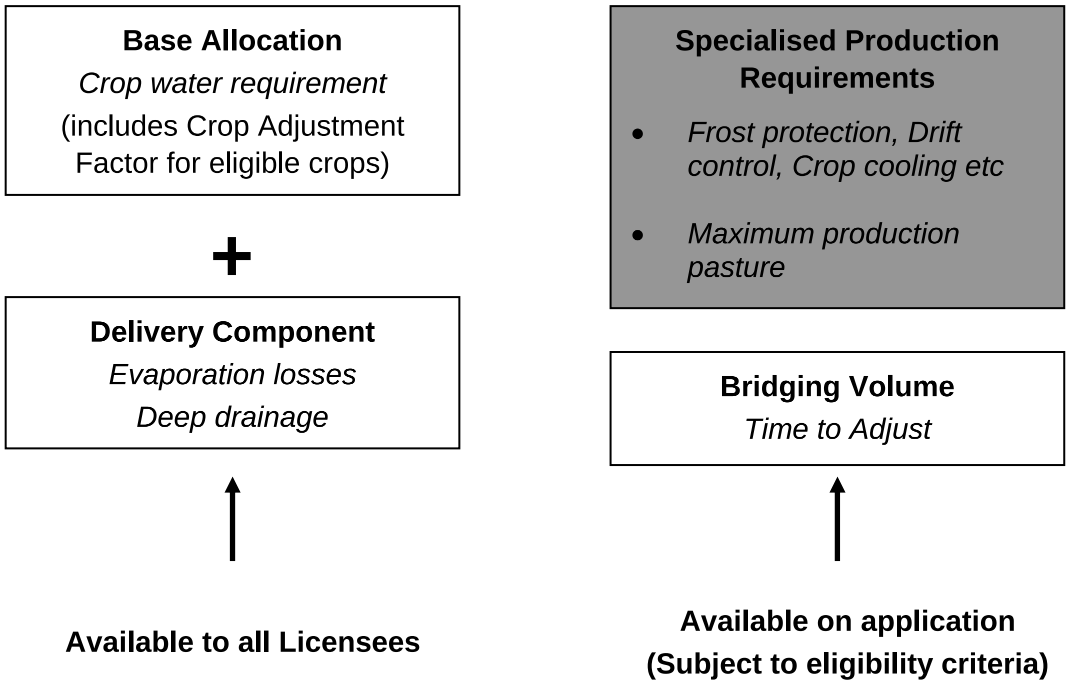

Figure 1. Proposed Volumetric Conversion Model

The crops (and processes) that have been identified as being entitled to a 'Specialised Production Requirement' are listed in Table 2. As one of the key principles of volumetric conversion is to ensure that reasonably efficient irrigators are able to continue their current practices, the management processes described below must have been practised prior to 1st July 2005 for the applicant to be entitled to an SPR.

Table 2. Crop production systems with Specialised Production Requirements

Crop	Process for which additional water is required
Fruit Trees (Apples)	• Cooling for prevention of sunburn • Cooling to aid the development of red pigment
Onions	• Prevention of soil drift • Establishment of a post harvest cover crop
Potatoes	• Prevention of soil drift • Run off from mounds (irrigation water not staying in target area) • In-ground storage • Cooling • Prevention of bruising during harvest operations • Establishment of a post harvest cover crop.
Vines	• Prevention of frost damage
Olives	• Salt leaching#
Subterranean Clover Seed	• Establishment of a post harvest cover crop
Maximum Production Pasture	• Increased Net Irrigation Requirement due to significant changes in pasture management systems

#The practice of salt leaching has been recognised as an additional water requirement only for olives as leaching fractions are incorporated in the Delivery Component for all other crops - see page 8 and Latcham et al. 2006 for more detail.

2. AIM AND OBJECTIVES

To develop a methodology for determining appropriate volumetric allocations for water requiring activities that are not accounted for in the Base or Delivery Component of the volumetric conversion model.

3. METHODOLOGY

3.1 GENERAL METHODOLOGY

SPR volumetric allocations were calculated for all crops other than MMP by defining trigger conditions. Trigger conditions are a set of criteria that define when SPR water is applied. The trigger values have been determined for each of the crops listed in Table 2 through consultation with industry.

In the simplest form, SPR allocations equate to average number of times Trigger conditions are met in any one growing season multiplied by the average application depth per event. However, where an additional volume of water has been allocated for crop water use, any SPR water that contributes to irrigation requirement is deducted - see below for model equation:

$$SPR = (T \times A) - NIR_{SPR}$$

SPR = Specialised Production Requirement

T = Average number of times Trigger Conditions are met. Where effective rainfall events coincide with an 'SPR event' the average number of applications (T) is adjusted (T_{Adj}).

A = Average Application Depth (mm). For some water requiring activities it is necessary to add a delivery component to the Application Depth (A+DC); where this is the case the minimum delivery component for spray irrigation has been used (see Latcham et al. 2006). The average application depth is deduced from grower records and/or consultation with industry.

NIR_{SPR} = SPR water that contributes to net irrigation requirement during the SPR period. The net irrigation requirement is calculated using FAO 56 methodology – see Skewes (2006) for more information. The percent of SPR water that is considered effective in supplying the net irrigation requirement is assessed for each individual activity.

Weather data was sourced from the Queensland Department of Natural Resources and Mines. SILO 'DataDrill' data covering the period 1980–2004 has been used. All SPR allocations are expressed as mm of water, and as megalitres (ML) per hectare of SPR crop planted.

3.2 MAXIMUM PRODUCTION PASTURE

The volumetric allocation for MPP is equivalent to the difference between the reference crop net irrigation requirement (NIR_0) and the Net irrigation requirement of Maximum Production Pasture (NIR_{MPP}). The calculation of NIR_{MPP} is detailed in Skewes (2006). A summary table showing all SPR_{MPP} allocations is shown in Appendix A. The SPR for maximum production pasture is expressed as megalitres (ML) of water per hectare of maximum production pasture planted.

3.3 CONSULTATION WITH INDUSTRY

The volumetric allocations for all SPRs have been developed in consultation with the relevant industry groups. Specialised production requirements were identified during the 2002 workshop series when regional crop calendars were developed. Specific information has been sought on individual crop practices through interviews and meetings with industry representatives. The methodology described in this report has been presented to each of the industry groups for comment; the report incorporates changes recommended by relevant parties. The specialised production requirements reviewed in this report have taken into consideration current literature on cropping practices, however the final calculations are based on current practice in the South East of South Australia. For more information on community consultation processes see Carruthers (2006).

4. CALCULATING THE SPECIALISED PRODUCTION REQUIREMENT FOR FRUIT TREES (APPLES)

4.1 BACKGROUND

Additional water is required in apple orchards to prevent the fruit becoming sunburnt and to aid in the development of red pigment in the skin. Cooling for sunburn prevention is practised from mid November through to March on hot windy (fire ban) days. Water is used to aid the development of red pigment in the skin when consecutive hot days are experienced in February and March.

4.2 CALCULATIONS

4.2.1 ALLOCATION FOR PREVENTION OF SUNBURN

$$SPR_{FT\ Sunburn} = (T \times A) - NIR_{SPR}$$

T = Average number of times the daytime temperature was ≥35°C (SILO DataDrill, Kalangadoo) in November through to March.

A = 3 mm (4 mm/hr sprinklers operated for 15 mins three times in a 24 hour period)[#].

NIR_{SPR} = 0. No $SP_{RFT\ Sunburn}$ water was considered to have contributed to apple crop water use.

$SPR_{FT\ Sunburn}$ = (9.12 x 3.00) – 0.00 = 27.36 mm

4.2.2 ALLOCATION FOR DEVELOPMENT OF RED PIGMENT

$$SPR_{FT\ Pigment} = (T \times A) - NIR_{SPR}$$

T = Average number of consecutive days with a maximum temperature ≥30°C (SILO DataDrill, Kalangadoo) in February and March. When there are two days in a row (where the maximum temperature is ≥30°C) it is assumed that one 'cooling' irrigation will be applied. Where there are three days, two events are assumed and so on.

A = 2 mm (4 mm/hr sprinklers operated for 30 mins in the evening)[#].

NIR_{SPR} = 0. No $SPR_{FT\ Pigment}$ water was considered to have contributed to apple crop water use.

$SPR_{FT\ Pigment}$ = (5.72 x 2.00) – 0.00 = 11.44 mm

A delivery component was not included in either the 'Sunburn' or 'Red Pigment' allocations as cooling does not require that the water reaches the ground surface. The application rate is based on the total volume of water pumped.

4.2.3 TOTAL FRUIT TREE (APPLE) SPECIALISED PRODUCTION REQUIREMENT (SPR_{FT})

= 27.36 + 11.44

= 39 mm

= 0.39 $MLha^{-1}$ of Fruit Trees planted

4.3 DISCUSSION

Trigger values and application depths were developed in consultation with the Apple Industry. As the Department of Water Land and Biodiversity Conservation has not historically separated apple trees from other types of orchard trees it is recommended that all licensees practising cooling should receive an SPR_{FT} allocation (39 mm), regardless of the fruit tree being grown. A single figure has been calculated for the whole of the SE as nearly all apples are grown in the area surrounding Kalangadoo.

5. CALCULATING THE SPECIALISED PRODUCTION REQUIREMENT FOR ONIONS

5.1 BACKGROUND

Water is applied during the early stages of the crop calendar to prevent soil drift. Soil drift is undesirable as it leads to soil erosion and sandblasting of the young onion plants. Once the onion crop has been harvested, a cover crop is established to ensure that the fertile top soil is retained. Water is not allocated for any of these processes through the base and delivery components of the model.

5.2 CALCULATIONS

For each of the processes described below, rainfall events greater than 3.5 mm (50% of irrigation application rate) were considered to replace an irrigation event. Allocations were calculated using SILO DataDrill rainfall data for locations closest to major onion growing areas (Mt Gambier in the South and Padthaway in the North). Allocations were calculated for Northern (Climatic Band 4A–9A) and Southern (Climatic Band 1A–3A) regions.

5.2.1 ALLOCATION FOR PREVENTION OF SOIL DRIFT

$$SPR_{O\ Drift} = (T_{Adj} \times A_{+DC}) - NIR_{SPR}$$

T_{Adj} = Average number of times it is necessary to wet the soil to prevent soil drift adjusted for effective rainfall events (>3.5 mm). Irrigations are applied on average every second day over a six week period; there are 21 possible drift control events. For the Northern region September and October Padthaway 'SILO DataDrill' rainfall data was analysed, for the Southern region August and September Mount Gambier data was used.

A_{+DC} = 8.26 mm (7 mm plus 18% delivery component).

NIR_{SPR} = $SPR_{O\ Drift}$ water contributing to the net irrigation requirement of the onion crop during the first 6 weeks. In the Southern regions no $SPR_{O\ Drift}$ water was considered to have contributed to crop water use, in the Northern regions 14.60 mm of $SPR_{O\ Drift}$ water was considered to have contributed to net irrigation requirement.

$SPR_{O\ Drift}^{Sth}$ = (9.58 x 8.26) – 0.00 = 79.13 mm

$SPR_{O\ Drift}^{Nth}$ = (14.93 x 8.26) – 14.60 = 108.72 mm

5.2.2 ALLOCATION FOR THE ESTABLISHMENT OF A POST HARVEST COVER CROP

$$SPR_{O\ Cover\ Crop} = (T \times A_{+DC}) - NIR_{SPR}$$

T = Bare cultivated soil. As these conditions persist until the cover crop is established the trigger value is constant (equivalent to 1).

A_{+DC} = NIR of cover crop plus 18% delivery component for spray irrigation. The Irrigation requirement is based on growing cereal. It has been assumed that: (1) The cereal crop will emerge 5 days after sowing and (2) that the crop is only irrigated for a further 10 days until it reaches 7–8 cm in height. The NIR of establishing a cover crop was calculated for each of the climatic bands and then averaged for the Northern and Southern regions. January ET0 and rainfall data were used in the calculation.

NIR_{SPR} = $SPR_{O\ Cover\ Crop}$ water contributing to crop water use (of onion crop). As the onion crop has been harvested prior to the sowing of the cover crop, no $SPR_{O\ Cover\ Crop}$ water is considered to have contributed to the net irrigation requirement of the onion crop.

$SPR_{O\ Cover\ Crop}^{Sth}$ = (1.00 x 31.00) – 0.00 = 31 mm

$SPR_{O\ Cover\ Crop}^{Nth}$ = (1.00 x 38.00) – 0.00 = 38 mm

5.2.3 TOTAL SPECIALISED PRODUCTION REQUIREMENT FOR ONIONS (SPR_O)

SPR_O^{Sth} = 79.13 + 31

= 110 mm

= 1.1 $MLha^{-1}$ of Onions planted

SPR_O^{Nth} = 108.72 + 38

= 147 mm

= 1.47 ML ha^{-1} of Onions planted

5.3 DISCUSSION

At present there is very little documentation detailing onion crop management practices in the SE of South Australia. The general irrigation practices described above have been developed in consultation with representatives from the onion industry. The lack of information about the amount of water used in SPR processes has required that many assumptions have been made in the above calculations. For this reason the final SPR allocations were compared with AWUR data; a good correlation was found between the proposed allocation and the volumes pumped by reasonably efficient onion growers. A SPR allocation of 110 mm for Southern regions and 147 mm for Northern Regions is thus recommended.

6. CALCULATING THE SPECIALISED PRODUCTION REQUIREMENT FOR POTATOES

6.1 BACKGROUND

There are many water requiring processes in the potato crop production system that are not accounted for in the Base and Delivery components of the conversion model. During the first five weeks of the crop calendar additional water is required to prevent soil drift. Soil drift is undesirable as it leads to soil erosion and sandblasting of the young potato plants. From week six to week twelve more water is applied than that required by the crop, this is because the mounds in which the potatoes are grown are typically formed from non-wetting sands. Grower experience shows that up to 30% of the water applied is 'shed' i.e. up to 30% of the water applied is not available to the potatoes. During harvest operations water is applied to maintain optimal storage conditions and to prevent the potatoes from being bruised by the harvester. After harvest, a cover crop is sown to prevent the loss of the fertile topsoil. There is no water allocated for any of these processes through the base and delivery components of the model.

6.2 CALCULATIONS

For each of the processes described below, rainfall events greater than 2.5 mm (50% of irrigation application rate) were considered to replace an irrigation event. Allocations were calculated using SILO DataDrill rainfall data for locations closest to major potato growing areas (Kalangadoo in South and Bordertown in North). For Northern (climatic bands 4A–9A) and Southern regions (1A–3A) allocations were calculated for early and late plantings, these were averaged to produce the final North and South allocation figures.

6.2.1 ALLOCATION FOR PREVENTION OF SOIL DRIFT

$$SPR_{P\ Drift} = (T_{Adj} \times A_{+DC}) - NIR_{SPR}$$

T_{Adj} = Average number of times it is necessary to wet the soil to prevent drift adjusted for effective rainfall events (>2.5 mm). Irrigations are applied on average every second day over a five week period; there are 18 possible drift control events. For the Northern region September and October Bordertown 'SILO DataDrill' rainfall data was analysed, for the Southern region October and November Kalangadoo data was used.

A_{+DC} = 5.90 mm (5 mm plus 18% delivery component).

NIR_{SPR} = $SPR_{P\ Drift}$ water contributing to the net irrigation requirement of the potato crop during the first five weeks. The amount of $SPR_{P\ Drift}$ water contributing to net irrigation requirement varied with location and the time of planting (see equations below).

$SPR_{P\ Drift}^{Sth\ Early}$ = (10.52 x 5.90) – 0.00 = 62.07 mm

$SPR_{P\ Drift}^{Sth\ Late}$ = (12.88 x 5.90) – 17.10 = 58.89 mm

$SPR_{P\ Drift}^{Sth\ Avg}$ = 60 mm

$SPR_{P\ Drift}^{Nth\ Early}$ = (11.02 x 5.90) – 0.00 = 65.02 mm

$SPR_{P\ Drift}^{Nth\ Late}$ = (12.23 x 5.90) – 1.70 = 70.46 mm

$SPR_{P\ Drift}^{Avg}$ = 68 mm

6.2.2 ALLOCATION FOR MOUNDING LOSSES

$$SPR_{P\ Mounding} = (T_{Adj} \times A_{+DC}) - IR$$

T_{Adj} = Average number of times it is necessary to wet the soil to account for mounding losses adjusted for effective rainfall events (>2.5 mm). Irrigations are applied over a six week period. It has been reported that during this period the irrigation requirement increases as the canopy develops, irrigation increases from every second night in week one to every night in week six. On the basis of this assumption there are 30 possible $SPR_{P\ Mounding}$ events. For the Northern region October/ November (early plant) and November/ December (late plant) Bordertown 'SILO DataDrill' rainfall data was analysed, for the Southern region November/ December and December/ January Kalangadoo data was used.

A_{+DC} = 5.90 mm (5 mm plus 18% delivery component).

NIR_{SPR} = $SPR_{P\ Mounding}$ water contributing to the irrigation requirement during week 6–12 of potato crop calendar. The amount of $SPR_{P\ Mounding}$ water contributing to net irrigation requirement varied with location and the time of planting (see equations below).

$SPR_{P\ Mounding}^{Sth\ Early}$ = (24.59 x 5.90) – 114.14 = 30.94 mm

$SPR_{P\ Mounding}^{Sth\ Late}$ = (25.81 x 5.90) – 154.33 = -2.05 mm ⇒ 0*

$SPR_{P\ Mounding}^{Sth\ Avg}$ = 15 mm

$SPR_{P\ Mounding}^{Nth\ Early}$ = (24.10 x 5.90) – 86.46 = 55.73 mm

$SPR_{P\ Mounding}^{Nth\ Late}$ = (25.83 x 5.90) – 153.03 = -0.63 mm ⇒ 0*

$SPR_{P\ Mounding}^{Nth\ Avg}$ = 28 mm

*A negative SPRMounding value indicates that crop water use exceeds the amount of water applied for mounding losses, therefore the SPR requirement is 0.

6.2.3 ALLOCATION FOR HARVEST (BRUISE MANAGEMENT, COOLING, STORAGE)

$$SPR_{P\ Harvest} = (T_{Adj} \times A_{+DC}) - NIR_{SPR}$$

T_{Adj} = Average number of times it is necessary to irrigate to maintain optimal soil moisture conditions adjusted for effective rainfall events (>2.5 mm). Harvest operations are normally completed within three weeks. It has been assumed that growers irrigate every second day throughout this period, although there are 10 possible 'Harvest' events, the allocation has been based on 7.5 events as the crop is progressively harvested, reducing the area requiring $SPR_{P\ Harvest}$. March and April (Kalangadoo) rainfall data has been used for the Southern region and February and March (Bordertown) for the Northern.

A_{+DC} = 5.90 mm (5 mm plus 18% delivery component).

NIR_{SPR} = 0. No SPRP Harvest water was considered to have contributed to the irrigation requirement of potatoes during harvest operations.

$SPR_{P\ Harvest}^{\ Sth\ Early}$ = (5.21 x 5.90) – 0.00 = 30.74 mm

$SPR_{P\ Harvest}^{\ Sth\ Late}$ = (4.40 x 5.90) – 0.00 = 25.96 mm

$SPR_{P\ Harvest}^{\ Sth\ Avg}$ = 28 mm

$SPR_{P\ Harvest}^{\ Nth\ Early}$ = (6.43 x 5.90) – 0.00 = 37.94 mm

$SPR_{P\ Harvest}^{\ Nth\ Late}$ = (6.09 x 5.90) – 0.00 = 35.93 mm

$SPR_{P\ Harvest}^{\ Nth\ Avg}$ = 37 mm

6.2.4 ALLOCATION FOR THE ESTABLISHMENT OF A POST HARVEST COVER CROP

$$SPR_{P\ Cover\ Crop} = (T \times A_{+DC}) - NIR_{SPR}$$

T = Bare cultivated soil. As these conditions persist until the cover crop is established the trigger value is constant (equivalent to 1).

A_{+DC} = NIR of cover crop plus 18% delivery component. The Irrigation requirement is based on growing cereal. It has been assumed that: (1) The cereal crop will emerge five days after sowing and (2) that the crop is only irrigated for a further 10 days until it reaches 7–8 cm in height. The NIR of establishing a cover crop was calculated for each of the climatic bands and then averaged for the Northern and Southern regions. January ET_0 and rainfall data were used in the calculation.

NIR_{SPR} = $SPR_{P\ Cover\ Crop}$ water contributing to crop water use (of potato crop). As the potato crop has been harvested prior to the sowing of the cover crop, no $SPR_{P\ Cover\ Crop}$ water is considered to have contributed to the net irrigation requirement of the potato crop.

$SPR_{P\ Cover\ Crop}^{\ Sth}$ = (1.00 x 31.00) – 0.00 = 31 mm

$SPR_{P\ Cover\ Crop}^{\ Nth}$ = (1.00 x 38.00) – 0.00 = 38 mm

6.2.5 TOTAL SPECIALISED PRODUCTION REQUIREMENT FOR POTATOES (SPR_P)

$SPR_P^{\ Sth}$ = 60 +15+ 28 + 31

= 135 mm

= 1.35 ML ha^{-1} of Potatoes planted

$SPR_P^{\ Nth}$ = 68 + 28 + 37 + 38

= 170 mm

= 1.7 ML ha^{-1} of Potatoes planted

6.3 DISCUSSION

At present there is very little documentation detailing potato crop management practices in the SE of South Australia. The general irrigation practices described above have been developed in consultation with representatives from the potato industry. The lack of information about the amount of water used in SPR processes has required that many assumptions have been made in the above calculations. For this reason the final SPR allocations were compared with AWUR data; a good correlation was found between the proposed allocation and the volumes pumped by reasonably efficient potato growers. A SPR allocation of 135 mm for Southern regions and 170 mm for Northern Regions is thus recommended.

7. CALCULATING THE SPECIALISED PRODUCTION REQUIREMENT FOR VINES

7.1 BACKGROUND

Frost can cause serious damage and/or total crop loss in vines. The perennial nature of grapevines means that frost events not only impact upon the current season's crop, but also future crops; productivity may be reduced for several seasons after a severe frost event. Warming the vineyard by applying water to the canopy (using sprinklers) is considered to be the most effective protection against frost damage. There is no water allocated for frost protection in the base or delivery components of the model.

7.2 CALCULATIONS

7.2.1 ALLOCATION FOR THE PREVENTION OF FROST DAMAGE

$$SPR_V = (T \times A) - NIR_{SPR}$$

T = Average number of times overnight temperature is <2°C at Coonawarra weather station during September to November. September to November is considered to be the frost risk period. Coonawarra weather data has been used as this region has by far the largest area of vines with frost protection.

A = 25.00 mm. Average amount of water applied for frost protection (mm) deduced from records supplied by licensees.

NIR_{SPR} = 0. No SPR_V water is considered to contribute to the vine net irrigation requirement during months September to November.

SPR_V = (6.20 x 25.00) – 0.00 = 155 mm

7.2.2 TOTAL SPECIALISED PRODUCTION REQUIREMENT FOR VINES (SPR_V)

SPR_V = 155 mm

= 1.55 $MLha^{-1}$ of vines planted with frost protection systems installed

A delivery component was not included in the 'Frost' allocation, as 'vineyard warming' does not require that the water reaches the ground surface. The application rate is based on the total volume of water pumped.

7.3 DISCUSSION

The number of frost events experienced in any one growing season is variable. In the last 20 years, the number of events has varied from 1 (1988) to 14 (1995 - Bureau of Meteorology Coonawarra Weather Station). As the number of frost events varies greatly from season to season, so too does the need for frost protection water. It is therefore important that the water accounting rules governing the use of frost water take into account this variability. A consensus was reached with the viticulture industry to use Coonawarra weather data for the whole of the South East.

8. CALCULATING THE SPECIALISED PRODUCTION REQUIREMENT FOR OLIVES

8.1 BACKGROUND

The presence of soluble salts in high concentrations in the soil has detrimental effects on plant health. When saline irrigation water is used for irrigation it is necessary to leach the salts out of the rootzone. This prevents the soil from becoming ‘salinised’ and plant yields from declining. Olive trees in the South East are typically grown in areas where irrigation water is moderately to highly saline (>2500 μScm^{-1} electrical conductivity); it is therefore necessary to perform leaching irrigations.

Leaching irrigations are also practised in other cropping industries, however water for salt leaching is considered as an additional allocation only for olives. For all other crops the water used for salt leaching has been included in pumped volume records and thus is accounted for in the Delivery Component of the volumetric conversion model. Olives are an exception, because, at present there are no fully mature commercial olive groves in the South East. The water requirements of fully mature olive trees have therefore not been represented in pumped volume data. The water requirement of a mature tree is likely to be greater than a developing tree; it is therefore necessary to allow an additional volume of water for the practice of salt leaching.

8.2 CALCULATIONS

8.2.1 ALLOCATION FOR SALT LEACHING IN OLIVE ORCHARDS

$$SPR_{OL} = (T \times A) - NIR_{SPR}$$

T = Average number of times it is necessary to apply ‘leaching’ irrigations to prevent the soil profile from becoming salinised. Leaching irrigations are applied on average twice a year.

A = 14.00 mm. Average amount of water applied for leaching irrigations (mm) deduced from records supplied by licensees.

NIR_{SPR} = SPR_{OL} water contributing to olive crop water use. Grower records show that the timing of leaching irrigations varies greatly, it is therefore not possible to calculate how much ‘leaching’ water contributes to olive crop water use. In most instances the amount would be very small as growers often maximise the efficiency of the leaching irrigation by capitalising on large rainfall events.

$SPR_{OL} = (2.00 \times 14.00) - 0.00 = 28$ mm

8.2.2 TOTAL SPECIALISED PRODUCTION REQUIREMENT FOR OLIVES (SPR_{OL})

SPR_{OL} = 28 mm

= 0.28 $MLha^{-1}$ of Olives planted

8.3 DISCUSSION

A SPR allocation of 28 mm (per ha of olives planted) is recommended for licensees irrigating olives with saline water (electrical conductivity greater than or equal to 2500 μScm^{-1}).

9. CALCULATING THE SPECIALISED PRODUCTION REQUIREMENT FOR SUBTERRANEAN CLOVER SEED

9.1 BACKGROUND

It is common practice for subterranean clover seed growers to plant a cover crop after the seed has been harvested to prevent loss of the fertile top soil. The water required to establish a cover crop is not included in the base or delivery components of the model.

9.2 CALCULATIONS

9.2.1 ALLOCATION FOR THE ESTABLISHMENT OF A POST HARVEST COVER CROP

$$SPR_{S\ Cover\ Crop} = (T \times A_{+DC}) - NIR_{SPR}$$

T = Bare cultivated soil. As these conditions persist until the cover crop is established the trigger value is constant (equivalent to 1).

A_{+DC} = NIR of cover crop plus 18% delivery component. The Irrigation requirement is based on growing cereal. It has been assumed that: (1) The cereal crop will emerge 5 days after sowing and (2) that the crop is only irrigated for a further 10 days until it reaches 7–8 cm in height. The NIR of establishing a cover crop was calculated for each of the climatic bands and then averaged for the Northern and Southern regions. January ET_0 and rainfall data were used in the calculation.

NIR_{SPR} = $SPR_{S\ Cover\ Crop}$ water contributing to crop water use (of subterranean clover seed). As the subterranean clover seed crop has been harvested prior to the sowing of the cover crop, no $SPR_{P\ Cover\ Crop}$ water is considered to have contributed to the net irrigation requirement of the subterranean clover seed.

$SPR_{S\ Cover\ Crop}^{\ Sth} = (1.00 \times 31.00) - 0.00 = 31$ mm

$SPR_{S\ Cover\ Crop}^{\ Nth} = (1.00 \times 38.00) - 0.00 = 38$ mm

9.2.2 TOTAL SPECIALISED PRODUCTION REQUIREMENT FOR SUBTERRANEAN CLOVER SEED (SPR_S)

$SPR_{S\ Cover\ Crop}^{\ Sth}$ = 31 mm

= 0.31 $MLha^{-1}$ of Subterranean Clover Seed planted

$SPR_{S\ Cover\ Crop}^{\ Nth}$ = 38 mm

= 0.38 $MLha^{-1}$ of Subterranean Clover Seed planted

10. CALCULATING THE SPECIALISED PRODUCTION REQUIREMENT OF MAXIMUM PRODUCTION PASTURE

10.1 BACKGROUND

Maximum Production Pasture (MPP) is a crop category that has been recognised by the Department of Water Land and Biodiversity Conservation as a result of discussions with pasture growers and agricultural consultants. In the last 10 years there have been significant changes in pasture management systems. These changes have been recognised in the FAO Irrigation and Drainage Handbook 56 (Allen et. al. 1998) by an increase in crop coefficient values for pasture. As the name suggests, MPP requires more inputs (including water) than other classes of pasture. The following management practices distinguish 'MPP' from 'Pasture'. In a management system where MPP is being grown[1]:

- Irrigations are scheduled to ensure that the crop water requirement of maximum production pasture is met, the crop is never waterlogged and never suffers from water stress.
- Soil fertility is actively managed and fertiliser is applied according to a nutritional plan.
- The pasture species are regularly maintained.
- The pasture species are capable of producing large volumes of dry matter with a high metaboliseable energy and crude protein content.
- The grazing regime ensures that the pasture is always achieving maximum growth i.e. the pasture is cell or rotational grazed.
- High livestock production rates are achieved.

Where a pasture system is managed in the manner described above, the standard 'pasture' allocation (and associated delivery component) will not be sufficient for growing Maximum Production Pasture; hence the need for an SPR allocation.

10.2 CALCULATIONS

The volumetric allocation for MPP is equivalent to the difference between the reference crop NIR and the NIR of MPP. The calculation of NIR_{MPP} is detailed in Skewes (2006).

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[1] At the time of writing this report the detailed eligibility criteria for those seeking a MPP allocation were still being developed.

10.3 RESULTS

The volumetric allocation for MPP varies with climatic band, irrigation system type and delivery zone (see Skewes 2006 and Latcham et al. 2006 for more information). The volume of additional water varies from 0.6 $MLha^{-1}$ to 2.87 $MLha^{-1}$ of MPP grown. The SPR_{MPP} allocation for each management zone is listed in Appendix A.

10.4 DISCUSSION

During the early phases of the project concerns were raised about the adequacy of proposed allocations for properties where the pasture management system has significantly changed since prescription. Results from data collection programs (Annual Water Use Returns, Metered Extraction Trials and Field Irrigation System Trials) have verified these concerns. There are some growers who are managing their pasture systems in a way that legitimately requires more water (along with other inputs), than previously recognised. For this reason it is recommended that if a grower can demonstrate that they have been growing ‘Maximum Production Pasture’, they should be allocated an additional volume of water that is appropriate for the location of the property and the irrigation system type used.

APPENDICES

A. SPECIALISED PRODUCTION REQUIREMENTS (ML)

Management Area*	Vines - Frost Protection	Fruit Trees	Potatoes	Olives	Onions	Sub Clover Seed	Maximum Production Pasture*		
							Spray	*Flood*	*Drip*
Bangham	1.55	0.38	1.70	0.28	1.47	0.38	1.01	1.74	0.95
Beeamma	1.55	0.38	1.70	0.28	1.47	0.38	1.01	1.74	0.95
Benara	1.55	0.38	1.35	0.28	1.10	0.31	1.44	1.74	1.25
Blanche Central	1.55	0.38	1.35	0.28	1.10	0.31	1.33	1.74	1.25
Bool	1.55	0.38	1.70	0.28	1.47	0.38	1.13	2.14	1.07
Bowaka	1.55	0.38	1.70	0.28	1.47	0.38	1.13	2.23	1.07
Bray	1.55	0.38	1.35	0.28	1.10	0.31	1.27	2.51	1.20
Cannawigara	1.55	0.38	1.70	0.28	1.47	0.38	0.72	0.94	0.68
Coles	1.55	0.38	1.70	0.28	1.47	0.38	1.20	2.37	1.13
Comaum	1.55	0.38	1.70	0.28	1.47	0.38	1.20	2.27	1.13
Compton	1.55	0.38	1.35	0.28	1.10	0.31	1.44	1.74	1.25
Conmurra	1.55	0.38	1.70	0.28	1.47	0.38	1.20	2.37	1.13
Donovans	1.55	0.38	1.35	0.28	1.10	0.31	1.44	1.74	1.25
Duffield	1.55	0.38	1.70	0.28	1.47	0.38	1.01	2.00	0.95
Fox	1.55	0.38	1.70	0.28	1.47	0.38	1.20	2.37	1.13
Frances	1.55	0.38	1.70	0.28	1.47	0.38	1.07	1.40	1.01
Glenburnie	1.55	0.38	1.35	0.28	1.10	0.31	1.33	1.74	1.25
Glenroy	1.55	0.38	1.70	0.28	1.47	0.38	1.20	2.27	1.13
Grey	1.55	0.38	1.35	0.28	1.10	0.31	1.31	2.58	1.23
Hacks	1.55	0.38	1.70	0.28	1.47	0.38	1.13	2.14	1.07
Hindmarsh	1.55	0.38	1.35	0.28	1.10	0.31	1.33	1.74	1.25
Hynam East	1.55	0.38	1.70	0.28	1.47	0.38	1.07	2.72	1.01
Hynam West	1.55	0.38	1.70	0.28	1.47	0.38	1.07	2.72	1.01
Joanna	1.55	0.38	1.70	0.28	1.47	0.38	1.20	1.57	1.13
Joyce	1.55	0.38	1.70	0.28	1.47	0.38	1.13	2.23	1.07
Kennion	1.55	0.38	1.35	0.28	1.10	0.31	1.27	2.51	1.20
Killanoola	1.55	0.38	1.70	0.28	1.47	0.38	1.20	2.37	1.13
Kongorong	1.55	0.38	1.35	0.28	1.10	0.31	1.44	1.74	1.25
Lacepede	1.55	0.38	1.70	0.28	1.47	0.38	1.13	2.23	1.07
Lake George	1.55	0.38	1.35	0.28	1.10	0.31	1.27	2.51	1.20
Landseer	1.55	0.38	1.70	0.28	1.47	0.38	1.01	2.00	0.95
Lochaber	1.55	0.38	1.70	0.28	1.47	0.38	1.07	2.72	1.01
Macdonnell	1.55	0.38	1.35	0.28	1.10	0.31	1.44	1.74	1.25
Management Area 1 (MA1)	1.55	0.38	1.70	0.28	1.47	0.38	1.01	2.57	0.95
Management Area 2 (MA2)	1.55	0.38	1.70	0.28	1.47	0.38	1.01	2.57	0.95

Management Area	Vines - Frost Protection	Fruit Trees	Potatoes	Olives	Onions	Sub Clover Seed	Maximum Production Pasture*		
							Spray	*Flood*	*Drip*
Management Area 3 (MA3)	1.55	0.38	1.70	0.28	1.47	0.38	1.01	2.57	0.95
Management Area 4 (MA4)	1.55	0.38	1.70	0.28	1.47	0.38	1.01	2.57	0.95
Marcollat	1.55	0.38	1.70	0.28	1.47	0.38	1.01	2.57	0.95
Mayurra	1.55	0.38	1.35	0.28	1.10	0.31	1.31	2.58	1.23
Minecrow	1.55	0.38	1.70	0.28	1.47	0.38	1.13	2.23	1.07
Monbulla	1.55	0.38	1.35	0.28	1.10	0.31	1.27	2.51	1.20
Moorak	1.55	0.38	1.35	0.28	1.10	0.31	1.44	1.74	1.25
Mount Benson	1.55	0.38	1.70	0.28	1.47	0.38	1.13	2.23	1.07
Mount Muirhead	1.55	0.38	1.35	0.28	1.10	0.31	1.31	2.58	1.23
Moyhall	1.55	0.38	1.70	0.28	1.47	0.38	1.13	2.23	1.07
Murrabinna	1.55	0.38	1.70	0.28	1.47	0.38	1.13	2.23	1.07
Myora	1.55	0.38	1.35	0.28	1.10	0.31	1.33	1.74	1.25
North Pendleton	1.55	0.38	1.70	0.28	1.47	0.38	0.72	0.94	0.68
Ormerod	1.55	0.38	1.70	0.28	1.47	0.38	1.13	2.87	1.07
Peacock	1.55	0.38	1.70	0.28	1.47	0.38	1.01	2.00	0.95
Riddoch	1.55	0.38	1.35	0.28	1.10	0.31	1.31	2.58	1.23
Rivoli Bay	1.55	0.38	1.35	0.28	1.10	0.31	1.31	2.58	1.23
Ross	1.55	0.38	1.70	0.28	1.47	0.38	1.20	2.37	1.13
Shaugh	1.55	0.38	1.70	0.28	1.47	0.38	0.60	0.79	0.57
Short	1.55	0.38	1.35	0.28	1.10	0.31	1.27	2.51	1.20
Smith	1.55	0.38	1.35	0.28	1.10	0.31	1.27	2.51	1.20
Spence	1.55	0.38	1.70	0.28	1.47	0.38	1.13	2.23	1.07
Stewarts	1.55	0.38	1.70	0.28	1.47	0.38	1.13	2.87	1.07
Stirling	1.55	0.38	1.70	0.28	1.47	0.38	0.72	1.54	0.68
Struan	1.55	0.38	1.70	0.28	1.47	0.38	1.20	2.27	1.13
Symon	1.55	0.38	1.35	0.28	1.10	0.31	1.31	2.58	1.23
Tatiara	1.55	0.38	1.70	0.28	1.47	0.38	0.87	1.49	0.82
Townsend	1.55	0.38	1.70	0.28	1.47	0.38	1.13	2.23	1.07
Waterhouse	1.55	0.38	1.70	0.28	1.47	0.38	1.20	2.37	1.13
Western Flat	1.55	0.38	1.70	0.28	1.47	0.38	0.87	1.49	0.82
Willalooka (east)	1.55	0.38	1.70	0.28	1.47	0.38	0.87	1.49	0.82
Willalooka (west)	1.55	0.38	1.70	0.28	1.47	0.38	0.87	2.21	0.82
Wirrega (south)	1.55	0.38	1.70	0.28	1.47	0.38	0.87	1.49	0.82
Wirrega (north)	1.55	0.38	1.70	0.28	1.47	0.38	0.72	1.23	0.68
Woolumbool	1.55	0.38	1.70	0.28	1.47	0.38	1.07	2.11	1.01
Young	1.55	0.38	1.35	0.28	1.10	0.31	1.33	1.74	1.25
Zone 2A	1.55	0.38	1.35	0.28	1.10	0.31	1.31	1.71	1.23
Zone 3A	1.55	0.38	1.35	0.28	1.10	0.31	1.27	2.41	1.20
Zone 5A	1.55	0.38	1.70	0.28	1.47	0.38	1.13	1.48	1.07
Zone 8A	1.55	0.38	1.70	0.28	1.47	0.38	0.72	0.94	0.68

* Note – See Figure 2 in Appendix B for location of Management Areas

B. LOCATION OF MANAGEMENT AREAS

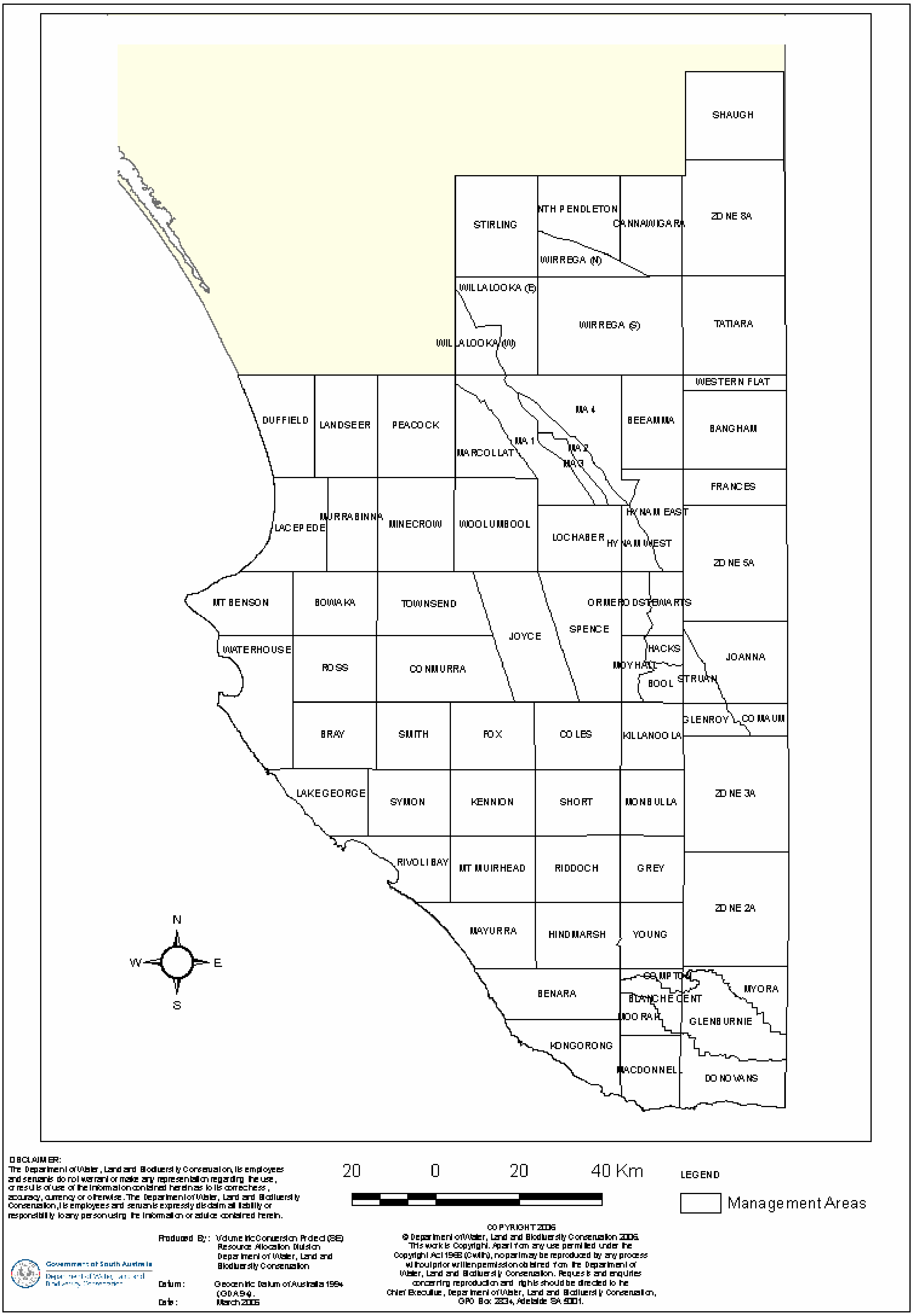

Figure 2. Location of Management Areas

UNITS OF MEASUREMENT

Units of measurement commonly used (SI and non-SI Australian legal)

Name of unit	Symbol	Definition in terms of other metric units	Quantity
day	d	24 h	time interval
degrees celcius	°C	Base unit	Temperature
hectare	ha	10^4 m^2	area
hour	h	60 min	time interval
irrigation rate / requirement	ML/ha	mm depth	rate
megalitre	ML	10^3 m^3	volume
millimetre	mm	10^{-3} m	length
percent	%	fractions, decimal	proportion
year	y	356 or 366 days	time interval

Micro siemens per centimetre μScm^{-1} electrical conductivity

GLOSSARY

Annual Water Use Returns (AWUR's). End of season reporting process whereby water license holders detail their water use activities for the given season. The details required include areas of crop types grown and assessments of volumes pumped.

Area-Based Licensing System (haIE). Existing water access entitlements to irrigate a given area of crop per annum, with no restrictions on the volume of water applied to the crop. Measured in terms of hectares of irrigation equivalents (haIE).

Base Allocation (BA). The crop water requirement component of the proposed volumetric licenses. Base Allocation (ML) = haIE x NIRo

Bridging Volume (BV). The Bridging volume is an additional temporary water allocation that may be granted on application subject to eligibility criteria. The bridging volume is designed to give irrigators who are pumping in excess of their new volumetric allocation time to adjust to the new system.

Climatic Bands. 10 Climatic Bands across the South East that were developed to better represent the range of evapotranspiration and rainfall rates across the SE of SA. It is proposed that these Climatic Bands form the basis for determination of each irrigator's volumetric allocation.

Crop Adjustment Factor (CAF). The Crop Adjustment Factor provides additional base allocation for licensees where, due to initial calculations problems, the existing area-based licensing system does not provide adequate allocation.

Crop Calendar. Representation of the critical periods of crop growth and development for a crop in a particular geographical location, under certain management practices. Used to assign crop coefficients to months of the year to represent the crop water requirements of the crop at that location under those management practices.

Crop Water Requirement. Depth of water required by a crop for evapotranspiration (ETC) during a given period (Doorenbos and Pruitt, 1977).

Deep Drainage. Water that percolates past the crop root zone and is no longer available to the crop for transpiration.

Delivery Component (DC). The volume of water that a reasonably efficient irrigator needs to extract in excess of the crop water requirement to irrigate and grow the crop to account for application and distribution losses.

Delivery Zones (DZ). Areas of like characteristics within the SE. They were used to calculate delivery components and have been developed using soil mapping data, volume pumped data and other hydrogeological information sources (ie depth to water table, salinity).

Evapotranspiration (ET). Rate of water loss through transpiration from vegetation plus evaporation from the soil (Doorenbos and Pruitt, 1977).

FAO 56. Food and Agriculture Organization of the United Nations. FAO Irrigation and Drainage Paper, 56 (1998) - Crop Evapotranspiration; Guidelines for Computing Crop Water Requirements.

Field Irrigation System Trials (FIST Program). Field trial sites equipped with monitoring equipment to collect detailed information on the on-farm irrigation water balance.

Frost Protection. Water applied to the crop canopy using fixed overhead sprinklers to prevent frost damage to the crop.

Leaching. The application of irrigation water to minimise the built up of salts from the crop root zone.

Maximum Production Pasture (MPP). A category of pasture that has been recognised as having increased NIRc due to significant changes in pasture management systems.

Megalitre (ML). One ML equal one million litres or one thousand Kilolitres.

Metered Extraction Trials (MET Program). A field trial program aimed at generating accurate 'real-life' volume pumped data representative of irrigation practices in the region.

Net Irrigation Requirement - Specialised Production Requirements (NIRSPR). Amount of SPR water contributing to NIR – see below.

Net Irrigation Requirement (NIR). Depth of water required for meeting evapotranspiration minus contribution by effective precipitation, ground water, stored soil water; does not include operational losses and leaching requirements (Doorenbos and Pruitt, 1977).

Post-Harvest Cover Crop. A crop sown after the harvest of annual crops to stabilise and retain the bare soil.

Reference Crop Evapotranspiration (ET_0). Rate of evapotranspiration from an extended surface of 8–15 cm tall, green grass cover of uniform height, actively growing, completely shading the ground and not short of water (Doorenbos and Pruitt, 1977).

SILO DataDrill. Continuous interpolated daily climatic data. Queensland Department of Natural Resources and Mines.

Soil Drift Control. The application of irrigation water to a bare field or emergent crop for the purpose of preventing soil from being lost or causing crop damage due wind drift.

Specialised Production Requirements (SPR). (1) Water that is necessarily applied as a part of the crop production process that does not contribute to crop water use and is not included in the delivery component (e.g. to prevent soil drift or to protect against frost damage). (2) Water that is required in addition to base allocation due to significant changes in the crop production system (as recognised by FAO 56). For example Maximum Production Pasture.

Spray Irrigation. Pressurised irrigation systems with water applied through some form of sprinkler/s. Water is delivered from the pump to the sprinkler through pipe works. Includes centre pivots, fixed sprinklers and travelling irrigators.

Volumetric Conversion Model. Describes the components and methodologies for the conversion of existing area-based allocations to volumetric allocations.

Volumetric Licensing System. Licensees are entitled to pump a certain volume of water per annum, but are not restricted by the area of crop/s grown.

Water Allocation Plan (WAP). A plan prepared by a Natural Resource Management Board or water resource planning committee and adopted by the Minister in accordance with Division 3 Part 7 of the Water Resources Act 1997.

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