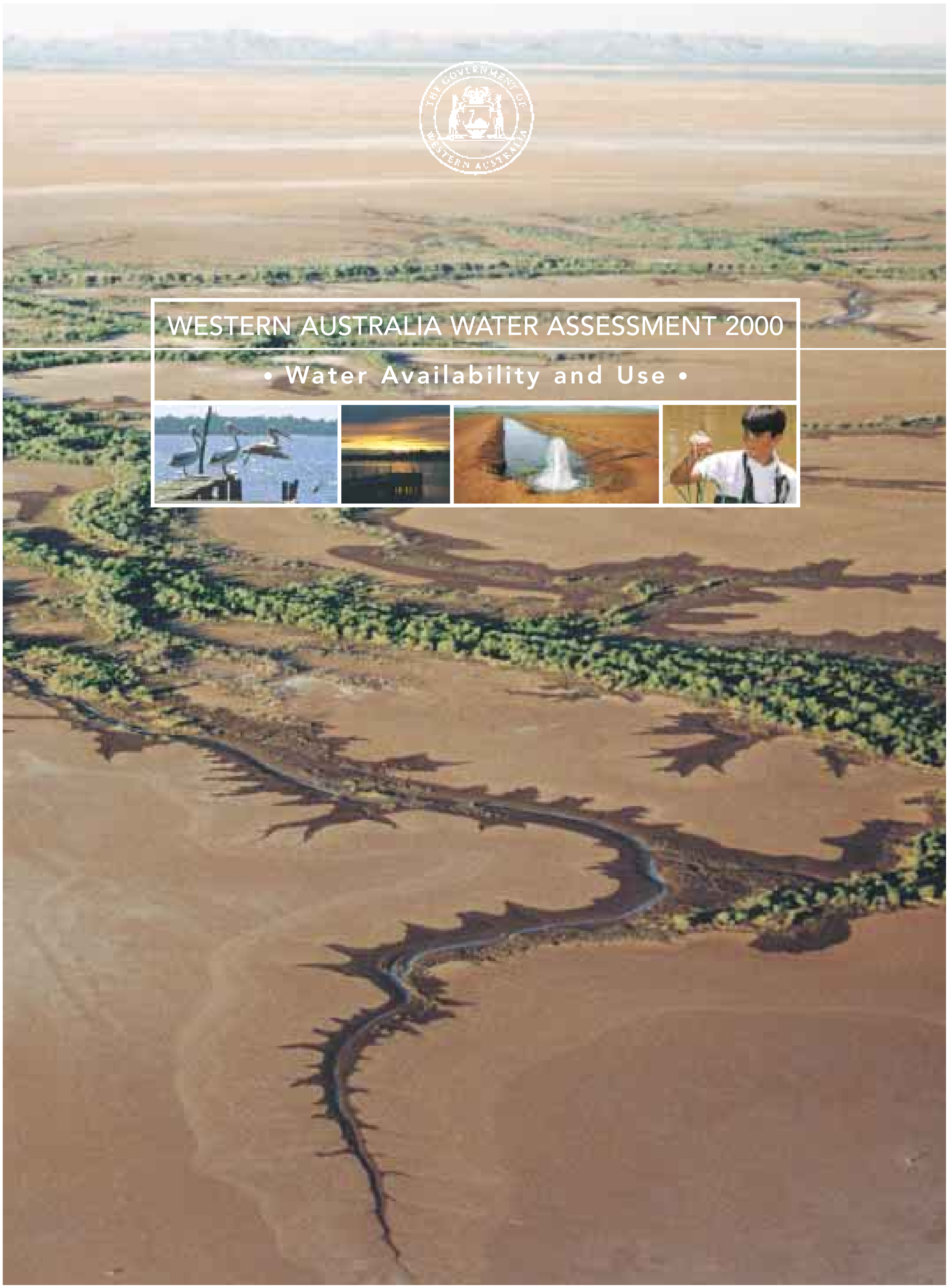

WESTERN AUSTRALIA WATER ASSESSMENT 2000

• Water Availability and Use •

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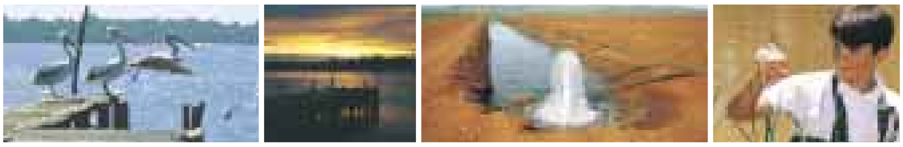

WATER AND RIVERS COMMISSION

POLICY AND PLANNING DIVISION

WATER AND RIVERS
COMMISSION

Acknowledgments

This report was prepared by a multidisciplinary team of internal and external water resources professionals. The Commission acknowledges and appreciates the many contributors to this report. Major contributors are as follows;

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Reference Details

The recommended reference for this publication is: Water and Rivers Commission 2000, *Western Australia Water Assessment 2000* - Water Availability and Use, Water and Rivers Commission Policy and Planning Division.

ISBN 0-7309-7498-7

Printed on recycled stock

November, 2000

Foreword

Water is our most vital resource. It sustains our precious and unique ecology, community and economic progress. In-depth knowledge of our water's availability, use and demands is essential to balance its use among the various needs.

This report was based on results from the recently-completed National Land and Water Resources Audit Water Availability and Use Theme, a program of the Natural Heritage Trust.

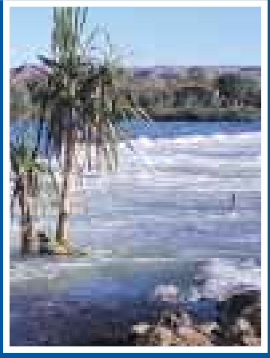
Western Australia has recognised the importance of this theme and has contributed resources to maximise the information obtained and to disseminate the results to the community.

The information contained in this report outlines the current state of Western Australia's water resources, and provides a realistic assessment of water available for future State development.

In brief, the results have shown that Western Australia is managing its water resources well, even though usage has about doubled in the last 15 years and is expected to just about double again in the next decade.

This expected growth creates management issues for the Water and Rivers Commission. With this in mind, the State has put into place programs to maintain the appropriate level of management and to ensure continued responsible development that benefits the Western Australian community and the natural environment.

Roger Payne
Chief Executive Officer

CONTENTS

Executive Summary

This assessment of Western Australia's water resources forms part of the National Land and Water Resources Audit - Water Availability and Use Theme, which was last undertaken in 1985. The main differences from the last audit include the incorporation of water for the environment when assessing the amount of water available for use; categorisation of all resources based on their utilisation; identification of management responses and gaps; and assessment of future demand areas.

The estimates of sustainable water yield presented in this audit are preliminary only, based on the best information available at the current time. They are expected to be revised in the future as more detailed investigations and planning are carried out in specific areas of the State. The allocation of resources to the environment in Western Australia is based on a combination of reservation of resources from development and the specification of minimum environmental flows in areas where development is permitted. Western Australia is favourably positioned in the management of its water resources by this two-tier allocation process and the recognition of the importance of groundwater aquifers to wetland health.

The volume of water that can economically and sustainably be harvested from Western Australia's water resources is a fraction of the volume of the total resource. On a Statewide basis nearly 90% of surface water streamflow is allocated to the environment and significant volumes of groundwater are reserved to protect groundwater dependent ecosystems.

The sustainable yields from surface water and groundwater resources are estimated to be 5,207 GL/yr and 6,304 GL/yr respectively. The available groundwater resource is fairly evenly divided between the high reliability sedimentary basins and the lower reliability fractured rock aquifers.

Water use over the last 15 years has roughly doubled to approximately 1800 GL/yr. Groundwater use has increased threefold, primarily in the Perth sedimentary basin. Surface water use has risen 40% principally due to the Ord River irrigation scheme.

The State's water resources were categorised according to their utilisation. This assessment revealed that: (i) about a third of the State's water resource systems are at a high or fully allocated level; and (ii) instances of over-allocation are very small and few in number. The Water and Rivers Commission is integrating this categorisation of water resources from the Audit into its allocation management process.

The majority of the State's water resources are being managed at an appropriate level, but some shortfalls were identified which are being addressed and water use will be reduced to bring consumption to within sustainable limits.

Water use is expected to double again over the next 20 years. This will place additional pressures on available water resources, particularly in those areas where water use is currently approaching sustainable limits. Significant management resources will be required to ensure the continued management of the resource at an appropriate level and the continued protection of the State's natural resources.

1 Introduction



This audit of Western Australia's water resources forms part of Theme 1 of the National Land and Water Resources Audit – Water Availability and Use. The audit is funded under the Commonwealth Government's National Heritage Trust. Contributions are also being made by the Western Australian Government to operationalise and disseminate the results to the benefit of the Western Australian community.

The last Statewide audit of Western Australia's water resources was documented in Review85, which was produced over 15 years ago. The current audit has endeavoured to remain consistent with Review85 to enable comparisons to be made between these two snapshots of the State's water resources.

The current audit takes into consideration many of the changes which have occurred since the last review, such as:

- National and State legislative and policy reforms;
- Changes in the level of water use;
- Additional monitoring data;
- Improvements in the techniques and technology for defining and assessing the extent and availability of water resources; and
- Improvements in the management of water resources, particularly with regard to the provision of environmental water allocations.

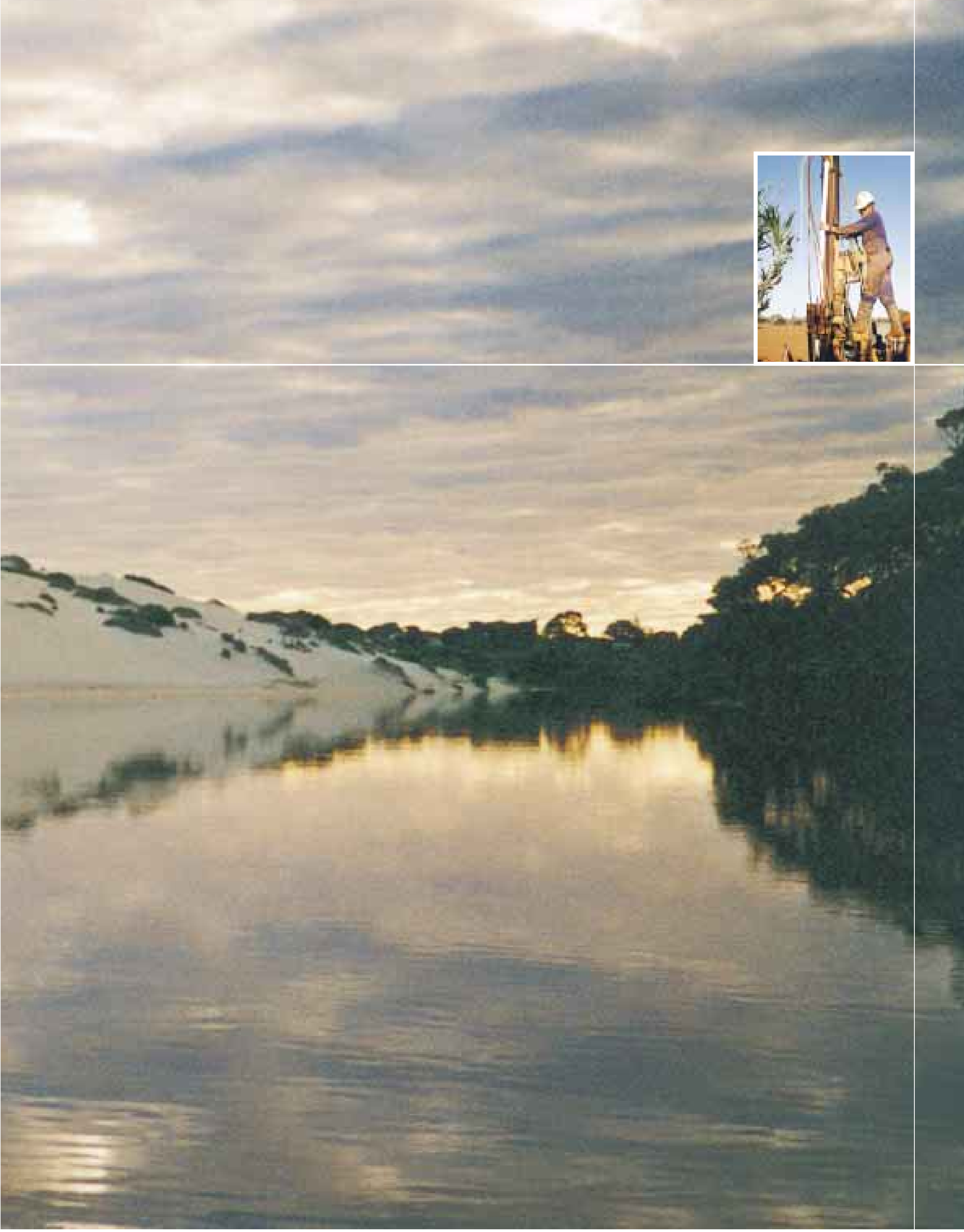
This document outlines the key findings from the audit in Western Australia. In particular, the document covers:

- The legislative, policy and administrative framework for water resources management in Western Australia;
- The current status of surface and/or groundwater resources in terms of the available resource, divertible yield, sustainable yield, current use and allocation;
- Categorisation of each resource in terms of water use relative to sustainable yield;
- The potential for further development and the ability of resources to meet projected future demands; and
- A gap analysis of the adequacy of current management of water resources.

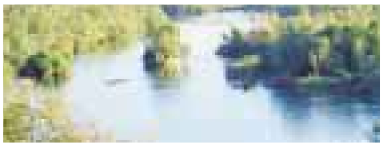
In many areas where current water use is well below first order estimates of sustainable yield, rigorous technical investigations and public consultation on specific management objectives have not necessarily been undertaken.

For the purposes of the audit, working assumptions were made about the status of resources where detailed information was not available. It is important to understand that such assumptions are not prescriptive.

The audit is a review, not a plan, designed to provide an analytical framework for the precautionary management of water resources. The audit assists in the development of processes to define and protect social and environmental water allocations and provides a basis for discussion and planning of future economic development.



2 Water Regimes in Western Australia



2.1 OVERVIEW

Western Australia covers one third of the continent of Australia and exhibits a wide range of rainfall and runoff conditions. The climate varies from the tropical monsoon region in the north of the State to the erratic rainfall and semi-arid climate of the north-west and interior to the temperate, winter rainfall regions of the south. Most rivers in Western Australia are intermittent, with summer flow in the north, winter flow in the south and ephemeral river flows in the north-west and interior. Perennial streams are a relatively unfamiliar feature.

Physiographically, the State is dominated by the ancient hardrock plateaux of the Western Plateau and Pilbara regions. These features are flanked on the west coast by the younger Perth and Carnarvon sedimentary basins, and in the eastern deserts by the Eucla, Officer and Canning sedimentary basins with the Kimberley hardrock regions to the northeastern corner of the state. Substantial quantities of confined and unconfined groundwater of varying quality occur in the sedimentary basins. In the hardrock plateaux, groundwater occurs in lesser but valuable quantities in fractured rocks and surficial river alluvium.

Drainage of the interior of the Western Plateau and desert basins is internal and poorly defined. Well defined river systems drain to the coast from the southern and western perimeter of the plateau and river systems are well incised in the hardrock Kimberley Plateau.

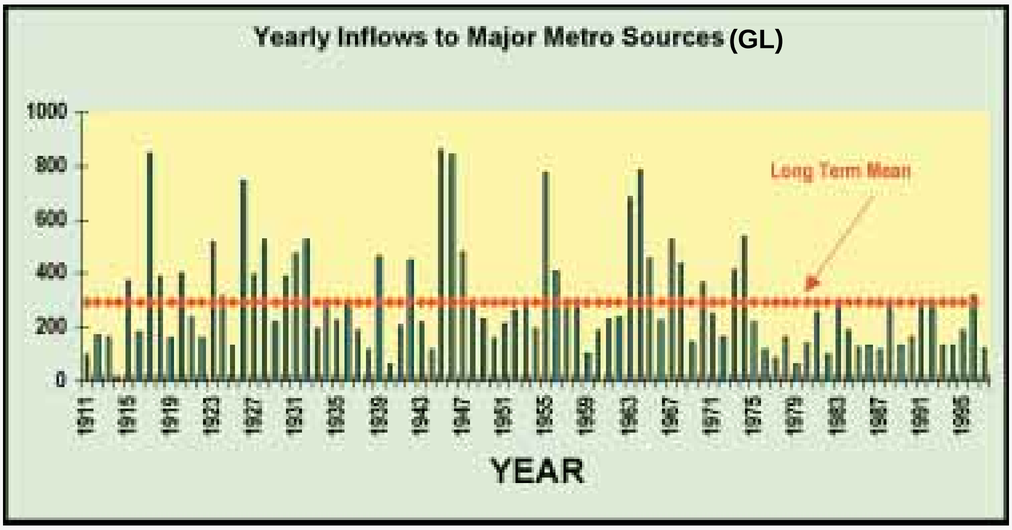
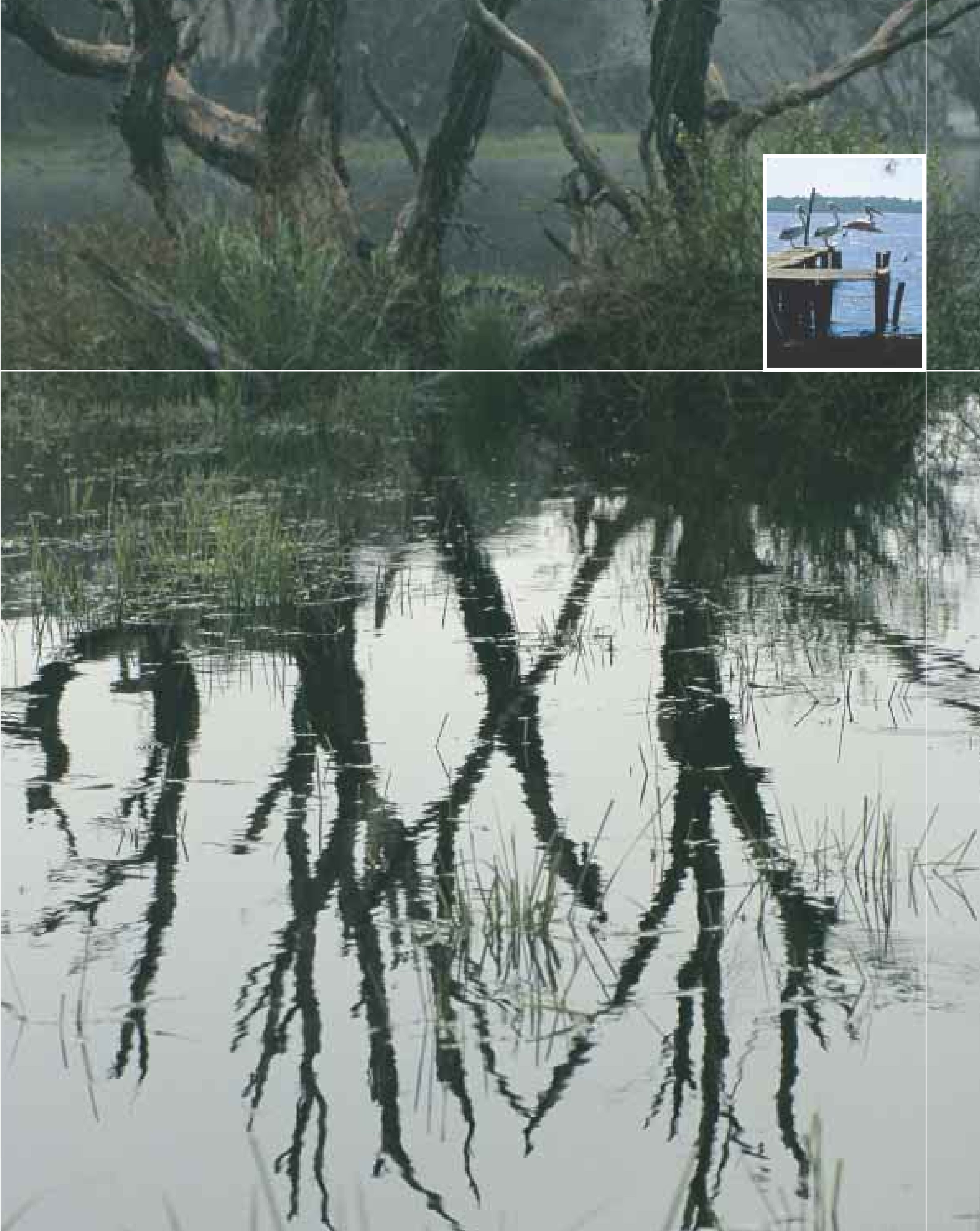
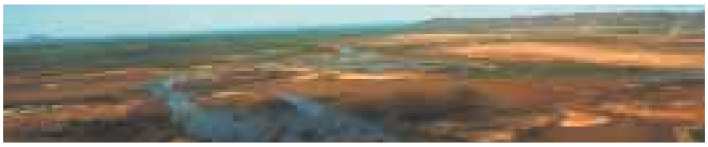


FIGURE 2-1

ANNUAL INFLOWS TO MAJOR METROPOLITAN RESERVOIRS (GL)



2.2 CHANGES IN CLIMATIC BASELINE



Long-term rainfall data in the south-west of the state indicates that the region has experienced a prolonged period of below average rainfall, including reductions in the number of days of rainfall each year and a reduction in the amount of rainfall occurring during higher rainfall events. This has affected the availability of water resources in the south-west, as illustrated in Figure 2-1 of the annual inflows to Perth metropolitan reservoirs. It is clear from this figure that no wet years have occurred over the last 25 years of record and that inflows have been equal to or below long-term average inflows throughout this period. A fundamental long-term shift in climatic conditions has significant implications for the determination of sustainable yields and the allocation of water resources.

The State is actively involved in researching this situation through its Indian Ocean Climate Initiative. Research has not yet identified the cause for this phenomenon nor whether this trend is likely to continue. However, current research opinion favours explanations associated with natural variability of rainfall over cycles of ten years or more. Research on the greenhouse effect has suggested that a drier climate scenario could develop in this region in the future as a consequence of greenhouse gas emissions, but such research is not conclusive and does not explain a climatic shift relating only to the last 25 years of record.

Whether the dry regime continues or not, it has now been so sustained that it has forced significant changes in regional water management. For example the amount of water allocated from Perth Metropolitan sources has been adjusted downwards in several consecutive steps and new sources (mostly groundwater) have been added to the system. Such adaptation was already underway prior to Review85 and the full effects on water resources management are therefore not manifest in comparisons between the Audit and Review85.

3 Water Management in Western Australia

3.1 STRATEGIC WATER MANAGEMENT REFORM

The natural water regime of Western Australia resulted in historic differences in industry structure and operation from those in the other smaller and more populous states of Australia. However, as with the other states, growing pressure on resources and improvements in best water management practices have led to the need for reform. Targeted areas of reform include service delivery, water trading, pricing, independence of resource management, water for the environment and advances in water allocation.

In 1994 Western Australia joined other states in agreeing to the National Water Reform Framework developed under the Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) and the Council of Australian Governments (COAG). The State government committed itself to this reform under the National Competition Policy in 1995. Compliance involved continuing the general course that had already been set by the State government in completing a range of reforms and improvements to the water industry.

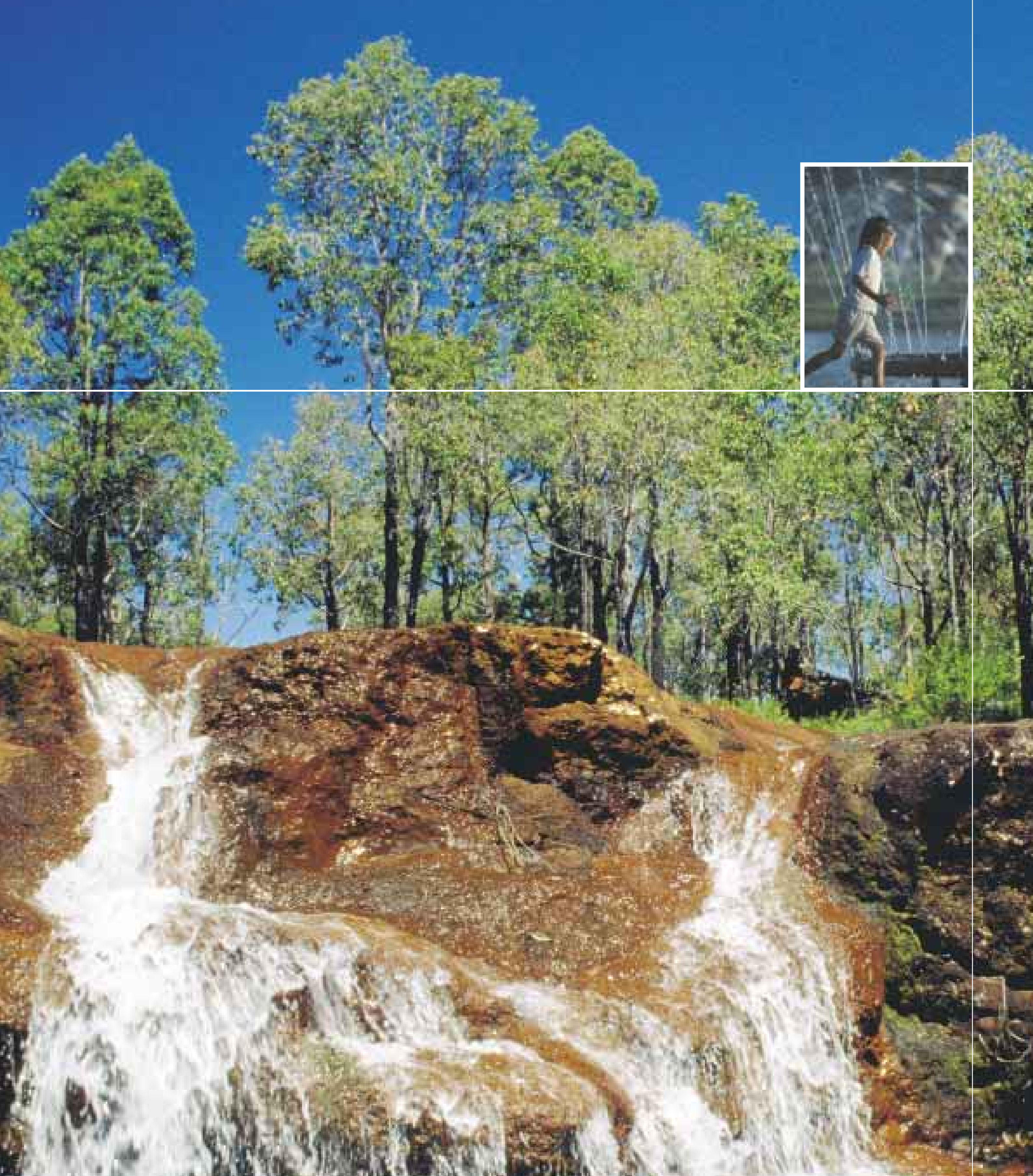
Western Australia is in the fortunate position of having a water market which is generally less committed than in the more populous states of Australia. The State Government has been able to undertake more deliberate planning rather than focussing only on the more limited water reform measures available in a highly or over-committed market. Reforms were also conditioned by the established practice and priority of groundwater and wetlands management in Western Australia.

The State Government embarked on a water law reform program that is currently leading to major legislative amendments to the *Rights in Water and Irrigation Act 1914*. These amendments include the stated objective of achieving the sustainable use and management of water resources. This aims to ensure that water remains available to future generations, that the values of water resources are maintained and that the adverse effects of water use are minimised.

The State Government fundamentally altered the structure of the water industry as part of its reform measures. Water resources management was integrated into one agency and was institutionally separated from the water supply service sector. To avoid creating new conflicts of interest, water resources management was held separate from the agricultural, industrial and mining support sectors.

The vastness of the State and the comparatively low levels of utilisation and competition for the majority of resources also determined the State's strategic position in respect to water trading. Trading needs to be approached progressively, like other measures, as use of a particular resource increases. The State's priorities for implementing tradeable entitlements were towards a small number of surface and groundwater systems where conditions were appropriate, while establishing trigger systems to stimulate the timely preparation for water markets on other resources when utilisation reaches appropriate levels.

The State has been actively working on water provisions for the environment for more than a decade. It has pioneered work on groundwater provisions for wetlands on the Gnangara and Jandakot Mounds. A State Policy on Water Provisions for the Environment has recently been finalised.



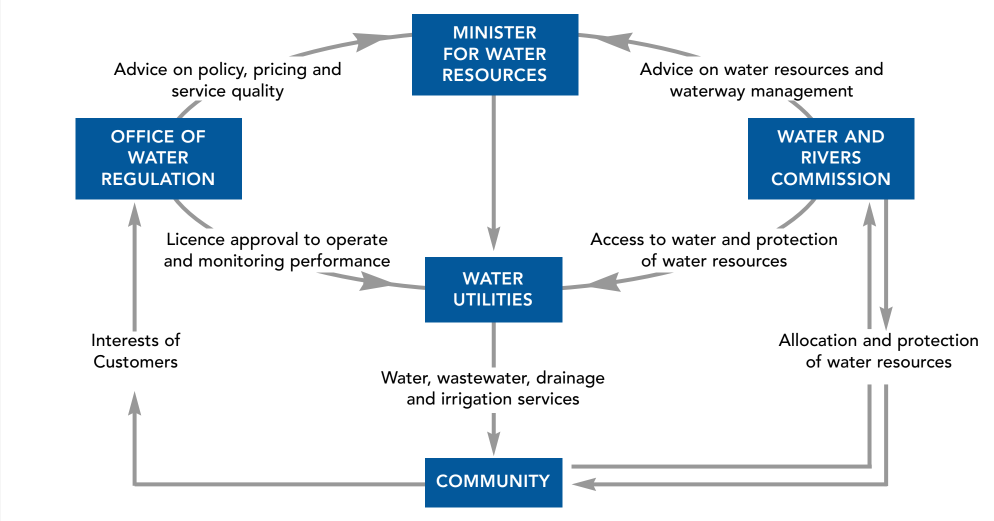


FIGURE 3-1 – ORGANISATIONAL STRUCTURE OF WATER MANAGEMENT

Another major element of water resources reform, the National Water Quality Management Strategy, has been developed progressively since the early 1990s. A project is underway to implement an associated State Water Quality Management Strategy. This strategy is a natural complement to the water allocation process and contributes to the protection of the quality of water allocations and entitlements.

Compliance with the central commitments of the COAG Competition Policy Agreement in respect to water reform was reviewed formally in the second tranche approvals at June 30, 1999. In respect to those approvals, the National Competition Council advised that it was "of the view that Western Australia has met major reform commitments of the second tranche".

3.2 WATER INDUSTRY STRUCTURE

The current organisational structure of water management in Western Australia was introduced in 1996 as part of the State Government's water reforms. The regulatory structure, illustrated in Figure 3-1, separates service provision (the responsibility of the water utilities) from the setting of service standards (the responsibility of the Office of Water Regulation) and resource management (the responsibility of the Water and Rivers Commission).

In recent years, water service providers have moved towards corporatisation within a more competitive framework for water supply provision. Irrigator groups have been split into independent and self-sufficient co-operatives.

The Water Corporation is by far the State's largest water service provider. Other water service industry participants include the Bunbury and Busselton Water Boards, irrigation scheme co-operatives and port authorities.

The Water and Rivers Commission was established under the Water and Rivers Commission Act 1995 and is responsible to the Minister for Water Resources. The Commission is required to assess, protect and manage the State's water resources. Water service provision licences are issued by the Office of Water Regulation, however all water service providers and the majority of self-suppliers must also have a water allocation licence from the Water and Rivers Commission. Licensing of water allocations is an important mechanism to ensure water use is within sustainable yields. The Commission's policy decisions and operations are subject to the State's environmental protection legislation and are undertaken in consultation with other State agencies, industry and the community.

3.3 MODES OF WATER ALLOCATION

Two distinct modes of water allocation with respect to the provision of water for the environment are actively employed in Western Australia. The first involves the reservation of resources in areas of high conservation value, while the second involves the determination of environmental water provisions and associated sustainable yields. The audit calculations have sought to replicate these two modes of allocation in the creation of resource inventories.

Allocation by reservation of purpose is generally applied at a regional and sub-regional scale. It consists of reserving some resources from development (e.g. wild and scenic rivers or groundwater in conservation reserves) and assigning others for development subject to determination of appropriate rules of permit. This mode of water allocation, through reservation of resources for specific environmental purposes and beneficial uses, contributes strongly to protection of environmental diversity and to the conservation of high value environmental areas.

Reservation by purpose has been actively employed through regional plans such as the Perth-Bunbury study and the Busselton-Walpole study. The coordination of water allocation planning with land use and environmental planning in these studies resulted in highly significant reservations of water resources with consistent reservations or constraints through land reserves.

Allocation by the determination of environmental water provisions is implemented at a resource level in regions not already reserved. In these areas where development of the resource is permitted, water use is regulated to within certain limits which incorporate environmental water provisions determined specifically for that resource. This mode of allocation may be implemented under plans developed at sub-regional or local area level. It contributes to the maintenance of environmental quality by satisfying objectives (e.g. maintenance of wetland levels linked to aquifers or maintenance of flow regimes downstream of diversions) set for the source.

The determination of sustainable yields has reached relatively advanced levels of sophistication with respect to some environmentally sensitive unconfined aquifers. This active development in groundwater allocation has been a natural result of regional environmental priorities and public environmental review processes. Wetlands associated with unconfined aquifers have been the most significant "flow maintenance issue" in contemporary water development in this State.

3.4 MANAGEMENT OF WATER ALLOCATION

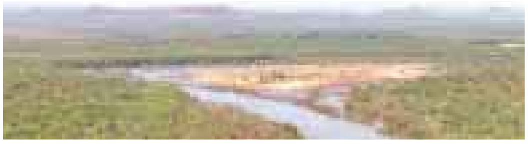
The State Government has long followed a principle of precautionary progression of yield determination with groundwater resources allocated within sustainable yields. More recently it has moved to establishing similar principles for surface water allocation. These principles revolve around:

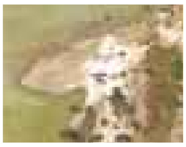
1) Monitoring demand growth against precautionary estimates of sustainable yield; and

2) Escalating management responses accordingly.

A graduated management response is specified for resource investigation, monitoring, allocation planning, and management of use. At low levels of resource development, the monitoring, planning and management of the resource is conducted at a broad scale. When demand monitoring indicates that the level of water resource development is increasing or is expected to increase, monitoring activities are intensified and resource specific investigations are carried out. At higher levels of development, detailed hydrologic and hydrogeologic studies are undertaken and ecological assessments are made to accurately define sustainable yields. At each stage, regulation of the resource through conditions of use is increased and the use of market mechanisms are explored once a fully allocated status is reached. This process provides optimal management of the resource by intensifying management responses as use progresses, and by improving estimates of sustainable yield as the level of water use increases relative to the sustainable yield.

4 The Audit Method





4.1 OVERALL APPROACH

This audit has taken a significant step beyond previous State and National reviews by creating preliminary assessments of environmentally sustainable yield at regional scales across the State. Previous resource audits have not extended beyond estimation of the technically divertible yield.

The adopted methodology of estimating sustainable yields is consistent with the allocation processes being implemented in Western Australia, including the expectation that some resources will be generally withheld from development and others will be developed with soundly established environmental water provisions. Estimates produced in this way have introduced very substantial environmental water allocations which create conservative or precautionary estimates of sustainable yield. As a result of these audit assumptions, sustainable yields are generally significantly less than the divertible yields of Review85 (divertible yields were Review85's only indicator of available supplies) except in areas where subsequent hydrological investigation has substantially increased the estimated magnitude of the resource.

In the case of allocation by reservation of purpose, yield estimates for the audit were reduced below divertible yields by including constraints from regional allocation and land reservation plans, policy or regulations. An estimate was made of the surface water resources reserved from development as explicitly stated or strongly implied in established regional plans, policies or regulations. To these established regional constraints, subjective estimates were made of the volume of surface water resources associated with regional reservations likely to be established. Although involving subjective judgement, the inclusion of these additional reservations was guided by the experience of regional planning over the last decade and was seen to realistically reflect overall outcomes at a drainage division scale.

It is important to stress that these assumptions about individual resources are considered appropriate for audit estimates of sustainable yield at a regional scale. However, these yield estimates are not based on sufficient specific information to be regarded as prescriptive for an individual resource unless it has been formally established under due planning processes. Rather, they are a realistic estimate of yield at a regional scale for the purposes of regional and statewide planning.

4.2 CATEGORISATION OF RESOURCES AND MANAGEMENT RESPONSES BY UTILISATION LEVEL

It is a prime intention of the Audit to assess the general state of water allocation in relation to demand pressures. After estimating sustainable yields, individual resource units were classified in relation to the level of utilisation of sustainable yield in that unit. The level of management activity for these resource units was classified into response categories appropriate to different levels (categories) of utilisation, as shown in Table 4-1. Statistical presentation of the gaps between categorised utilisation levels for each resource unit and the category of its actual management situation enables a general assessment of priority areas in the implementation of water allocation across the State.

DEFINITIONS OF YIELD	ALLOCATION AND USE
MEAN ANNUAL FLOW	The amount of surface water that on average is generated by a catchment each year
DIVERTIBLE YIELD	The amount of surface water that can economically be diverted from a catchment each year.
SUSTAINABLE YIELD	The amount of water that can be sustainably harvested each year from a water resource after making provision for environmental and social values.
CURRENT ALLOCATION	The amount of water which is currently allocated for use from a water resource each year.
CURRENT USE	The amount of water which is currently used from a water resource each year.

UTILISATION AS % OF SUSTAINABLE YIELD	0-30%	30-70%	70-100%	>100%
LEVEL OF USE CATEGORY	C1	C2	C3	C4
CORRESPONDING RESPONSE CATEGORY	R1	R2	R3	R4

TABLE 4-1:

RESOURCE CATEGORIES ACCORDING TO LEVEL OF UTILISATION

When categorising resources, utilisation was generally specified as the volume of water allocated and not the volume of water actually being used as these were mostly not available, except for in the Ord. Allocations and use are generally not so markedly different in Western Australia as to produce significantly differing results. For most purposes, categorisation based on allocation (including some informal allocations which exist in low use or low risk situations) is believed to give the more useful result. Allocation is for the 1996/97 year for the surface water and 1999/00 for the groundwater. These include system and distribution losses.

This is the basis of categorisation employed in this report. Categorisation by use is also available in the Audit's assembled data, although with groundwater there are a small number of Groundwater Management Units where the categorisation by use is not available.

4.3 GAP ANALYSIS OF SHORTFALLS IN MANAGEMENT RESPONSE

The level of utilisation as a proportion of the sustainable yield defines the level at which a resource should be managed. As the level of use increases, the management response should be escalated to improve the knowledge and management of the resource. In some cases, the management of a resource can lag behind the desired level of management. These shortfalls in water resource management were identified in the audit by comparing the actual level of management of each resource against the desired level of management defined for each utilisation category. This was based on a relative scale of management from 1 (low level of management) to 4 (high level of management), corresponding to each of the four categories of use listed in Table 4-1. For instance, where a resource was close to full allocation (utilisation category 3 and desired response category 3) but available data only

allowed a basic estimate of sustainable yield to be made, equivalent to an actual management response category 2, the gap between the actual and desired level of management response was assessed as –1. In summary, the management gap was defined as:

Management gap = actual management response category – utilisation category

The management actions corresponding to each category are quite comprehensive and for the purposes of brevity have not been included in this summary document.

5 Surface Water Resources

5.1 REPORTING UNITS

The reporting units adopted in the audit are consistent with those used in Review85 and the Australian Water Resources Council (AWRC) drainage divisions and basins. The area covered by each of the 44 surface water management areas that are reported upon in the audit are shown in Figure 5-1. These surface water management areas are further aggregated into the four drainage divisions shown in Figure 5-2, which serve to provide a much quicker overview of the general status of resources across the state. The four drainage divisions are the South West, Indian Ocean, Timor Sea and Western Plateau drainage divisions.

5.2 YIELD

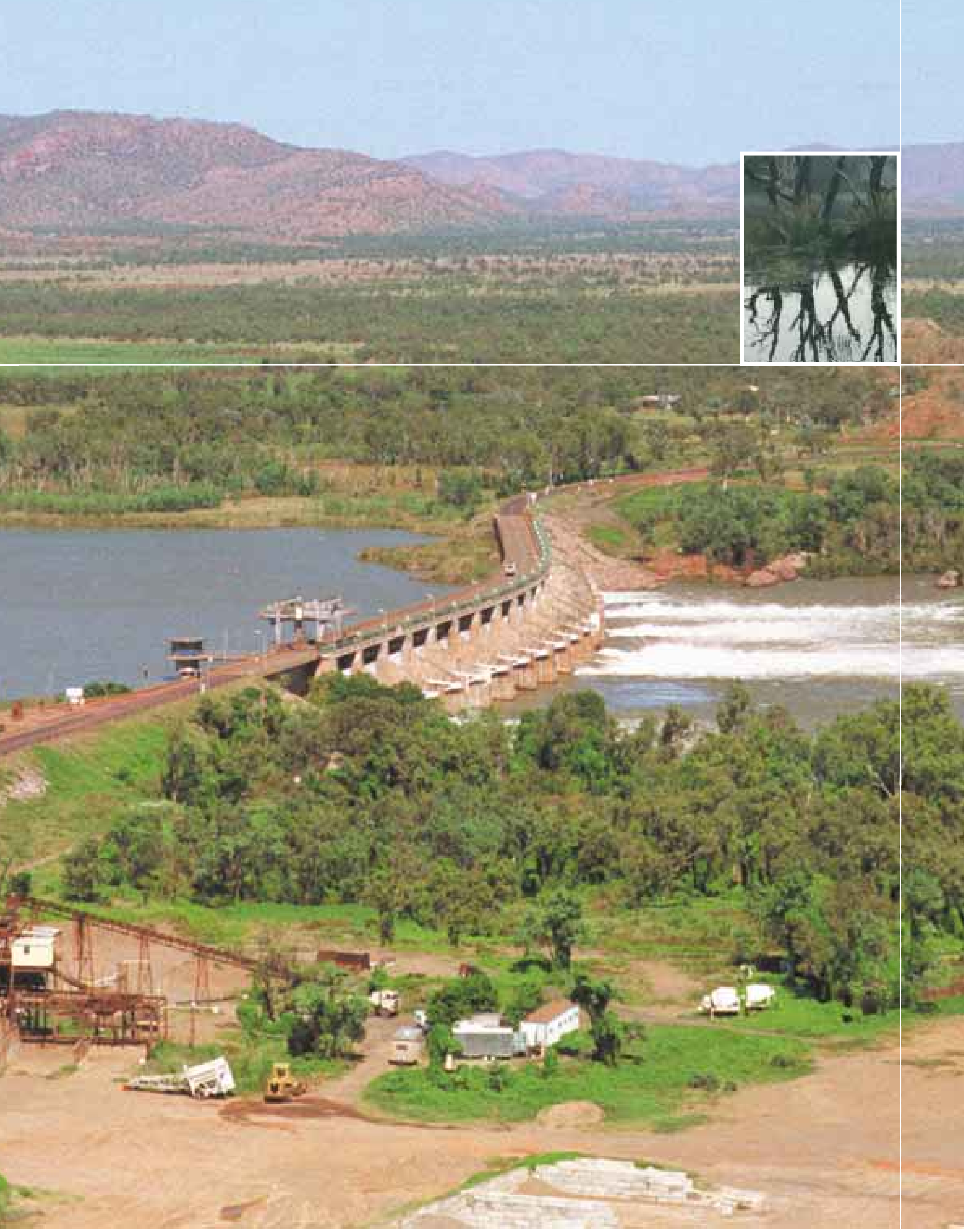
The water yield of surface water management areas and drainage divisions was assessed in terms of the mean annual flow, divertible yield, sustainable yield and quality. The results of this assessment for fresh/marginal resources by drainage division are shown in Figure 5-2 and Figure 5-3. As stated previously in Section 4.1, audit estimates of sustainable yield are not designed to be prescriptive in areas where detailed investigations and public planning processes have not yet been undertaken.

In the **South West** drainage division, where streamflow data and hydrologic analyses are relatively accurate and advanced, the values of mean annual flow (6,785 GL/yr) and technically divertible yield (2,935 GL/yr) were within 3% of the Review85 estimates. The Review85 estimate included conservative assumptions with respect to climate which have equated closely to the persisting dry conditions experienced since that estimate was made in 1985.

Sustainable yield in the South West drainage division of 1,608 GL/yr is limited to around 55% of divertible yield or 24% of mean annual flow, despite this being the most highly developed region in the State. Most of this anticipated difference between sustainable yield and divertible yield is the result of setting aside some rivers and tributaries in reserves as part of the allocation of water by reservation of purpose. Various regional planning initiatives have contributed to the establishment of river and stream reservation, including the Perth-Bunbury and Busselton-Walpole regional allocation planning processes and land use planning decisions relating to Conservation Reserves and the Regional Forest Agreement.

Sustainable yields in the **Indian Ocean** drainage division are estimated to be around 40% of divertible yields. However, due to high flow variability, the divertible yield itself is only 16% of the mean annual flow. Again, reservation of environmentally and culturally sensitive areas is the main type of environmental flow allocation with around half of these areas already in established planning provisions.

Recent streamflow assessments increased the estimate of mean annual flow (4,609 GL/yr) by 16% compared with the Review85 estimate. In Review85, divertible yield for this drainage division was considered to be heavily constrained by the availability of fresh aquifers suitable for conjunctive use. Re-appraisal of the hydrology of reservoirs in the region, including re-assessment of inflow variability, salinity and evaporation, has demonstrated that technically feasible yields can be reliably diverted without dependence on conjunctive use. As a result, the estimate of divertible yield (739 GL/yr) has increased by 150% relative to the Review85 value. This current estimate is based on reservoir analyses independent of conjunctive use. The availability of aquifers suitable for conjunctive use is interpreted as improving the security of this estimate of divertible yield. Although considered a significant improvement over Review85, the audit figures for this drainage division are still only rated as reconnaissance level assessments.



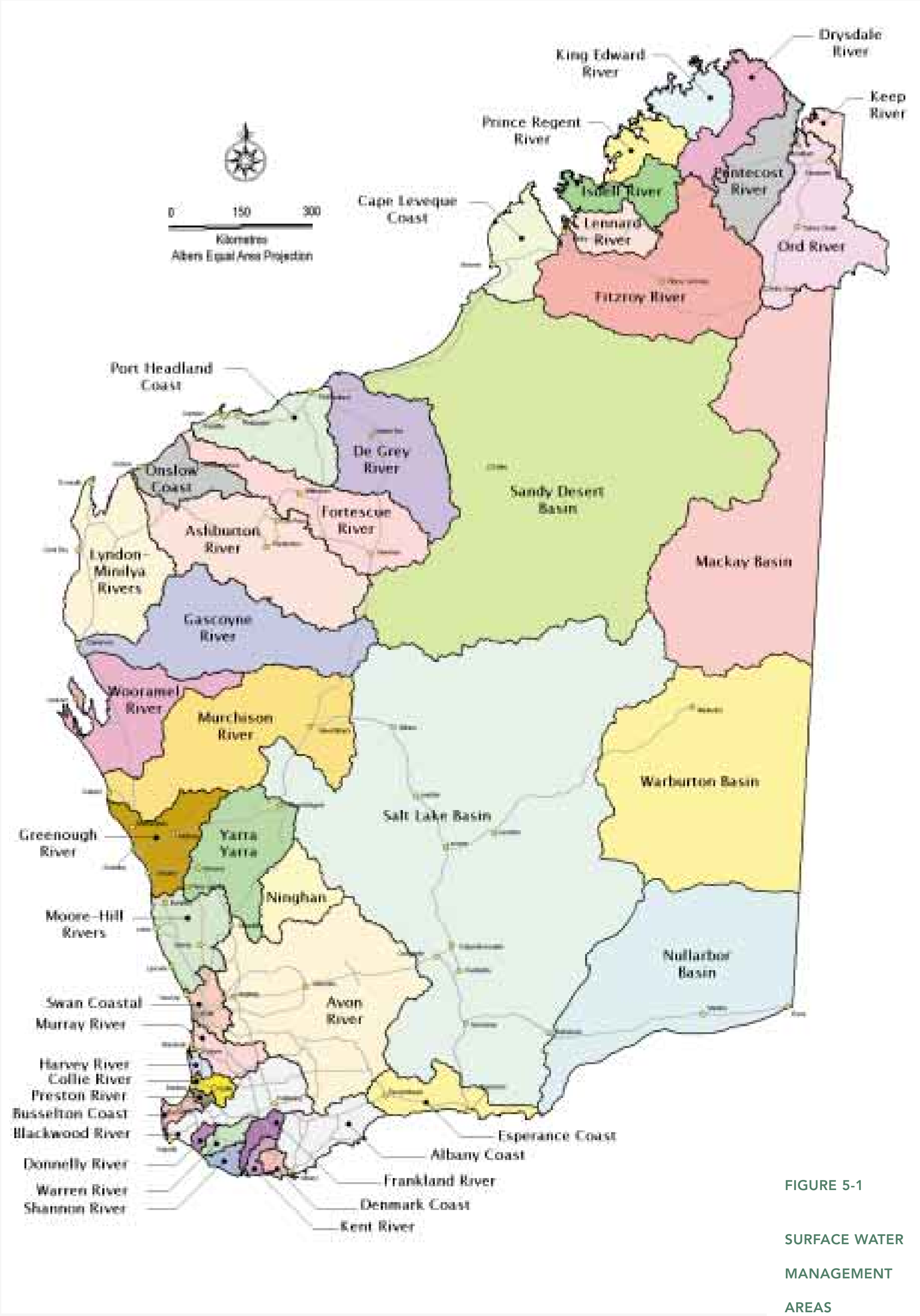
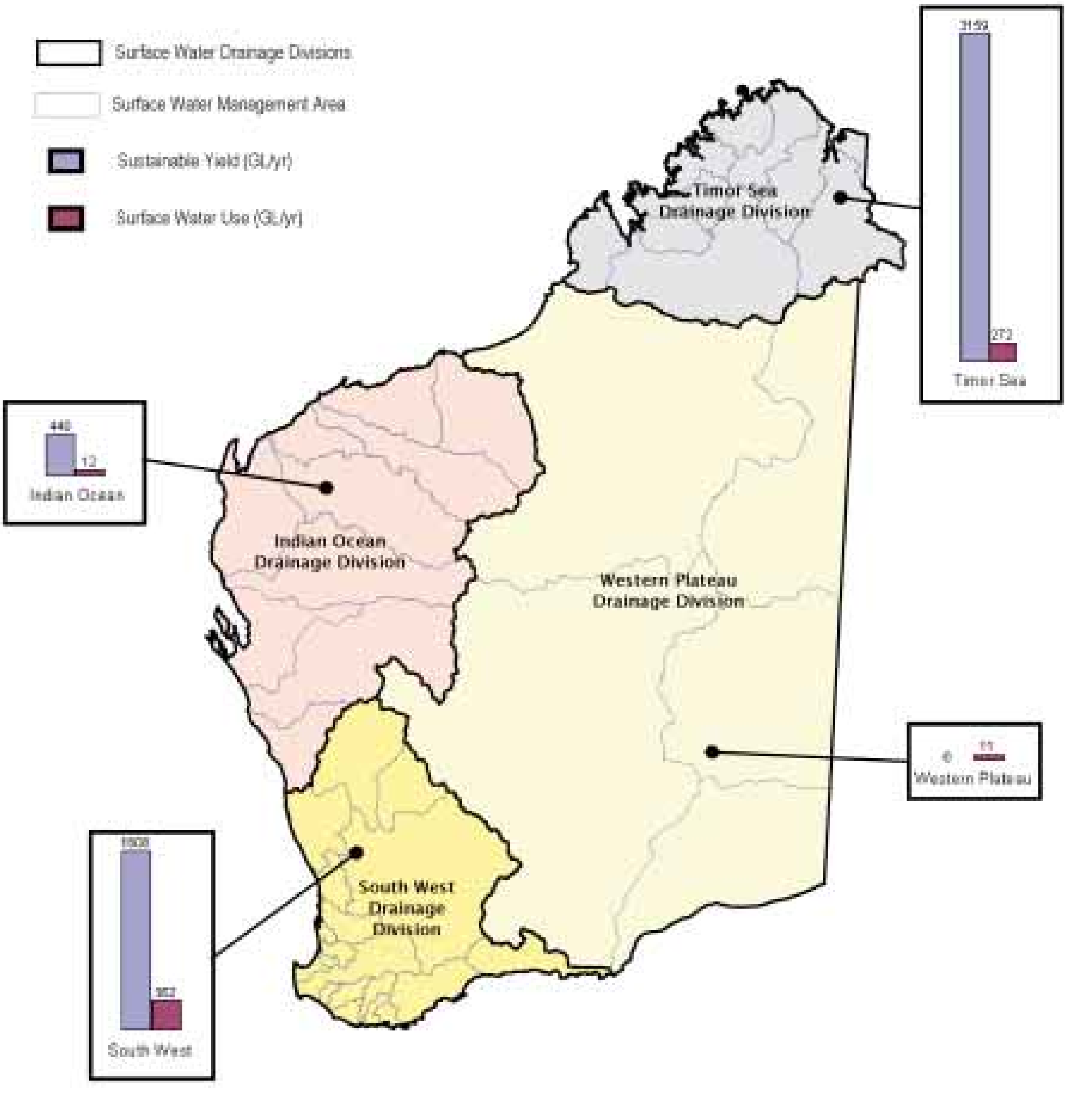


FIGURE 5-1

SURFACE WATER MANAGEMENT AREAS



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The audit is a review, not a plan, designed to provide an analytical framework for the precautionary management of water resources. The audit assists in the development of processes to define and protect social and environmental water allocations and provides a basis for discussion and planning of future economic development.

FIGURE 5-2

SURFACE WATER SUSTAINABLE YIELDS AND USE WITHIN DRAINAGE DIVISIONS

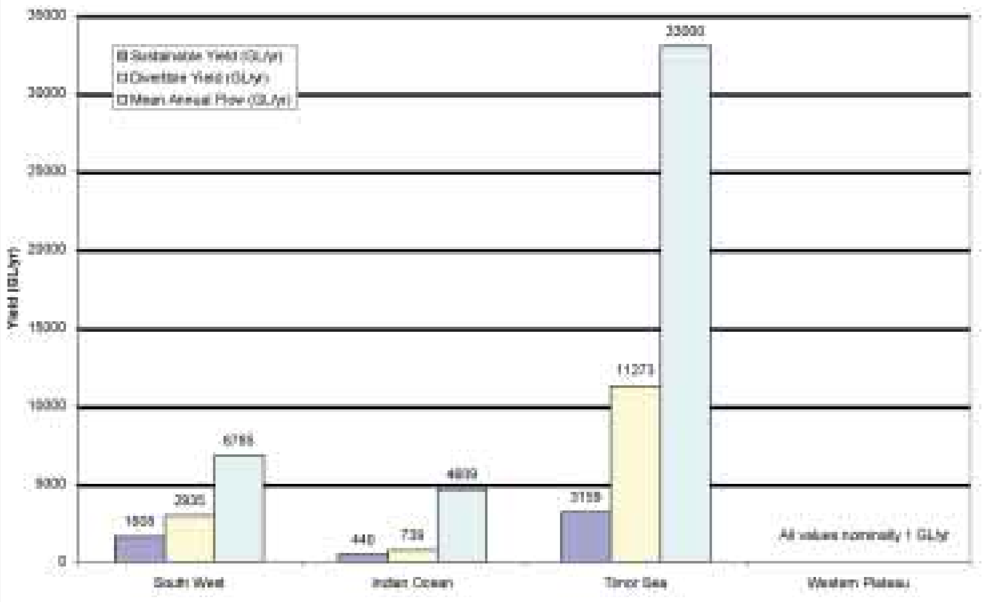


FIGURE 5-3

SURFACE WATER YIELD BY DRAINAGE DIVISION

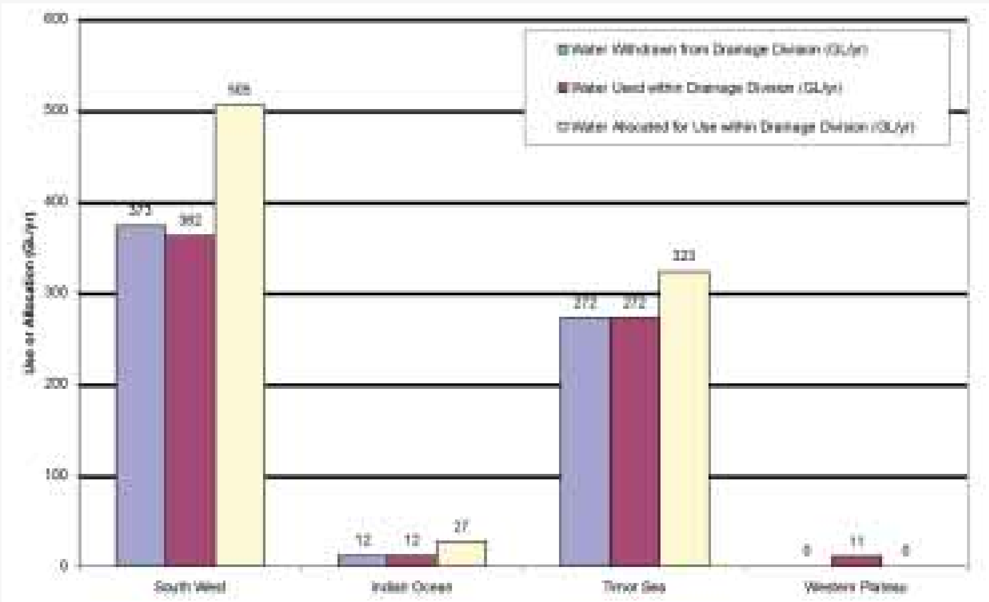


FIGURE 5-4

SURFACE WATER USE BY DRAINAGE DIVISION

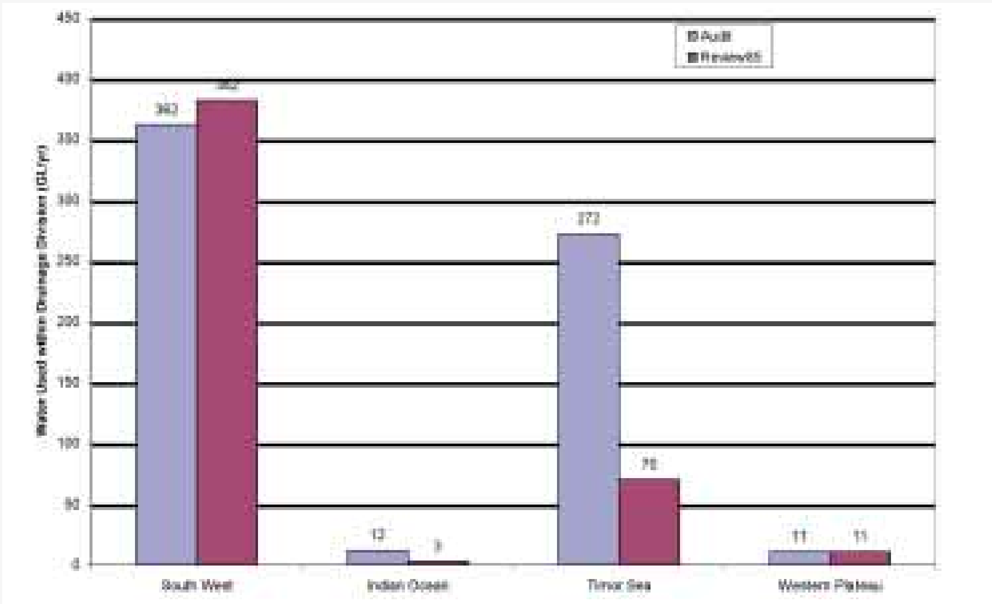


FIGURE 5-5

CURRENT AUDIT AND REVIEW85 ESTIMATES OF SURFACE WATER USE

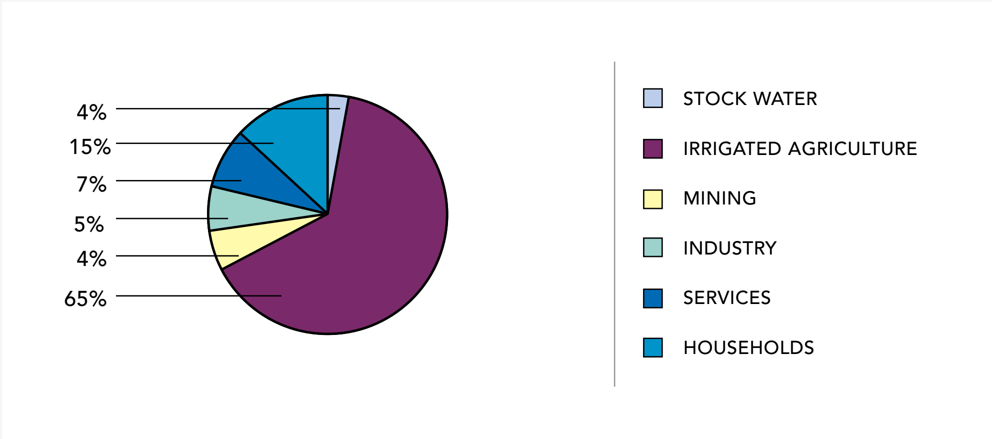


FIGURE 5-6

STATEWIDE SURFACE WATER USE BY USER GROUP

In the **Timor Sea** drainage division, the mean annual flow (33,000 GL/yr) and divertible yield (11,273 GL/yr) are 10% and 30% higher than the Review85 estimates of these two parameters respectively. This is largely due to the additional 15 years of streamflow data collected since the Review85 estimates were made. It is anticipated that only about 30% of the divertible yield, or around 10% of the mean annual flow, will be realised as sustainable yield in this drainage division. Most of these environmental flow provisions are attributable to the wilderness value of the area. About half of the area reserved by purpose is in established reserves such as Prince Regent Park, while the other half are anticipated in future planning decisions. A much smaller proportion of around 10% of environmental flow is associated with specific environmental flow provisions in areas of consumptive water use.

Mean annual flow, divertible yield and sustainable yield of the **Western Plateau** drainage division were all assigned a nominal value of 1 GL/yr for the audit.

The above estimates of sustainable yield anticipate very considerable proportions of the mean annual flow and divertible yield to be reserved for environmental purposes. Across the State, it is estimated that almost two thirds of divertible yield will be allocated to the environment, ranging from 40% in the Indian Ocean drainage division to 72% in the Timor Sea drainage division. The majority of these environmental flows are the result of the reservation of land by purpose.

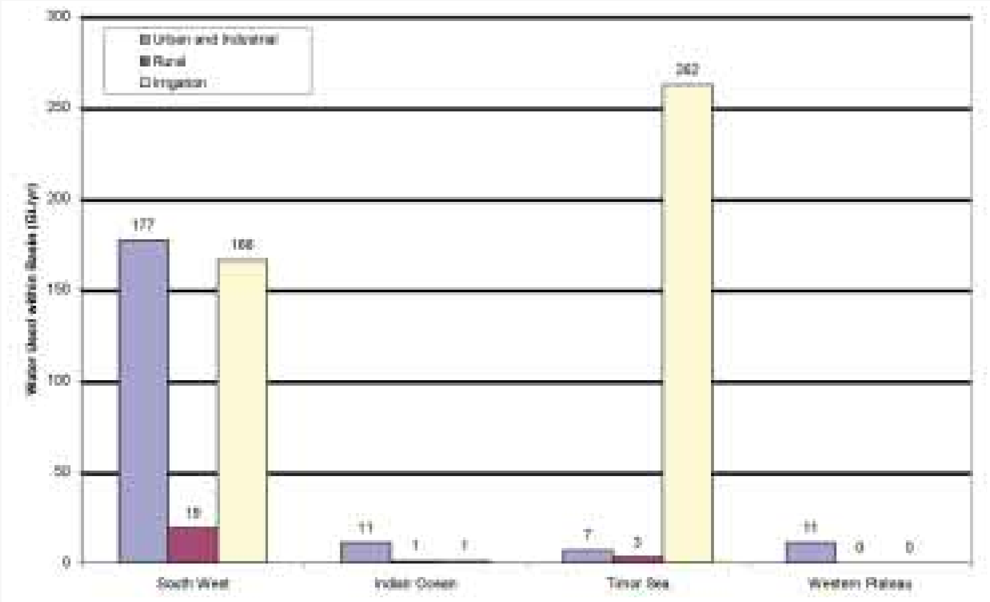


FIGURE 5-7

SURFACE WATER USE BY USER GROUP AND DRAINAGE DIVISION

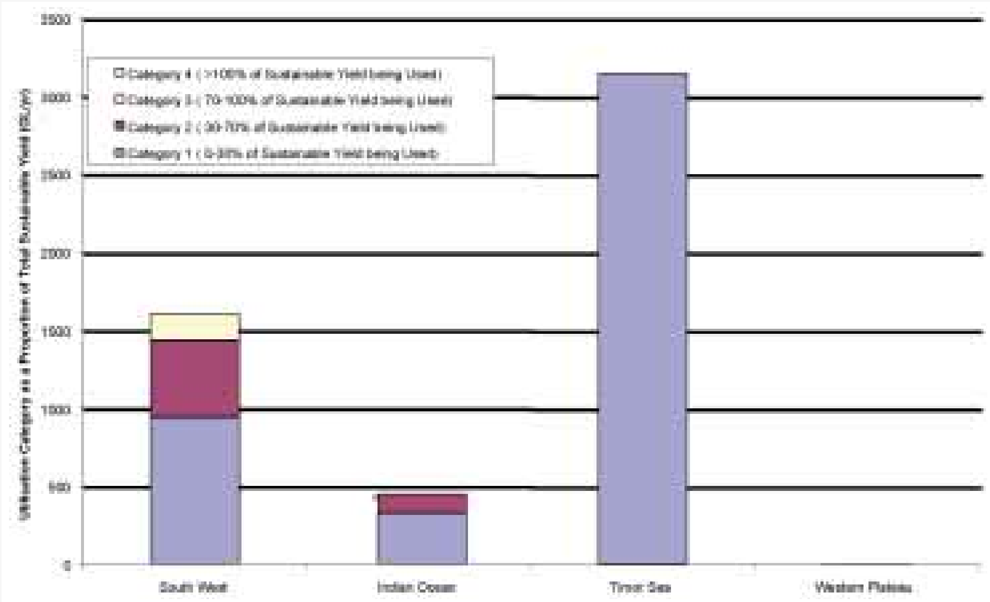


FIGURE 5-8

SURFACE WATER RESOURCE UTILISATION WEIGHTED BY SUSTAINABLE YIELD

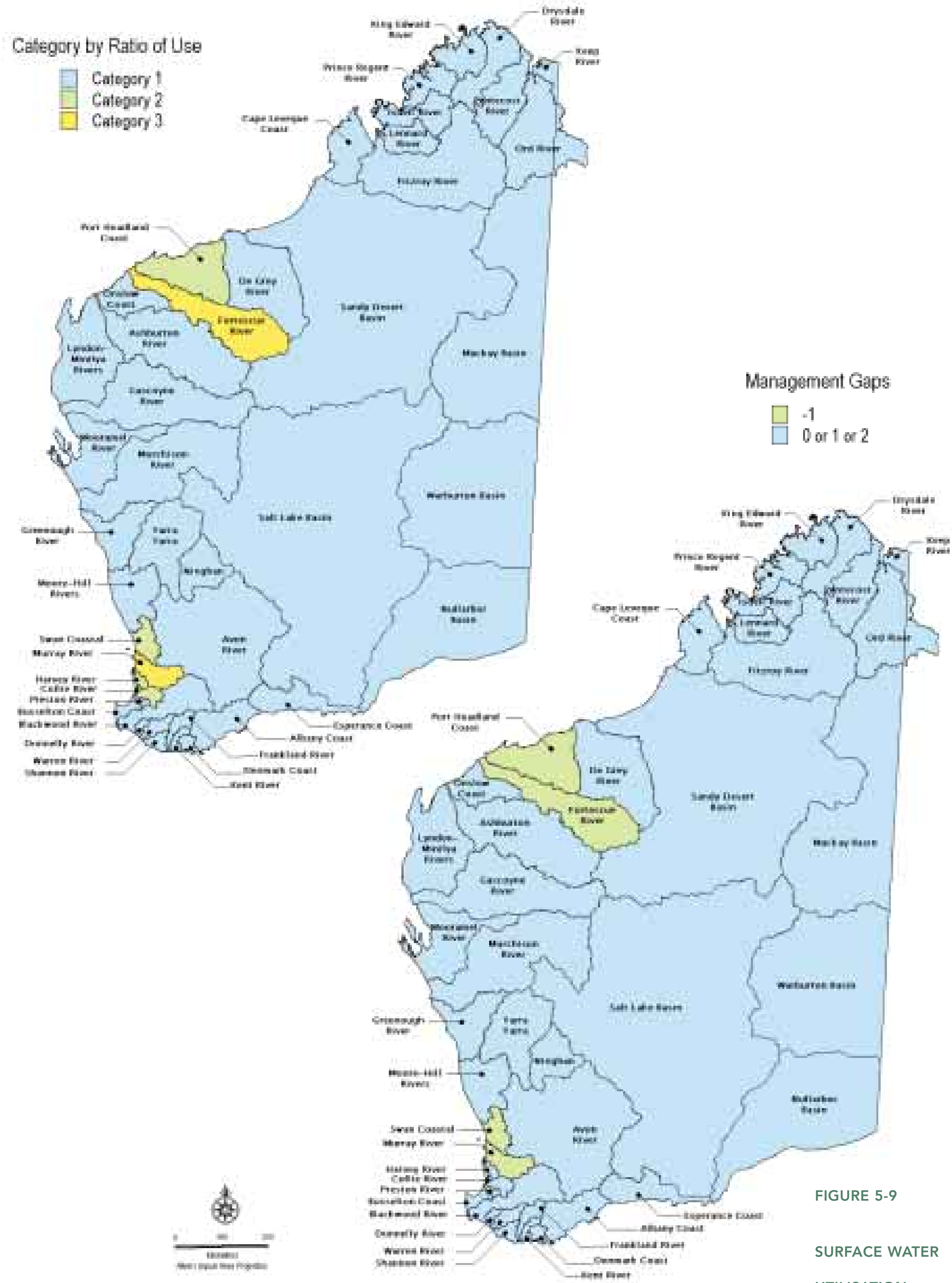


FIGURE 5-9

SURFACE WATER UTILISATION CATEGORIES AND MANAGEMENT GAPS

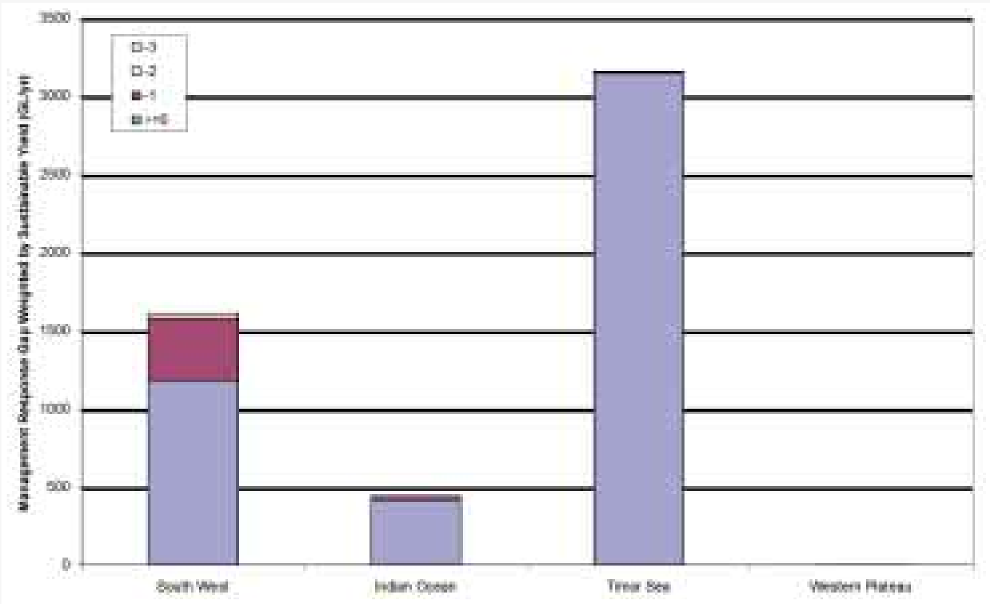


FIGURE 5-10

SURFACE WATER MANAGEMENT RESPONSE GAP WEIGHTED BY SUSTAINABLE YIELD

5.3 ALLOCATION AND USE

The amount of water withdrawn from each drainage division, the amount of water used (including inter-division transfers) and the amount of water allocated for use in 1996/97 are shown in Figure 5-4. The volumes of water used within each division are also shown in Figure 5-2. Total surface water use across the State is estimated to be 658 GL/yr, with most of this water being consumed in the South West (362 GL/yr) and the Timor Sea (272 GL/yr). Water use in the Ord River basin accounts for 99% of the water used in the Timor Sea drainage division. The amount of water used in the Indian Ocean and Western Plateau drainage divisions is 12 GL and 11 GL respectively. A total of 11 GL is transferred from Mundaring Weir in the South-West drainage division to Kalgoorlie in the Western Plateau, via the Goldfields Agricultural Water Scheme(GAWS) pipeline, which accounts for the difference between the amount of water withdrawn from these two drainage divisions and the amount of water actually used. The amount of water allocated in each drainage division is higher than actual water use because of seasonal variations in use.

Water use estimated for the audit was compared with the Review85 estimates, as shown in Figure 5-5. Some caution needs to be exercised in comparing the two estimates because there are inaccuracies in both data sets, particularly with regard to self-supplied use (mainly farm dams).

The audit estimate of total water use in the South-West drainage division is slightly lower than the Review85 figure. This is largely because of the decline in usage from public irrigation systems, most notably in the Busselton-Harvey region where the estimate of water use has dropped by around 40 GL since Review85. This highlights the opportunities for future transfers into other basins through water markets, which will be facilitated by the transfer capacity of the Harvey development scheme currently in an implementation phase within the region. The decrease in the estimate of water use in the South-West is also partly due to the effects of sustained drought in dampening the growth of water use from the Perth water supply system. Despite the regular imposition of water restrictions, the estimate of annual water use in the Perth-Mandurah area still increased by 30 GL relative to the Review85 estimate.

In the Timor Sea drainage division, the difference in water use estimates between Review85 and the audit are dominated by the growth in annual water use in the Ord Irrigation Area by around 208 GL. The demise of the Camballin Irrigation Scheme on the Fitzroy River, which was equal to an annual water use of around 5 GL, also contributed to the difference between the two estimates.

In the Indian Ocean drainage division, water use has increased since Review85 with the commissioning of the Opthalmia Dam and Harding Dam conjunctive use schemes for water supply to Mount Newman and the West Pilbara. Water use in the Western Plateau drainage division has remained constant over the last two decades.

The demands for water by different sectors of the economy are illustrated in Figure 5-6 and Figure 5-7. At a

Statewide level, 66% of total water use is for irrigation purposes, 31% is for urban and industrial use and 3% meets rural demands for water. It is clear from Figure 5-6 that water use is dominated by the Ord River irrigation scheme in the Timor Sea drainage division, and the urban and irrigation demands in the South-West, including Perth.

5.4 RESOURCE UTILISATION

Resource utilisation is expressed as the volume of water allocated relative to sustainable yield, as previously outlined in Section 4.2. For the audit in Western Australia, an analysis of resource utilisation at the level of surface water management areas was considered too coarse. Utilisation was categorised at the level of local management areas within river basins in order to provide a more accurate picture of the pressure on the resource. This should be borne in mind when comparing Western Australia's audit results on resource utilisation with other states, which may be collating information at the scale of the surface water management area. The results of the analysis for Western Australia, aggregated to drainage divisions, are shown in Figure 5-8, and a state-wide depiction is given in Figure 5-9.

These figures show that allocations sum to less than 30% of the sustainable yield (Category 1) for the majority of resources and that there is significant further potential to develop these water resources in a sustainable manner. Importantly, none of the State's surface water resources are currently over-allocated (Category 4). Allocations in the Ord River area in the Timor Sea drainage division are within Category 1, indicating the potential for further water resource development in this area.

However, about a third of the State's surface water systems were found to be in the Category 3 level of utilisation and many of these were considered to be fully allocated. In total, some 38% of the State's allocated water resources are allocated to the sustainable limit. Most of these heavily committed systems are in the South-West Drainage Division. While this situation indicates a satisfactory physical state, management implications arise from this, as discussed in the later section on management shortfalls.

5.5 MANAGEMENT RESPONSES AND SHORTFALLS

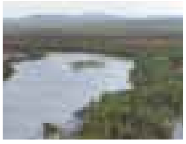
The current levels of utilisation indicate that the allocation of the State's surface water resources is within sustainable limits. In order to ensure the continued sustainability of water use under increasing demand pressures, these water resources must be managed appropriately. The appropriateness of the level of management of a resource given the level of utilisation of the resource was assessed according to the method outlined in Section 4.3. The results, shown in Figure 5-10, indicate that the majority of the State's surfacewater resources are being managed at an appropriate level, with the gap between management practice and management needs being greater than or equal to zero. This analysis is based on an assessment of management responses at the local management area rather than the coarser surface water management area. However, for visual display, the results at the local management level have been aggregated up to the basin, or surface water management area, as shown in Figure 5-9.

The actual management response fell one stage behind that recommended for the utilisation category of the resource (gap = -1) in a total of 8% of surface water resources (by sustainable yield) across the State. These shortfalls predominantly occurred in the management of major water supply reservoirs in the South-West drainage division. Water from these dams was allocated prior to the introduction of recent reforms in the water industry. In more recent decades, these developments have been associated with public environmental reviews and conformed with the requirements of contemporary environmental law. While it is believed that no major environmental stress situations have resulted from these developments, the allocation processes are not in full conformity with post-reform practice with respect to environmental water provisions and therefore further review of these provisions is warranted.

The actual management response fell two stages behind that recommended for the utilisation category of the resource (gap = -2) in a total of 1% of surface water resources (by sustainable yield) across the State. These shortfalls occur for smaller resources and include some of the self-supplied sources of the South-West which are proving demanding in a regulatory sense.

In due course, sustainable yield and environmental water provisions will be reviewed in those areas where management response lags behind that recommended for the level of utilisation it is experiencing. This management situation is an inevitable outcome of reform and, to a lesser degree, of the pace of growth in water demand. Priority will need to focus on the smaller number of larger or potentially sensitive resources in which there is a perceived gap in management response or concerns of potential environmental stress. When setting priorities to address these management shortfalls, consideration will also need to be given to the significance of the resource, the utilisation category of the resource and demand growth projections. This management response situation represents a significant base workload in future allocation activity, even without the pressures of increasing use.

6 Groundwater Resources



6.1 REPORTING UNITS

Groundwater management areas (GMAs) are statutory areas defined by the Water and Rivers Commission and declared under the Metropolitan Water Supply Sewerage and Drainage Act and the Rights in Water Irrigation Act. These GMAs cover all areas of the State except for the unincorporated areas (UAs) in the south-west and along the southern coast. An unincorporated area is simply an area not included within any GMA. GMAs have been established for various reasons such as the protection of town water supplies and to enable legislative control of groundwater in response to various development pressures. Some of the GMAs, particularly in the Perth groundwater basin, have been further sub-divided into groundwater management sub-areas to meet local groundwater management requirements. The GMA boundaries follow cadastral boundaries (mostly roads and property boundaries) or boundaries defined by latitude and longitude. As a result, most of the GMAs do not closely correspond with natural physiographic features and aquifer extent.

For the purposes of the audit, the term **Groundwater Management Unit (GMU)** was applied to a discrete aquifer within a GMA or UA. As part of the audit, all known major aquifers currently being exploited or considered likely to be exploited in the foreseeable future were identified in each GMA and their extent determined from the State geological or hydrogeological maps. In the sedimentary basins where aquifers may be superimposed on one another at different depths or the aquifer extends into several GMAs, each aquifer or part of an aquifer is dealt with as a separate GMU.

A total of 174 GMUs were identified across the State, as shown on Figure 6-1. These GMUs ranged in size from 1 km^2 (Dwellingup) to 312,250 km^2 (Canning). GMUs located within the three overlying aquifers within the Perth Basin are depicted in greater detail in Figure 6-2. The unincorporated area was split into seven GMUs corresponding to their respective groundwater provinces (geological subdivisions).

These GMUs were aggregated into seven geographic **groundwater divisions** for the purposes of summary reporting, as shown in Figure 6-3. These groundwater divisions are broadly described as Sedimentary Basins (Perth, Carnarvon, Canning and Officer-Eucla) or Fractured Rock Divisions (Kimberley, Pilbara and Yilgarn), although some exceptions are admitted on geographic grounds, such as including Northampton (fractured rock aquifer) in the Perth "sedimentary" division and Collie (sedimentary aquifer) in the Yilgarn "fractured rock" division.

6.2 YIELD

Sustainable groundwater yields were based in the first instance on results derived from existing Groundwater Area Allocation Plans, (Water) Management Plans or on the outcomes of long-term monitoring of groundwater levels within an aquifer and associated abstraction volumes. This yield includes groundwater from fresh to hypersaline quality. For GMUs where detailed studies or long-term monitoring data were not available, the sustainable yield for each was given by the renewable groundwater resource minus an allowance for wetlands and, where appropriate, for seawater intrusion. The renewable groundwater resource was determined from the area of land surface or aquifer multiplied by the mean annual rainfall and the applicable recharge factor for each defined area. Recharge factors for the Perth groundwater division were derived from existing management plans. For the remainder of the State, they were either derived from groundwater investigations or were estimated by reference to other areas and consideration of rainfall, topography and aquifer type.

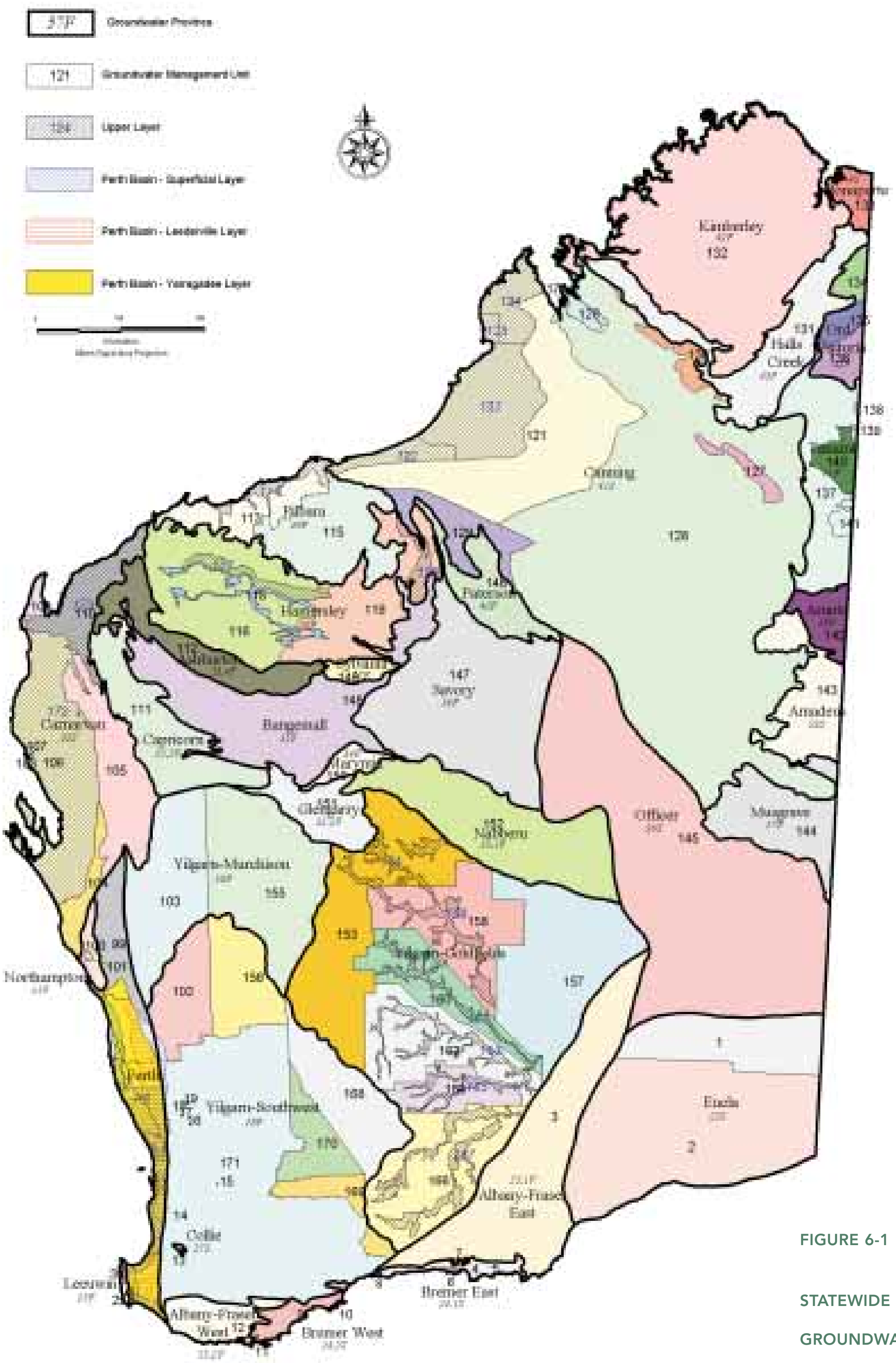


FIGURE 6-1

STATEWIDE GROUNDWATER MANAGEMENT UNITS

GMU ID	GMU NAMES
1	Eucla North
2	Eucla South
3	Albany-Fraser East
4	Bremer East
5	Condingup
6	Esperance
7	Gibson
8	Hopetoun
9	Bremer West
10	Bremer Bay
11	Albany
12	Albany-Fraser West
13	Collie
14	Dwellingup
15	Happy Valley
16	Bolgart-Bolgart East
17	Yenart
18	New Norcia
19	Yerecoin
20	Blackwood-Superficial
21	Blackwood-Leederville
22	Blackwood-Yarragadee
23	Blackwood-Lesueur
24	Blackwood-Sue
25	Blackwood-Leeuwin
26	Busselton Capel-Superficial
27	Busselton Capel-Leederville
28	Busselton Capel-Yarragadee
29	Busselton Capel-Sue
30	Busselton Capel-Naturaliste
31	Bunbury-Superficial
32	Bunbury-Leederville
33	Bunbury-Yarragadee
34	Unincorporated-Cookernup
35	Southwest Coastal-Superficial
36	Southwest Coastal-Leederville
37	Southwest Coastal-Cockleshell Gully
38	Murray-Superficial
39	Murray-Leederville
40	Murray-Cockleshell Gully
41	Serpentine-Superficial
42	Serpentine-Leederville
43	Serpentine-Yarragadee
44	Serpentine-Cockleshell Gully
45	Rockingham-Superficial
46	Rockingham-Leederville
47	Rockingham-Yarragadee
48	Rockingham-Cockleshell Gully
49	Jandakot-Superficial
50	Jandakot-Leederville
51	Jandakot-Yarragadee
52	Cockburn-Superficial
53	Cockburn-Leederville
54	Cockburn-Yarragadee
55	Perth-Superficial
56	Perth-Leederville
57	Perth-Yarragadee

GMU ID	GMU NAMES
58	Gwelup-Superficial
59	Gwelup-Leederville
60	Gwelup-Yarragadee
61	Rottnest
62	Mirrabooka-Superficial
63	Mirrabooka-Leederville
64	Mirrabooka-Yarragadee
65	Swan-Superficial
66	Swan-Superficial-Scarp
67	Swan-Leederville
68	Swan-Yarragadee
69	Wanneroo-Superficial
70	Wanneroo-Leederville
71	Wanneroo-Yarragadee
72	Gnangara-Superficial
73	Gnangara-Leederville
74	Gnangara-Yarragadee
75	Yanchep-Superficial
76	Yanchep-Leederville
77	Yanchep-Yarragadee
78	Gingin-Superficial-Scarp
79	Gingin-Superficial-Plateau
80	Gingin-Superficial-Coastal Plain
81	Gingin-Leederville-Parmelia
82	Gingin-Leederville
83	Gingin-Yarragadee
84	Jurien-Watheroo
85	Jurien-Superficial
86	Jurien-Leederville
87	Jurien-Yarragadee
88	Jurien-Cockleshell Gully
89	Jurien-Lesueur
90	Arrowsmith-Coorow
91	Arrowsmith-Mullingarra
92	Arrowsmith-Superficial
93	Arrowsmith-Parmelia
94	Arrowsmith-Yarragadee
95	Arrowsmith-Cockleshell Gully
96	Arrowsmith-Lesueur
97	Arrowsmith-Cockleshell Gully
98	Gascoyne-Yarragadee
99	Gascoyne-Yuna
100	Northampton Complex
101	Northampton Town
102	Gascoyne-Mullewa
103	Gascoyne-Byro
104	Gascoyne-Tumblagooda
105	Gascoyne-Bidgienaya
106	Gascoyne-Birdrong
107	Gascoyne
108	Gascoyne-Alluvium
109	Gascoyne-Exmouth
110	Pilbara-Peedamulla
111	Gascoyne-Province
112	Ashburton-Province
113	Pilbara West
114	Pilbara Coast-Alluvium
115	Pibara East
116	Hamersley West

GMU ID	GMU NAMES
117	Hamersley-Fortescue
118	Hamersley-Wittenoom
119	Hamersley East
120	Hamersley-Carawine
121	Canning-Wallal
122	Canning-Pardoo
123	Canning-Lagrange
124	Canning-Pender
125	Canning-Broome Town
126	Canning-Erskine
127	Canning-Erskine Southeast
128	Canning
129	Canning-Dora
130	Canning-Napier
131	Halls Creek Province
132	Kimberley
133	Bonaparte
134	Ord-Argyle
135	Ord-Bungle Bungle
136	Ord-Nicholson
137	Tanami 1
138	Tanami 2
139	Tanami 3
140	Tanami 4
141	Tanami 5
142	Arunta
143	Amadeus
144	Musgrave
145	Officer
146	Paterson
147	Savory
148	Bangemall
149	Sylvania
150	Marymia
151	Glengarry
152	Nabberu
153	East Murchison-Wiluna
154	East Murchison-Wiluna-Superficial
155	East Murchison-Cue
156	East Murchison-Ningham
157	Goldfields-Minigwal
158	Goldfields-Lake Carey
159	Goldfields-Lake Carey-Superficial
160	Goldfields-Raeside
161	Goldfields-Raeside-Superficial
162	Goldfields-Rebecca
163	Goldfields-Rebecca-Superficial
164	Goldfields-Roe
165	Goldfields-Roe-Superficial
166	Goldfields-Lefroy-Dundas
167	Goldfields-Lefroy-Dundas-Superficial
168	Goldfields-Deborah
169	Kondinin-Ravensthorpe
170	Westonia
171	Yilgarn-Southwest
172	Gascoyne-Superficial
173	Pilbara-Peedamulla-Superficial
174	Derby

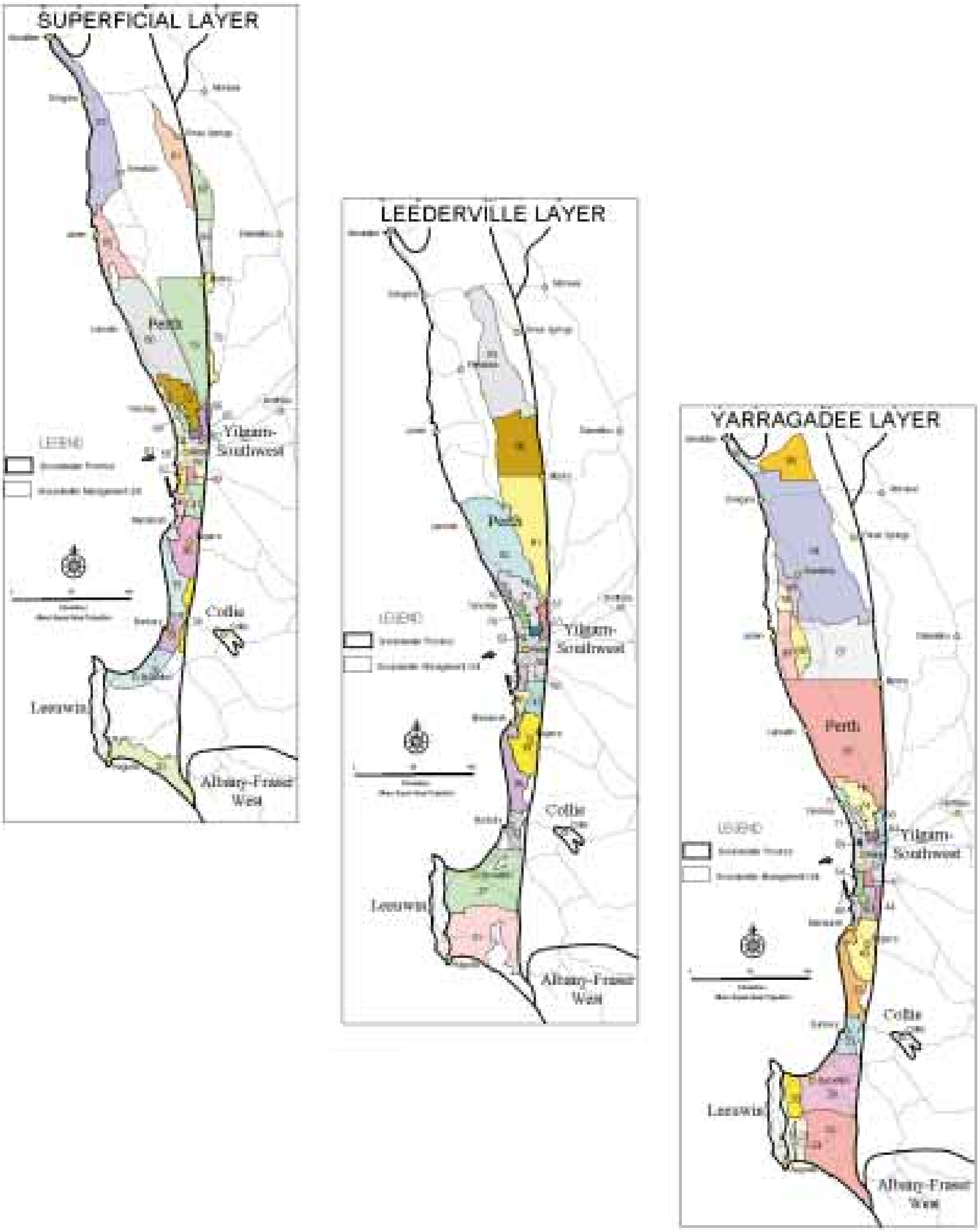
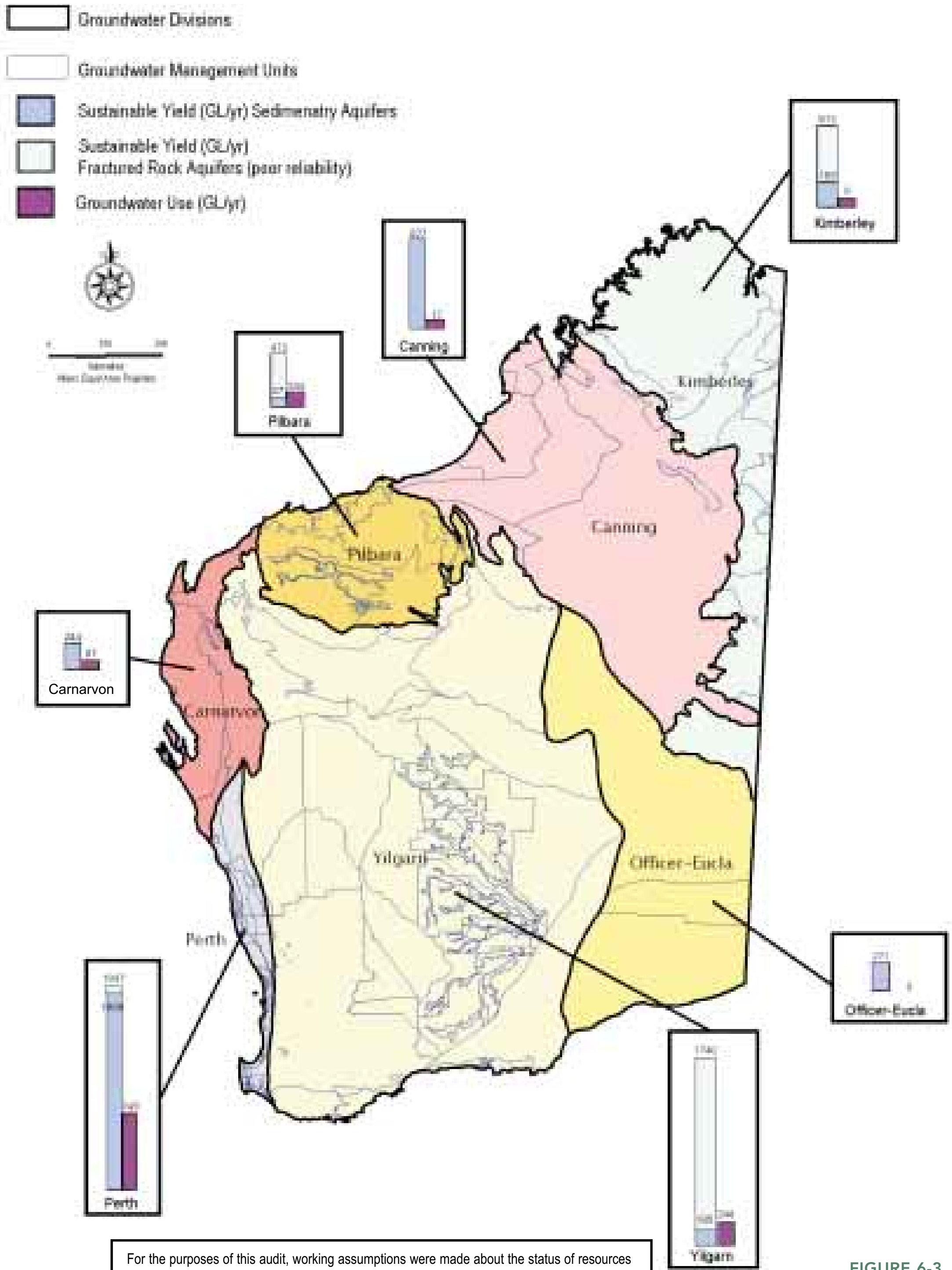


FIGURE 6-2

GROUNDWATER MANAGEMENT UNITS IN THE PERTH BASIN



For the purposes of this audit, working assumptions were made about the status of resources where detailed information was not available. It is important to understand that such assumptions are not prescriptive.

The audit is a review, not a plan, designed to provide an analytical framework for the precautionary management of water resources. The audit assists in the development of processes to define and protect social and environmental water allocations and provides a basis for discussion and planning of future economic development.

FIGURE 6-3

GROUNDWATER SUSTAINABLE YIELDS AND USE WITHIN DIVISIONS

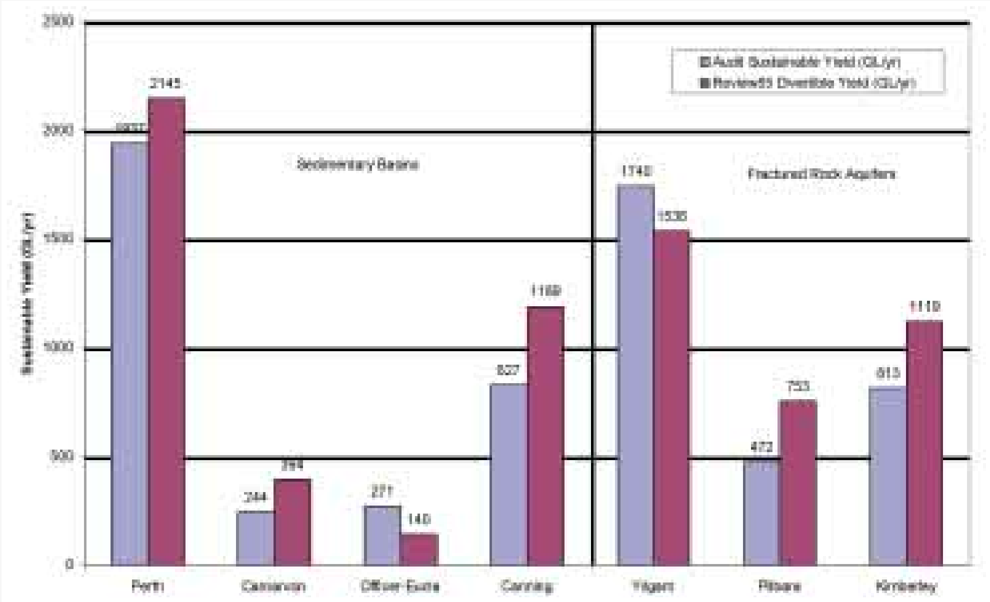


FIGURE 6-4

CURRENT AND REVIEW 85 ESTIMATES OF GROUNDWATER YIELD

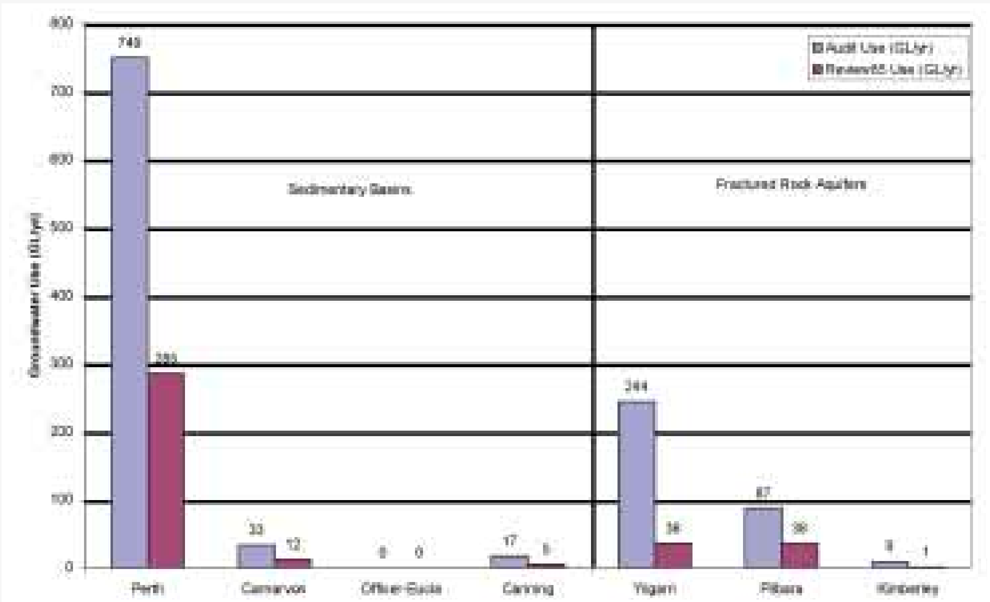


FIGURE 6-5

CURRENT AND REVIEW85 ESTIMATES OF GROUNDWATER USE

The result of this analysis is shown in Figure 6-3 and Figure 6-4. The total sustainable yield for the State was estimated to be 6,304 GL/yr, with 3,279 GL/yr available from the sedimentary basins and 3,025 GL/yr from the fractured rock divisions. Across the state, the audit estimate of sustainable yield is around 14% lower than the Review85 estimate of divertible yield. This is largely attributable to the audit inclusion of environmental water provisions for groundwater dependent ecosystems, but also reflects improvements in data availability and assessments. Changes in land use such as clearing, urbanisation and drainage also affect sustainable yield estimates. For Perth, the Review85 estimates were conservative and already gave implicit recognition to an allowance for wetlands which masked the full effect of allocating water to the environment in that division.

The estimates of sustainable yield are generally considered to be conservative but it is important to note, particularly with respect to the fractured rock divisions, that they include resources which Review85 classed as minor sources. These minor sources are distributed resources only able to be developed using small bores and spear systems. These systems are extremely important to pastoral supplies, but because of their dispersed nature, they are not reliable nor amenable to high utilisation. The minor sources tend to dominate the sustainable yield assessments in the fractured rock provinces simply because of their areal extent in comparison with free yielding resources. Care should therefore be taken not to assume that there is potential for intensive development from the fractured rock divisions, despite the apparent high availability of water.

6.3 GROUNDWATER USE

The total volume of groundwater use in Western Australia is estimated to be 1,138 GL/yr, with 798 GL/yr being extracted from the sedimentary basins and 340 GL/yr used from the fractured rock divisions. Groundwater use by groundwater division is shown in Figure 6-3 and Figure 6-5, which illustrate that the majority of groundwater use is in the Perth (749 GL/yr), Yilgarn (244 GL/yr) and Pilbara (87 GL/yr) groundwater divisions. The Review85 estimates of groundwater use are consistently lower than those from the current audit. Groundwater abstraction data for Review85 may in some cases have been incomplete and it therefore would be unwise to attribute all of this increase in use to growth in demand. The three groundwater divisions with the most significant increases in water use since Review85 are Perth, Yilgarn and Pilbara. In these three cases, there is no doubt that a very significant increase has actually occurred. Groundwater use within the State has increased threefold since 1985.

The increase in the Perth groundwater division is due to growth in both public water systems and self-supplied use for urban, mining and industrial use, as well as growth in the vigorously developing and generally high value irrigation industry on the Coastal Plain. Growth in groundwater use in the Yilgarn groundwater division is dominated by mining development and includes significant amounts of mine dewatering and deliberate mining of hypersaline groundwater. Growth in the Pilbara region is attributable to growth in water use for mining and urban/industrial supply.

The majority of groundwater use is for mining, irrigated agriculture and urban use, as shown in Figures 6-6 and 6-7. The total groundwater use for these purposes is 840 GL/yr, with 60% of this occurring in the sedimentary basins. Irrigation water use from groundwater totalled 299 GL/yr with over 90% of this occurring within the Perth groundwater division.

6.4 GROUNDWATER RESOURCE UTILISATION

The current use of groundwater resources relative to the sustainable yield is listed for each groundwater division in Table 6-1. Around 18% of the State's available groundwater resources are currently being used. The highest level of resource utilisation at the divisional scale occurs in the Perth basin (39%), which reflects the high accessibility and economic utility of that particular resource. The level of utilisation in the fractured rock divisions is expected to remain low at the divisional scale because of the dispersed nature of the resource.

Although local variations occur at the sub-aquifer level, the level of utilisation at the GMU scale provides a fair indication of the general physical state of aquifers and is shown in Figure 6-8. The level of utilisation in each groundwater division, as aggregated from data at the GMU scale, is shown in Figure 6-9. This figure shows that the majority of resources are in the Category 1 level of utilisation, reflecting a low level of allocative stress. However nearly 30% of the State's GMUs are at a high or fully allocated level.

Only two of the State's GMUs are over-allocated. Their combined sustainable yield is 11 GL/yr. The rate of extraction from the Murray Cockleshell Gully GMU in the Perth groundwater division exceeds its estimated sustainable yield of 2.6 GL/yr by about 45%. However the resource is allocated to a single user and is being actively managed with a strategy in place to reduce their dependence on groundwater by drawing upon more surface water.

The rate of extraction from the Collie Sedimentary Basin in the Yilgarn groundwater division is also greater than desirable and is having a detrimental effect on the environment. Water is extracted for coal mine dewatering and power generation processing. However a strategy is in place for power generation companies to change the source of their process water from groundwater to surface water over the next 5 years. This will bring extraction within sustainable limits.

For GMUs at categories below level 4, some sub-aquifer areas may be locally over-allocated with other sub-aquifers compensating by their lower allocation levels. Generally, these local situations are managed within the distributive capacity of the aquifer hydraulics.

There are a significant number of Category 3 GMUs in the Perth groundwater division where utilisation is at or near sustainable limits. These include the intensively investigated superficial resources of the Gnangara and Jandakot mounds where environmental water provisions are established at reform standards. They also include the Leederville and Yaragadee confined aquifers which are considered to be fully allocated. Significant work is underway to improve the understanding of these aquifers and their sustainable limits. Water markets are also expected to be introduced in the near future to assist in the management of water demand.

In the Goldfields region, large volumes of hypersaline groundwater are extracted for mineral processing and mine de-watering. Extraction rates exceed direct recharge rates and the paleochannel confined aquifer storage volume has reduced. This is considered to be acceptable because the resource is hypersaline and current use does not appear to have any detrimental environmental impact. Pressure heads in most paleochannel aquifers appear to stabilise over time due to induced recharge from surrounding areas. Sustainable limits are set to the licensed allocation volumes.

In the Gascoyne region, the Carnarvon alluvial aquifers of the Gascoyne River that have been used for established irrigation areas are considered to be fully allocated. Controlled aquifer storage reductions within safe limits are allowed over the two or three year periods between river flow replenishment events. Further use of adjacent river-fed aquifers is under investigation.

The Albany GMU is considered to be fully allocated.

Among these high utilisation GMUs are a small number where there are issues associated with extractive pressure and a need for appropriate management. An example is in the Carnarvon Basin where a $4M program of capping flowing artesian bores is in progress.

Currently the State's underground water resources are in a satisfactory physical state in respect to extractive pressure and are being utilised sustainably. There are some localised issues of manageable scale and a significant demand growth at a regional scale in the Category 2 and 3 areas in the Perth groundwater division.

GROUNDWATER DIVISION	SUSTAINABLE YIELD (GL/YR)	GROUNDWATER USE (GL/YR)	USE DIVIDED BY SUSTAINABLE YIELD
PERTH	1,937 (1909)	749	39
CARNARVON	244 (244)	33	13
OFFICER-EUCLA	271 (271)	0	0
CANNING	827 (827)	17	2
TOTAL SEDIMENTARY BASINS	**3,279**	**798**	**24**
YILGARN	1,740 (185)	244	14
PILBARA	472 (27)	87	18
KIMBERLEY	813 (153)	9	1
TOTAL FRACTURED ROCKS	**3,025**	**340**	**11**
TOTAL ALL DIVISION	**6,304**	**1,138**	**18**

( ) denotes the portion of sustainable yields from sedimentary aquifers.

TABLE 6-1

GROUNDWATER RESOURCE UTILISATION

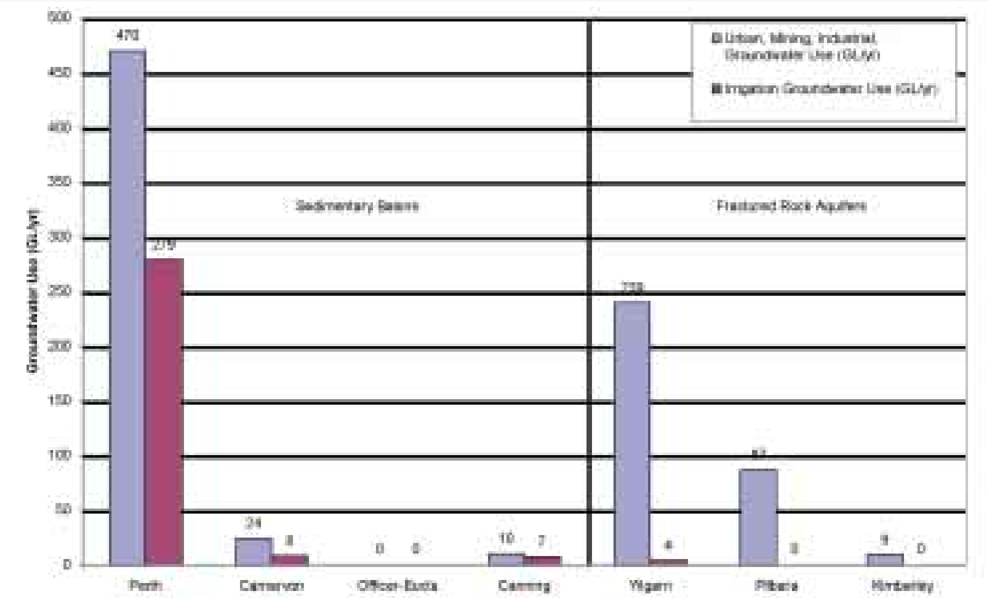


FIGURE 6-6

GROUNDWATER USE BY USER GROUP WITHIN DIVISIONS

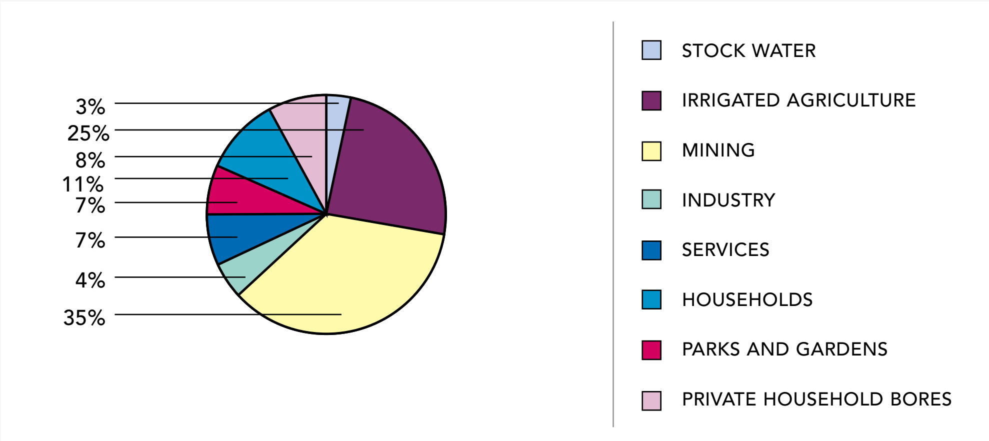


FIGURE 6-7

STATEWIDE GROUNDWATER USE BY USER GROUP

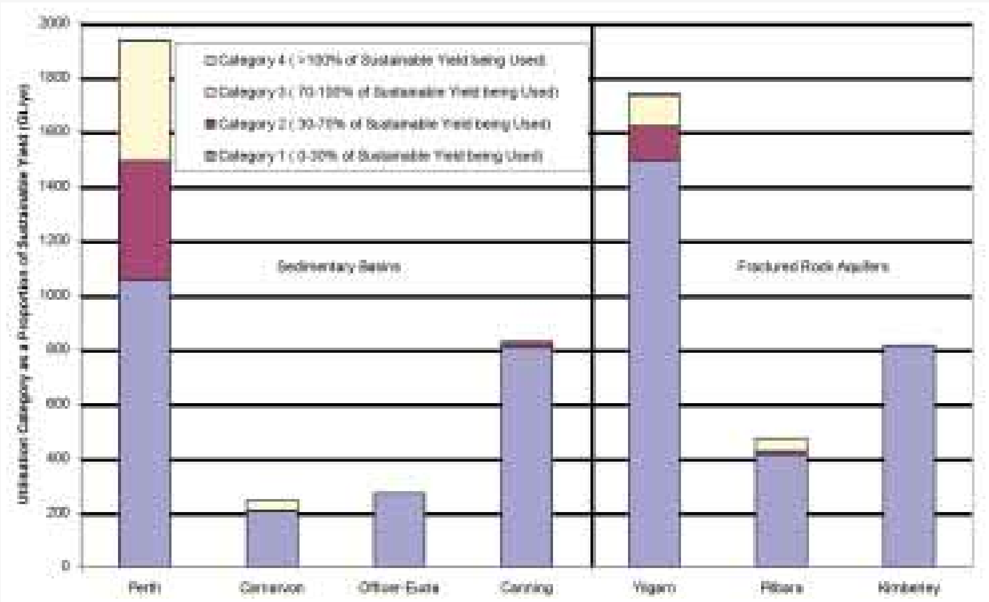


FIGURE 6-9

GROUNDWATER RESOURCE UTILISATION WEIGHTED BY SUSTAINABLE YIELD

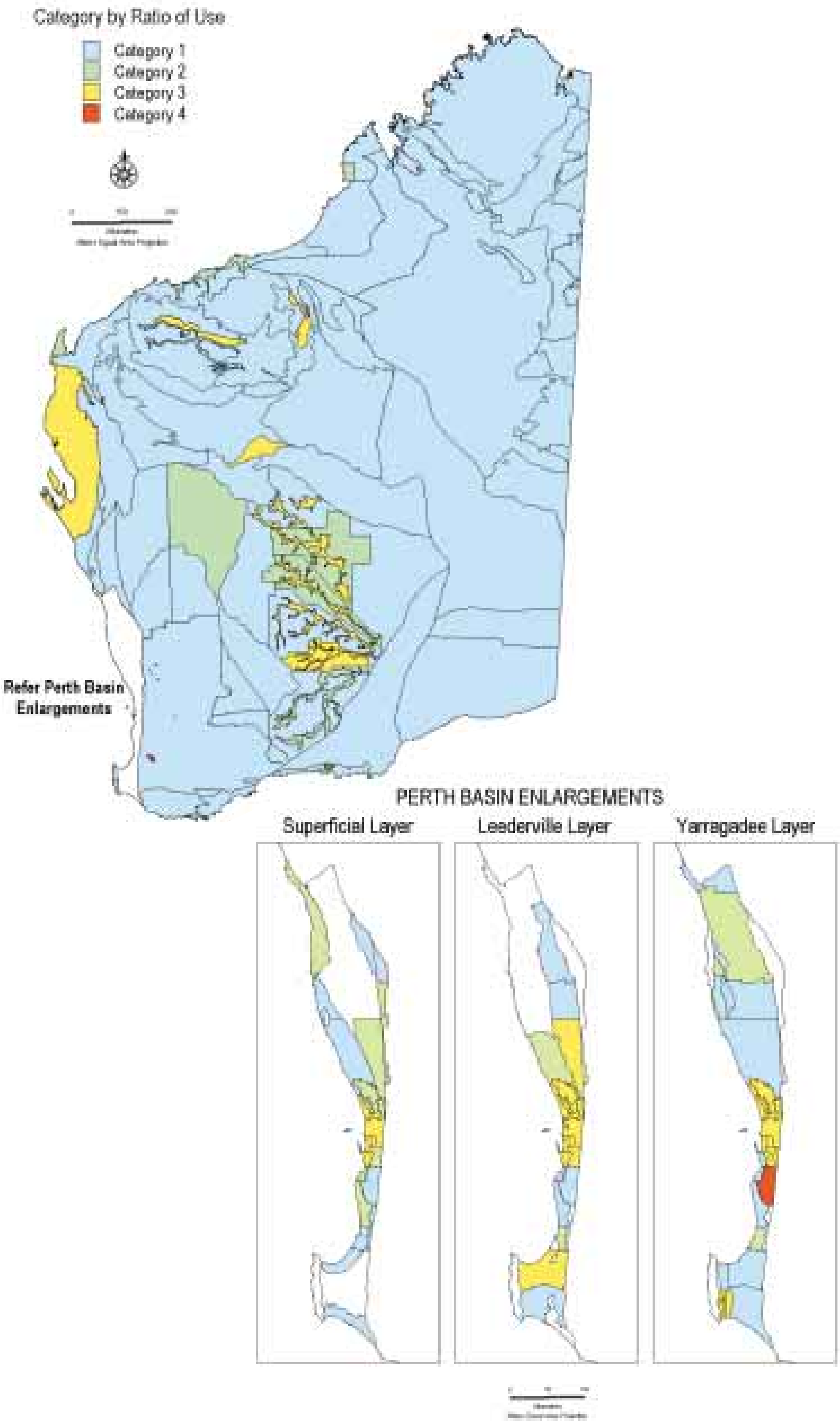


FIGURE 6-8

GROUNDWATER RESOURCE UTILISATION

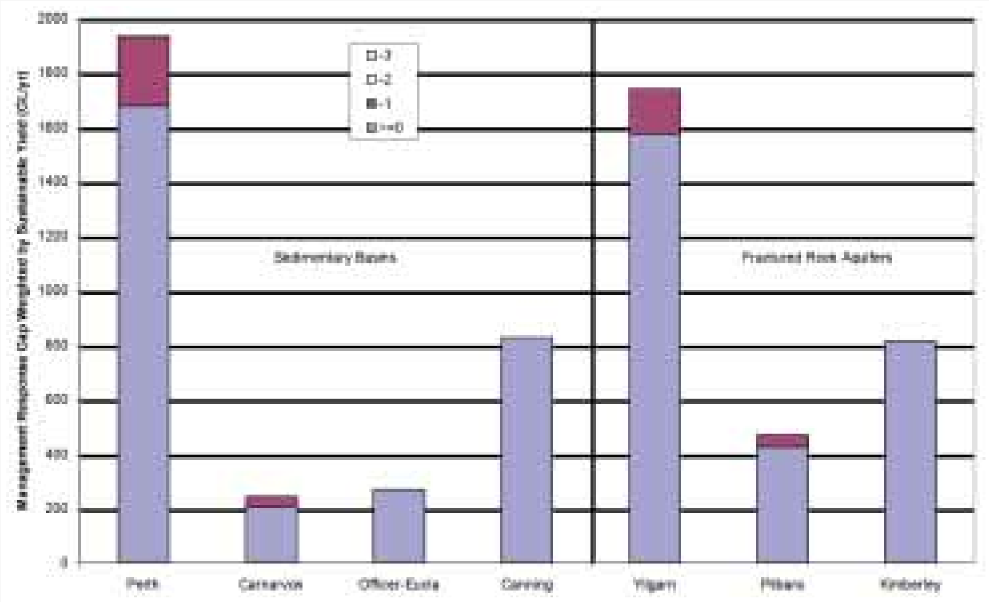


FIGURE 6-10

GROUNDWATER MANAGEMENT RESPONSE GAP WEIGHTED BY SUSTAINABLE YIELD

6.5 MANAGEMENT SHORTFALLS

The assessed gaps between the desired level of management given the level of utilisation and the actual level of management at the GMU scale are presented in Figure 6-10 for each groundwater division and pictorially in Figure 6-11. These figures indicate that the majority of the State's groundwater resources are being appropriately managed. The actual management response fell one stage behind that recommended for the utilisation category of the resource (gap = -1) in a total of 8% of groundwater resources (by sustainable yield). The management response fell two stages (gap = -2) behind that recommended for two GMUs in the Perth groundwater division.

The methodology preserved assessments at the sub-aquifer level where management gaps were evident at this more detailed level. It was also assumed that management was lagging behind the desired level of management where sufficient details were not available to make an accurate assessment.

These response gaps are a key issue for review following the audit. This represents a significant base workload in process improvement, even without the pressures caused by increasing use. Such action needs to give careful consideration to priorities in addressing management gaps.

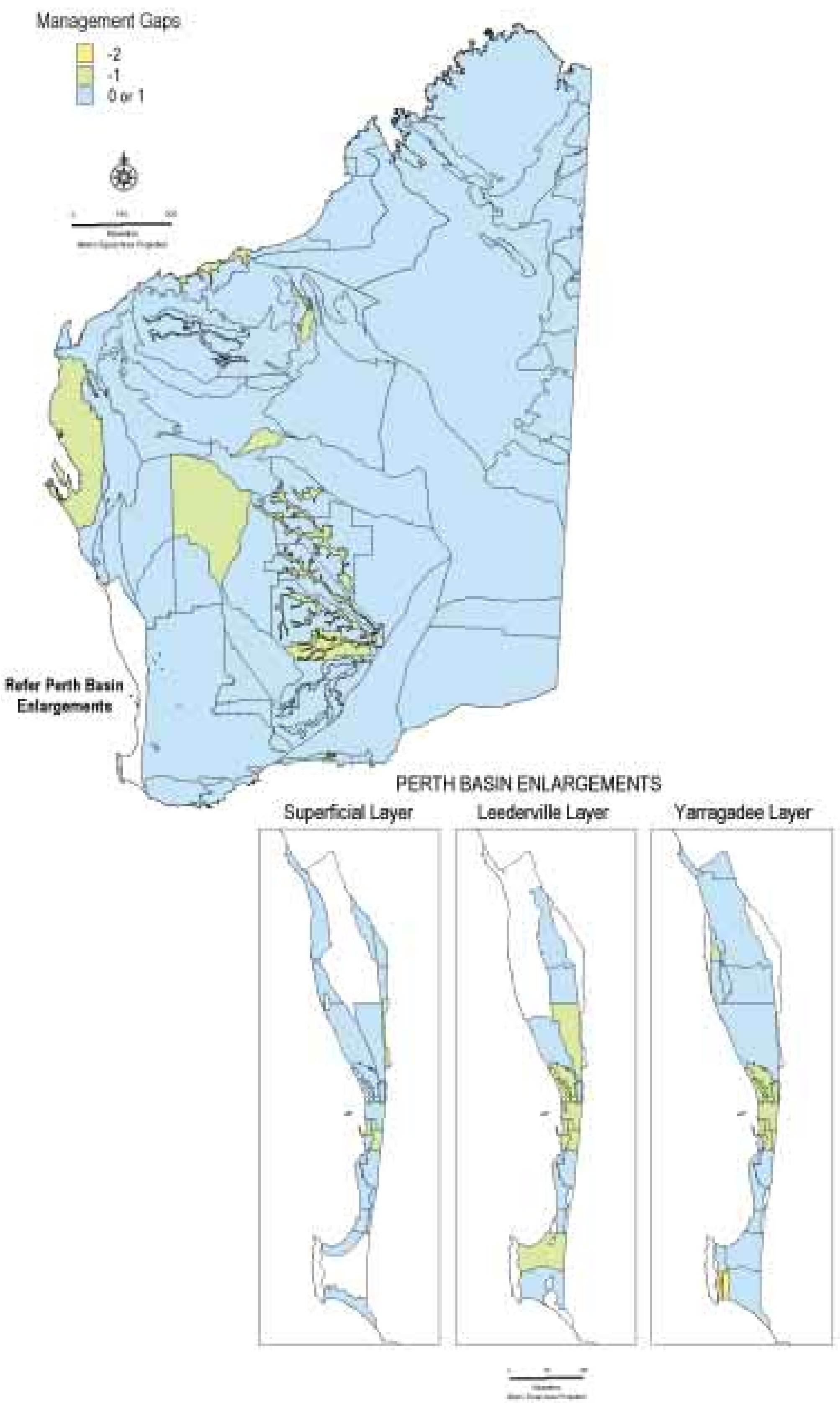


FIGURE 6-11

GROUNDWATER RESOURCE MANAGEMENT GAPS

7 Management of Water Resources into the Future

7.1 INTRODUCTION

As part of the Audit, demand scenarios were developed to indicate the likely future demands for water and the pressure that these demands are likely to exert on available resources. The year 2020 was selected for the future projection of water resource development estimates.

7.2 HISTORICAL GROWTH IN WATER USE

The comparisons of groundwater use between current audit estimates and Review85 previously presented in this document indicate significant growth in water use since the nominal 1983/84 base year of Review85. In Review 85 the estimated gross water consumption in the State from all sources was 835 GL/Yr. In this Audit, figures for current use (based on Water and Rivers Commission's licensed volumes in 1999-00) indicate that gross water consumption from all sources, including losses, amounts to 1,791 GL/Yr. This is shown by use type in Figure 7-1 and by state region in Figure 7-2.

Difficulties encountered in Review85 in capturing all water use data, changes in the definition of water use, and quality control issues generally, suggest that growth rates should not be inferred from a comparison of these data. Significant factors apart from normal economic growth have affected the estimates of total water use from these two sources. These include mine dewatering (not adequately covered in Review85), the significant "step-function" of development in the Ord Irrigation Scheme and a widespread increase in self-supplied irrigation activity from surface water and groundwater in the South West.

7.3 DEMAND PROJECTIONS

In this study, seven primary user sectors have been adopted, namely (i) stock, (ii) irrigation agriculture, (iii) mining, (iv) manufacturing industry, (v) service industries (eg financial, tourist, education and health sectors), (vi) urban parks and gardens, and (vii) domestic households. Demand projections were undertaken using the MONASH economic model by transposing population and industry growth projections within each sector to likely demands for water. The basic statistical units for which demands were estimated are shown in Figure 7-3. These 19 demand regions are consistent with Australian Bureau of Statistics (ABS) statistical boundaries.

Modelling to the year 2020 indicates an estimated aggregated State growth rate in water demand of 3.2% per annum, with regional rates varying from 2.2% to 5.2%. This growth relates to a Statewide water demand in the order of 3,600 GL in the year 2020. Figure 7-4 depicts the historical use of water from 1900 to the present year and its projected use to the year 2020. The estimates have assumed that physical production in the mining and irrigation industries, and hence their water requirements, will grow faster than real value added. This assumption is consistent with views expressed in the recent Australian Bureau of Agriculture and Resource Economics (ABARE) Outlook 2000 Conference. Water demand in manufacturing and services is assumed to grow in proportion to real value added. Household water demand is assumed to grow proportionally to population growth rates in each water demand region, as projected by the ABS and the Western Australia Ministry for Planning.

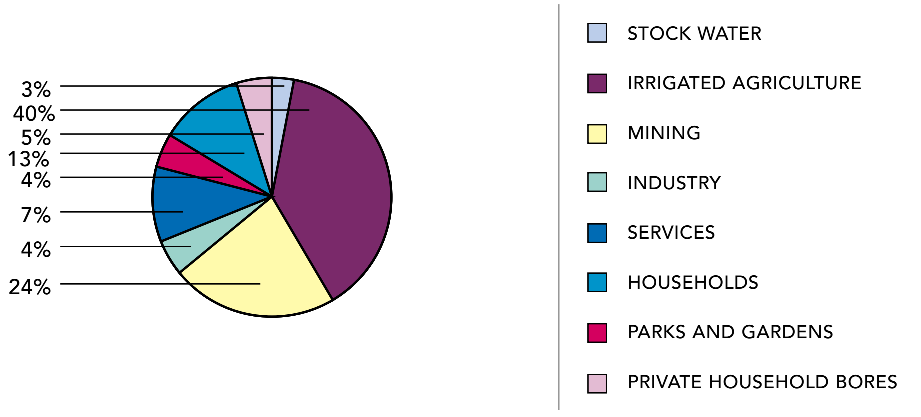


FIGURE 7.1:

TOTAL STATEWIDE WATER USE BY USE GROUP IN 1999-00

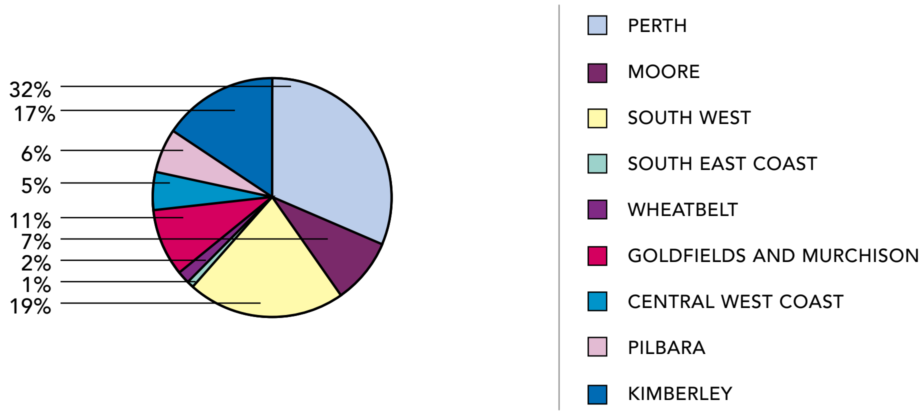


FIGURE 7-2:

REGIONAL SHARES OF TOTAL WATER USE IN 1999-00

In absolute terms, the largest growth in water use is expected in the Perth and Moore (urban and irrigation), Ord (irrigation), Preston (urban and irrigation) and Goldfields (mining) demand regions. Coupled with the commonly recognised expectation for growth associated with urban centres and the next phase of the Ord River development, there is an indication of continued intensification of demand for (resource management-intensive) self-supplied water in the south western and eastern areas of the State.

7.4 RESOURCE UTILISATION IN THE YEAR 2020

The projected changes in the level of resource utilisation for the year 2020 are shown in Figure 7-5 for surface water drainage divisions and in Figure 7-6 and Figure 7-7 for groundwater divisions. Overall it is predicted that there will be five additional surface water management areas in Category 3 (70-100% of sustainable yield allocated), whilst the number of areas in lower utilisation categories will drop accordingly. Management action will be aimed to eliminated the current over-allocation in two GMUs before the year 2020. The number of GMUs in Category 3 (70-100% of sustainable yield allocated) is expected to increase from 47 to 68 by the year 2020 and there will be a corresponding decrease in the number of GMUs in the lower utilisation categories.

FIGURE 7-3

DEMAND REGIONS

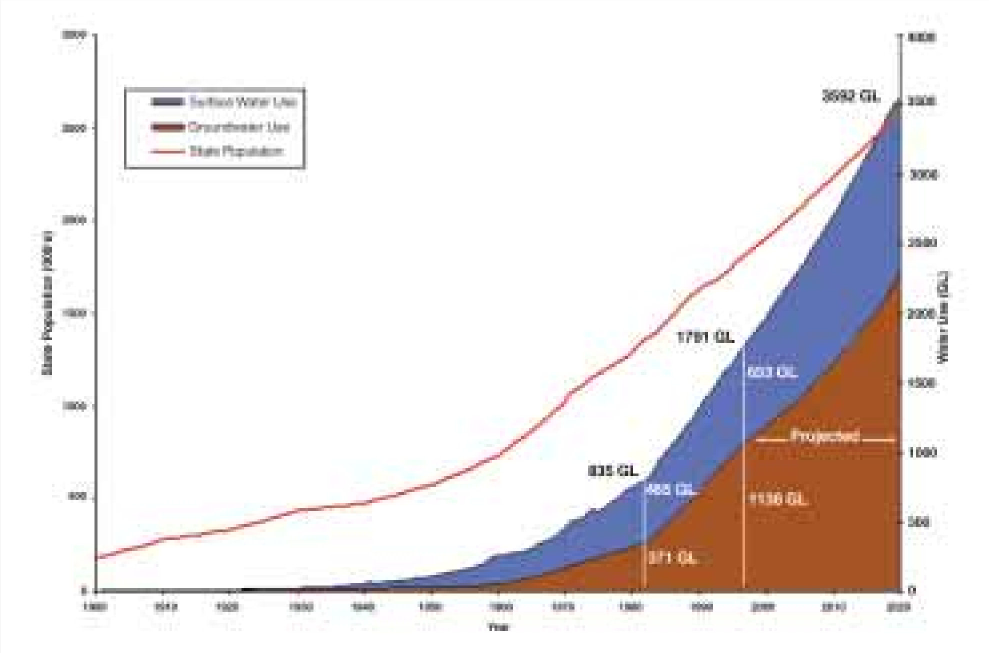


FIGURE 7-4

HISTORICAL WATER USE AND DEMAND PROJECTIONS

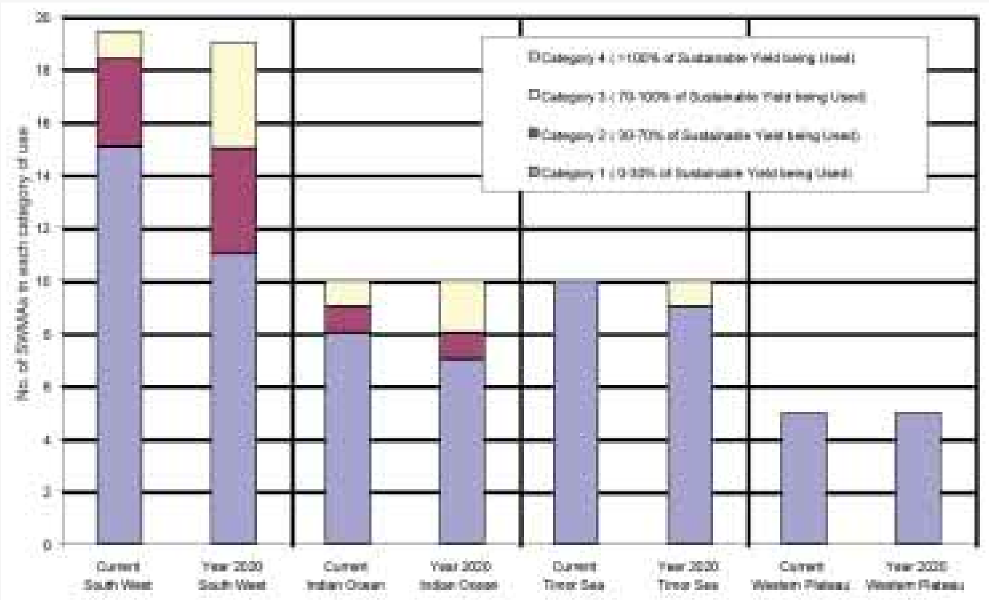


FIGURE 7-5

CHANGE IN SURFACE WATER RESOURCE UTILISATION CATEGORY

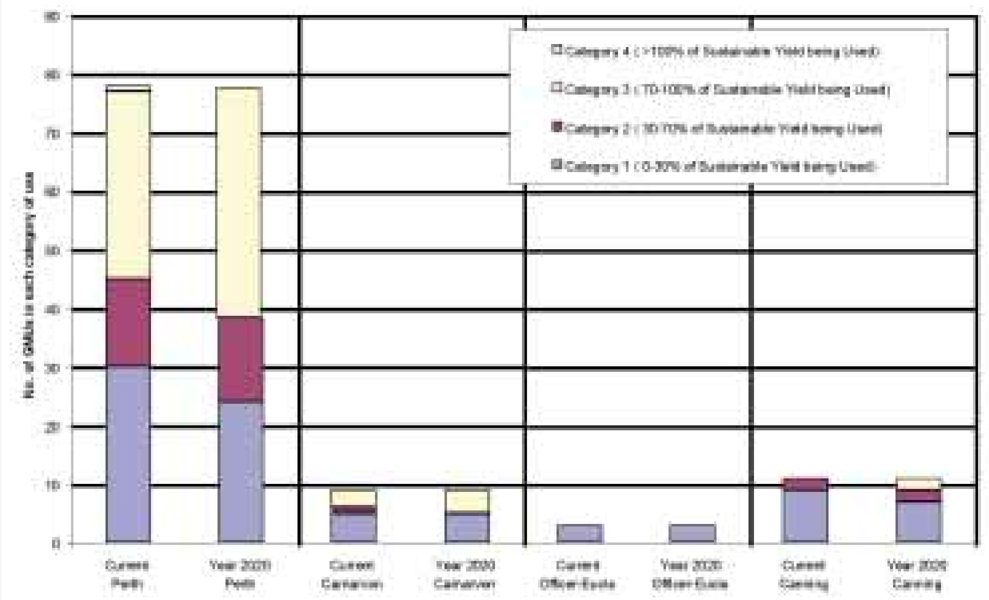


FIGURE 7-6

CHANGE IN GROUNDWATER SEDIMENTARY BASIN RESOURCE UTILISATION CATEGORY

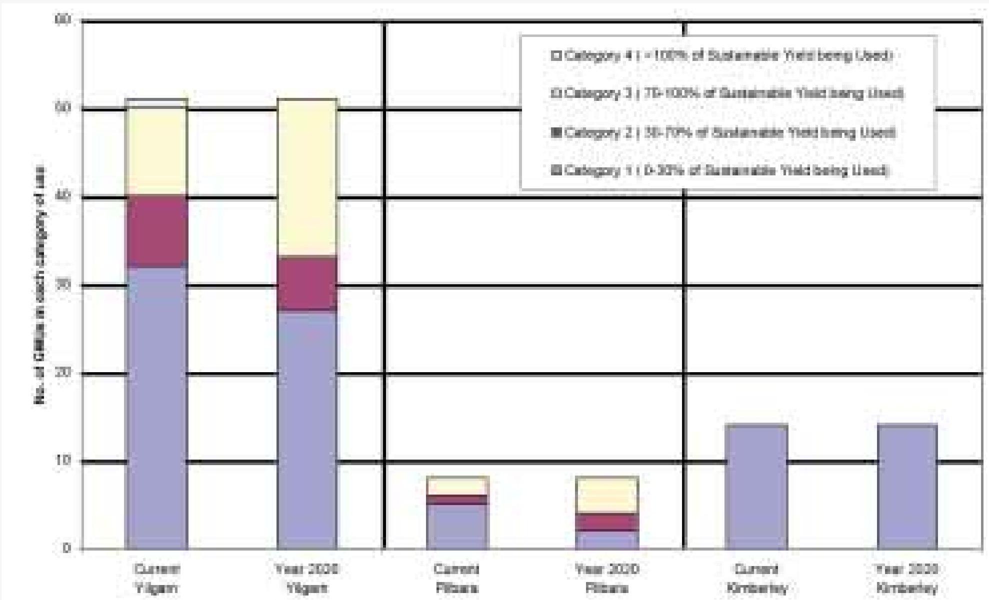
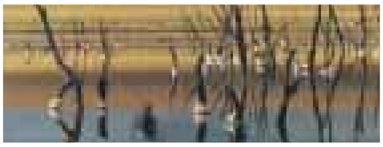
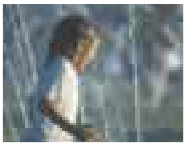


FIGURE 7-7

CHANGE IN GROUNDWATER FRACTURED ROCK AQUIFER RESOURCE UTILISATION CATEGORY

8 Conclusions and Future Directions





The Western Australian component of the National Land and Water Resources Audit has achieved a number of important outcomes for the management of water resources across the State. These outcomes are summarised below.

8.1 WATER AND THE ENVIRONMENT

- The audit has produced a significantly more meaningful inventory of State water resources by incorporating environmental water provisions for the first time in yield estimates. This was in accordance with the State's two-tiered process of addressing environmental water requirements.

8.2 RESOURCE MAGNITUDES

- As a consequence of new investigative data, the base estimates of resources (ie before incorporating environmental allocations) have altered in a few instances. However, for the greater part, these base figures are comparable with previous inventories such as Review85.
- The most significant change in the magnitude of resources has been in the estimates of surface water resources of the Indian Ocean Drainage Division. Work of the last decade has increased confidence in the physical capability to harvest surface water in this Division and the divertible resource estimates have increased very substantially.
- A major climate perturbation has persisted for 25 years in the South West region in which annual rainfalls, streamflow and groundwater recharge have been consistently below average. The cause and the possibility of its persistence are not understood. This phenomenon has required significant, and effectively permanent, adjustments in regional allocations and major investment in mitigative action for public water systems. Such adaptations were partly anticipated in the Review85 assessments.

8.3 THE EFFECT OF ENVIRONMENTAL WATER ALLOCATIONS

- The introduction of environmental water allocations has markedly written down the total volume of resources available for sustainable development in relation to the potential inferred by the inventories of Review85.
- The indicated effect of environmental water allocations has been particularly marked in respect to surface water resources. On a State-wide basis some 65% of divertible yield is considered likely to be allocated to the environment, either by reservation of resources in undeveloped areas or the specific provision of environmental water allocations in developed areas.
- The effect of environmental water allocations on groundwater availability are more difficult to isolate than for surface water. However, the effects are greatest on superficial and unconfined resources where more direct environmental contact occurs.
- The groundwater sustainable yield estimates of the Audit are some 14% less than the State's divertible yield figures in Review85. This is despite the general tendency for the volume of groundwater resources to increase progressively with the acquisition of new data. This difference, coincidentally, is probably of similar scale to the overall effect of environmental water provisions on resource estimates. However, other variations between Review85 and the Audit figures mask the effect of these provisions in particular Divisions.


- Assumptions made for assessing environmental water allocations for the purpose of the Audit are indicative not prescriptive. In particular they cannot be interpreted as site specific. However, the broad outcomes are considered representative of the allocation systems currently employed in Western Australian practice.

8.4 CURRENT LEVELS OF UTILISATION

- The current State-wide commitment of surface water to development is about 16% of sustainable yield. The corresponding State-wide figures for sedimentary and fractured rock aquifers were around 25% and 11% respectively.
- Being less intensively allocated than for more populous states, the Western Australian water market demonstrates more opportunity to provide substantial volumes of water for the environment in advance, rather than retrospectively in the water allocation process.
- This circumstance has been stressed by the State as affording an opportunity to make planned reservations of high value streams or rivers a central part of its comprehensive allocation process in association with other State planning processes. The Audit has confirmed this potential.
- Even for the South West Drainage Division, the most developed part of the State, up to 70% of the environmental water allocations are likely to come from regional/sub regional allocation and land planning reservations. About one third come from development level environmental water provisions which has been the sole focus of attention in the National Water Reform process. For the Timor Sea Drainage Division, the reservation of undeveloped areas may account for as much as 90% of the environmental water allocation and the corresponding estimate for the Indian Ocean Drainage Division is approximately 60%.
- This outcome suggests that national reform and future national audits should give more attention to allocations by reservation of undeveloped land and recognise that a comprehensive system of environmental water allocation desirably incorporates a balance of reserving areas from development and providing allocations for the environment in areas where consumptive use is permitted.

8.5 MODEL GROUNDWATER PROVISIONS

- The importance of groundwater development on the Perth Coastal Plain, coupled with the importance of unconfined groundwater aquifers in supporting significant wetlands, has led to a considerable degree of sophistication in the provision of water for the environment from groundwater aquifers. These examples provide an ideal process model for other parts of the State and a useful case study nationally.

8.6 UTILISATION - ACTUAL STATE OF THE RESOURCES

- The Audit categorisation of resources by utilisation is being integrated in the allocation management processes of the Water and Rivers Commission.
- The results of the Audit suggest that the current level of allocative stress on Western Australian water resources is comparatively low. For the most part, water allocation in the State has the opportunity to progress towards higher levels of utilisation through processes which follow precautionary principles.
- Instances of over-allocation are very small and few in number. However, there are a number of resources at the limit of sustainability where progressive review is desirable. Schedules of these sources, their circumstances and action status are established as active working documents.
- The Audit reveals an environment in which only a small fraction of water use is yet at levels which will stimulate the establishment of a water market. These are predominantly in the area of Perth and the South West Irrigation District.

8.7 MANAGEMENT RESPONSES

- While the Audit is generally encouraging in what it reveals about the current state of the resource from an allocation viewpoint, it also highlights some issues in respect to application of the allocation process.
- The Audit reveals that, although current State process is consistent with reform, and although the general outcome of historic practice is very favourable on the ground, there is a significant heritage of allocation implemented under older processes, plans and records. This inheritance needs to be brought up to reform levels of management if sustainable outcomes are to be maintained in the future.

- The State is active in working towards water markets in a few 'market ready' resources and is pursuing some particular market opportunities in the local economic mix. However, activity on upgrading historic allocations, plans and records to current standards needs to be afforded proper priority against action on water markets.
- Some of the assessed response gap between allocation process and desired response may be due to database weaknesses. This needs active review. The move towards marketed water entitlements will demand a strong and well maintained database.

8.8 WATER AND THE ECONOMY - PROJECTION OF FUTURE MANAGEMENT LOADS

- The State Audit, with its 'Water and the Economy' activity, is seeking to extend this 'allocation process' assessment to an appreciation of the added process l oad in the future associated with demand growth.
- The Audit shows that water demand has grown strongly in Western Australia since Review85. Preliminary work on Water and the Economy anticipates a continuing strong demand growth to 2020 at an aggregated rate State-wide of 3.2% equivalent to an approximate doubling of demand. This suggests a very substantial task ahead in maintaining processes which ensure sustainable use.
- Despite an estimated doubling of water use by year 2020, no SWMAs are expected to be over allocated, although high levels of resource development are expected within four additional basins. Twenty additional groundwater resources are expected to reach high levels of development as a result of future water demand.
- One area of particular significance is growth in demand for self-supplied surface water. Historically this has been a comparatively small issue in the Western Australian hydrological regime. However, in recent years it has grown as a process issue of important proportions in socio-economic terms. Although relatively small in terms of resource scale, these developments are particularly demanding in process terms.

• Glossary •

CURRENT ALLOCATION

The amount of water which is allocated for use from a water resource each year.

ALLUVIUM

Detrital material transported by streams and rivers.

AQUIFER

A geological formation or group of formations able to receive, store and transmit significant quantities of groundwater.

CONFINED AQUIFER

An aquifer located between upper and lower layers of low permeability (layers within which water does not flow freely).

CONJUCTIVE USE

The use of water from different sources in the most efficient and effective manner.

DIVERTIBLE YIELD

The amount of surface water that can economically be diverted from a catchment each year.

EPHEMERAL RIVER

A river with short-lived irregular flows.

FRACTURED ROCK AQUIFER

Hard rock region that generally contains water within its open spacings, such as from a fracture.

GIGA LITRE (GL)

A volume that equates to one thousand million litres or one million cubic metres.

GROUNDWATER

Water occurring below the land surface.

HARD ROCK

Igneous or metamorphic rock consisting of interlocking mineral grains.

MEAN ANNUAL FLOW

The amount of surface water that on average is generated by a catchment each year.

MONASH ECONOMIC MODEL

Formerly called the ORANI model, it has been developed over the past 15 years in order to trace the impacts of alternative national economic scenarios and industry policies on individual industries and regions. It can also be used to examine the implications of "shocks" at regional level that come from new major projects.

NATIONAL LAND AND WATER RESOURCES AUDIT

The National Land and Water Resources Audit is one of the programs of the Natural Heritage Trust. Its purpose is to provide a comprehensive national appraisal of Australia's natural resource base. More details on the Audit can be found in its website www/nlwra.gov.au

PERENNIAL STREAMS

Stream that flows all year.

RELIABILITY OF WATER RESOURCE

Potential as a supply source to meet water use demands.

SEDIMENTARY AQUIFER

A porous and permeable aquifer, such as sand, conglomerate or limestone.

SEDIMENTARY BASIN

An area containing a thick and laterally extensive sequence of sedimentary rocks that have not been severely altered or deformed.

SURFACE WATER

An open body of water such as a stream, river, lake or reservoirs.

SUSTAINABLE YIELD

The amount of water that can sustainably harvested each year from a water resource. This includes both economic and environmental considerations.

UNCONFINED AQUIFER

An aquifer without an overlying layer of lower permeability which generally gets direct vertical water recharge from the surface.

USE

The amount of water which is actually used from a water resource each year.