GOVERNMENT OF WESTERN AUSTRALIA

PILBARA REGION WATER RESOURCES REVIEW AND DEVELOPMENT PLAN SUMMARY REPORT 1996

WATER RESOURCE ALLOCATION AND PLANNING SERIES

WATER & RIVERS COMMISSION REPORT WRAP 4 1996

WATER AND RIVERS COMMISSION

WATER & RIVERS COMMISSION
Hyatt Centre
3 Plain Street
East Perth
Western Australia 6004
Telephone (09) 278 0300
Facsimile (09) 278 0301

Agriculture in the Pilbara (John Bush, Auswest Ecology Consulting Services)

PILBARA REGION
WATER RESOURCES REVIEW AND
DEVELOPMENT PLAN
SUMMARY REPORT
1996

A pamphlet designed to provide the community with an outline of the water resources in the Pilbara Region and the probable future usage of that water in the Region

Water and Rivers Commission
Policy and Planning

WATER AND RIVERS COMMISSION
WATER RESOURCE ALLOCATION AND PLANNING SERIES
REPORT NO WRAP 4 1996

Acknowledgements

Richard Forrest (Author), Jade Coleman (Co-Author), Peter Goodall, Jenny Hart, Ian Loh, John Ruprecht and Peter Van De Wyngaard of the Water and Rivers Commission, Gerry McCourt of McErry Digital Mapping, Gary Crisp of the Water Corporation, Bob Wark of Geo-Eng Australia and Vince Piper of AGC Woodward - Clyde.

Reference Details

The recommended reference for this publication is: Water and Rivers Commission 1996, *Pilbara Region Water Resources Review and Development Plan, Summary Report,* Water and Rivers Commission, Water Resource Allocation and Planning Series No. WRAP 4.

ISBN 0-7309-7263-1

Text printed on recycled stock,
Onyx 100% recycled 100gsm
Cover, Topkote Dull Recycled 256gsm
December 1996

Summary

Introduction

This booklet provides a concise outline of the existing and potential water resources as well as an insight into the possible future growth rates of population, industry and agriculture in the Pilbara Region. More detail may be found in the main report entitled Pilbara Region Water Resources Review and Development Plan (1996). The Water and Rivers Commission and its predecessor, the Water Authority, has seen the need for a Pilbara water resource review to be undertaken for some time. The release of the Pilbara 21 Study (1992), which identified the need for the State to quantify surface and ground water resources in the Region to develop a management plan, gave the project the necessary impetus.

The Pilbara Region is recognised by the State as having great export potential and the requirement for water is essential for development to occur. This pamphlet summarises the water resources in the Region and the likely water requirements of potential developments that could be supplied from these sources.

The study area is defined by the boundary shown in Figure 1 and has been drawn up to include the Australian Water Resources Council (AWRC) Drainage Basins 706 - 710, and the north-west portion of the Sandy Desert, to include mining centres such as Telfer as well as Aboriginal communities such as Punmu. The total study area covers 337 212 km^2.

The major towns in Drainage Basin 706 are Paraburdoo and Tom Price; in Drainage Basin 707, Onslow and Pannawonica; in Drainage Basin 708, Newman and Wittenoom; in Drainage Basin 709, Dampier, Karratha, Wickham, Roebourne and Port Hedland; in Drainage Basin 710, Goldsworthy, Marble Bar and Nullagine; and in the Sandy Desert Basin 025, Telfer.

A large proportion of the study area is used for the grazing of sheep and cattle. Pastoral properties constitute the major economic land use, in terms of area covered, in the Region. In the past, this has caused environmental damage through overstocking and overgrazing, due to the lack of knowledge and controls of operating in a variable, harsh environment. Other major land uses in the region include mining, resource processing, fishing and tourism. The mining industry in the Pilbara Region is considered of great importance to the economic development of the State.

Water Resources

Water resources in the Region can be divided into two components; surface water and groundwater.

The surface water resources include the Region's rivers, streams, wetlands and pools. The Region has surface rivers and streams, some of which have the potential to be dammed. The surface water resources referred to in this booklet are shown in Figure 2 and Figure 3.

The groundwater resources of the Region provide the majority of the water supplies to towns, industry and agriculture. The Region does not conform precisely to the groundwater area boundaries, however, it does contain the Pilbara Groundwater Area and part of the East Murchison and Gascoyne Groundwater Areas. The groundwater resources are illustrated in Figure 4.

This very preliminary assessment has indicated that in some cases environmental values are likely to be significantly affected by water resource development, while other potential developments may remain relatively unconstrained.

Water Use Projections

Water service and demand projections were undertaken. Water services for each town were undertaken to form the basis of the town water supply projections and are illustrated in Figure 5. Based on these water demand projections, water source development options for each water supply were offered. Water demand projections for industry and agriculture were undertaken also.

Water Resource Development Plans

Most of the towns in the study area obtain their water from groundwater resources. Those that obtain their water from surface water resources have a conjunctive groundwater scheme. The towns supplied by groundwater have enough surplus capacity available in the aquifer to allow for expansion of their existing borefields. Currently Robe River Iron Associates are

looking at the possibility of the sale of surplus capacity from the Pannawonica groundwater source to the Water Corporation.

The expected major growth centres of the study area are the Karratha and Port Hedland regions. The combined water demand for these two centres is predicted to increase from the current combined demand of 15.8 GL/yr to about 79 GL/yr by the year 2025. Currently, the West Pilbara and Port Hedland Water Supply Schemes do not have adequate surplus to meet anticipated demands within the planning period. However, there are sufficient potential source development options for both schemes to meet these anticipated demands. This is shown in Table 2.

Conclusions

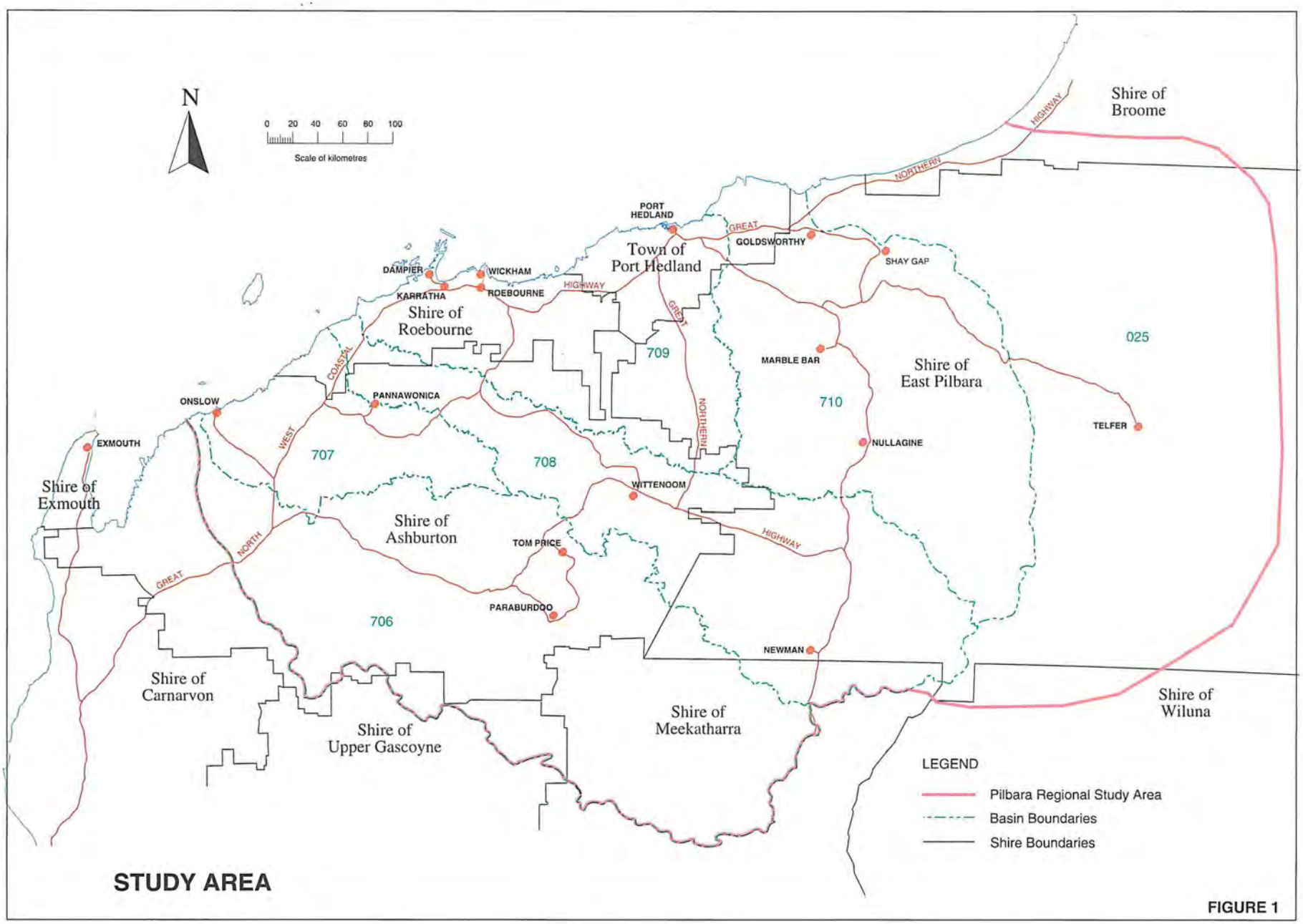
It would appear that all the Pilbara town water supply sources are capable of meeting unrestricted demand under normal climatic conditions. However, during extended dry periods some towns will experience restrictions.

The currently approved Harding/Millstream conjunctive use scheme has a system yield of 15 GL/yr. A comprehensive water management and monitoring programme is being developed to allow for a review of the impacts of high draw rates on environmental features at Millstream. This report will be a companion document to CALM's Millstream - Chichester National Park Management Plan. The sustainable yield from the West Pilbara Water Supply Scheme, which includes Millstream, will be determined as part of that planning and review process.

The large companies operating in the Pilbara in the late 1960's and 1970's made agreements with the State that entitled them to specific quantities of water from the Water Authority's (now the Water Corporation) water schemes. This entitlement was for domestic as well as industrial purposes. The quantity of water used for industrial purposes can be easily metered. However, the companies have been selling their houses to employees which makes it difficult to measure the quantity of water being used for domestic purposes.

The combined entitlement of companies drawing water from the West Pilbara Water Supply Scheme amounts to almost 10.8 GL annually. They are currently using 5.1 GL. The combined entitlement, with the addition of the domestic demand outside the combined company entitlement (4.1 GL) equates to almost 15 GL/yr, which is the full capacity of the current scheme. Similarly, for the Hedland Water Supply Scheme, the combined entitlement of companies drawing water amounts to almost 6.5 GL annually. They currently use 3.0 GL. If the full entitlement were required the scheme would need to deliver about 10 GL annually (3.5 GL from domestic demand outside the combined company entitlement). Based on DRD's list of potential industries that could be developed, it is highly unlikely that developments at Karratha and Port Hedland would require more than 70 GL/yr by the year 2025.

It would appear that the availability of water resources in the Region will not impede new developments in the Pilbara. The Pilbara 21 Study stated that as a result of the costly development of these resources, they "be allocated and used in an efficient and equitable manner". Water intensive industries should be discouraged unless they have a high " value added " component.


N
0 20 40 60 80 100
Scale of kilometres
Shire of Broome
NORTHERN HIGHWAY
PORT HEDLAND
GREAT NORTHERN HIGHWAY
GOLDSWORTHY
SHAY GAP
Town of Port Hedland
DAMPIER
WICKHAM
KARRATHA
ROEBOURNE
Shire of Roebourne
COASTAL
709
MARBLE BAR
Shire of East Pilbara
025
ONSLOW
PANNAWONICA
710
TELFER
EXMOUTH
WEST
707
708
NULLAGINE
Shire of Exmouth
WITTENOOM
Shire of Ashburton
NORTH
GREAT
TOM PRICE
HIGHWAY
PARABURDOO
706
NEWMAN
Shire of Carnarvon
Shire of Upper Gascoyne
Shire of Meekatharra
Shire of Wiluna
LEGEND
Pilbara Regional Study Area
Basin Boundaries
Shire Boundaries
STUDY AREA
FIGURE 1

Surface Water Resources

The surface water resources include the Region's rivers, streams, wetlands, and pools. The Region has surface rivers and streams, some of which have the potential to be dammed.

The Pilbara is a region which experiences extreme climatic conditions. Severe droughts and major floods can occur at close intervals and their effect on individuals, communities and government agencies can be significant. The regional assessment of the surface water resources requires information on the climate (rainfall and evaporation) and streamflow.

Rainfall was first officially measured in 1882 at Cossack, near Roebourne. By 1900, the number of rainfall stations had increased to 43, and currently there are 167 daily read rainfall stations operated by the Bureau of Meteorology. The Water Authority (now Water Corporation) commenced measurement of rainfall in 1968, and by 1994 had 76 rainfall stations (pluviographs) in the Pilbara Region.

The first measurements of streamflow in the Pilbara commenced in December 1965 on the Harding and Fortescue Rivers. By 1970, there were 20 gauging stations in the Pilbara. From 1970 to 1975 a further 16 gauging stations were opened. Since 1975, there has been a slight decrease in the total number of stations operating, with 12 new stations balanced by the closure of 16 stations. Currently, there are 28 gauging stations measuring streamflow operated by the Water and Rivers Commission in the Pilbara Region and 2 stations measuring water level at the Harding and Opthalmia Dams.

Table 1: Flow Frequencies and Median Annual Flow

River	No. Times Flowed	Period of Record	Median Annual Flow (GL/yr)
Ashburton	19	1971 - 1991	410
Cane	7	1986 - 1992	61
Robe	15	1972 - 1992	15
Fortescue	22	1968 - 1992	95
Maitland	17	1972 - 1992	10
Sherlock	18	1967 - 1991	40
Yule	13	1972 - 1992	150
DeGrey	16	1974 - 1991	780
Shaw	19	1967 - 1991	98
Coongan	19	1966 - 1992	30

Surplus available surface water will be foregone for development where the diversion development, such as a dam, would have an unacceptably adverse impact on environmental/social issues. Specific constraints will be determined for each development according to the downstream environmental/social needs and other issues through the environmental impact assessment process which is administered by the Department of Environmental Protection (DEP) and the Environmental Protection Authority (EPA). Development of any surface water resources must pass through this process before it is implemented.

The following is a summary of the surface water resources of each river basin.

Ashburton River Basin (706)

The surface water resources of the Ashburton River Basin are generally good. Only one potential dam site has been recognised on the Ashburton River. Additional yield may be available if the dam site is used conjunctively with groundwater.

- Catchment Area (km²): 77 037
- Mean Annual Flow (GL/year): 320
- Amount Reserved For In-situ Uses (GL/year): 9
- Amount Available For Withdrawal (GL/year): 311
- Annual Divertible Yield (GL/year): 37

Dam/Damsite	Average Streamflow (GL/year)	Storage Capacity (GL)	Divertible Yield (GL/year)	Potential Divertible Yield (GL/year)
Ashburton River (DS34)	320	1 120	N/A	37

Onslow Coast Basin (707)

The Onslow Coast Basin is dominated by the Robe and Cane Rivers. The Robe River catchment is the subject of extensive mining claims and these have a profound impact on the development of water resources. Five potential dam sites have been identified in this basin.

- Catchment Area (km²): 17 558
- Mean Annual Flow (GL/year): 80
- Amount Reserved For In-situ Uses (GL/year): 4
- Amount Available For Withdrawal (GL/year): 76
- Annual Divertible Yield (GL/year): 22

Dam/Damsite	Average Streamflow (GL/year)	Storage Capacity (GL)	Divertible Yield (GL/year)	Potential Divertible Yield (GL/year)
Robe River (DS124)	27	1 120	N/A	4
Robe River (DS154)	18	72	N/A	9
Kumina Creek (DS20)	2.5	13	N/A	0
Cane River (DS74)	62	110	N/A	6
Cane River (DS114)	18	90	N/A	3

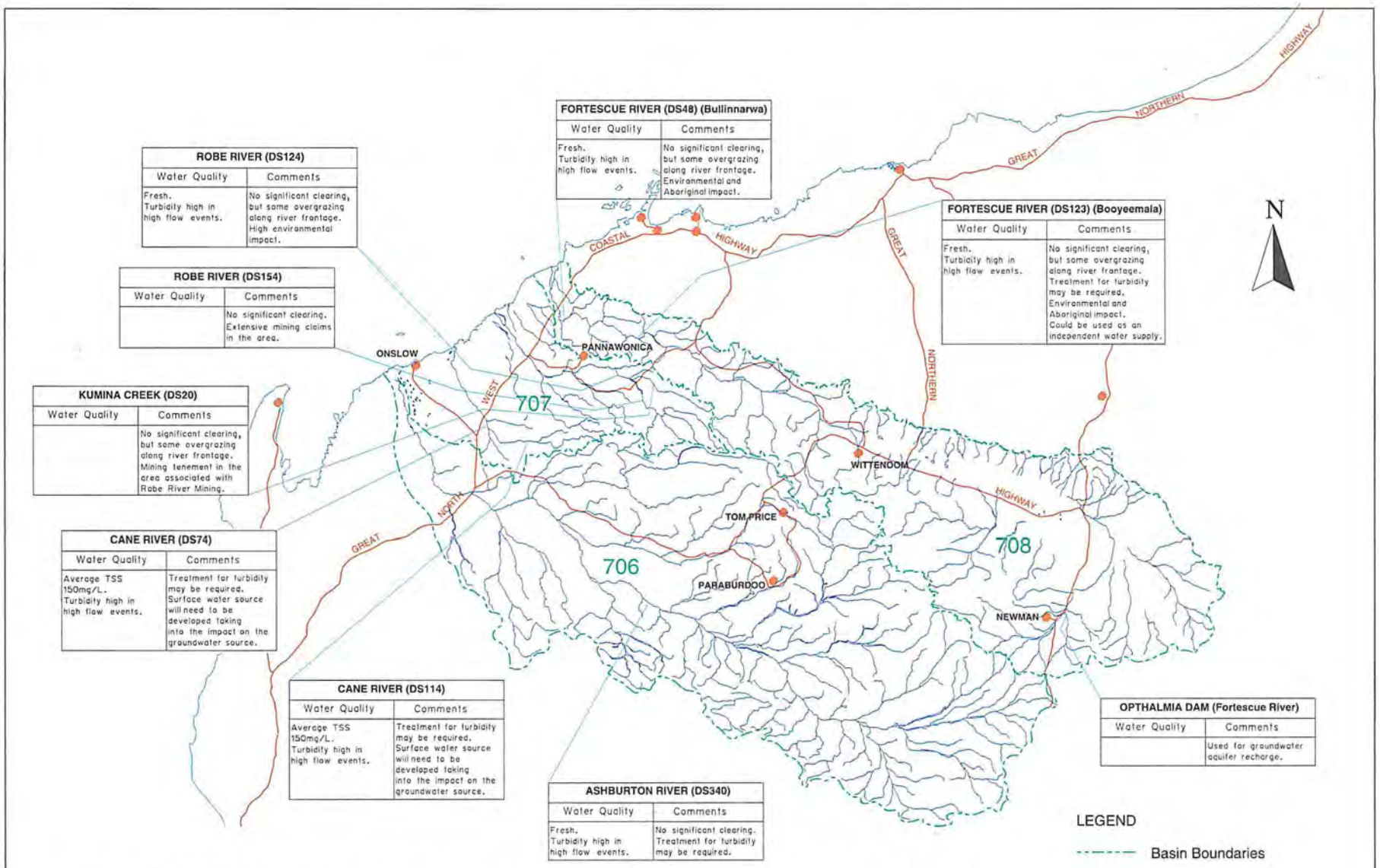
Fortescue River Basin (708)

The surface water resources of the Fortescue River Basin are generally good. Two potential dam sites have been identified on the Fortescue River. The development of dams at these sites will have a significant impact on the environment and Aboriginal values. The Opthalmia Dam is used to artificially recharge the groundwater source for the Newman Town Water Supply Scheme.

- Catchment Area (km^2): 49 795
- Mean Annual Flow (GL/year): 200
- Amount Reserved For In-situ Uses (GL/year): 14
- Amount Available For Withdrawal (GL/year): 186
- Annual Divertible Yield (GL/year): 106

Dam/Damsite	Average Streamflow (GL/year)	Storage Capacity (GL)	Divertible Yield (GL/year)	Potential Divertible Yield (GL/year)
Fortescue River (DS48)	200	672	N/A	54
Fortescue River (DS123)	147	210	N/A	42
Fortescue River (Opthalmia Dam)	31	32	10	-

Fortescue River (John Bush, Auswest Ecology Consulting Services)



ASHBURTON RIVER, ONSLOW COAST AND FORTESCUE RIVER BASINS - SURFACE WATER SOURCE AND WATER QUALITY

FIGURE 2

Port Hedland Coast Basin (709)

The Port Hedland Coast Basin is dominated by the Maitland, Harding, George, Sherlock, Peawah, Yule and Turner Rivers. Four potential dam sites have been identified in this basin. The development of dams at these sites will have a significant impact on the environment and Aboriginal values.

- Catchment Area (km²): 35 191
- Mean Annual Flow (GL/year): 418
- Amount Reserved For In-situ Uses (GL/year): 18
- Amount Available For Withdrawal (GL/year): 400
- Annual Divertible Yield (GL/year): 37.8

Dam/Damsite	Average Streamflow (GL/year)	Storage Capacity (GL)	Divertible Yield (GL/year)	Potential Divertible Yield (GL/year)
Yule River (DS95)	184	644	N/A	8.0
Harding River (D43)	42.1	63.8	15	15*
Sherlock River (DS48)	172	602	N/A	8.3
Nunyerry Creek (DS9)	10	820	N/A	5
Munni Munni Creek (DS15)	20	80	N/A	1.5

* constrained by environmental management issues

DeGrey River Basin (710)

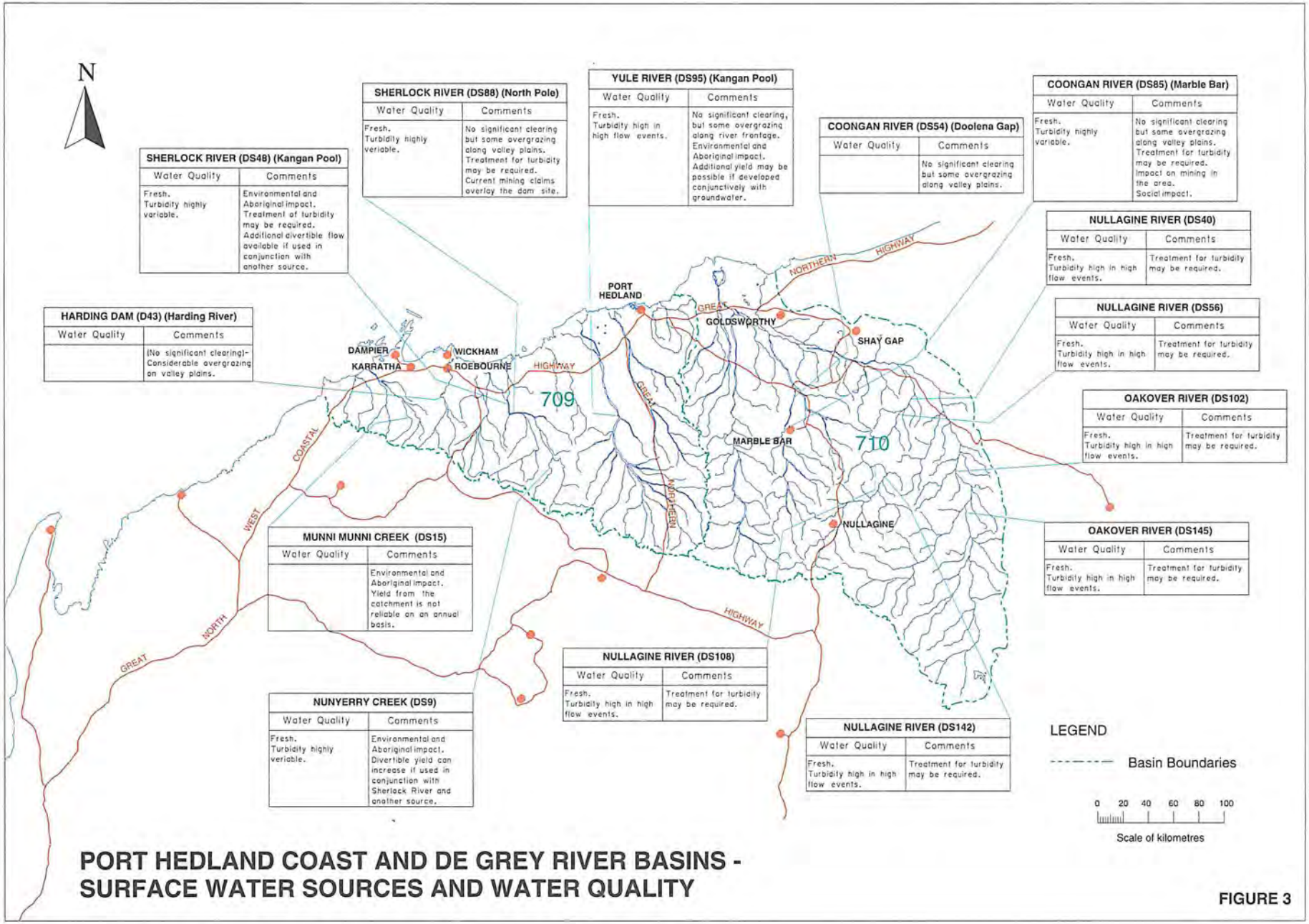
The DeGrey River Basin is dominated by the DeGrey, Strelley, Shaw, Coongan, Oakover and Nullagine Rivers. Ten potential dam sites have been identified in this basin. The development of dams at some of these sites will have an impact on future and existing mining tenements.

- Catchment Area (km²): 56 889
- Mean Annual Flow (GL/year): 890
- Amount Reserved For In-situ Uses (GL/year): 64
- Amount Available For Withdrawal (GL/year): 826
- Annual Divertible Yield (GL/year): 326 - 521

Dam/Damsite	Average Streamflow (GL/year)	Storage Capacity (GL)	Divertible Yield (GL/year)	Potential Divertible Yield (GL/year)
Shaw River (DS88)	180	502	N/A	80
Coongan River (DS54)	130	240	N/A	15
Coongan River (DS87)	110	440	N/A	26
DeGrey River (DS158)	600	2400	N/A	120 - 200
Oakover River (DS102)	260	950	N/A	20 - 50
Oakover River (DS145)	120	590	N/A	5 - 25
Nullagine River (DS40)	125	200	N/A	0 - 20
Nullagine River (DS56)	115	460	N/A	25 - 40
Nullagine (DS108)	90	360	N/A	20 - 35
Nullagine (DS142)	80	410	N/A	15 - 30

Sandy Desert Basin (025)

The Sandy Desert Basin has no significant river features.



PORT HEDLAND COAST AND DE GREY RIVER BASINS - SURFACE WATER SOURCES AND WATER QUALITY

FIGURE 3

Groundwater Resources

Groundwater occurs throughout the Pilbara Region in the Precambrian basement rocks, Phanerozoic sedimentary basins and Cainozoic deposits. It originates from direct rainfall recharge over outcropping basement rocks and from infiltration of rainfall and runoff through Cainozoic deposits. Groundwater in the Late Jurassic to Early Cretaceous sediments of the western Canning Basin originates from direct infiltration of rainfall, and groundwater in the Mid to Late Jurassic sediments of the Canning Basin originates mostly from downward flow through the younger sediments in the southern part of the Western Canning Basin. Groundwater in the Carnarvon Basin sediments originates from leakage through the Cainozoic deposits.

The most significant and exploited groundwater resources of the Pilbara Region are contained within the alluvial aquifers on the coastal plains and the valley fill aquifers within the Fortescue Valley and Hamersley Range. Minor calcrete and alluvial aquifers in the upland areas are important for the provision of small quantities of groundwater for pastoral station supply and also provide water for some small towns. Groundwater resources in basement rocks are exploited locally for mining and town supply purposes as well as for miscellaneous infrastructure development purposes.

To facilitate long term management of the groundwater resources most of the region covering these basins has been proclaimed as Groundwater Areas (GWA's) under provisions of the Rights in Water and Irrigation Act (1914) (RIWI). The location of existing GWA's and the estimated availability of groundwater resources within the study area are illustrated in Figure 4.

Pilbara Groundwater Area

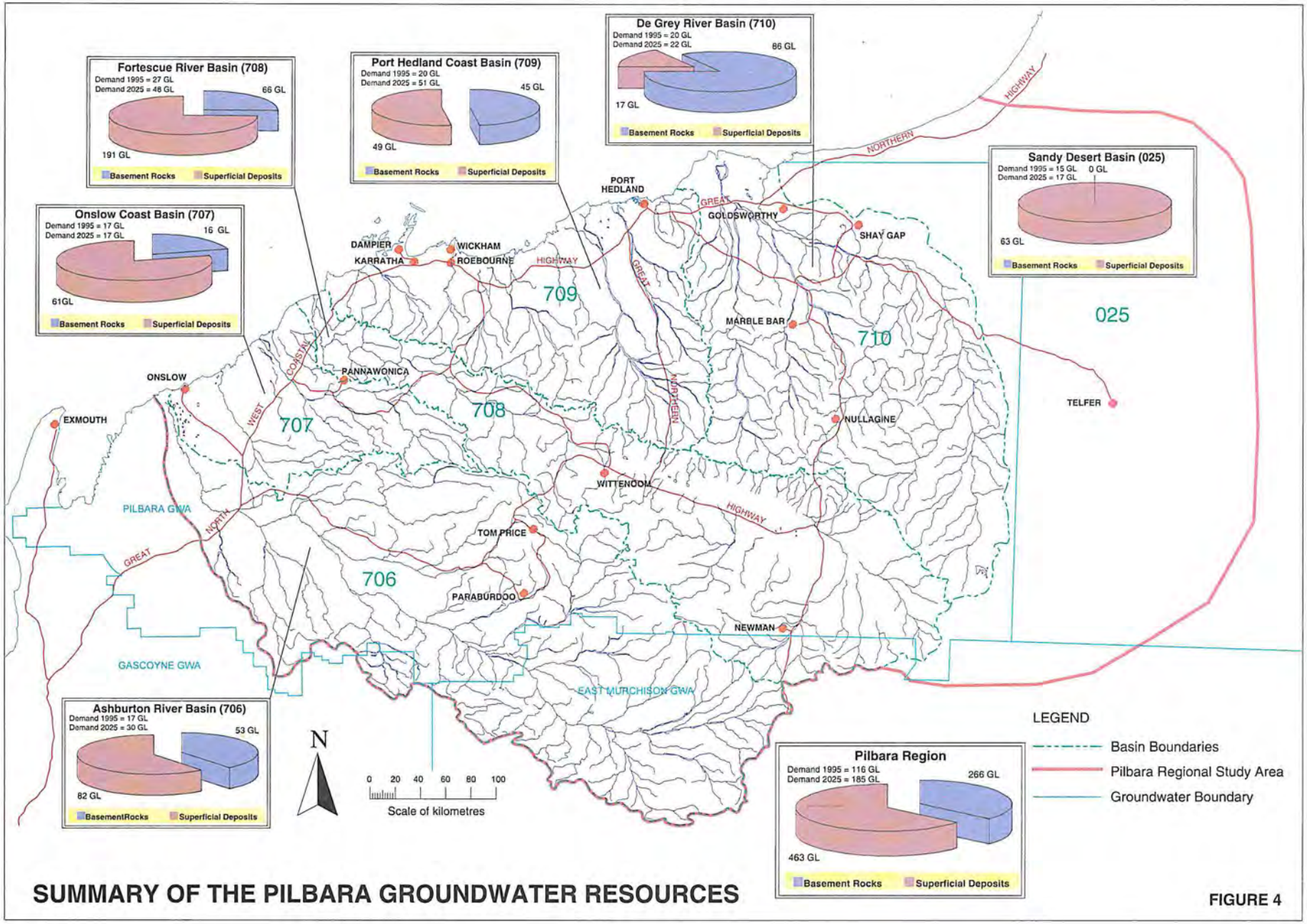
The GWA consists of 2 subareas and covers a total area of 23 6755 km^2. The GWA overlays 66% of the study area (335 490 km^2). The total available groundwater resource of the Pilbara GWA is not defined for each subarea. The water resource is allocated to both public and private use under Fundamental Allocation Principles. Total allocation for the Pilbara GWA is about 114 GL. This is distributed across a total of 147 licences. The greatest water usage in the area comes from industry and mining. Water is generally fresh, but in some areas it is marginal or variable.

East Murchison Groundwater Area

The East Murchison GWA consists of 1 subarea and covers a total area of 543 717 km^2. The GWA overlays 11% of the study area. The total available groundwater resource of this GWA is not defined. Water is allocated to both public and private use under Fundamental Allocation Principles. Total private allocation is 14 148 ML and total public allocation is 650 ML. These are distributed across 34 licences. The greatest water usage comes from mining (14 131 ML). Water quality is variable.

Gascoyne Groundwater Area

The Gascoyne GWA consists of 9 subareas and covers a total area of 209 771 km^2. The GWA overlays less than 1% of the study area. The total available groundwater resource of this subarea is not defined. Water is allocated to private use under Fundamental Allocation Principles. Total private allocation is 310 ML. These are distributed across 17 licences. The greatest water usage comes from horticulture (132 ML) and industry (85 ML). Water quality is variable.



SUMMARY OF THE PILBARA GROUNDWATER RESOURCES

FIGURE 4

Environmental/Social Issues

This very preliminary assessment has indicated that in some cases environmental values are likely to be significantly affected by water resource development, while other potential developments may remain relatively unconstrained. The environmental and social values of each river basin are outlined below.

Environmental Issues

Harding/Millstream

Work is being done on Harding/Millstream because of concern about vegetation health downstream of the dam. A study of the environmental water requirements of Millstream has been completed (Welker, 1995). This report discusses a number of environmental issues of interest. These include:

- the consequences of groundwater discharge from the Millstream aquifer on systems of interest, such as Deep Reach Pool, Chinderwariner Pool, Millstream and woodley deltas and Palm Spring;
- the environmental influences on vegetation at Millstream;
- the tolerance of plants to water stress; and
- the impact of declining groundwater levels on tree species.

The study also outlines water resource management options to mitigate impacts on the Millstream vegetation.

The Millstream aquifer supports ecosystems that are unique and are of substantial environmental significance. The Water and Rivers Commission has made a formal commitment to protect parts of the Millstream ecosystem from adverse impacts of groundwater abstraction.

Further work is now being undertaken by the Water Corporation to establish a detailed management and monitoring programme so that the sustainable yield can be more accurately defined.

Surface Water Sources

The construction of dams in the West Pilbara Region may cause the loss of:

- riverine vegetation;
- temporary and permanent pools;
- aquatic habitats; and
- potential eutrophication within the dams.

Groundwater Sources

Groundwater sources appear to be the most likely sources to be developed in the short term. Surface water sources will have a greater impact on the environment, as well as on Aboriginal interests. It is likely that many potential sources would require a formal environmental impact assessment under the Environmental Protection Act 1986 before they could be developed for public water supply.

Cultural Values

Aboriginal Sites

Robe River

In the past, Aboriginal people have not raised any objections to the concept of a dam being constructed on the Robe River.

Fortescue River

If a dam at Booyeemala site was constructed there would be a loss of numerous Aboriginal engravings and development within the area of the "ancestral route" which is an important feature of the mythology of traditional Aborigines. However, the reservoir would not affect any known sacred sites.

A dam at Bullinnarwa Site (DS48) could possibly affect Aboriginal sites.

Gregory and Dogger Gorge are sites of particular importance to Aborigines. Inundation of Aboriginal art, habitation and ceremonial sites would occur. Dams at either gorge are no longer considered as options for development for water supplies because impacts to Aboriginal heritage and the environment that would occur would be unacceptable.

Sherlock River

The construction of a dam at site Kangan Pool (DS48) would inundate several Aboriginal habitation sites and at least one ceremonial site.

Maitland River

There are possible Aboriginal sites in the area of the potential dam site on Munni Munni Creek (DS15).

Social Values

Recreational Values

A reservoir at DS123 on the Robe River would constitute a new tourist attraction and potential recreational resource.

The development of a reservoir on Nunyerry Creek (DS9) would have beneficial impacts as a tourist and recreational site. This area is being considered for possible inclusion into Millstream/Chichester National Park.

Currently, environmental, social and cultural water requirements have not been evaluated on a site by site basis in the Pilbara Region. For the purposes of this study, 25% of the total water resources have been reserved for environmental, social and cultural water requirements. Until requirements have been established on a site by site basis, this preliminary allocation will ensure the maintenance of environmental, social and cultural values in the Pilbara Region.

=> Environment/Social and Cultural Water Requirement: 108 125 ML.

Aboriginal Rock Art Engravings - Harding River Dam

Town Water Supply Projections and Water Source Development Options

Resource development, which caused rapid population growth in the Pilbara between 1966 and 1974, has also led to considerable fluctuations in the populations of towns in the Region. Production workforces are smaller than those required for the construction phase of projects and workforce restructuring, the slowdown of construction activity and productivity increases, demanded by volatile and increasingly competitive world markets, have recently combined to reduce town populations.

On the other hand, new projects, increasing numbers of service providers, both public and private, and a trend for families rather than single workers to settle in the Region, have all acted to increase population.

Virtually all the Region's development and population are located in the western half. To date, the eastern half has been largely ignored because of its harsh desert environment and remoteness.

The population of the Pilbara Region and the domestic demand for water is both directly and indirectly influenced by the development of industry in the Region. Domestic water consumption comprises industrial domestic water demand as well as the domestic requirements of each town that are not directly governed by the large industries. The industrial domestic water demand will be directly influenced by the growth of industries. While the domestic water demand of the towns (other than industrial domestic demand) will be indirectly influenced by the growth of industries, which spur the expansion of existing service industries or the development of new service industries.

The large companies operating in the Pilbara in the late 1960's and 1970's made agreements with the State that entitled them to specific quantities of water from the Water Authority's (now Water Corporation) schemes. This entitlement was for domestic as well as industrial purposes. The quantity of water used for industrial purposes can be easily metered, however the companies have been selling their houses to employees which makes it difficult to measure the quantity of water being used for domestic purposes. For the purpose of this study, domestic water demand was assumed to be 10% of the total water demand.

Since developments and population are predominantly located in the western half of the Pilbara Region, it is important that the water resources of this area are allocated sustainably, now and in the future. Similarly, the water resources in the eastern half of the Pilbara Region need to be considered in future planning and development, even though currently the pressure on the water resources is not as crucial as in the western half.

Bore No. 4 - Millstream Borefield (John Bush, Auswest Ecology Consulting Services)

The Pilbara is well known for the mobility of its population, having many short stay residents. The 1986 Census showed that only 5% of the Region's population had lived at the same address for 1 year and 25% for 5 years. The rate of mobility has declined because there are fewer major construction projects. Indications are that several new major construction projects are expected over the next 5-10 years. This will serve to increase mobility, possibly to the levels experienced in the 1960's.

In addition to the above, there is a large itinerant population that moves through the Pilbara during the winter months. There also tends to be a migration of people away from the Region during the summer months of December and January.

Water resources are required to support the population trends of the Pilbara Region. Mobility related to construction projects will have local, short term impacts on water resources, whereas mobility related to seasonal patterns will have a regional and longer term influence on the water resources. These influences need to be considered in the overall planning and allocation of the Region's water resources.

While the Department of Resources Development forecasts that the Pilbara iron ore exports could increase at a rate of up to 5% per annum for the next 10 years (Prospect, March-May 1995), mainly through new mine development in the Central Hamersley Range area extending east of Karajini National Park, the extent of permanent population growth resulting from this expansion will be greatly influenced by trends in contract mining and fly-in/fly-out workforces.

A significant, and growing, proportion of the Pilbara population is represented by fly-in/fly-out workers. It is estimated that currently as many as 1 800 people commute regularly from outside the Region (Sinclair Knight Merz, 1996). A large number of these are employed at offshore petroleum exploration and production facilities, although the majority are now working on mainland projects in the mining industry, either with construction and mining contractors or under employment agreements with the mining companies.

Growth in the number of fly in/fly out workers will result in a decrease in resident town populations and therefore, domestic water consumption. Based on the water delivery figures from Telfer (fly in/fly out mine) the water delivered reduces to about half.

To plan for future growth of the Region it is important to identify future population numbers. In order to support an increasing population, adequate facilities, such as water supply, must be provided.

Water demand projections are shown in Figure 5. Domestic water requirements are assumed to be 10% of the total demand.

Harding River Dam

Industrial Development and Growth Potential

Mineral Resource Industry

Over the last 30 years the Region's economic development has been increasingly dominated by the iron ore mining and offshore petroleum industries. These activities, along with new projects for adding value to the iron ore and petroleum products, are expected to continue to dominate the local economy into the foreseeable future.

The Pilbara economy is crucial to the Western Australian and Australian economy, providing two of the State's largest exports, both of which have played a key role in its economic development. The most important industry in employment terms in the Pilbara is mining, which directly accounts for over 40% of the employed population. In addition, the Region's iron ore industry provides about 7% of Australia's export earnings. Ongoing development of oil, natural gas and other mineral resources will ensure continued economic growth in the Region, and the development of open, multiple employer towns.

It is difficult to predict growth in an area such as the Pilbara, as it is largely driven by the mineral resource industry. The Pilbara 21 Final Strategy Report (1992), listed several strategies proposed for the Pilbara. The main strategy was that new development would be concentrated into existing major centres, such as Karratha and Port Hedland.

The availability of water resources will play a major role in the development of industry in the Pilbara Region. The introduction of major industrial sites, such as the proposed Cape Lambert, Maitland and Boodarie Estates, will draw a number of industries into relatively confined regions. The local availability of water supplies, as well as the potential pollution of water resources, needs to be considered when planning for the number of industries within these Estates. Competition for water resources may become an issue if the number of industries and potential growth of existing industries within a particular Estate cannot be supported by the available water sources. In this situation, the development of new sources will have to be negotiated.

Tourism Industry

Tourism continues to develop as a major force in the diversification of the Pilbara economy. Tourism is seen by the Region as the industry of the future.

The progress of the tourism industry has been slow. It is generally agreed that the reasons for this lack of growth include a shortage of budget/medium priced accommodation, low levels of investment in tourism infrastructure and product, unsealed roads, poor interpretation and limited tour options and opportunities to experience Aboriginal culture.

In general, the Pilbara is viewed by tourists as a "stopover" rather than a "destination". A recent market research study on tourism movements by Market Equity Pty Ltd reveals that over half of existing tourists claim to be "just passing through" as opposed to being attracted to the Region by a particular feature.

Several recent initiatives which will impact on the development of the tourism industry include:

- Completion of the Pilbara Gascoyne Offshore Islands Ecotourism Management Strategy.
- Professionalising the Pilbara tourism industry, including the establishment of a new regional tourism body and the implementation of a marketing strategy to increase the awareness of the Region.
- CALM has called for expressions of interest for development of low key tourism accommodation and construction of an airstrip within Karajini National Park.
- There is a renewed interest in new accommodation developments catering, either initially or ultimately, for tourists in coastal towns.
- The new generation of major resource processing projects.

The development of tourism in the Region in the next 25 years is dependent on a number of factors, including:

- Development of accommodation and tourism product in the Region.
- Development of mechanisms which expedite land release for tourism purposes which are currently impeded by the number of agencies involved in the process.
- Ability of the Region to attract investors and offer an environment which is conductive to investment.

Growth in the tourism industry will create a greater proportion of the Region's domestic water demand dependent on seasonal change, moving away from the current dependence on the growth of existing mining operations and the establishment of new operations. In the event of tourism growth in the Pilbara Region, water supplies will need to be able to cater for the increase in population, and therefore domestic water demand, during the peak tourist seasons.

Fishing Industry

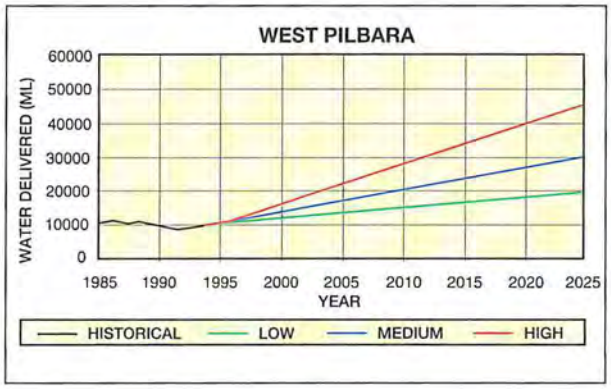
While the fishing industry is small by comparison with operations in other coastal regions of the State, it makes an important contribution to the diversification of the regional economy by exploiting a valuable resource. Established fisheries in the Pilbara Region are located at Onslow, Dampier, Point Samson and Port Hedland.

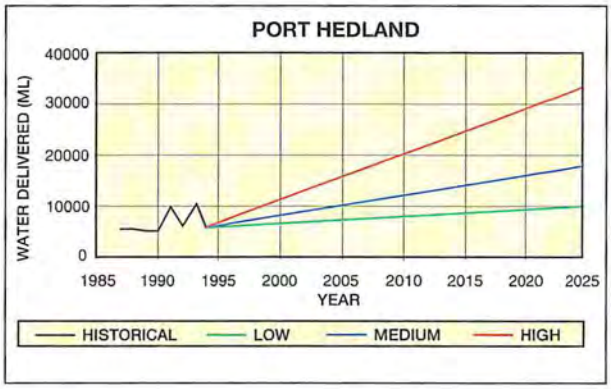
For the fishing industry to expand beyond its current level, new fisheries such as deepwater trawling and tuna longline fishing will have to be established. There is also some scope for small mud-crab fisheries. Similarly, the technology used in existing fisheries will have to improve if the Region's industry is to remain competitive. However, perhaps the biggest prospect for the industry is the development of aquaculture (Pilbara 21 Study, 1991).

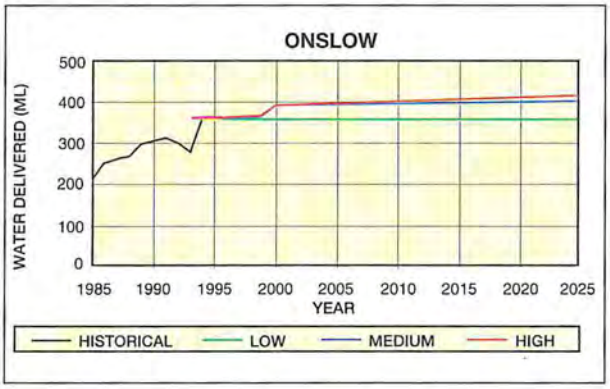
In general, the fishing industry has some room for expansion. This expansion is not expected to largely affect the water resources of the Pilbara Region.

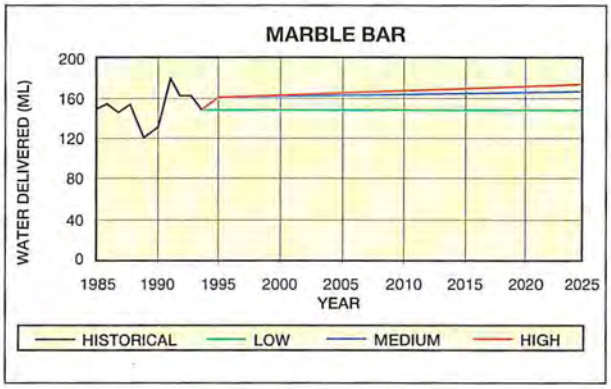
Mt Whaleback Mine - Newman (John Bush, Auswest Ecology Consulting Services)

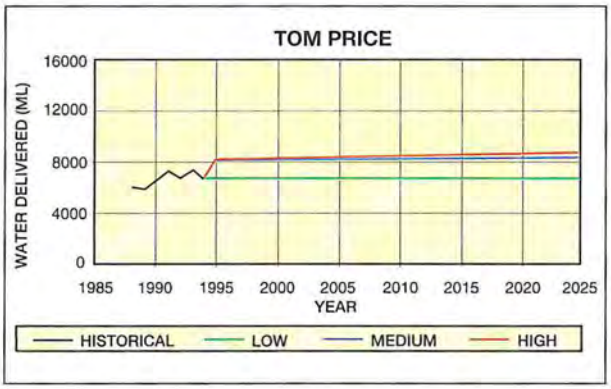
Figure 5: Town Water Supply/Industrial Projections











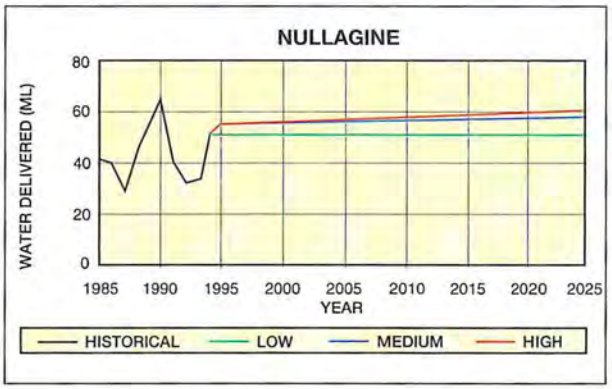
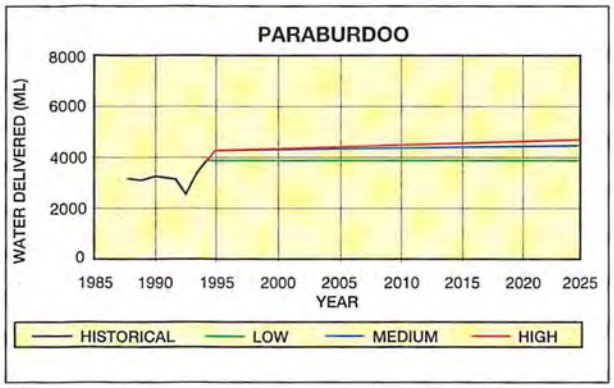
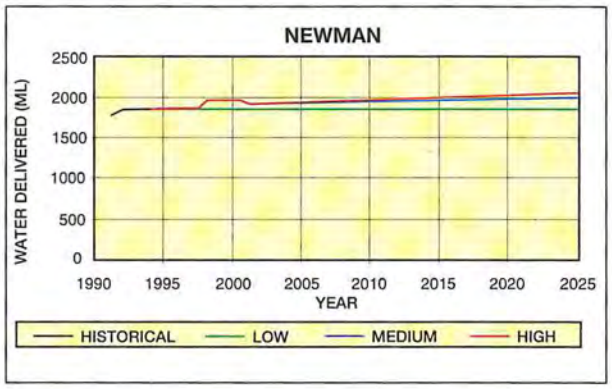
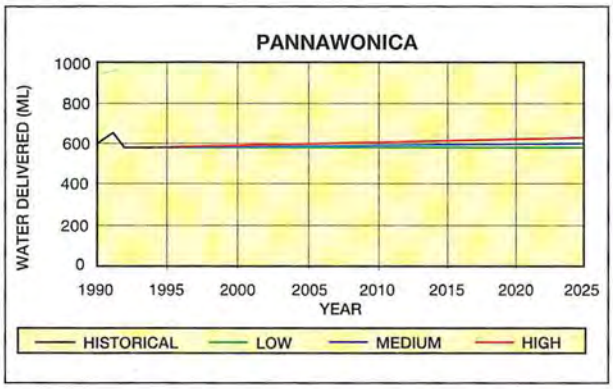
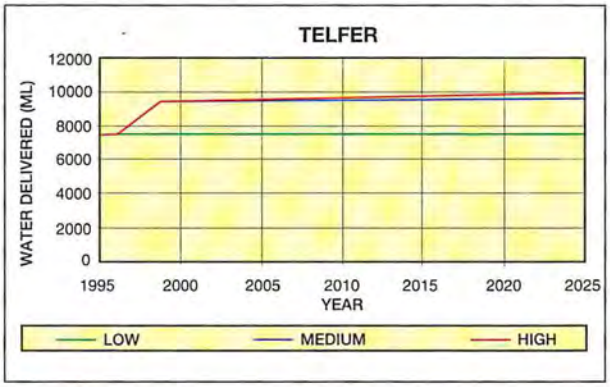


Figure 5 continued









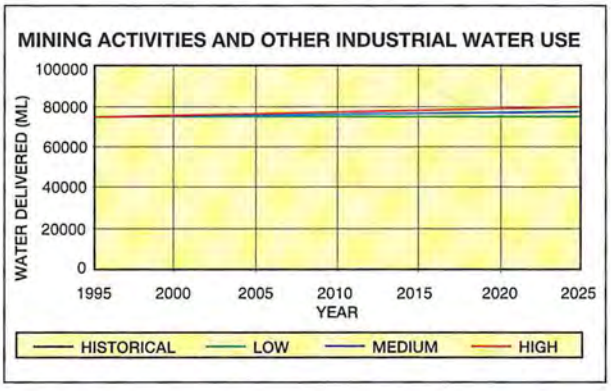


Table 2: Town Water Supply/Industrial Projections and Water Source Development Options

Town Water Supply Scheme	Source	Current Licence (ML)	Demand 2025 (medium) (ML)	Demand 2025 (high) (ML)	Development Options
West Pilbara	Harding Dam/Millstream aquifer	15 000	30 000	45 000	Maitland alluvium, Lower Fortescue aquifer
Onslow	Cane River Borefield	350	401	417	Extension of existing borefield
Tom Price	Fortescue & Hardey River Borefields	8 047	8 516	8 921	Extension of existing borefield
Paraburdoo	Paraburdoo Borefield	4 300	4 354	4 561	Extension of existing borefield
Pannawonica	Eastern Deepdale Borefield (Robe River)	700	605	635	Extension of existing borefield
Port Hedland	Yule & DeGrey River Borefields	12 000	17 000	34 000	(1) Upgrade of existing borefield (2) Extension of existing borefield
Marble Bar	Coongan River Borefield	200	167	175	Extension of existing borefield
Nullagine	Nullagine River Borefield	280	57	60	Extension of existing borefield
Newman	Opthalmia Dam/ Fortescue River Borefield	10 000	1 967	2 050	Currently under investigation
Telfer	Wilki/Glen, South Wilki & Gardens Borefields	(none)	9 449	9 855	Extension of existing borefield
Inland Mining/Industry	Various groundwater sources	72 417	76 038	79 659	Extension of existing borefields

Agricultural Development and Growth Potential

The development of the pastoral industry was responsible for exploration and European settlement of the Region. The major land use is the grazing of sheep and cattle on native vegetation. Rainfall is too low and erratic to sustain agricultural cropping or broad scale improved pasture development, characteristic of the South West areas.

Several pastoral stations are operated by Aboriginal groups, including Yandeyarra, Kangan, Pippingarra, Strelley, Carlindie, Warralong, Coongan, Lalla Rookh, Mt Welcome and Peedamulla. There are currently 63 pastoral leases in the Pilbara Region.

In recent years the survival of the industry has been placed in jeopardy by fluctuating seasons as well as fluctuating domestic and international market prices.

Increasing pressure from competing uses of pastoral lease land will come from conservation, horticulture, mining and in some cases, aquacultural needs. Although not competing for vast tracts of pastoral lease land, new business ventures related to tourism and recreation, horticulture and aquaculture will require access across pastoral lease land to coastal or riverine sites or alternatively to what is considered good pastoral land.

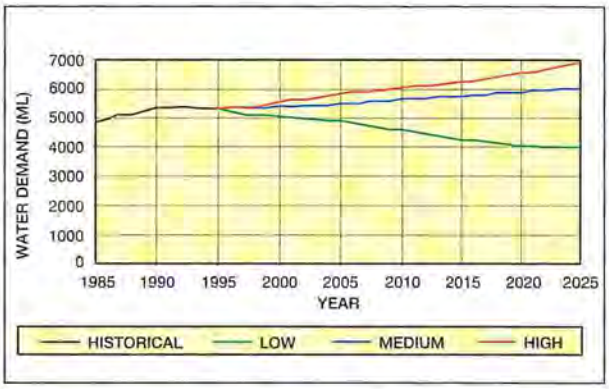
Prospects for pastoral development are limited by the Region's climate. Prospects for further expansion will also depend on market development, pastoral management and the issue of Native Title.

Other forms of intensive agriculture, such as horticulture, have not developed to a large commercial scale to date, although vegetables for the local Pilbara market have been grown at near-coastal locations such as DeGrey Station, Roebourne Plains and near Port Hedland.

The agricultural industry of the Pilbara (pastoral and horticulture) has a minimal water demand in comparison to the water demand of the mineral resource industries in the Pilbara. The expected future demand from the agricultural industry will not place a heavy burden on the existing water sources.

The future of pastoral activity in the Pilbara is likely to reflect the fortunes of the cattle industry. Estimates of the growth of cattle numbers over the next 25 years vary, but there is general agreement that the rate of increase is unlikely to be as strong as over the past 25 years. Sheep numbers have declined steeply over the past 30 years. The consensus in the industry is that this decline will continue (Sinclair Knight Merz, 1996).

Figure 6: Pastoral Industry Water Demand Projections



The Pilbara Region is capable of supporting horticultural practices. However, the limiting factor for its growth in the Pilbara has been the availability of developed water sources. The establishment of horticultural activities in the Pilbara is generally cost prohibitive unless access to an established water source and infrastructure is available. In addition, Native Title issues must be resolved before land is released for horticultural use.

Current water allocation for horticultural purposes is about 29 ML/yr. This is not expected to increase significantly during the planning period of this report and due to the difficulty in determining its growth, horticultural activities were not projected.

Water demand for agricultural purposes in the Pilbara Region are not significant compared to water demand for mining and industrial activities. Future increases in water demand for pastoralism are relatively small and water resources in the Region are expected to be able to meet demand to at least 2025. Possible water sources for horticulture in the Pilbara Region are the Turner, DeGrey and Fortescue Rivers as well as the decommissioned groundwater source at Goldsworthy.

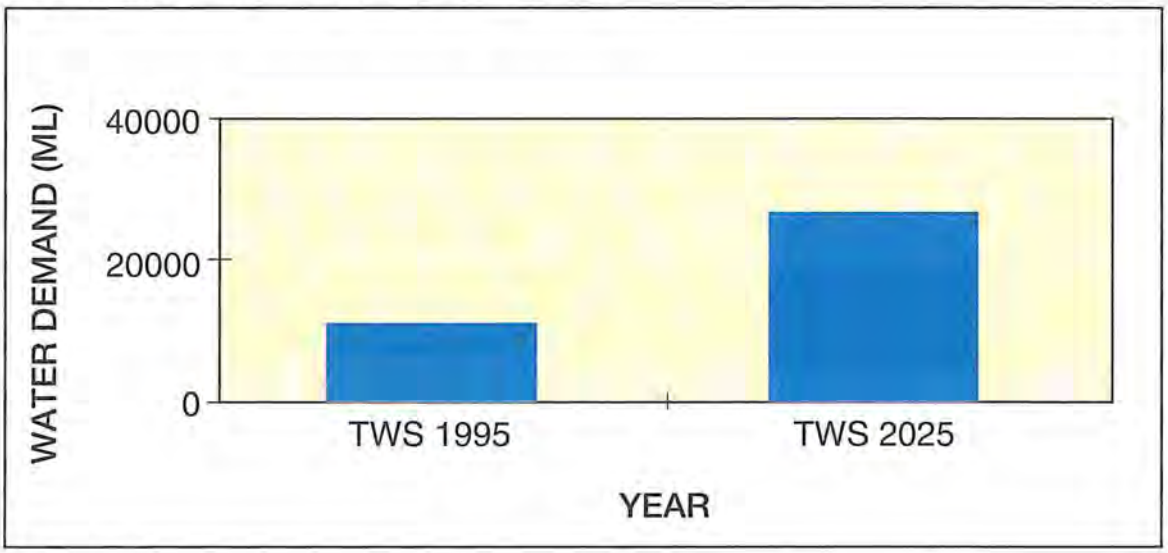
Conclusion

The West Pilbara Town Water Supply Scheme obtains its water from the Harding/Millstream System. The Harding/Millstream system is a conjunctive use system. This means that it is the combination of a surface water source with a groundwater source. Currently, the West Pilbara Water Supply Scheme is mainly used for town water supply and industrial purposes.

Water demand from the West Pilbara Water Supply Scheme in the year 2025 is expected to reach 30 GL/yr, an increase of about 21 GL/yr from the current demand. The main constraint to the system is the assessed yield of the Millstream aquifer. The most logical solution to increase the conjunctive yield would be to increase the groundwater availability to the scheme. It has been assessed that the draw from Millstream should be constrained to 15 GL/yr until we know more about the environmental water requirements of the system. It would appear to be appropriate to develop a new groundwater source to supplement the contribution from Millstream.

Future developments include groundwater from the river alluvium along the Maitland River. The Water Corporation are currently investigating the Maitland River groundwater source and suggest that this option would be feasible if a yield of 3-4 GL/yr could be obtained. Coupled with Millstream at 15 GL in any one year, the groundwater sources could produce almost 20 GL in years where Harding Dam is dry. This will enable us to maximise the value of the Harding Dam. The addition of the Lower Fortescue Aquifer would have the same result; would yield far more, but at a far greater cost.

Figure 7: Likely Demand From the West Pilbara Water Supply Scheme



The town of Port Hedland, including South Hedland, obtains its water supply from production wells located in the Yule and DeGrey Rivers. Currently, the Port Hedland Water Supply Scheme is mainly used for town water supply and industrial purposes.

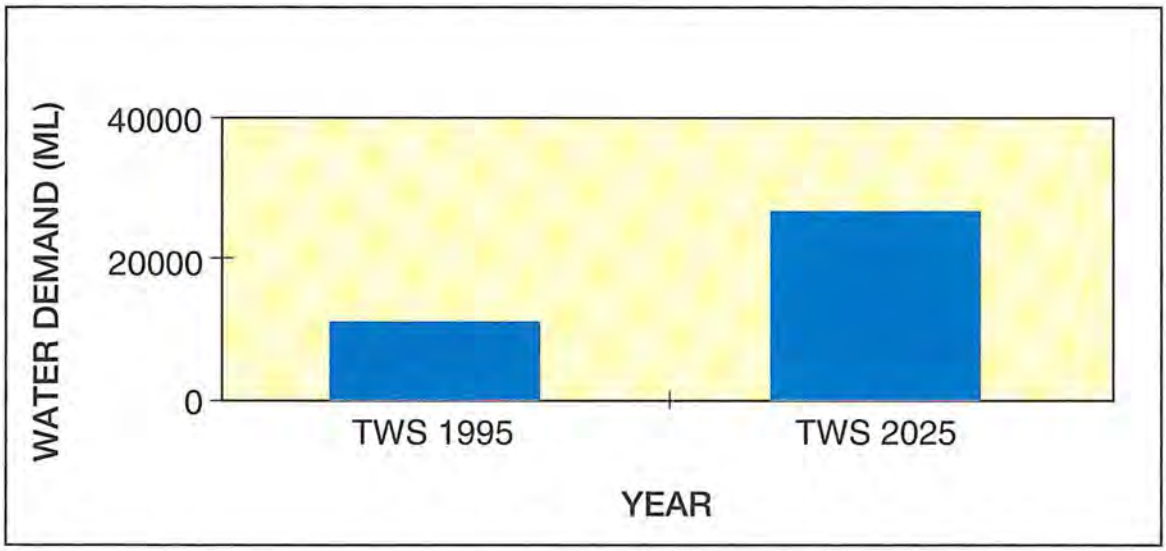
Water demand from the Port Hedland Water Supply Scheme in the year 2025 is expected to reach 17 GL/yr, an increase of about 10.5 GL/yr from the current demand. A major borefield upgrade, including electrification and automation, is currently planned by the Water Corporation for the Port Hedland water sources. This will provide a combined additional yield of 1 GL/yr by the year 1999.

Future developments of the Port Hedland water sources would be:

(i) complete existing proposals to upgrade both the Yule and DeGrey borefields (13.2 GL/yr); and

(ii) extend the Yule and DeGrey borefields in the upstream direction (34 GL/yr).

Figure 8: Likely Demand From the Port Hedland Water Supply Scheme

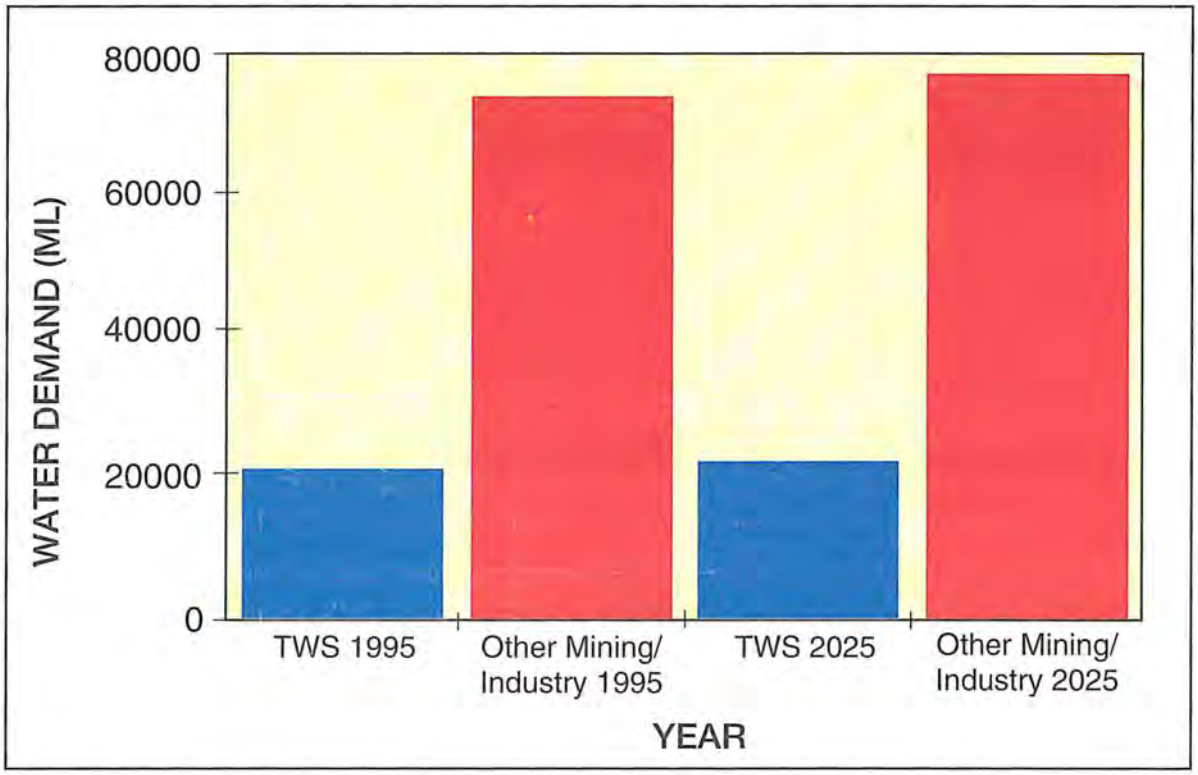


The major mining centres in the Pilbara Region obtain water from town water supplies or private bores licensed by the Water and Rivers Commission. These sources supply mining activities, such as dust suppression and exploration, as well as domestic demand.

The combined water demand from these sources in the year 2025 may be as high as 103 GL/yr, an increase of about 7 GL/yr from the current demand.

Future developments by the expansion of existing borefields in the Pilbara Region will meet regional demands.

Figure 9: Likely Demand From Inland Mining Centres and Other Town Water Supply Schemes



It would appear that all the Pilbara town water supply sources are capable of meeting unrestricted demand under normal climatic conditions. However, during extended dry periods some towns will experience restrictions.

It would appear that the availability of water resources in the Region will not impede new developments in the Pilbara. The Pilbara 21 Study stated that as a result of the costly development of these resources, they "be allocated and used in an efficient and equitable manner". Water intensive industries should be discouraged unless they have a high " value added " component.

Glossary

Aquifer	A geological formation or group of formations capable of receiving, storing and transmitting significant quantities of water.
Brackish water	Water of salinity 1000 - 3000 mg/L TSS.
Dam	A structure constructed across a river valley to store stream flow and allow it to be diverted for water supply use and for release in a controlled manner for downstream use.
Demand	The amount of water required from the water supply system. Divertible water The average annual volume of water which could be removed from developed or potential sources on a sustainable basis.
Diversion	Development of a water resource to harvest some or all of its divertible water.
Fresh water	Water of salinity less than 500 mg/L TSS.
Gigalitre	1000 Megalitres.
Groundwater	Water which occupies the pores and crevices or rock or soil.
Groundwater area	An area proclaimed under the Rights in water and Irrigation Act 1911 in which private groundwater abstraction is licensed.
Kilolitre	1000 litres.
Marginal water	Water of salinity 500 - 1000 mg/L TSS.
Megalitre	1000 Kilolitres.
River basin	The catchment of river(s) as defined by the Australian Water Resources Council for presenting hydrological data.
Saline water	Water resources of salinity greater than 3000 mg/L TSS.
Salinity	The measure of the total soluble (or dissolved) salt, ie. mineral constituents in water. Water resources are classified on the basis of that salinity in terms of milligrams per litre Total Soluble Salts (mg/L TSS).
Scheme supply	Water diverted from a source (or sources) by a water authority or private company and supplied via a distribution network to customers for urban, industrial or irrigation use.
Self supply	Water diverted from a source by a private individual, company or public body for their own individual requirements.
Strategy	A set of policies or means aimed at a set of objectives designed to bring various actions under unified direction in order that the organisation's or community's objectives may be effectively served. It may consist of one or more source options, water efficiency policies, as well as a commitment to research and develop "environmentally friendly" options.
Surface water	Water flowing or held in streams, rivers and other wetlands in the landscape.
Sustainable yield	The rate of water extraction from a source that can be sustained on a long-term basis without exceeding the rate of replenishment. Sustainable groundwater use limits extraction to no more than the recharge rate and requires sufficient throughflow to prevent significant ocean water intrusion into aquifers.

System yield	The maximum demand that the water supply system can sustain under specified expectation of restrictions (currently restrictions are expected in 10% of years).
Treatment	Application of techniques such as settlement, filtration, chlorination, to render water suitable for drinking purposes.
Turbidity	Clouding of water due to suspended material in the water causing a reduction in the transmission of light.
Water Reserve	An area proclaimed under the metropolitan water Supply Sewerage and Drainage Act or Country Areas water Supply Act to allow the use of water on or under land for public water supplies.
Water Resources	Water in the landscape (above and below ground) with current or potential value to the community and the environment.
Watertable	The surface of the unconfined groundwater, which may be above ground as swamps or lakes in low-lying areas. Measured as the level to which water rises in a well tapping an unconfined aquifer.
Well	A hole dug or drilled (bore) from the ground surface into a groundwater aquifer to monitor or to withdraw water. Household wells are commonly termed bores.
Wellfield	A grouping of wells to extract large volumes of groundwater, generally for scheme supply.
Wetland	Area of seasonally, intermittently or permanently waterlogged soils or inundated land, whether natural or otherwise, fresh or saline.
Yield benefit	The increase in system yield which occurs when source is added to the water supply system.