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G J. Luke

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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.

Contents

1. Abstract

The provision of adequate supplies of good quality drinking water for livestock is of major concern to farmers and graziers in Western Australia. The quantity of water required by livestock depends upon many factors including:

- type of stock
- environmental factors
- water quality
- type of feed
- animal's physiological condition

This technical report presents a technique whereby the water requirements of livestock in different parts of the State can be estimated. This technique is based upon a general model, which relates daily water requirement to average daily temperature.

Deviations from the standard conditions upon which the model is based will result in changes to the average daily water requirement. A method by which the affect of these changes can be assessed is presented. By following the procedure it is possible to estimate the water requirement of livestock when exposed to such conditions as saline water supplies/ saltbush pastures, heat waves, etc.

There is also a brief discussion on the way that changes to the animals physiological condition may affect its requirement for water. This section is a brief overview and not meant to be an exhaustive review of the literature on the subject. From this discussion an indication of the possible consequences of different physiological changes can be obtained, and the need to change management practices assessed.

Tables presenting estimates of daily and monthly water requirements for sheep in various south-west and pastoral centres, are provided. Before these estimates are used however it is strongly advised that the text be consulted. This is especially the case for users relying on these estimates as an input to Damcat.

Although this report discusses water consumption by livestock, most of the information presented refers to sheep. Where possible this information is related to other types of stock.

2. General Water Consumption Model

In Australia, there have been many studies into the factors, which affect the water consumption practises of sheep (2,3,5-8,10-14,18,22,25-29). The data in the literature can be used to develop a general sheep drinking rate model, for a set of standard conditions.

A set of standard conditions have already been defined for the concept of a dry sheep equivalent (D.S.E.)(5,6).

A D.S.E. is defined as a sheep which is:-

1. non lactating

2. with a liveweight of 45 kg

3. in forward store condition (livestock market reporting condition score 3<9>)

4. grazing a maintenance diet of sub clover based pasture/ or something similar

5. drinking relatively fresh water (< 1,000 mg/L T.S.S.).

Providing water is not rationed, or that intake is not limited by unappetising water the amount of water consumed by a D.S.E. varies throughout the year. That amount ranges from zero during winter when there is green feed available to approximately 4 litres per day when the maximum temperature reaches 40°C (6). Many other workers have also recognised that sheep increase their intake of water as daily temperatures rise (2,3,5,7-8,12,15).

There is also a considerable body of research, which can contribute more information regarding the drinking rate of sheep under specific temperature conditions (3,11-14,18,22,25-27). Those which conform to the standard conditions defined for a D.S.E., or which could be adjusted on a body weight basis (see Figure 2) have been used to develop a relationship between drinking rate and average maximum daily temperature (Figure 1).

The relationship can be described by the equation:

$DR = 0.191183T - 2.88245$

DR = Drinking Rate (L/day)
T = Average maximum daily temperature (°C)
$r^2 = 0.84$

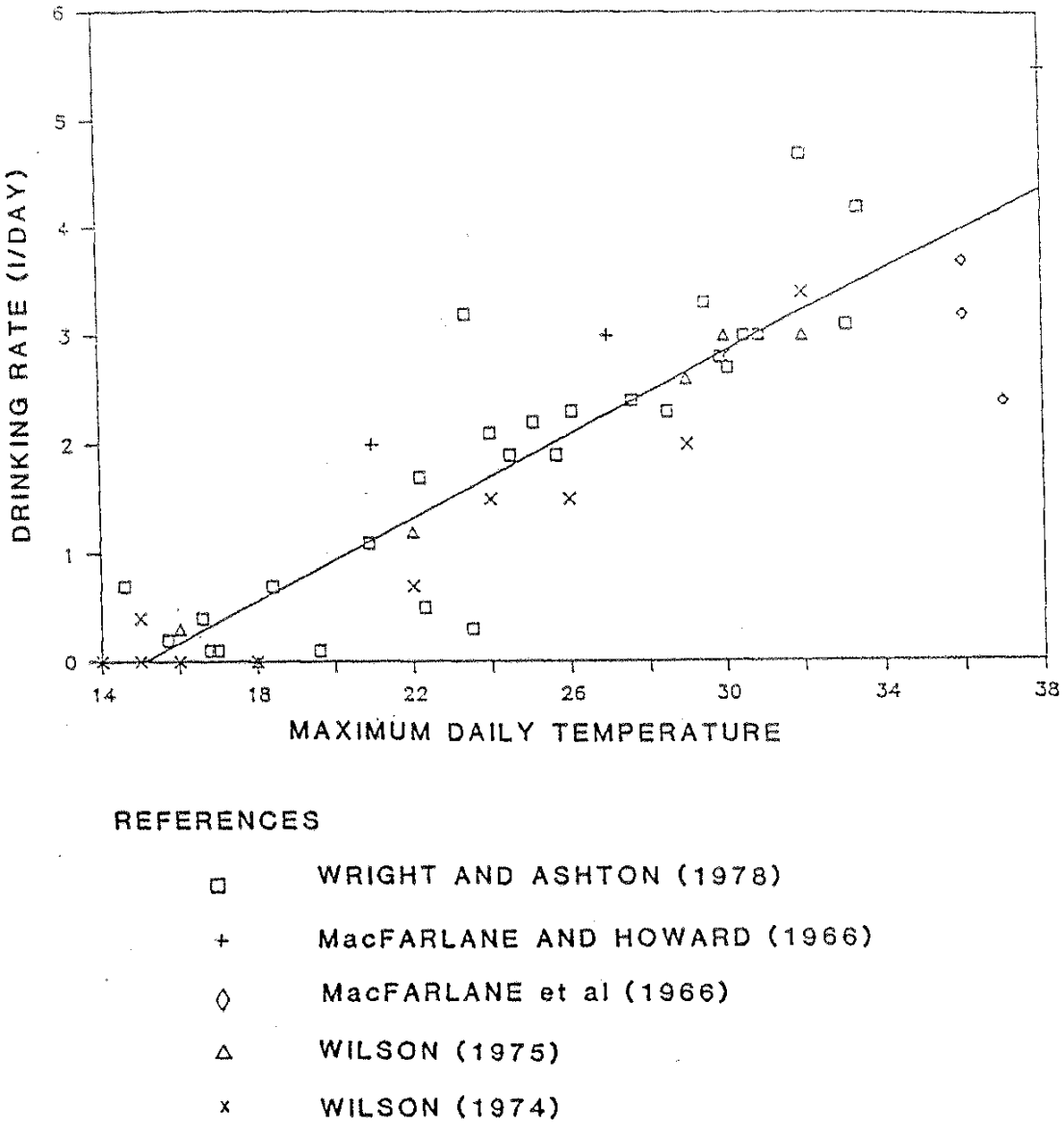

Figure 1. Relationship between maximum daily temperature and the drinking rate of sheep.

The equation may be used to estimate the quantity of water that a D.S.E. will consume under different temperature conditions in southern Australia.

It is important to remember that this relationship applies to grazing sheep under southern Australian conditions. Those conditions result in low daily temperatures coinciding with green paddock feed, and high temperatures with dry feed.

There will be many cases in which these, and other, standard D.S.E. conditions do not apply. Therefore it is necessary to understand how variations from the standard conditions affect the consumption of drinking water by livestock. While these various factors are discussed separately it should be remembered that they interact.

3. Effect of Saline Water on Drinking Rates

There are considerable differences between individual sheep in their tolerance to saline drinking water (20,24,27). Their tolerance to saline water is also related to the salt content in their feed (15).

When sheep are grazing non-saline pastures their consumption of water increases with the concentration of salt in the water (16) as shown in Table 1.

Table 1. Effect of increasing salt concentration in drinking water on the water consumption of sheep grazing non-saline feed

Total soluble salts (mg/L)	Consumption compared to a D.S.E. (%)	Quality for different classes of sheep
Fresh Water	100	All sheep
3,500	120) …….)	All sheep but introduce gradually especially to weaners
7,000	140)	
10,500 - 14,000	170-280	All dry adult sheep

Particular attention should be given to the fact that different classes of sheep tolerate different qualities of water. This is also true for other types of stock (l,7,8) as shown in Table 2.

Table 2. Safe upper limits of total salts in water for livestock

	mg/L
Poultry	3,000
Dairy cattle (milk producing)	3,500
Pigs, lambs and calves	4,500
Lactating ewes	6,000
Horses	6,500
Dairy cattle (dry)	7,000
Beef cattle	10,000
Sheep (adult, dry)	10,000 to 14,000

From W.A.D.A. Farmnote 3/82 and Australian Meat Research Committee Review No. 41, March 1981.

4. Effect of Feed on Drinking Rate

The quantity, quality and salt content of feed affect the amount livestock drink. Factors such as the salinity of the water interact with the feed regime to affect drinking rates.

4.1 Quantity and quality of feed

The voluntary intake of dry matter increases when the diet becomes less digestible, and decreases when the digestible energy of the ration is increased (4). Water intake (from all sources) is related to the intake of dry matter (4). The more moisture supplied in the feed, the lower the need for drinking water.

The total water intake for sheep has been described .using the equation:

TWI = 3.36DMI - 0.99 (4)

TWI = Total Water Intake (L/Day)
DMI = Dry Matter Intake (kg/Day)

The same author reports that the relationship holds for several breeds of sheep and cattle. The formula could be used to estimate a sheep's water requirement if the dry matter intake, and water content of the feed are known.

In support of the general relationship described, measurements taken at Merredin showed that sheep on an ad-lib paddock diet drank twice as much as sheep on a rationed diet(3). Therefore the quantity and quality of available feed can affect the amount that sheep drink. When water is scarce, ad-lib feeding, especially with poor quality feed, should be avoided as it may exacerbate the water shortage.

This is important to remember because the D.S.E.: Drinking rate model (Figure 1) includes several feed characteristics. These are, that the sheep have available a maintenance diet of sub. clover based pasture, which is green in winter and dry in summer.

The main time that these conditions will not be met is during a drought. Sheep being handfed grain or hay will require more water than those grazing green pasture. The same applies in the case of sheep being hand fed grain in summer.

The problem therefore is to estimate how hand feeding will affect water requirements. Pen fed sheep have been shown to have a different need for drinking water than paddock fed sheep (22), as shown on Figure 2.

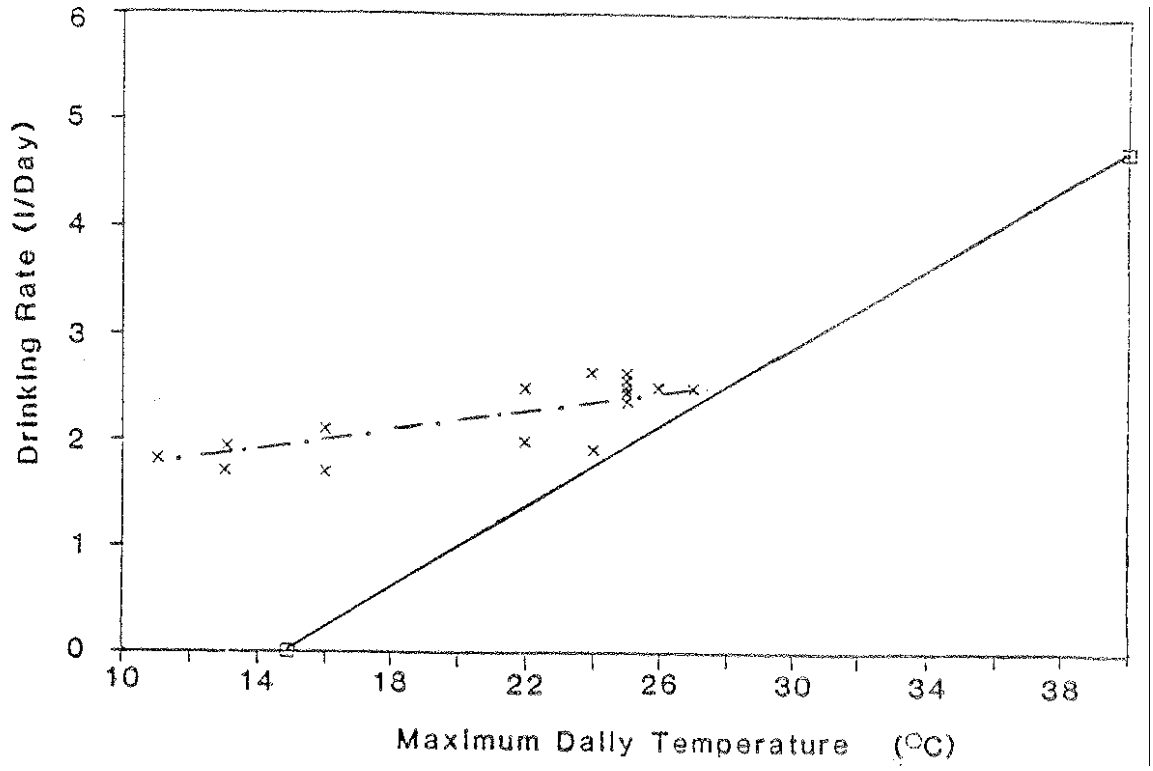

Figure 2. Effect of temperature on the drinking rates of paddock and pen fed sheep

The different responses reflect two things. One is the change in the quality of the paddock feed. The paddock fed sheep grazed lower quality dry feed under high temperature conditions, hence ate more and drank more. The second aspect is the increase in water requirement of the pen fed sheep as temperatures rose. Even though the sheep had a similar diet throughout, their higher need for water for evaporative cooling is seen under higher temperatures.

These data suggest that for sheep, hand fed in paddocks during the cool months of a drought, an allowance must be made for drinking. That allowance could be calculated from the D.M.I.: water content relationship already discussed, or from Figure 2 estimated to be about 2 litres per day.

4.2 Effect of Grazing Saltbush Pastures.

The drinking rate is affected by an interaction between the salt in the feed, and in the water. This interaction depends upon many factors including the type of feed (25). In general, the higher the proportion of saltbush in the diet, the less salt the animal can tolerate in the water. There are also considerable differences in the responses of individual sheep.

Sheep grazing saltbush pastures should have good quality water available. If good quality water is available, sheep on saltbush drink about twice as much as those on sub-clover based pastures (16,26,27). Intakes of water as high as 11.3 litres per day have been recorded for penned sheep eating mixed saltbush diets (2).

Of particular interest for sheep grazing saltbush is the maximum concentration of salt, which they can tolerate in their drinking water. Various workers have reported successful grazing of saltbush pastures when the sheep have access to waters of different salinities. These include 1,080 (15), 2,000 (28), 2,362 (23) and 3,000 (23) mg per litre. One trial using rates from fresh up to 16,000 mg per litre'27' concluded that for adult dry sheep, 8,000 mg per litre is a safe upper limit on a mixed saltbush, grass pasture. By comparison, at Maya, 54 kg sheep drinking 7,281 mg per litre water lost about 7 kg bodyweight over 7 weeks on saltbush, and 9 kg on cereal stubble (23). It is possible that this rate of weight loss may not be acceptable, and therefore on pure saltbush pastures, waters with more than 7,000 mg per litre salt should be avoided.

5. Effect of Physiological State of the Animal on Drinking Rates

The physiological condition of an animal affects its drinking rate. Important factors to be considered include:

5.1 Size

The intake of water is usually expressed in terms of either litres per day or litres per unit of bodyweight per day. Different authors use different bodyweight comparisons. Under Australian conditions a unit of kg liveweight 0.82 has been used (12). As the D.S.E. model is based on sheep of 45 kg L.W. the allowance for drinking water should be changed in proportion to weight.

e.g. If a sheep weighs 65 kg how much more water will it drink than a D.S.E. (45 kg)?

Answer:

$$\frac{65^{0.82}}{45^{0.82}} = \frac{30.66}{22.68} = 1.35$$

The 65 kg sheep will drink 1.35 times as much as the D.S.E.

5.2 Pregnancy and Lactation

Pregnant ewes drink more than non-pregnant ones. Water intake increases by the third month of gestation, is doubled by the fifth month, and is greater for twin-bearing ewes than for ewes carrying a single foetus (4). During lactation the increase in the volume of water consumed is greater than the volume of water in the milk produced. It is estimated that lactating ewes require 100 per cent more water than non-lactating ewes (4).

5.3 Shearing

A short-term increase in drinking rate is usually reported after shearing, especially in hot weather(13). This is related to the loss of the insulating effect of the fleece and a higher need for water for evaporative cooling.

5.4 Productivity

In one study (11) sheep selected from a flock on the basis of heavier wool production consumed about 25% more water than the average for the whole flock.

5.5 Walking distance

Increasing the distance between water and feed points resulted in lower feed and water intakes (24). There are differences between breeds in their ability to cover long distances and in the frequency of drinking as the distances increased. A distance of

3.2 km from feed to water did not affect the rate of drinking or feeding for either Merinos or Border Leicesters (24) compared to a 1.6 km distance. With a 4 km distance, Merino sheep drank three times every two days, and at 4.8 km once a day. Border Leicesters drank twice daily until the distance reached 5.6 km, when they drank once daily. Food intake declined with both breeds as distance from water increased, but water intake only declined at distances above 3.2 km. Clearly sheep are prepared to walk long distances for food and water. Presumably however production of meat and wool will be reduced as intakes decline. Therefore although in emergencies food and watering points may be widely separated, the closer they are together the better.

5.6 Competitive behaviour

Competition between sheep for feeding trough space, and the "shy-feeder" syndrome, have been reported. It is also possible that there may be shy-drinkers. If that is the case, failure to supply enough water either during peak demand periods (see section 6) or from a carted supply, may result in some sheep failing to drink. In order that the competitive effects due to lack of trough space be limited, it has been recommended that 1 m of trough be made available for each 130 sheep or 30 cattle (7). The peak daily requirement should also be delivered over a four hour period (7).

6. Effect of Type of Stock on Drinking Rates

Work with sheep (14), goats (6,19) and cattle (4) has shown both inter and intra species differences. Perhaps the major variation documented that is of interest under southern Australian conditions is that Border Leicester sheep consume 70% more water than Merinos, of a comparable body weight (14).

The major differences of interest are those between species. Various workers have documented differences between species (7,18,19,29) usually describing them in terms of litres of water consumed per day. In order that the model previously described can be more widely used it is more desirable to express the water requirements of different stock in terms of D.S.E.'s).

Table 3 represents an attempt to express the variously reported water requirements for different stock in terms of D.S.E.'s.

Table 3. Comparative water requirements for different classes of stock (in D.S.E.'s)

Class	No. of D.S.E.'s
Sheep - non lactating adult (Merino type)	1
- lactating ewe (Merino type)	2
Cattle - dairy cow	15
- beef cattle	10
Horses	10
Pigs - sow and litter	10
- boar	2
- weaners	2
Goats - Angoras	1
- milking goats	2

7. Application of the Drinking Rate Model

The general model has been used to estimate the average daily and monthly water requirements of D.S.E.'s in various south-west and pastoral centres (Tables 4 and 5).

As has been explained/ these average estimates will need to be modified to take into account conditions or factors, which differ from those defined for a D.S.E.
These include:

saline water (see page 4)

saltbush pasture (see page 7)

size of sheep (see page 7)

species of stock (see page 9)

and the other factors discussed

e.g. how much water should be allowed for a 65 kg wether grazing saltbush pasture at Katanning, in February.

D.S.E. at Katanning in February	=	2.7 L/day
+ allowance for saltbush	=	2.7 x 2 = 5.4
+ allowance for size	=	5.4 x 1.35 = 7.3
The average February allowance	=	7.3 L/day.

In Western Australia the drinking rate model is also used as a component of the Damcat programme (5). The Damcat programme aims to design a drought-proof dam and roaded catchment water supply, for a particular historic drought. During a drought, stock will need to be hand fed, and they will have a higher water requirement than the model predicts (see Figure 2). Therefore the Damcat programme places a lower limit of 2 L/day on estimated drinking rates. For more details refer to the Damcat Manual.

Finally several other factors, which should be allowed for when using these figures for budgeting water use, are:

1. Evaporation from dams when estimating an annual requirement (DRM Technical Report 65 "Evaporation data for Western Australia).

2. Spillage from troughs, either by stock or during cleaning-out operations.

3. Seepage from dams.

4. The model was derived for the south-west areas. Although it has been checked against measured consumption for sheep at Kalgoorlie (J. Laws pers. comm.) care is needed when using the data in Table 5.

8. Peak Requirements

The tables quote estimated average daily water requirements. During summer heat waves the peak consumption rates will be greater than these average estimates. In order to assist with the designing of reticulation systems, an idea of the peak requirements is needed. Examining temperature data shows that the State can be split into six zones (figure 3) by comparing the difference between the mean daily maximum temperature for the hottest month, with the highest daily maximum recorded for that month. Table 6 shows the percentage increase in allowance, above the averages in Tables 4 and 5, which must be added to allow for peak daily demand.

Table 6. Effect of maximum temperature conditions on the peak daily water requirements, expressed as a percentage of average daily water requirements.

Zone	Location	Peak as percentage of average
1	Inland pastoral stations	125
2	North coast (north of Exmouth)	135
3	Wheatbelt centres	145
4	West coast (Busselton-Exmouth)	150
5	Inland south-west (Bunbury-Albany)	160
6	South coastal	180

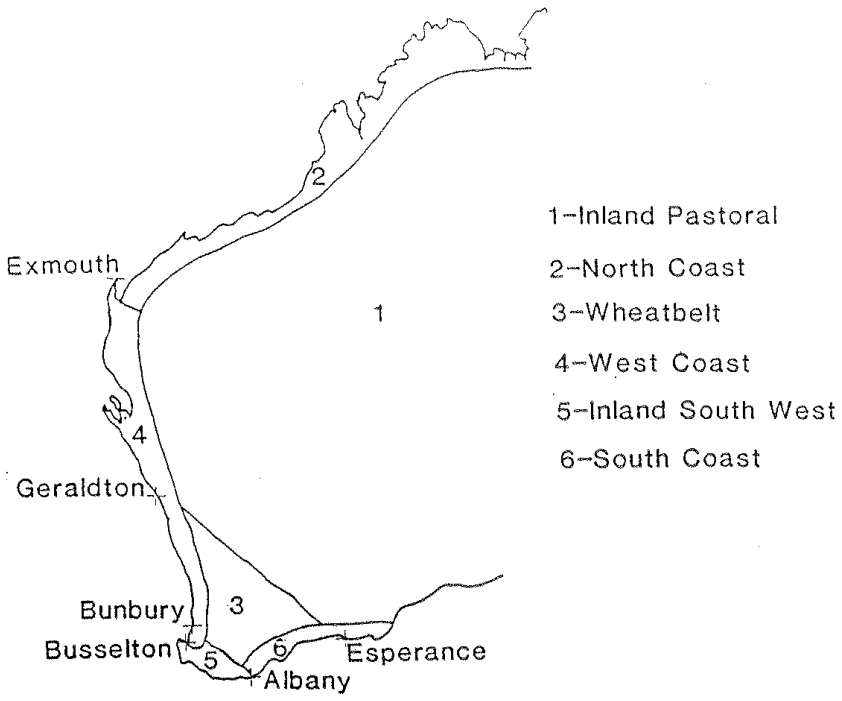

Figure 3: Zones in Western Australia used for predicting peak stock water requirements.

9. Information in Tables 4 and 5

The estimates for each centre are expressed in two forms:-

* Average daily requirement for 1 D.S.E. in litres. This figure should be used for estimating peak daily requirements and the affect of factors or conditions, which differ from those defined for a D.S.E.

** Average monthly requirement for 100 D.S.E. quoted in cubic metres. This figure should be used when budgeting for long-term needs. Technotes 4/76 "Damcat", and 11/87 "Water Depletion from Farm Dams: Consumption Curves", the Damcat Manual and D.R.M. Technical Report No. 64 "Storage Life of farm dams", can be referred to for further information.

Table 4. South West Centres - Estimated Livestock Water Consumption
Line 1 - litres/head/day - *
Line 2 - m3/100 head/month - **

Station	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
Albany Town *	1.5	1.5	1.4	1.1	0.7	0.3	0.1	0.2	0.4	0.6	1.0	1.3	-
**	4.6	4.2	4.2	3.3	2.0	0.8	0.3	0.7	1.2	2.0	3.1	4.0	30.4
Bencubbin	3.7	3.5	3.0	2.0	1.1	0.4	0.2	0.5	1.1	1.9	2.6	3.3	-
-	11.5	9.9	9.4	5.9	3.3	1.1	0.7	1.5	3.3	5.8	7.8	10.3	70.5
Brookton	3.4	3.3	2.7	1.9	1.0	0.3	0.2	0.3	0.8	1.6	2.3	3.2	-
	10.6	9.3	8.4	5.6	3.1	1.0	0.7	1.0	2.4	4.9	6.8	9.8	23.9
Bunbury	2.4	2.4	2.1	1.5	0.9	0.5	0.3	0.4	0.6	0.9	1.5	2.0	
	7.4	6.8	6.4	4.5	2.8	1.4	1.0	1.2	1.7	2.9	4.5	6.2	46.8
Corrigin	3.4	3.1	2.6	1.7	0.8	0.2	0.0	0.2	0.8	1.5	2.2	2.9	
	10.4	8.7	8.1	5.0	2.5	0.6	0.1	0.7	2.3	4.6	6.7	9.1	58.8
Cranbrook	2.2	2.1	1.9	1.3	0.8	0.0	0.0	0.4	0.4	0.7	1.3	1.9	
	6.8	5.9	5.9	4.0	2.3	0.1	0.0	1.1	1.3	2.1	4.0	5.9	39.4
	11.0	10.0	9.1	5.9	4.0	1.8	1.3	1.6	2.9	5.4	7.3	9.9	70.2
Donnybrook	2.9	2.9	2.4	1.7	0.9	0.4	0.3	0.4	0.7	1.1	1.8	2.5	
	9.1	8.1	7.5	5.1	2.8	1.3	0.8	1.3	2.1	3.5	5.5	7.7	54.8
Esperance Downs	2.6	2.5	2.1	1.5	0.8	0.2	0.2	0.3	0.7	1.2	1.7	2.2	
	8.1	7.0	6.6	4.4	2.4	0.7	0.5	0.8	2.1	3.7	5.2	6.9	48.4
Geraldton	3.2	3.3	3.0	2.3	1.6	1.1	0.8	1.0	1.3	1.8	2.3	2.8	
	9.9	9.2	9.3	7.0	5.1	3.2	2.6	3.0	3.9	5.5	6.8	8.5	74.0
Goodlands	3.9	3.8	3.4	2.2	1.3	0.6	0.5	0.7	1.4	2.1	2.7	3.4	
	12.2	10.6	10.4	6.5	4.2	1.8	1.6	2.1	4.3	6.4	8.0	10.4	78.5
Holt Rock	3.4	3.2	2.6	1.6	1.0	0.3	0.2	0.5	1.0	1.6	2.4	3.2	
	10.4	9.1	8.1	4.9	3.0	1.0	0.5	1.4	2.9	5.0	7.1	9.9	63.3
Jerramungup	2.8	2.7	2.1	1.4	0.6	0.1	0.2	0.4	0.6	1.1	1.7	2.5	
	8.7	7.5	6.6	4.3	1.9	0.2	0.7	1.3	1.9	3.3	5.1	7.7	49.2

Table 4. South West Centres - continued

Station	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
Kalgoorlie	3.5	3.2	2.8	1.9	1.0	0.4	0.3	0.6	1.3	2.0	2.6	3.3	
	11.0	9.0	8.6	5.7	3.2	1.3	0.8	2.0	4.0	6.2	7.9	10.1	69.5
Katanning	2.9	2.7	2.2	1.4	0.6	0.0	0.0	0.1	0.5	1.1	1.9	2.6	
	9.0	7.7	6.9	4.3	1.9	0.1	0.0	0.2	1.4	3.3	5.7	8.0	48.5
Kondinin	3.5	3.3	2.6	1.6	1.0	0.3	0.1	0.3	0.8	1.6	2.4	3.3	
	10.7	9.3	8.1	4.9	3.0	1.0	0.4	0.8	2.4	5.0	7.1	10.1	62.8
Lake Grace	3.2	3.0	2.5	1.6	0.9	0.2	0.1	0.3	0.8	1.5	2.2	2.9	
	9.9	8.4	7.7	4.9	2.7	0.7	0.2	0.8	2.3	4.6	6.5	9.0	57.7
Lake King	3.0	2.8	2.4	1.6	0.9	0.3	0.2	0.4	0.8	1.5	2.1	2.5	
	9.3	7.9	7.5	4.9	2.7	0.8	0.7	1.3	2.4	4.7	6.3	7.8	56.3
Manjimup	2.3	2.2	1.8	1.1	0.4	0.0	0.0	0.0	0.3	0.7	1.2	1.8	
	7.1	6.3	5.6	3.2	1.3	0.0	0.0	0.0	0.8	2.1	3.7	5.7	35.8
Margaret River	2.3	2.5	2.1	1.2	0.8	0.4	0.3	0.2	0.5	0.8	1.2	2.0	
	7.1	7.0	6.4	3.5	2.4	1.2	0.8	0.7	1.4	2.4	3.6	6.1	42.6
Merredin Res Stn	3.6	3.4	2.8	1.9	1.0	0.3	0.1	0.4	1.1	1.7	2.5	3.2	
	11.0	9.6	8.8	5.7	3.0	0.9	0.4	1.1	3.2	5.3	7.6	10.0	66.6
Moora	3.6	3.6	2.9	2.0	1.3	0.6	0.4	0.5	1.0	1.7	2.4	3.2	
	11.0	10.0	9.1	5.9	4.0	1.8	1.3	1.6	2.9	5.4	7.3	9.9	70.2
Mukinbudin	3.8	3.7	3.1	2.1	1.2	0.5	0.3	0.6	1.1	2.0	2.6	3.2	
	11.8	10.3	9.6	6.2	3.6	1.6	1.0	1.9	3.4	6.3	7.8	10.0	73.5
Mullewa	4.1	4.0	3.5	2.5	1.6	0.9	0.6	0.9	1.6	2.2	3.0	3.7	
	12.7	11.3	11.0	7.6	4.8	2.6	2.0	2.8	4.7	6.9	9.0	11.3	86.7
Munglinup Old	2.6	2.6	2.1	1.8	1.2	0.5	0.5	0.4	0.9	1.2	1.5	2.2	
	8.0	7.3	6.5	5.3	3.9	1.6	1.5	1.4	2.7	3.9	4.5	6.8	53.4
Munglinup Old	2.6	2.6	2.1	1.8	1.2	0.5	0.5	0.4	0.9	1.2	1.5	2.2	
	8.0	7.3	6.5	5.3	3.9	1.6	1.5	1.4	2.7	3.9	4.5	6.8	53.4
Narembeen	3.5	3.4	2.9	1.9	1.0	0.4	0.3	0.5	1.0	1.8	2.4	3.2	
	10.9	9.4	8.9	5.8	3.2	1.2	0.9	1.4	3.0	5.6	7.2	10.0	67.5
Narrogin	3.0	2.8	2.3	1.4	0.6	0.0	0.0	0.0	0.4	1.2	1.9	2.7	
	9.3	7.9	7.1	4.1	1.9	0.0	0.0	0.1	1.3	3.6	5.6	8.3	49.2
Norseman	3.3	3.1	2.6	1.7	1.0	0.4	0.3	0.6	1.2	1.8	2.5	3.0	
	10.3	8.6	8.1	5.2	3.0	1.1	0.8	1.8	3.6	5.7	7.4	9.4	65.0
Northam	3.6	3.5	3.0	2.1	1.1	0.5	0.3	0.5	1.0	1.6	2.5	3.3	
	11.2	9.9	9.2	6.2	3.4	1.4	1.0	1.6	3.1	5.1	7.6	10.1	69.8
Perenjori	4.2	4.0	3.5	2.3	1.6	0.8	0.6	0.8	1.4	2.0	2.9	3.9	
	12.9	11.1	10.9	6.8	4.9	2.3	1.8	2.4	4.1	6.3	8.7	12.1	84.3
Ravensthorpe	2.7	2.5	2.2	1.6	0.9	0.3	0.2	0.4	0.8	1.4	1.8	2.5	
	8.4	7.1	6.7	4.8	2.7	1.0	0.7	1.3	2.5	4.3	5.5	7.6	52.6
Rocky Gully	2.1	2.0	1.6	1.1	0.7	0.0	0.0	0.0	0.3	0.7	1.2	1.9	
	6.5	5.6	4.8	3.4	2.1	0.0	0.0	0.1	0.8	2.0	3.7	5.9	34.9

Station	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
Salmon Gums Rstn	2.9	2.8	2.4	1.6	0.8	0.3	0.2	0.4	1.0	1.5	2.1	2.7	
	9.1	7.7	7.3	4.7	2.6	0.9	0.5	1.3	3.0	4.8	6.3	8.3	56.5
Scadden	2.5	2.3	2.1	1.6	0.8	0.3	0.2	0.4	0.8	1.2	1.7	2.3	
	7.6	6.4	6.4	4.8	2.4	0.8	0.6	1.3	2.5	3.6	5.2	7.1	48.7
Southern Cross	3.8	3.6	3.0	2.0	1.1	0.4	0.2	0.6	1.3	2.0	2.8	3.5	
	11.6	10.0	9.3	6.1	3.3	1.1	0.7	1.8	3.9	6.2	8.4	10.8	73.2
Three Springs	4.2	4.0	3.5	2.3	1.6	0.8	0.6	0.8	1.4	2.0	2.9	3.9	
	12.9	11.1	10.9	6.8	4.9	2.3	1.8	2.4	4.1	6.3	8.7	12.1	84.3
Upper Swan	3.5	3.5	3.1	2.2	1.4	0.7	0.6	0.6	1.0	1.6	2.3	3.1	
	11.0	9.9	9.5	6.5	4.2	2.2	1.9	1.9	3.0	5.1	6.9	9.6	71.7
Wagin	3.0	2.8	2.4	1.6	0.8	0.2	0.0	0.2	0.6	1.2	1.9	2.8	
	9.4	7.9	7.5	4.7	2.5	0.5	0.1	0.5	1.7	3.7	5.6	8.6	52.7
Wialki	3.8	3.7	3.3	2.1	1.3	0.6	0.4	0.7	1.4	2.1	2.6	3.3	
	11.8	10.4	10.3	6.4	3.9	1.8	1.4	2.0	4.3	6.5	7.9	10.3	77.0
Wokalup	2.4	2.4	2.1	1.5	0.9	0.5	0.3	0.4	0.6	0.9	1.5	2.0	
	7.4	6.8	6.4	4.5	2.8	1.4	1.0	1.2	1.7	2.9	4.5	6.2	46.8
Wongan Hills	3.7	3.6	2.9	2.1	1.2	0.5	0.4	0.5	1.0	1.8	2.6	3.4	
	11.4	10.0	9.1	6.2	3.6	1.5	1.1	1.6	3.1	5.7	7.8	10.4	71.5

Table 5. Pastoral Centres

Estimated stock water consumption - litres/head/day - *

- m3/100 head/month - **

Station	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
Anna Plains *	3.8	3.8	4.1	3.9	3.2	2.5	2.5	2.9	3.5	3.7	4.0	4.0	
**	11.9	10.7	12.6	11.8	10.0	7.6	7.8	9.1	10.5	11.5	11.9	12.5	127.9
Beverley Spgs	3.8	3.5	3.5	3.5	3.2	2.8	2.7	3.2	3.6	4.0	4,2	4.1	
	11.9	9.9	10.9	10.5	10.0	8.3	8.3	9.9	10.9	12.5	12.7	12.6	128.4
Blina	4.3	3.9	4.0	4.0	3.3	2.8	2.8	3.3	3.9	4.5	4.7	4.6	
	13.4	11.0	12.5	11.9	10.1	8.5	8.6	10.2	11.8	13.8	14.0	14.3	140.1
Bohemia Downs	4.6	4.5	4.2	4.1	3.3	2.9	2.9	3.5	4.3	5.1	5.4	5.2	
	14.2	12.5	13.1	12.2	10.3	8.8	8.8	10.9	13.0	15.8	16.1	16.3	152.0
Boolathana	3.0	3.2	3.0	2.5	2.1	1.6	1.4	1.5	1.7	2.0	2.1	2.5	
	9.2	9.0	9.2	7.6	6.4	4.7	4.2	4.5	5.2	6.2	6.4	7.9	80.5
Booylgoo	4.0	3.8	3.3	2.3	1.3	0.6	0.5	0.9	1.7	2.4	3.2	3.8	
	12.4	10.7	10.3	6.9	4.0	1.8	1.5	2.7	5.2	7.5	9.5	11.7	84.2
Camballin	4.4	4.1	4.1	4.0	3.4	2.9	2.9	3.4	4.1	4.7	4.9	4.9	
	13.8	11.5	12.6	11.9	10.5	8.8	9.1	10.7	12.3	14.6	14.8	15.1	145.7
Carnarvon	3.1	3.3	3.1	2.6	2.1	1.5	1.3	1.4	1.7	2.1	2.3	2.7	
	9.6	9.2	9.5	7.8	6.4	4.5	4.1	4.5	5.2	6.4	6.8	8.3	82.3
Carnegie	4.4	4.2	3.7	2.8	3.6	1.0	1.0	1.3	2.2	3.0	3.8	4.2	
	13.6	11.6	11.6	8.5	11.3	2.9	3.0	4.1	6.7	9.3	11.3	13.0	106.9
Christmas Creek	4.6	4.3	4.2	4.0	3.3	2.9	2.8	3.4	4.2	4.9	5.2	5.1	
	14.1	12.1	12.9	12.1	10.2	8.8	8.8	10.7	12.7	15.3	15.5	15.7	148.9
Coodardy	4.3	4.2	3.6	2.7	1.6	0.8	0.6	1.0	1.8	2.5	3.4	4.0	
	13.5	11.6	11.3	8.0	4.8	2.3	2.0	3.2	5.5	7.8	10.2	12.5	92.7
Derby	3.8	3.8	3.8	3.8	3.3	2.8	2.7	3.1	3.6	3.9	4.1	4.0	
	11.7	10.5	11.9	11.5	10.1	8.5	8.5	9.7	10.9	12.2	12.2	12.5	130.2
Earaheedy	4.4	4.2	3.8	2.9	1.7	1.0	1.0	1.3	2.3	3.0	3.8	4.3	
	13.8	11.6	11.7	8.6	5.4	3.1	3.2	4.2	6.8	9.4	11.4	13.3	102.5
Exmouth	4.2	4.1	3.9	3.1	2.3	1.7	1.6	1.8	2.4	3.1	3.6	4.0	
	12.9	11.6	12.0	9.4	7.0	5.2	5.1	5.6	7.2	9.7	10.7	12.5	108.9
Fairfield	4.0	3.8	4.0	3.9	3.2	2.7	2.7	3.2	3.8	4.2	4.4	4.3	
	12.5	10.5	12.5	11.8	10.0	8.2	8.4	9.9	11.3	13.1	13.1	13.3	134.6
Fitzroy Crossing	4.3	4.1	4.2	4.0	3.3	2.8	2.8	3.3	4.0	4.7	4.9	4.8	
	13.4	11.5	12.9	12.1	10.1	8.5	8.6	10.3	12.1	14.4	14.6	14.8	143.3
Giralia	4.6	4.5	4.2	3.4	2.6	1.9	1.8	2.1	2.7	3.4	3.9	4.5	
	14.2	12.6	12.9	10.3	8.0	5.7	5.5	6.4	8.1	10.4	11.6	13.8	119.5
Halls Creek	4.2	4.0	3.8	3.5	2.8	2.3	2.2	2.9	3.6	4.1	4.4	4.3	
	12.9	11.3	11.9	10.5	8.7	6.8	6.9	8.8	10.7	12.8	13.1	13.3	127.7

Station	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
Hamelin Pool	4.2	4.1	3.8	2.9	1.9	1.2	1.1	1.4	2.0	2.5	3.2	3.8	
	12.9	11.6	11.7	8.7	6.0	3.7	3.3	4,2	5.9	7.8	9.6	11.7	97.1
Jiggalong	4.3	4.1	3.8	3.0	2.0	1.2	1.2	1.7	2.6	3.3	4.0	4.3	
	13.4	11.5	11.7	9.0	6.1	3.7	3.7	5.3	7.8	10.1	11.9	13.4	107.6
Kalumburu	3.3	3.2	3.4	3.4	3.2	2.9	2.9	3.4	3.7	4.0	4.0	3.7	
	10.2	9.1	10.4	10.3	9.8	8.6	9.1	10.4	11.2	12.5	12.1	11.4	125.1
Karratha	3.9	3.6	3.7	3.6	2.8	2.1	2.0	2.2	2.8	3.5	3.4	3.8	
	12.0	10.1	11.6	10.7	8.7	6.3	6.1	6.7	8.4	10.7	10.3	11.6	113.2
Kimberley Downs	4.1	3.7	4.0	3.9	3.3	2.8	2.7	3.2	3.8	4.2	4.3	4.3	
	12.8	10.5	12.3	11.8	10.1	8.3	8.4	9.9	11.3	13.0	13.0	13.3	134.7
Kimberley Res Stn	4.0	3.8	3.9	3.8	3.4	2.9	2.9	3.4	4.0	4.4	4.5	4.3	
	12.5	10.6	12.0	11.5	10.5	8.8	9.0	10.6	12.0	13.7	13.5	13.3	138.0
Kununurra	4.1	3.9	3.9	3.9	3.4	3.0	2.9	3.5	4.1	4.4	4.5	4.4	
	12.6	10.9	12.0	11.8	10.5	8.9	9.0	10.9	12.2	13.8	13.5	13.6	139.7
Leonora	4.2	3.9	3.5	2.5	1.5	0.8	0.6	1.1	1.9	2.6	3.4	4.0	
	13.2	11.0	10.9	7.5	4.7	2.3	2.0	3.3	5.6	8.1	10.1	12.3	91.0
La Grange	3.6	3.7	3.8	3.9	3.2	2.8	2.7	3.0	3.4	3.6	3.7	3.8	
	11.3	10.2	11.9	11.7	9.9	8.3	8.3	9.2	10.1	11.3	11.1	11.9	125.2
Laverton	4.0	3.8	3.4	2.5	1.5	0.7	0.7	1.0	1.6	2.4	3.1	3.9	
	12.5	10.6	10.7	7.4	4.5	2.2	2.0	3.0	4.9	7.5	9.3	12.1	86.7
Learmonth	4.4	4.3	4.0	3.4	2.6	1.8	1.7	2.2	2.7	3.3	3.7	4.2	
	13.5	12.2	12.4	10.3	8.0	5.5	5.3	6.8	8.2	10.1	11.0	13.2	116.5
Leopold Downs	4.1	3.9	4.1	4.0	3.2	2.8	2.7	3.2	3.9	4.4	4.6	4.5	
	12.8	10.9	12.6	11.9	10.0	8.3	8.4	10.0	11.6	13.6	13.7	13.9	137.7
Liveringa	4.6	4.1	4.1	4.0	3.3	2.9	2.9	3.4	4.1	4.7	5.0	4.9	
	14.2	11.5	12.6	11.9	10.3	8.8	8.8	10.6	12.3	14.7	14.9	15.1	145.7
Mardie	4.4	4.3	4.2	3.9	3.1	2.5	2.3	2.7	3.3	3.8	4.1	4.3	
	13.5	12.0	13.2	11.8	9.6	7.4	7.2	8.3	9.8	11.6	12.3	13.5	130.2
Meekatharra	4.4	4.2	3.6	2.8	1.7	1.0	0.9	1.3	2.1	2.7	3.5	4.1	
	13.6	11.8	11.3	8.3	5.4	3.0	2.7	4.0	6.2	8.4	10.6	12.8	98.1
Millasiddee	4.9	4.5	4.2	4.1	3.4	3.1	2.9	3.6	4.4	5.3	5.5	5.5	
	15.2	12.7	13.1	12.2	10.4	9.2	9.1	11.2	13.3	16.4	16.6	16.9	156.3
Minderoo	4.3	4.2	4.1	3.6	2.6	2.0	1.9	2.2	2.9	3.3	3.8	4.2	
	13.3	11.7	12.7	10.7	8.1	6.0	5.8	6.9	8.6	10.1	11.3	13.0	118.2
Mt Clare	4.9	4.4	4.2	3.0	2.0	1.4	1.3	1.7	2.5	3.4	4.0	4.6	
	15.1	12.4	12.9	9.1	6.2	4.2	3.9	5.3	7.4	10.4	11.9	14.2	113.0
Mt Elizabeth	3.9	3.6	3.5	3.4	3.1	2.8	2.7	3.2	3.7	4.0	4.3	4.1	
	12.0	10.1	10.8	10.2	9.7	8.3	8.3	10.0	11.0	12.5	12.9	12.6	128.4
Mt Magnet	4.4	4.1	3.8	2.6	1.6	0.9	0.7	1.1	1.8	2.7	3.5	4.2	
	13.8	11.4	11.6	7.9	5.1	2.7	2.1	3.3	5.5	8.3	10.4	12.9	95.0

Station	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
Mt Newman	4.3	4.2	3.8	3.0	2.0	1.3	1.2	1.7	2.6	3.3	4.0	4.3	
	13.5	11.6	11.7	9.1	6.2	3.8	3.9	5.4	7.9	10.3	12.0	13.4	108.8
Muggon	3.9	3.8	3.6	2.7	1.6	1.1	0.9	1.2	1.7	2.4	3.0	3.8	
	12.1	10.8	11.2	8.1	5.1	3.2	2.8	3.6	5.2	7.4	9.1	11.7	90.3
Napier Downs	3.9	3.6	4.0	3.9	3.2	2.7	2.7	3.1	3.7	4.0	4.2	4.1	
	12.2	10.1	12.3	11.7	10.0	8.0	8.3	9.6	11.0	12.5	12.5	12.6	130.8
Nita Downs	4.1	4.0	4.3	4.1	3.3	2.9	2.9	3.2	3.7	4.2	4.2	4.3	
	12.7	11.1	13.2	12.3	10.3	8.6	9.0	9.9	11.1	13.1	12.6	13.5	137.4
Nookanbah	4.7	4.3	4.2	4.0	3.3	3.0	2.9	3.5	4.3	5.0	5.3	5.2	
	14.6	12.2	12.9	12.1	10.3	9.0	9.0	10.9	12.8	15.6	15.8	16.0	151.2
Ord River	4.2	4.0	3.8	3.7	3.1	2.6	2.5	3.1	3.8	4.3	4.5	4.4	
	12.9	11.1	11.9	11.0	9.5	7.8	7.8	9.7	11.4	13.4	13.5	13.8	133.8
Paynes Find	4.1	4.1	3.3	2.8	1.7	0.7	0.6	1.0	1.8	2.2	3.2	3.8	
	12.8	11.4	10.3	8.5	5.3	2.0	1.8	3.2	5.4	6.8	9.7	11.9	89.1
Pt Hedland	4.0	4.0	4.1	3.8	2.9	2.3	2.2	2.6	3.3	3.7	4.0	4.1	
	12.5	11.3	12.8	11.4	9.0	7.0	6.9	8.2	9.8	11.5	12.1	12.8	125.3
Quanbun	4.5	4.2	4.1	4.0	3.3	3.0	2.9	3.4	4.2	4.8	5.1	5.0	
	14.1	11.9	12.8	12.1	10.3	9.0	9.0	10.6	12.5	15.0	15.3	15.5	148.1
Sandstone	4.0	3.9	3.3	2.4	1.3	0.6	0.5	0.9	1.7	2.4	3.3	3.9	
	12.3	10.9	10.3	7.2	4.2	1.8	1.4	2.7	5.2	7.4	9.9	12.0	85.3
Sandstone	4.0	3.9	3.3	2.4	1.3	0.6	0.5	0.9	1.7	2.4	3.3	3.9	
	12.3	10.9	10.3	7.2	4.2	1.8	1.4	2.7	5.2	7.4	9.9	12.0	85.3
Sturt Creek	4.4	4.2	4.1	3.6	2.8	2.2	2.1	2.7	3.5	4.1	4.5	4.5	
	13.6	11.8	12.8	10.8	8.5	6.6	6.7	8.4	10.6	12.8	13.4	13.9	129.9
Tableland	4.2	3.8	3.8	3.7	3.1	2.7	2.6	3.2	3.9	4.4	4.5	4.5	
	13.0	10.7	11.8	11.1	9.7	8.0	8.1	10.0	11.7	13.6	13.6	13.9	135.2
Three Rivers	4.7	4.3	4.0	2.9	1.9	1.2	1.1	1.5	2.4	3.2	3.8	4.4	
	14.4	12.2	12.3	8.7	5.8	3.5	3.4	4.5	7.1	9.9	11.5	13.6	121.3
Tom Price	4.7	4.7	4.2	3.5	2.4	1.8	1.7	2.1	2.9	3.6	4.2	4.7	
	14.5	13.0	13.1	10.4	7.4	5.5	5.4	6.5	8.8	11.2	12.5	14.4	122.7
Wiluna	4.3	4.1	3.6	2.7	1.6	0.9	0.8	1.2	2.1	2.8	3.6	4.2	
	13.3	11.5	11.3	8.0	5.1	2.7	2.3	3.9	6.3	8.8	10.9	12.9	97.0
Wooramel	3.6	3.7	3.4	2.8	1.4	1.4	1.2	1.4	1.9	2.3	2.7	3.2	
	11.3	10.4	10.6	8.3	4.4	4.1	3.7	4.3	5.6	7.1	8.2	10.0	88.0
Wyndham	3.9	3.7	3.8	3.8	3.4	2.9	2.9	3.4	3.9	4.4	4.4	4.1	
	12.2	10.3	11.6	11.3	10.4	8.7	9.0	10.6	11.8	13.6	13.3	12.7	135.5
Yeeda	4.5	3.9	4.0	3.9	3.3	2.9	2.8	3.4	4.0	4.5	4.7	4.7	
	13.9	11.0	12.5	11.8	10.3	8.7	8.7	10.4	11.9	14.0	14.1	14.4	141.7

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