



Government of **Western Australia**
Department of **Water**

Ord surface water allocation plan

For public comment

May 2012

Looking after all our water needs

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Department of Water

Water resource allocation planning series

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Foreword

It is an exciting time for the Kimberley region. Under the state's Royalties for Regions program we are seeing the largest development of irrigated land in the Ord River area since the 1960s.

To expand irrigation in the Ord River area, the industry needs secure and reliable water supplies. From 2014, we will see the demand for water increase by up to 120 GL to service 7 400 ha of new farmland north of Kununurra.

This new *Ord surface water allocation plan* supports, first and foremost, water for existing and new irrigation. The plan also supports the increasing need for hydropower generated through releases from Lake Argyle. Both of these demands are balanced against the need to leave enough water for the lower Ord River environment downstream of Lake Kununurra.

Managing water in the Ord River is not a simple task. This water allocation plan builds on the many decades that the Department of Water and Water Corporation have actively managed the river. It sets a new benchmark for water allocation and licensing in the area.

The plan explains how much water is available to support current and future irrigation. It includes new release rules for the Ord River reservoir and defines how licences will be adjusted over time as government approves new areas for irrigation.

Stakeholder input is critical to getting the plan right. We encourage you to send us your comments and views on the plan by 14 September 2012. The completed plan will be accompanied by a statement of response which will summarise how we used your comments.



Maree De Lacey
A/Director General
Department of Water

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Summary

The Department of Water is responsible for allocating and licensing the state's water resources under the *Rights in Water and Irrigation Act 1914*.

The *Ord surface water allocation plan* sets out how the department will allocate and license water in the Ord River surface water area. It also defines the water required for the lower Ord River environment. The release rules for the Ord River and Kununurra Diversion dams form a major component of the plan.

Purpose of the Ord surface water allocation plan

The *Ord surface water allocation plan* addresses the new demand for water under the Ord-East Kimberley expansion project, and commitments for the production of hydropower and maintenance of the downstream environment.

The plan replaces the *Ord River water management plan* (DoW 2006) and sets a new approach for managing water allocation and licensing in the area by:

- securing 865 GL of surface water at high reliability for current irrigation and future expansion of irrigation in the Ord
- defining dam release rules that provide water for irrigation and the downstream environment, and maximise the amount of hydropower that can be generated
- stating when restrictions to hydropower, irrigation and the environment will apply
- establishing how we will license water use and adjust water licences, as irrigation and hydropower demands change over time.

Water availability in the Ord surface water area

For management purposes we have divided the Ord area into five subareas. We have defined an allocation limit for each subarea and will issue licensed entitlements up to the allocation limit in each of them. Water is available for licensing in four out of the five subareas.

From the Main Ord subarea, 750 GL of water is available. This includes the current 335 GL allocation to the Ord Irrigation Cooperative; 400 GL for future expansion, including 80 to 120 GL for the proposed Goomig farmland (the first area to be developed with support from the Royalties for Regions irrigation expansion project); and 15 GL for direct river pumping.

From the Carlton-Mantineia subarea, 115 GL is available. This 115 GL of water combined with the 400 GL of water available from the Main Ord subarea makes 515 GL of water available for future expansion at 95 per cent reliability.

In total, including the current Ord Irrigation Cooperative licence, 865 GL of water is available. Its use will be primarily for irrigation purposes. Below is a summary of the allocation limits, annual reliability and water availability status for each subarea.

The proportion of the allocation limit available for use in a given year depends on the amount of water stored in Lake Argyle. Licensees in the Main Ord, Tarrara-Carlton and Carlton-Mantinea subareas can expect to receive their full entitlement in 95 per cent of years.

We may issue water licences for land in the Tarrara-Carlton subarea. However, we will allocate this water from the Main Ord subarea.

Subareas	Allocation limit (GL per year)	Annual reliability (per year)	Water available
Upper Ord	15	Variable	Yes
Main Ord	750	95%	Yes
Tarrara-Carlton	0	–	No
Carlton-Mantinea	115	95%	Yes
Dunham River	25	Variable	Yes
Total	905		

Allocation and licensing approach for the Ord area

New release rules

This plan defines how much water will be released downstream of the Ord River and Kununurra Diversion dams, under both the current and proposed enhanced rules for hydropower. The department has developed enhanced rules that increase the water available for diversion from the river, and maximise hydropower generation at the Ord River Dam Power Station. The enhanced rules are described in Chapter 5.

The power station release rules are a function of the water level in Lake Argyle and restrict power generation when storage levels in Lake Argyle are below average.

The current release rules allow for:

- 520 GL of water to be available¹ in 95 per cent of years
- an average of 243.1 GWh of electricity to be generated each year
- a guaranteed minimum of 210 GWh of electricity generation each year when water levels exceed 78 m AHD in Lake Argyle
- a guaranteed minimum of 89.1 GWh of electricity generation each year when water levels exceed 76 m AHD in Lake Argyle
- environmental water to be met or exceeded 94 per cent of the time.

The enhanced rules allow for:

- 865 GL of water to be available in 95 per cent of years
- an average of between 238.1 and 248.6 GWh of electricity generated per year

¹ Primarily for irrigation

- no guaranteed minimum for electricity generation
- environmental water to be met or exceeded 93 per cent of the time.

Managing in dry periods

We expect irrigation supply to be restricted in five out of every hundred years, when water levels in Lake Argyle are low. To manage water scarcity in these dry years, this plan sets the levels in Lake Argyle at which restrictions will apply to irrigation and other licensed water use, hydropower production and the environment.

The rules have been defined for both current and enhanced rules, so that it is clear how restrictions will apply under all likely future circumstances. Appendix A shows the levels in Lake Argyle that trigger restrictions to hydropower, irrigation and the environment.

Adjusting licences over time

We will match water entitlements with water use (as far as is practical) to maximise the amount of water available for irrigation and hydropower production at each stage of irrigation development.

To achieve this, we will adjust Water Corporation and water service provider licences as large applications for water are granted (approval of a licence greater than 30 GL will be the trigger) and/or as electricity demands change. This will ensure that future irrigation expansions can access secure, reliable water, while maximising hydropower production as irrigation expands.

How the department developed this plan

The department is updating the 2006 plan to secure water for irrigation expansion and to protect the lower Ord environment, in response to recommendations from the Environmental Protection Authority.

Working alongside our stakeholders, we developed the plan using new ecological and hydrological studies completed in the Ord area since 2006. This new work:

- updates our knowledge of the Ord River catchment's hydrology using updated rainfall and flow data
- defines water availability from Lake Argyle under a range of future demand scenarios, based on dam inflows between 1906–07 and 2003–04
- defines how much water is needed to remain in the lower Ord River (the environmental water provision).

We have used this information to set the objectives, allocation limits and reservoir release rules in the plan. We did this assuming a future climate in the Kimberley similar to that experienced in the region between 1906–07 and 2003–04. Our use of past climate records is appropriate given that the global circulation models used to project climate in the Kimberley do not indicate a clear wetting or drying trend.

Have your say

This plan is now released for public comment. Our public comment period is open until 14 September 2012.

In finalising the *Ord surface water allocation plan*, the department will review and consider each of the comments we receive. We will release a statement of response, alongside the final plan, which summarises each of the comments we received and how we considered them in the final plan.

People and organisations will not be individually identified, but we may quote directly from your comments so please state clearly if you do not wish us to do so.

Please send your comments by 5.00pm, 14 September 2012 to:

allocation.planning@water.wa.gov.au

or the address below:

Ian Loh

Water Allocation Planning Branch,

Department of Water,

PO Box 6822,

Perth, WA, 6842

1 Plan context and scope

The Ord River expansion project is now underway, with state government funding committed under the Royalties for Regions program. An additional 80 to 120 GL of water is expected to be delivered to the first 7340 ha of new farmland in the Goomig area by 2015.

This plan sets out how much water is available, and explains the rules that govern water management in the Ord area, so that the water required for irrigation, hydropower and the environment is available in as many years as possible.

The plan's allocation limits and release rules were developed based on the current dam infrastructure and considered existing commitments to hydropower generation and maintaining the downstream environment. If infrastructure or demand for water change, the plan will be reviewed and if necessary, replaced.

1.1 Purpose of the plan

Working alongside our stakeholders, the Department of Water developed this plan in response to:

- recommendations from the Environmental Protection Authority to maintain the environment of the lower Ord River
- the need to provide absolute clarity on the water available for irrigation development
- the need to meet irrigation demand balanced with the growing demand for hydropower and the needs of the downstream environment
- new hydrological and ecological work we have completed since the *Ord River water management plan* (DoW 2006) was released.

The *Ord surface water allocation plan*:

- secures 865 GL of water with increased reliability (full entitlements available 95 per cent of years) for current and future expansion of irrigation in the Ord area
- sets out reservoir release rules that maximise the production of hydropower while delivering enough water for irrigation and the needs of the downstream environment
- defines when restrictions to hydropower, irrigation and the environment will apply
- establishes how we will license water use and adjust water licences as irrigation and hydropower demands change over time.

1.2 Plan area

The *Ord surface water allocation plan* area is in the north-eastern Kimberley. The plan extends from the Western Australian border up to the Joseph Bonaparte Gulf to the north and areas to the west of Halls Creek.

The town of Kununurra is included within the plan boundary. The plan boundary does not include land within the Northern Territory

Water resources in the plan area

The plan considers the broader Ord River catchment, encompassing the Ord and Dunham rivers and tributaries. It includes the surface water resources of the Ord River Catchment to its tidal limit (Figure 1), including runoff that contributes to the Ord River from the Northern Territory.

Legislation and legal extent of the plan

The plan's licensing policies are applicable in the combined area of the Ord River and tributaries surface water area and the Ord River Irrigation District (Figure 2) as these areas are proclaimed under Part III of the *Rights in Water and Irrigation Act 1914*. That is, any water diverted from the Ord River and its tributaries in Western Australia will be managed according to the plan.

The licensing policies of the plan do not apply in the Northern Territory, but the plan provides water for irrigation development in the territory. A change to legislation in both Western Australian and the Northern Territory jurisdictions will be required when irrigation developments proceed across the border.

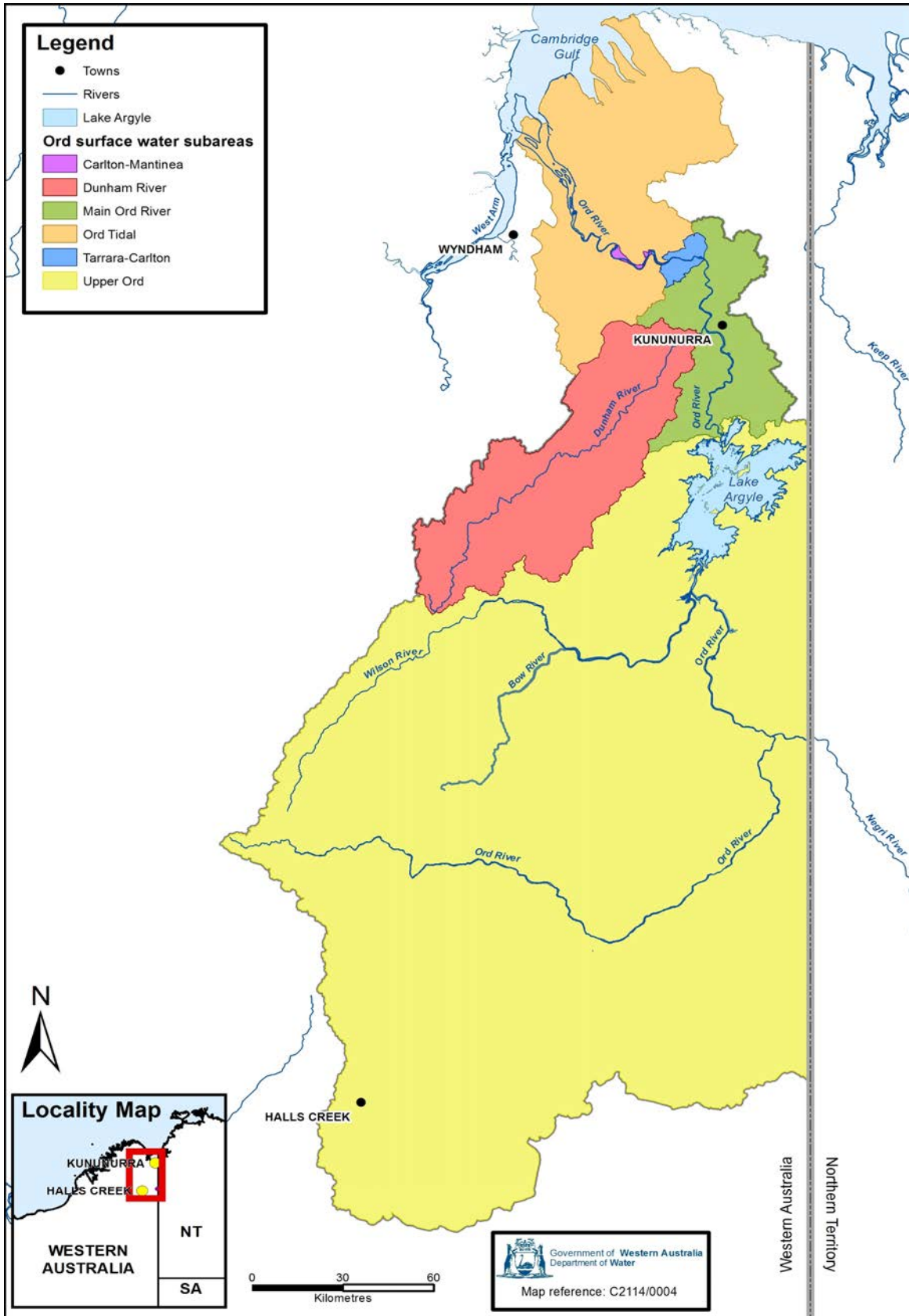


Figure 1 Ord catchment and surface water management subareas

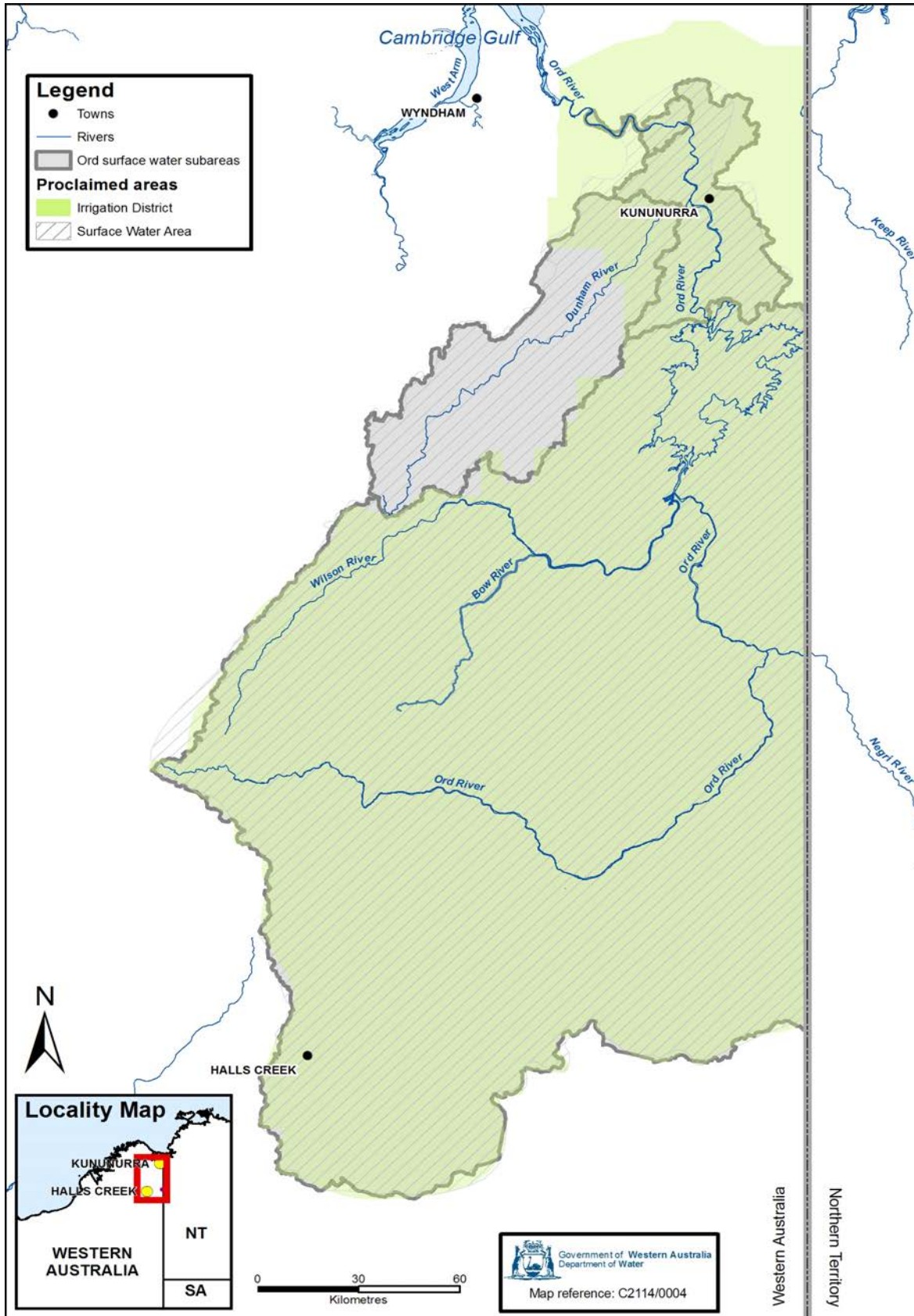


Figure 2 Proclaimed areas relevant to this plan

Subareas

To best administer water allocation and licensing, we divided the plan area into five subareas:

- Upper Ord (the catchment upstream of the Ord River Dam, including Lake Argyle)
- Main Ord (the catchment between the Ord River Dam and Tarrara Bar gauging station, including Lake Kununurra)
- Tarrara-Carlton (the catchment between Tarrara Bar gauging station and House Roof Hill)
- Carlton-Mantina (the catchment between Ivanhoe Crossing and the tidal limit)
- Dunham River (the Dunham River catchment).

The subareas downstream of Lake Argyle are shown in more detail in Figure 3.

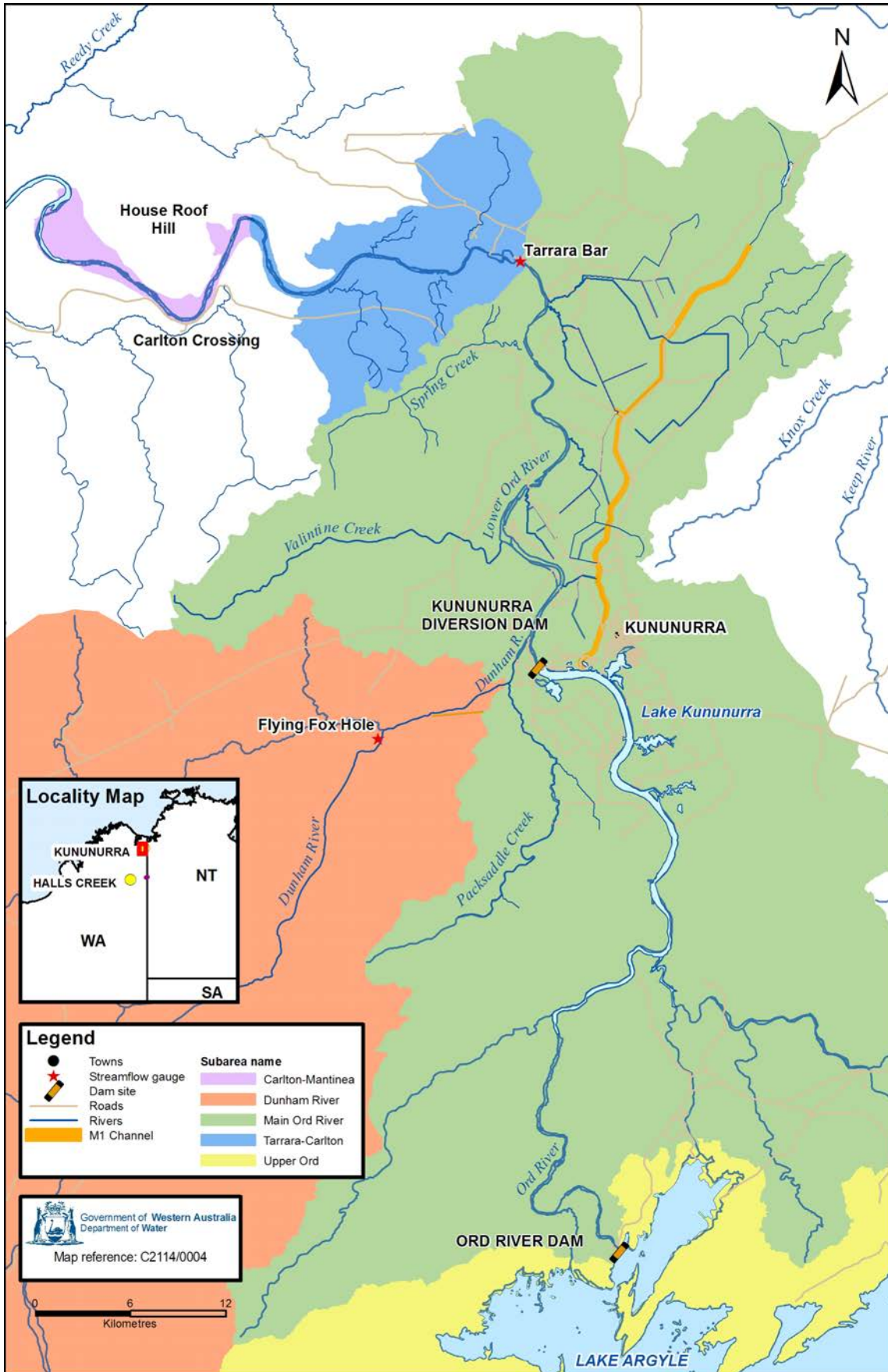


Figure 3 Enlargement of subareas downstream of Lake Argyle

1.3 Plan timeframe

The *Ord surface water allocation plan* is in effect until it is replaced by a new water allocation plan, amended or revoked by the Minister for Water.

We will assess the need to replace this plan in 2019 or earlier if the annual evaluation process identifies that that we should.

1.4 How we developed the plan

The department needed to update the 2006 plan mainly to support irrigation expansion in the East Kimberley and manage the growing electricity demand on the Ord River Dam Power Station. This is the second water allocation plan for the Ord River and replaces the plan published in December 2006.

We developed this plan using new ecological and hydrological studies completed in the Ord area since 2006. This new work:

- updates the hydrology for the Ord River catchment with new rainfall and flow data
- defines water availability from Lake Argyle under a range of future demand scenarios, based on a past sequence of dam inflow (1906–07 to 2003–04)
- sets out how much water is needed for the lower Ord River (the environmental water provision).

Working with water users and other government agencies in the area, we used information from the new work to set the plan's objectives, allocation limits and reservoir release rules.

We set the limits and rules in this plan assuming the future climate will be similar to that experienced in the Kimberley between 1906–07 and 2003–04. Our use of the past climate records is appropriate given the global circulation models used to project future climate in the region do not indicate a clear wetting or drying trend at 2030.

The 99 calendar year sequence of streamflows used to underpin this plan includes very dry (e.g. the 1930s) and very wet years (the past 10 years). The limits and rules have been set to share water effectively under the full range of these conditions.

The objectives set for the plan area closely align with the government's commitment to expand irrigated agriculture in the Ord area, while providing enough water for hydropower generation and the riverine environment downstream of Lake Kununurra.

The environmental water provision set in the plan was developed in response to recommendations from the Environmental Protection Authority (EPA 1999). The EPA made these recommendations based on requirements of the Council of Australian Governments' Water Reform Framework of 1994.

The plan's current and future licensing approach was established working with the Water Corporation, Pacific Hydro, Ord Irrigation Cooperative, Department of Regional Development and Lands and Department of Agriculture and Food.

For more information about water allocation planning see *Water allocation planning in Western Australia: a guide to our process* (DoW 2011).

1.5 Main stakeholder interests

Working with stakeholders was a major part of developing the *Ord surface water allocation plan*. In the Ord area, a number of groups are specifically interested in water allocation – including:

- irrigation service providers (Ord Irrigation Cooperative and Sunwater)
- the bulk water supplier (Water Corporation)
- local private users (self-supply irrigators, commercial businesses, the shire, boat operators)
- industry (Pacific Hydro and Rio Tinto)
- native title holders and local Indigenous groups (Miriuwung Gajerrong Corporation)
- local government (Shire of Wyndham – East Kimberley)
- other state government (Department of Regional Development and Lands, Department of Agriculture and Food and Environmental Protection Authority)
- federal government agencies (Department of Sustainability, Environment, Water, Population and Communities and National Water Commission).

In mid 2011 we released an update on the progress of the Ord plan for public comment. After that we met with all interested parties in both Perth and Kununurra to discuss aspects of the plan that involved them.

The main interests raised by stakeholders in the area included:

- how the plan supports the Royalties for Regions Ord-East Kimberley expansion project and the Ord Final Agreement
- water availability, both overall and per hectare for new farm lots
- priority of water allocation when Lake Argyle is approaching full allocation, including possible expansion into the Northern Territory and new Cockatoo Sands areas in Western Australia
- how much water is left in the lower Ord to maintain the environment, suitable water quality and water based recreation.

2 What the plan will achieve

The Department of Water has developed this plan to meet the water needs of irrigation expansion, hydropower and the environment in the Ord area.

The plan's outcomes and objectives were driven by:

- state and federal government plans to invest in the east Kimberley
- the Ord Final Agreement that allows local Indigenous people to participate in and benefit from irrigation expansion in the area
- the Environmental Protection Authority's recommendations to maintain the lower Ord River environment as it has established since the Ord River Dam was completed in 1972
- the Ramsar-listing of the Ord River floodplain and wetlands
- the 1994 Water Supply Agreement between Pacific Hydro and the Water Corporation for the Ord River Dam power station
- ecological and hydrological investigations undertaken in the Ord area and published since 2006
- irrigation industry requirements for a highly reliable water supply
- consultation with industry, government, Indigenous groups and the wider community.

The outcomes and objectives informed our decision making on the water allocation limits for each subarea and the release rules for the Ord River and Kununurra dams.

We will meet this plan's objectives by implementing the allocation limits and licensing approach and undertaking the monitoring program to check our management.

2.1 Outcomes

The outcomes of the *Ord surface water allocation plan* will be:

- secure and reliable water supplies for a strong and expanding irrigation industry
- a healthy lower Ord River environment
- as much hydropower production as possible, within the limits of the water needed by irrigators and the downstream environment
- Indigenous people using low-flow periods resulting from Ord Dam maintenance to realise traditional laws and customs – including fishing and ceremonies.

2.2 Objectives

The flow regime downstream of the Ord River and Kununurra Diversion dams will meet the following objectives:

- a) dry and wet season environmental flow targets at Tarrara Bar
- b) supply 865 GL of water in 95 per cent of years
- c) maximise hydropower generation within the limits of (a) and (b).

2.3 Strategies

To achieve this, the department will:

- facilitate adoption of the enhanced rules by Water Corporation and Pacific Hydro
- recoup unused water allocations to maximise the water available for new development and power generation
- change the release rules in the Water Corporation's operating strategy for the Ord River and Kununurra Diversion dams
- set the storage levels in Lake Argyle that trigger restrictions to irrigation, hydropower and the environment in low-flow years
- announce the likelihood and severity of restrictions following the Kununurra annual operations meeting.

3 Current and projected water demands

The Ord River and its tributaries provide water for consumptive demands such as irrigated agriculture and the mining and mineral processing industries.

Non-consumptive demands are also significant in the Ord area. These include water released through the Ord River Dam power station to generate hydropower and water left in the lower Ord River to maintain in-situ ecological, social and cultural values.

3.1 How water is distributed in the Ord

A major part of managing water in the Ord is balancing the release of water from Lake Argyle to meet the different seasonal and short-term patterns of water demand.

Most of the water used in the Ord area is stored and released from Lake Argyle by the Water Corporation. It owns, operates and maintains the Ord River Dam and is licensed by the Department of Water to store, release (but not divert) the water in the reservoir. Pacific Hydro own and operate a 30 MW power station constructed on the outlet works of the Ord River Dam.

The Water Corporation allows Pacific Hydro (under contract) to release water through the power station to generate electricity. The Water Corporation can also release water from Lake Argyle through the irrigation valves that by-pass the power station. Water is released through the power station whenever possible. Releases via the irrigation valves usually only occur when the hydropower station is undergoing maintenance (Figure 4).

The water released through the power station or irrigation valves flows into the Ord River and into Lake Kununurra. Riverside pumpers (self-suppliers) abstract water directly from Lake Kununurra, as well as from the lower Ord River downstream of the diversion dam (Figure 4).

The Ord Irrigation Co-operative takes water from Lake Kununurra:

- by diverting it under gravity into the M1 channel to supply members on the Ivanhoe Plain
- by pumping it into the Packsaddle supply channel to supply members on the Packsaddle Plain.

By 2014 the Ord Irrigation Cooperative is also expected to divert additional water into the M1 channel on behalf of the new water service provider for the new Goomig farmland area to supply the Ord irrigation expansion project area on the Weaber Plain. This is the first phase of developing the larger M2 channel supply area.

The M1 channel's capacity is being increased to enable delivery of the additional water, for the first 17km towards the Goomig farmland. The M2 channel is being constructed to take the water the remaining distance and will be extended further when subsequent phases proceed. When complete, the M2 channel will transport

water by gravity to the new irrigation areas from Lake Kununurra and supply the full 30,000 ha of the greater M2 Supply Area.

The Water Corporation releases water from Lake Kununurra into the lower Ord River, by raising some of the 20 gates of the Kununurra Diversion Dam. The releases are made up of surplus Lake Argyle spillage, surplus inflows from the diversion dam catchment, surplus hydropower releases and releases specifically to meet the lower Ord River’s environmental water provision.

The release of water from the Ord River and Kununurra Diversion dams serves multiple purposes. The water released for irrigation and the environment can also be used to generate hydropower, and releases made solely for hydropower partly meet the lower Ord River’s environmental requirements downstream of the diversion dam, see Figure 4. The dam releases also allow boats to navigate along the lower Ord River (from the mouth of the Ord to the diversion dam) most of the year.

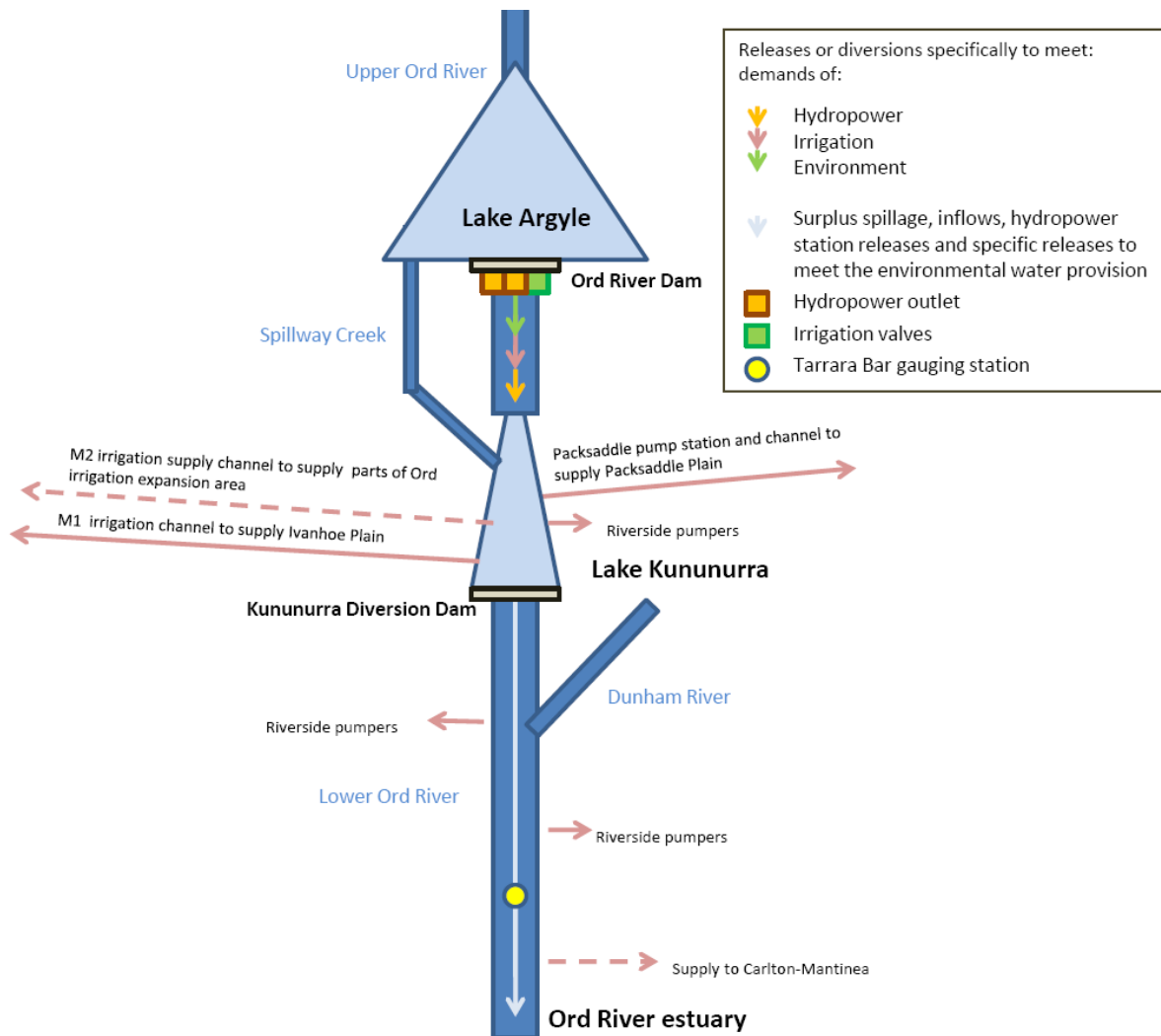


Figure 4 How water is distributed from the Ord River and Kununurra Diversion dams

However, the water needed for the different demands does not always coincide. In some years additional releases from the Ord River Dam are required to meet hydropower requirements, and in some years additional releases from the Kununurra Diversion Dam are needed to maintain the lower Ord River's environment. This is because the volume and timing of releases needed for hydropower are not always the same as those needed for the environment.

3.2 Consumptive use demands

Self-supplied mining and exploration

The Argyle Diamond Mine (Rio Tinto) has a licence to use surface water for camp and processing purposes and potable water supply. Rio Tinto has three licences to divert a total of 8.9 GL of surface water a year.

Self-supplied irrigation

The department has licensed 84 self-supply irrigators to abstract a total of 11.9 GL of water from the Ord River from Lake Kununurra and the lower Ord River between the Kununurra Diversion Dam and Tarrara Bar (Figure 3).

Irrigation supplied by the Ord Irrigation Cooperative

The Ord Irrigation Cooperative supplies 15 363 ha of irrigation-serviced farmland on 112 separate properties (supply points) on the Ivanhoe and Packsaddle plains.

During the past three years the cooperative has taken less than 200 GL/yr from Lake Kununurra. It currently holds a licence to take 335 GL/yr, which is valid until 2014, and supplies water to 63 irrigation cooperative members. Most is diverted at the M1 offtake. Water pumped via the Packsaddle pump station comprises 10 to 12 percent to the total diverted each year.

Irrigation expansion

The Western Australian Government has identified the Weaber Plain, West Bank, Knox Plain, and Carlton and Mantinea areas as potential development areas for further irrigation expansion (see Figure 5). Further developments are also possible across the border in the Northern Territory. The 2002 state environmental approvals of the M2 supply area project included 14 000 ha in the Northern Territory.

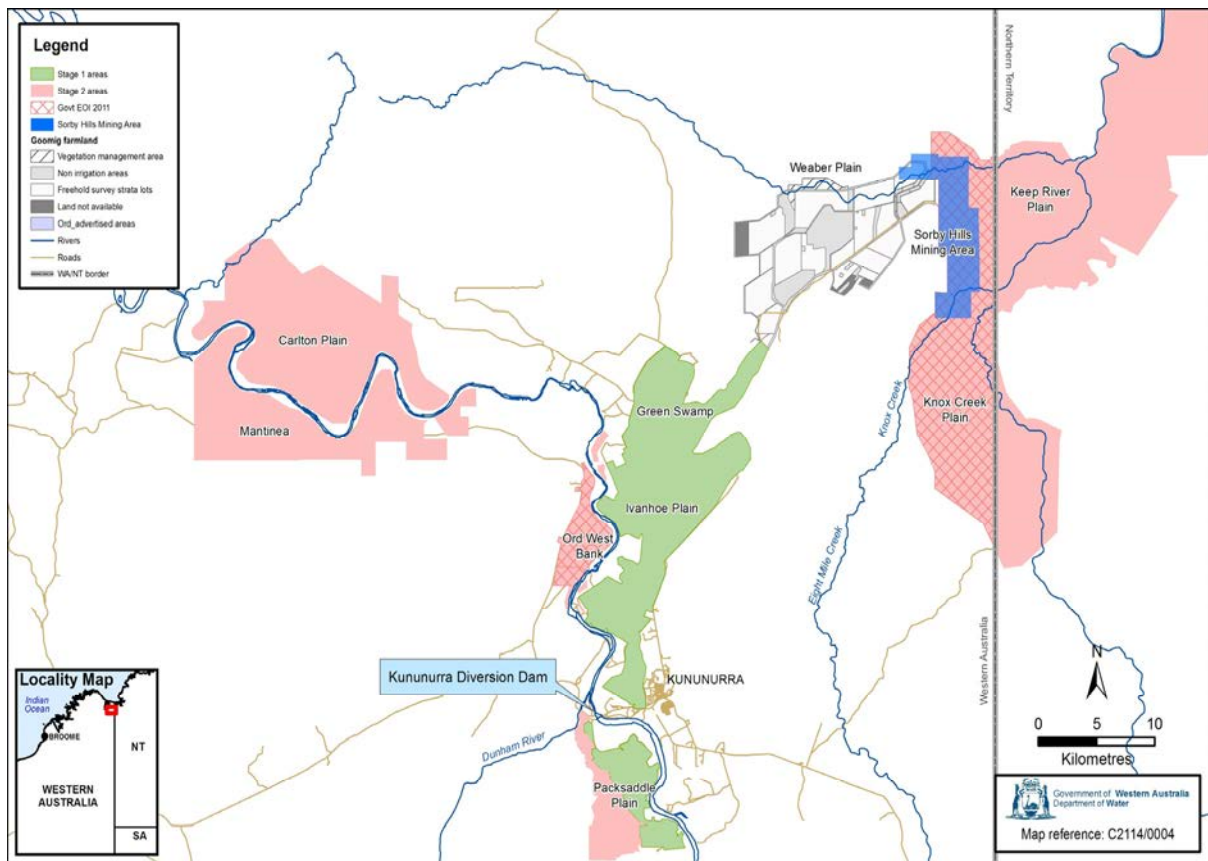


Figure 5 Proposed future irrigation development areas in the Ord surface water allocation plan area

The current Ord-East Kimberley expansion project will deliver 7400 ha of serviced farmland in the Goomig area on the Weaber Plain.

The timing, order and scale of development in the other areas will depend on investment and the timing of planning and environmental approvals. The approval status for the Carlton Plain, West Bank and Knox Plain development areas is summarised below.

Table 1 Approval status for Carlton Plain, West Bank and Knox Plain developments

Planning and approval issues	Carlton Plain ~ 8000 ha	West Bank ~ 1700 ha	Knox Plain ~6000 ha
Current/imminent land tenure	Freehold	VCL*	VCL
Agreement to surrender native title?	Yes	Yes	Yes
State/NT EP Act approval?	No	No	Yes
EPBC Act approvals – needed	Likely	Likely	Likely
– granted	No	No	No
Soil/water investigations sufficient for planning?	Yes	Yes	Yes

* vacant crown land

More detail on the approvals required under different legislation and the status of those approvals is provided in Section 1.2.8 of the *Ord surface water allocation plan methods report* (DoW 2012).

The range of possible irrigation demands in the Main Ord subarea is summarised below (Table 2). If each of the development areas proceed, and water demand in these areas is consistent with the range of demand listed, then water demand will equal or be greater than the allocation limit at some stage. When this occurs, a water market will develop.

Table 2 Irrigation developments and water demands in the Main Ord subarea

Development area	Gross development area (ha)	Nominal farmland area (ha)	Range of possible water demand[†] (GL/yr)
Stage 1 areas	19 000	16 000	230–350
<i>Ord expansion area supplied by the M2 channel</i>			
Ord irrigation expansion project (Weaber plains)	9 500	7 400	80–120
Knox Plain (in WA)	6 000	5 000	60–110
Sorby Hills Area (post mining)	4 000	3 000	30–65
Northern Territory	~16 000	14 000	140–210
<i>Ord expansion area not supplied by the M2 channel</i>			
Ord West Bank	1 700	1 000	16–25
East Bank and other miscellaneous	300	200	2- 5
New Packsaddle Plain area	1 700	800	8–12
Total	57 000	47 000	566–897
Cockatoo Sands		Not defined	Not known
Total	57 000⁺	47 000⁺	566⁺–897⁺

[†] At the point of diversion from the Ord River

If irrigation demand approaches the upper limits of Table 2 over the longer term, more water could be made available if the storage capacity of Lake Argyle is increased.

While beyond the scope of this plan, the department has undertaken reservoir simulations to assess the extra water potentially available if the base of the spillway were increased by up to two metres. Results are summarised in *Reservoir simulation in the Ord River catchment* (Smith & Rodgers 2010).

3.3 Non-consumptive water demands

Hydropower generation

Current agreement

The 1994 Water Supply Agreement for the power station is between Pacific Hydro and the Water Corporation and gives Pacific Hydro the right to generate at least 210 GWh/yr of electricity when water levels in Lake Argyle are greater than 78mAHD. It was a key consideration for the department when we developed the release rules in this plan.

To generate the 210 GWh annual commitment at mid lake levels about 2 100 GL must be released each year, while at low lake levels more than 2 500 GL must be released. This is because at lower lake levels more water must be released through the station to produce the same amount of hydropower.

Other provisions of the agreement allow Pacific Hydro to:

- generate electricity from any releases being made by Water Corporation
- jointly investigate revised water release rules (with the Water Corporation and Department of Water) that may increase the amount of electricity able to be generated.

Future projections

The electricity likely to be needed in the Ord area is growing rapidly (Figure 6). By 2014, we expect demand to be 150 per cent or greater than the 210 GWh/yr minimum guaranteed by the agreement.

Demand is likely to remain high for at least the next six years. The electricity demand on the east Kimberley electricity grid beyond 2017 is highly uncertain, but is likely to decrease after 2018 (as advised by Argyle Diamonds).

The hydropower station on the Ord River Dam cannot meet the projected electricity demand (Figure 6). A new source of electricity generation or existing diesel power stations at Argyle Diamond Mine and Kununurra will be required to meet the bulk of the growing electricity demand. However, the first priority is maximising the electricity that the existing station can generate.

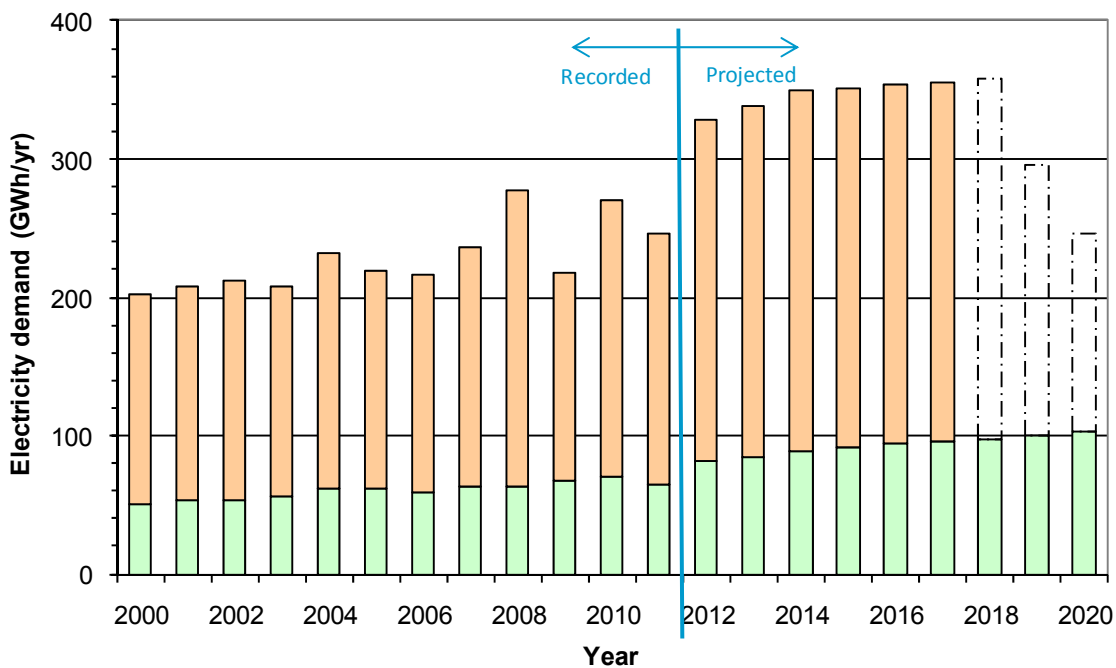


Figure 6 Recorded and projected demands on the East Kimberley Electricity Grid

Future power generation at the Kununurra Diversion Dam

A possible source of extra power would be to construct a 10 MW capacity hydropower station at the Kununurra Diversion Dam. The station would generate electricity from water released from Lake Kununurra to the lower Ord River.

Appendix C shows the average electricity that could be generated if the two hydropower stations (at both the Ord River and Kununurra Diversion dams) supplied to the East Kimberley electricity grid.

With a 10 MW station at the Kununurra Diversion Dam the average additional electricity generated would be more than 60 GWh/yr under the current licensed situation (350 GL/yr), and 50 GWh/yr if all water entitlements were granted (750 GL/yr).

Less water would need to be released from Lake Argyle, and the severity of irrigation restrictions would reduce – especially when irrigation entitlements approach full allocation (Appendix C).

3.4 Water for environment, social and cultural needs

Environmental water

The Ord River Dam's construction in the early 1970s greatly changed the flow regime of the lower Ord River. These changes to the hydrology in turn changed the environment.

Before the dam, the lower Ord River flooded regularly in the wet season, inundating large areas of the Ord River floodplain. In the dry season the river dried out to a series of isolated pools.

After the dam was built, average wet season flows in the lower Ord River reduced by 67 per cent, and average dry season flows increased by 430 per cent (based on data from 1974–75 to 2003–04).

In 1999 the Environmental Protection Authority recognised the importance of the post-dam environmental values that had developed in the lower Ord River and recommended they be protected.

The Department of Water has since developed and refined the environmental water provision for the lower Ord River, in response to the EPA's recommendation and in line with contemporary water management policy.

Environmental water provision

The environmental water provision is the flow regime predicted to maintain defined environmental values. The lower Ord River's provision is made up of a dry and wet season baseflow, wet season flow events and flood peaks.

The baseflow component:

- maintains shallow backwater habitat for small fish
- maintains deep pool habitat for large fish
- oxygenates and connects river pools
- inundates gravel and rapid runs that provide habitat for macroinvertebrates
- maintains permanent flow in shallow areas for algal production
- inundates water plants that provide habitat for fish and macroinvertebrates.

The wet season flow events and flood peaks inundate:

- lower riparian benches in the river to maintain algal production and provide habitat and potential spawning habitat for large fish
- deepwater backwater habitat to provide habitat and potential spawning sites for large fish
- wetlands
- in-stream obstacles to allow passage for migratory species
- eucalypts and other riparian species in the mid bank of the river
- and scour sediment and vegetation (to the extent possible since regulation).

The baseflow component of the environmental flow provision is higher upstream of House Roof Hill than downstream of it, because the main channel's shape changes.

Downstream of House Roof Hill deep pool habitat is more common and local backwater habitats are less so. Because of this, the flow rates needed to meet the

lower Ord's ecological needs downstream of House Roof Hill (to its tidal limit) can be 5 m³/sec lower.

For more information on how the environmental water provision was determined see the *Ord surface water allocation plan methods report* (DoW 2012), *Environmental values, flow related issues and objectives for the lower Ord River* (DoW 2006) and *Ecological water requirements for the lower Ord River* (Braithwaite & Malseed 2007).

Water to support traditional Aboriginal laws and customs

Native title consent determinations of the Federal Court of Australia in 2003 and 2006 determined the cultural and spiritual importance of the lower Ord River to the Miriuwung Gajerrong people in law. For details of the Miriuwung Gajerrong determinations (Number 1 on 9 Dec 2003 and Number 4 on 24 Nov 2006) see the *Ord surface water allocation plan methods report* (DoW 2012).

The views of the Miriuwung Gajerrong in relation to flows in the lower Ord River are reported in the *Ord River water management plan* (DoW 2006):

At the community workshop in 2000, representatives of traditional owners indicated that access to the river for fishing and ceremonial activities were important to Miriuwung and Gajerrong people, and suggested short periods of 'dry out' and 'wash out'. Subsequent discussions with traditional owners confirmed that having access to the river so they can pursue their traditional activities associated with the river, was important to the Miriuwung and Gajerrong people.

Short periods of low ('dry out') flows are important to (pre-dam) Dreaming stories of the Miriuwung Gajerrong. Such low flows are now very rare in the lower Ord River and usually only occur during periods of dam or power station maintenance.

The Department of Water and Water Corporation will coordinate dam maintenance with traditional owners and elders from the Miriuwung Gajerrong to maximise their opportunities to hold ceremonies and access the river during periods of low flow. Such access will be opportunistic – the department and Water Corporation cannot guarantee the frequency or duration of low flow events.

Social water

Water-based recreation on Lake Argyle, Lake Kununurra and the lower Ord River is important to the local economy and community. Most fishing and boating activity is only possible because the river is now regulated through the Ord River Dam and the river flows during the dry season (when it would have previously dried out).

The lower Ord River

Dry season flows in the lower Ord River will decrease as more water is diverted to supply new irrigation areas. This will affect the water available to meet social and recreational needs.

Dry season flows in the lower Ord were typically around 50 m³/sec after Lake Argyle first filled in 1974, and increased to 60–70 m³/sec after 1996 when the Ord River

Dam power station became fully operational. The average dry season flow rate is expected to be about 55 m³/s once the allocation limit has been reached (750 GL/yr). Thirty-seven per cent of dry seasons are likely to have an average flow of 42 m³/sec.

Lake Argyle and Lake Kununurra

Most water-based recreation takes place on Lake Kununurra and Lake Argyle during the dry season and involves commercial boat tours and private boating for recreational fishing.

The water needed for boating is provided by lake storage. However, tour boat operators on Lake Kununurra travel to the lake's upper reaches (40 to 45 km) and normally continue upstream (a further 15 km) to the base of the Ord River Dam. Flow rates of 50 m³/s are required for the boats to navigate to the dam's base.

Hydropower station releases normally exceed this flow rate, except at times of low power demand. In the past the Water Corporation has made additional releases for navigation via the Ord River Dam irrigation valves when the power station is releasing less than 50 m³/s. These extra releases are not of concern when water storage is high. Limits on navigational releases are appropriate, however, at times of low water storage, especially when other restrictions apply (Sections 5.4 and 5.5).

3.5 Balancing the consumptive and non-consumptive demands for water in the Ord

The department used the Ord River - Lake Argyle reservoir model to develop the release and restriction rules in this plan for a range of future demand scenarios.

The model scenarios represent a range of irrigation and hydropower demand likely to develop during the period the plan covers. These range from the demands of the recent past (with 350 GL/yr of irrigation demand and moderate power demand) to future demands characterised by high irrigation and high power demands. One of the model scenarios applies the enhanced rules approach for hydropower generation.

We based our modelling on estimated dam inflow over the historic period 1906–07 to 2003–04. This enabled us to determine how to manage dam releases given the natural variability of inflows. Through the process we recognised the importance of defining releases just before and during drought periods, such as those that occurred in the Kimberley in the 1930s and 1950s.

We used the modelling to:

- identify the most effective way to release water for irrigation, hydropower and the environment so that consumptive and non-consumptive demands were met in as many years as possible
- specify release rules from Lake Argyle and develop restriction policies for each demand during droughts

- estimate the number of years that the different demands were likely to be restricted.

The scenarios were modelled to meet three target criteria:

- full irrigation supply being met in 95 per cent of years
- irrigation supply being no less than 25 per cent of water demand in the driest year
- a minimum operating level for Lake Argyle of 70 m AHD.

We established allocation limits and release rules as restriction policies for irrigation, hydropower and environmental water demands for each demand scenario. The restriction policies define the levels in Lake Argyle at which each water supply or release rule is constrained. Because of the seasonal nature of inflows and lake levels, we defined restriction level triggers for each month of the year.

Based on the modelling, the allocation limits have been set so that the allocation will be available in most years, but a shortfall will occur in dry years – likely in about five out of every 100 years. For more information on the Ord River - Lake Argyle reservoir model simulations and demand scenarios see the *Ord surface water allocation plan methods report* (DoW 2012) and *Reservoir simulation in the Ord River catchment* (Smith & Rodgers 2010).

4 Water allocation limits and environmental water

This chapter sets out:

- the allocation limits in each subarea
- the flow regime needed to maintain the lower Ord River's environment.

The Department of Water has set allocation limits for each of the five subareas. The allocation limits are based on the outcomes and objectives set out in Chapter 2. Water for irrigation purposes (i.e. consumptive use) is managed through the allocation limits and licences.

Releases from the Ord River and Kununurra Diversion dams provide for the non-consumptive use of water for the environment and hydropower, along with rainfall and runoff from the Ord catchment, downstream of the Ord River Dam.

In this chapter we have detailed the flow regime that will be provided to maintain the lower Ord River's environment (the environmental water provision). The dam release rules are covered in Chapter 5.

For more information on how we developed the allocation limits and release rules for this plan see the *Ord surface water allocation plan methods report* (DoW 2012).

4.1 Components of the allocation limit

An allocation limit is an annual volume of water set aside for consumptive use from a water resource. This includes:

- the water available for licensing
- the water we account for that is exempt from licensing
 - under stock and domestic and riparian rights
 - for commercial use in unproclaimed areas
- the water set aside for future public water supply
- water set aside for Northern Territory irrigation expansion

In the *Ord surface water allocation plan* area the total allocation limit is available for licensing.

There is no exempt use or surface water reserved for public water supply. Water released for hydropower generation or the downstream environment is not part of the Ord's allocation limits.

4.2 Water allocation limits

The allocation limits for the Main Ord and Carlton-Mantina subareas were set in the 2006 plan and remain in place. Water allocation limits for the Upper Ord and the Dunham River subareas are newly set in this plan.

The department will allocate water up to the annual allocation limits and reliability for each of the surface water subareas (see Table 3).

Water is available for allocation in four out of the five subareas.

The Tarrara-Carlton subarea has a zero water allocation limit. However, water may be abstracted from it if the entitlement volume is transferred from the Main Ord subarea, and additional water is released from Lake Kununurra to flow into the Tarrara-Carlton subarea. This is necessary so that abstraction in the subarea does not lower water levels below target levels and affect important in-stream habitat.

As at October 2011, there is an application seeking an annual water entitlement of 104 GL from the Carlton-Mantinea subarea. If it is approved, it will significantly reduce the remaining water available in that subarea.

Table 3 Allocation limits for the Ord surface water allocation plan area

Subarea	Allocation limit (GL/yr)	Allocation limit components (GL/yr)		Annual reliability of supply	Water available for licensing in WA (GL/yr) (at November 2011)
		Licensable	Northern Territory licensable		
The Upper Ord	15	15	0	variable	6.1
Main Ord	750	590	160	95%	243.1
Tarrara-Carlton	0	0	0	N/A	0
Carlton-Mantinea	115	115	0	95%	115
Dunham River	25	25	0	variable	17.4
Total	905	745	160		373.2

4.3 Environmental water provision

The environmental water provision is the flow regime predicted to maintain defined environmental values. The lower Ord River environmental water provision comprises:

- a baseflow component that varies in the wet and dry seasons
- a series of annual and inter-annual wet season flow events
- infrequent wet season flood events.

The department has developed the provision to achieve a range of flows important to maintain environmental values in the lower Ord River. Figure 7 shows the range of flows that make up the environmental water provision in a year – a wet and dry season baseflow and a range of wet season flow peaks.

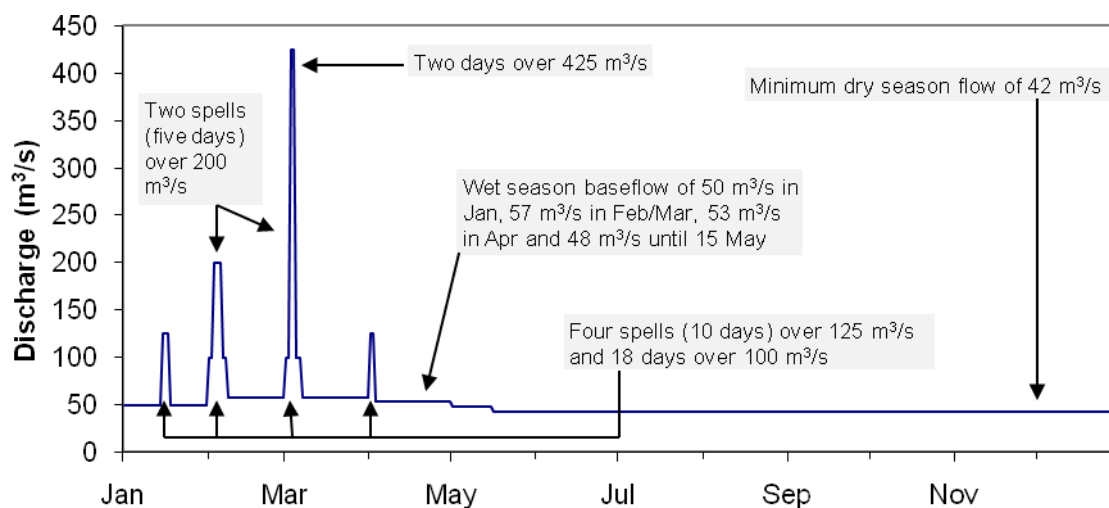


Figure 7 Lower Ord environmental water regime from Lake Kununurra to Tarrara Bar

The department has defined the baseflow (Table 4) and wet season peak flow targets (Table 5) that need to occur in the lower Ord River to maintain the habitat components listed in Chapter 3.

These components of the environmental water provision are achieved through a combination of releases from Lakes Argyle and Kununurra and unregulated catchment inflow.

Table 4 Baseflows to be measured at Tarrara Bar gauging station

	Lake Argyle water levels above which full EWP is met	EWP	Range of water levels in Lake Argyle – 1st level restrictions	Restricted EWP (1st level)	Lake Argyle water levels below which 2nd level restrictions are applied	Restricted EWP (2nd level)
	m AHD	m ³ /s	m AHD	m ³ /s	m AHD	m ³ /s
January	79.2	50	–	–	79.2	39
February	82.0	57	–	–	82.0	44
March	83.4	57	–	–	83.4	44
April	83.7	53	–	–	81.0	41
May	83.2	48*	83.2 to 79.4	37	79.4	32
June	82.8	42	82.8 to 76.8	37	76.8	32
July	82.3	42	82.3 to 76.2	37	76.2	32
August	81.7	42	81.7 to 75.3	37	75.3	32
September	81.1	42	81.1 to 74.3	37	74.3	32
October	80.5	42	80.5 to 73.1	37	73.1	32
November	80.0	42	80.0 to 75.7	37	75.7	32
December	79.5	42	79.5 to 75.3	37	75.3	32

* on 15 May the environmental water provision flow requirement drops from 48 m³/s to 42 m³/s

Table 5 Wet season peak flow targets

Number of events	Total target duration (days)	Duration remaining if (higher) flow targets have been met (days)	Average daily discharge (m ³ /sec)	
			Unrestricted conditions Lake Argyle levels > 82.0 m AHD (Feb) > 83.4 m AHD (Mar) > 83.7 m AHD (Apr)	Restricted conditions (Class 2) Lake Argyle levels < 82.0 m AHD (Feb) < 83.4 m AHD (Mar) < 83.7 m AHD (Apr)
1	2	–	≥ 425	–
2	5	3	≥ 200	≥ 154
4	10	5	≥ 125	≥ 96
N/A	18	8	≥ 100	≥ 77

The infrequent wet season flood events (Table 6) are also required for fish passage and scour of sediment. These flood events, while large and outside of the control of releases from the dam, are much less frequent now compared to before the Ord River Dam was built. They occur as a result of runoff from the catchment downstream of the Ord River Dam – mostly from the Dunham River catchment – and cannot be managed through control of releases from the dam.

Table 6 Infrequent wet season flood events

Flood event	Average daily discharge (m ³ /sec)
One event every two years	≥ 750
One event every four years	≥ 1400
One event every 27 to 35 years	≥ 3700

5 Water allocation and licensing policies

Water licences are the regulatory instrument the Department of Water uses under the *Rights in Water and Irrigation Act 1914* (WA) to manage the individual take of surface water and groundwater. Where water users legally require a licence, the department uses policies to guide how we assess licence applications and apply licence conditions.

This allocation plan includes policies to address water allocation and licensing in the plan area. The plan provides guidance for assessing licence applications as well as the specific conditions to apply to licences and operating strategies in the plan area.

5.1 Legislative requirements

The department manages water on behalf of the state under the *Rights in Water and Irrigation Act 1914*. The Act establishes the legislative framework for managing and allocating water in Western Australia. In administering the Act we abide by other state and federal legislation.

The department is responsible for managing water resources in Western Australia consistent with the objects of Part III of the *Rights in Water and Irrigation Act 1914*. The objects are specified in Section 4 (1) of the Act and are as follows:

- (a) To provide for the management of water resources, and in particular –
 - (i) for their sustainable use and development to meet the needs of current and future users; and
 - (ii) for the protection of their ecosystems and the environment in which water resources are situated, including by the regulation of activities detrimental to them
- (b) to promote the orderly, equitable and efficient use of water resources;
- (c) to foster consultation with members of local communities in the local administration of this Part, and to enable them to participate in that administration; and
- (d) to assist the integration of the management of water resources with the management of other natural resources.

5.2 Water licences

Water users in the *Ord surface water allocation plan* area require a water licence to lawfully take surface water under Section 5C of the *Rights in Water and Irrigation Act 1914*. The licence's annual water entitlement defines this legal right and specifies where and the purposes for which the water may be taken. In granting a water licence the department considers the allocation plan, as well as clause 7 (2) of Schedule 1 of the Act.

We may apply terms, conditions and restrictions to licences under clause 7 (1) of Schedule 1 of the Act. This may include an operating strategy, which is a set of operating rules and actions the licensee is required to implement (as a condition of the licence).

Our powers to alter any licence condition are specified under clause 24 (1) of Schedule 1 of the Act. The rights of licensees are covered under clause 26.

A permit is also required to interfere with the bed and banks of watercourses. This includes installing pumps or constructing dams, under Sections 11, 17 and 21 of the Act.

Compliance and enforcement

This legislation requires people or organisations to have legal authorisation to take surface water or groundwater or to interfere with the bed or banks of a watercourse in an area proclaimed under the Act. If these licences or permits are not obtained or their conditions are breached, the department will take appropriate enforcement action.

5.3 Allocation approach

Allocating water for irrigation expansion

The department has allocated 865 GL/yr for consumptive use in the Main Ord and Carlton-Mantinea subareas (Table 3). That is, up to 865 GL/yr of annual water entitlements can be granted from the Ord River downstream of Lake Argyle.

The irrigation demands dependent on Lake Argyle will change over time as new irrigation expansion areas are approved and as the demand for hydropower increases.

We will not issue more rights to water than is needed for efficient irrigation of planned crop types. This will allow irrigation developers to access secure, reliable water, and hydropower generation to be maximised while irrigation expands.

The 865 GL includes 115 GL available in the lower reaches of the Ord river, and 160 GL set aside for irrigation expansion in the Northern Territory (see below).

Northern Territory provision

This plan makes provision for 160 GL/yr of water from Lake Argyle for use in the Northern Territory. We have determined the 160 GL/yr based on a nominal 10 ML/ha of irrigation development over 14 000ha, plus an allowance of 20 GL for distribution losses.

We will review the Northern Territory provision in five years, or sooner if it is preventing the development of viable irrigation areas in Western Australia and/or there is no progress in developing irrigation areas in the Northern Territory.

Developers and water service providers

The Government of WA selects developers for new irrigation areas in the Ord area as part of its land release program. In the case of the Goomig farmlands project, government is acting as the developer. Private sector investors are planned to develop most future areas.

Where multiple irrigators/landowners are to take up land in a new area, the developer and the Department of Water will select a water service provider for the new area. A water service provider is subject to licensing by the Department of Water (rights to water) and the Economic Regulation Authority (ERA) (water service regulation).

When the developer selects the new landowners/ irrigators, the new irrigators submit their intended crop types and water demand to the new water service provider. The water service provider then applies to the department for a water licence, to meet the needs of its new customers.

Traditional owners

The Miriuwung Gajerrong people have agreed to surrender native title rights in development areas defined in the Ord Final Agreement (OFA), in exchange for a suite of benefits.

One of the benefits requires the proponent or developer to make serviced farmland available in most development areas. This benefit may be taken as a direct transfer of land, options to purchase extra land, and /or equity in the development.

In the case of the Goomig farmlands, where the State Government is the developer, the Miriuwung Gajerrong (MG) Corporation has agreed to receive five percent of the land by direct transfer (free of charge) and has the option to purchase a further 7.5 percent.

As one of the new land owners in the Goomig farmlands, the MG Corporation, or their agent, will obtain on farm entitlements to water as a customer of the water service provider for the development. They can apply directly to the department for a 5C licence, if their land has direct access to the Ord River.

Proposals to develop land where native title has been determined, and not covered by the OFA, cannot proceed until an agreement with the MG Corporation has been negotiated.

Trading

Trading of water entitlements between licensees in the Ord irrigation area is likely to start once water entitlements equal the allocation limits. This is not expected to happen in the seven-year life of this plan. When trading starts, we will assess applications with guidance from *Operational policy 5.13: Water entitlement transactions for Western Australia* (DoW 2010) and in accordance with Division 7 of Schedule 1 of the *Rights in Water and Irrigation Act 1914*.

Trading of on-farm water shares within the irrigation cooperative can occur consistent with their articles of association. Trading on-farm water rights

between customers of a new water service provider would occur as defined in customer contracts.

Managing in drought

Because some water is kept in storage to maintain a high reliability of supply, in most years the demands on water from Lake Argyle for irrigation, hydropower and the environment will be fully met. However in longer dry periods, such as those experienced in the Ord area in the 1930s, 50s and 80s, a shortfall is likely to occur.

We have defined the levels in Lake Argyle that will trigger restrictions to irrigation, hydropower and the environment in these circumstances. These levels are detailed in Appendix A.

5.4 Licensing approach

Water licensing in the Ord area is undertaken in accordance with the *Rights in Water and Irrigation Act 1914*, and the allocation limits, licensing approach, and licensing policies set in this plan. In the Ord River area the department grants 5C licences to self-supply users, water service providers and the Water Corporation.

The Department of Water regulates the release of water through the power station by the conditions we set on Water Corporation's 5C licence for the Ord River and Kununurra Diversion dams. The licence authorises the Water Corporation to store water in Lakes Argyle and Kununurra and requires the Water Corporation to operate the current dam infrastructure in accord with its approved operating strategy. The operating strategy includes the water release rules for the power station.

Licensing new demand as irrigation developments proceed

The Department will issue new entitlements as each new irrigation area proceeds. We will assess new licence applications and grant water entitlements based on justified need and efficient water use.

We will recoup unused entitlements to ensure that licensed entitlements in the Ord area are similar to the water used, so that water for further irrigation expansion and power generation is maximised. Provision will be made for reasonable changes in crop types from year to year. Savings made from efficiency gains, above expected efficiency targets, will not be recouped and can be either used or traded.

As we grant new water entitlements, we will also adjust the Water Corporation's operating strategy for the Ord River Dam to ensure all entitlements can be fully supplied in 95% of years (see below). This will be necessary to maximise the water available for new development and maintain the precision of the dam release and restriction rules, in line with changes to demands for irrigation and hydropower.

Current water release rules

In 2009, the Department established new water release rules for managing the projected high demand on the power station. The Water Corporation's operating strategy was changed to:

- establish water levels at which electricity generated at Pacific Hydro’s discretion would be limited (Table A2, Figure 8)
- require Water Corporation to check whether water levels triggered hydropower restrictions
- set a weekly limit on power generation when restrictions are triggered, based on the annual rates of 210 GWh/yr (Class1) and 89.4 GWh/yr (Class 2) restrictions (Figure 8)

In 2010, we introduced monthly limits for Class 1 hydropower restrictions. The limits include a banking and borrowing provision that gives operational flexibility around each monthly limit, but limits the total power generated to 210 GWh/year.

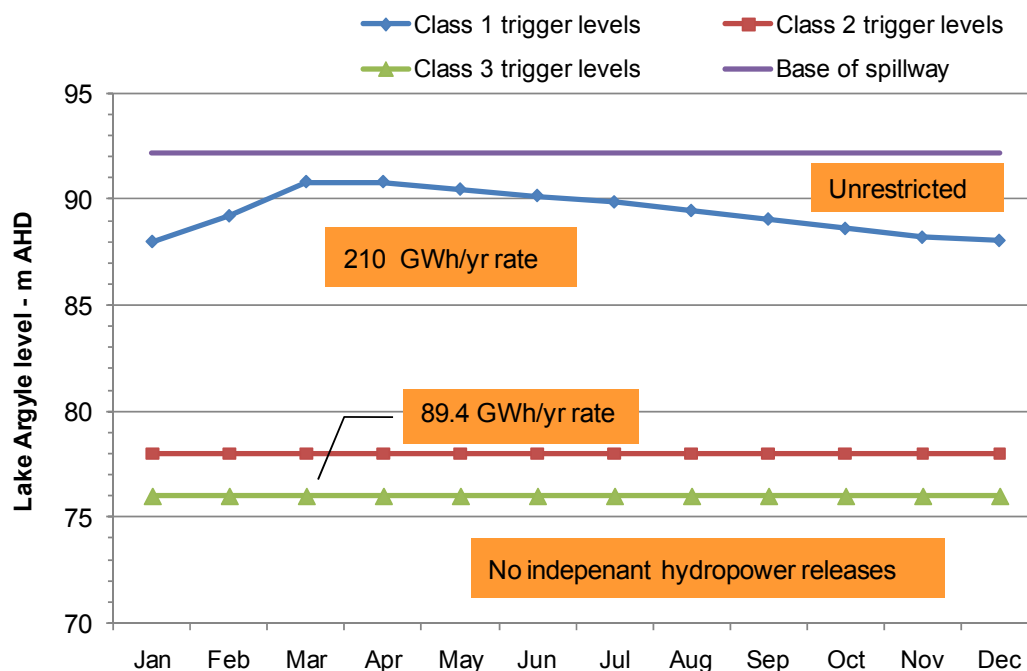


Figure 8 Hydropower restriction under current rules with 350 GL of irrigation demand

Table 7 sets out the monthly limits on electricity that Pacific Hydro may generate (independent of the electricity that could be generated from Water Corporation’s releases) when Class 1 and Class 2 restrictions apply. The monthly limits are based on recent seasonal patterns of electricity demand of the East Kimberley Electricity Grid.

Class 1 restrictions are triggered by the water level in Lake Argyle at the start of the month and continue for the full month unless levels reach the Class 2 trigger during the month. Weekly limits currently still apply to Class 2 restrictions, but negotiations are well advanced with Pacific Hydro and Water Corporation to replace this approach.

Table 7 Limits on Pacific Hydro's electricity generation

Month	Restriction Class		
	Class 1 [†] GWh	Class 2 GWh	MWh/day
January	18.23	7.54	243
February	15.61	7.55	270
March	18.16	7.86	254
April	16.95	7.67	256
May	16.71	6.52	210
June	16.13	5.86	195
July	17.15	5.96	192
August	18.00	6.25	202
September	17.97	7.91	264
October	18.08	9.40	303
November	19.33	9.29	310
December	17.74	7.58	245
Total	210.0	89.4	-

[†] Nominal limit adjusted by the banking and borrowing approach

Future water release rules

In future the department will licence Water Corporation using the general approach outlined below. Water Corporation will use this approach, with the trigger levels defined by either the current agreement or the enhanced rules approach (whatever is current at the time) to determine restrictions to hydropower.

General approach

The department will:

- maintain the current monthly banking and borrowing approach when Class 1 restrictions apply
- replace the weekly limits for Class 2 restrictions with a daily limit for each month
- apply the release rules on a daily basis when Class 2 or Class 3 restrictions apply

The daily limits on power generation for Class 2 restriction will be determined based on whether the electricity able to be generated from Water Corporation's required releases on the day, is larger than Pacific Hydro's Class 2 discretionary daily allowance each month (Table 7)

Compliance with Class 1 and Class 2 generation limits will be assessed over periods of four, six and 12 months.

Class 3 restrictions will apply when lake levels fall below 76 m AHD, and at this level Pacific Hydro will have no discretion to generate electricity, independent of Water Corporation's required releases. Class 3 electricity limits are therefore based on the electricity that can be generated from Water Corporation's required releases for irrigation and the environment.

We are committed to using this approach to manage hydro power releases under this plan and will only change the release rules in the following ways and situations:

- Adjusting the levels at which Class 1 and Class 2 restrictions are triggered as extra water entitlements are granted.
- Increasing the Class 2 annual electricity limit on Pacific Hydro, if Horizon Power’s demand exceeds 89.4 GWh/yr.

Enhanced rules approach

The department has developed an enhanced rules approach to defining water release rules for the power station that responds to the high power demand while maintaining highly reliable water for irrigation expansion. The approach has two aspects:

- Lowering the lake level at which Class 1 restrictions commence so that the station can run unrestricted more frequently when storage levels are moderate to high
- Increasing the level at which Class 2 restrictions commence so that less water is released, independent of Water Corporation needs, when lake levels are low and restrictions on irrigation are imminent.

This approach enables more electricity to be generated on average and more water entitlements to be granted at our target reliability of 95 per cent.

Figure 9 shows the enhanced water release rules approach when 350 GL of annual water entitlements have been granted, and illustrates the difference in approach from the current rules (Figure 8).

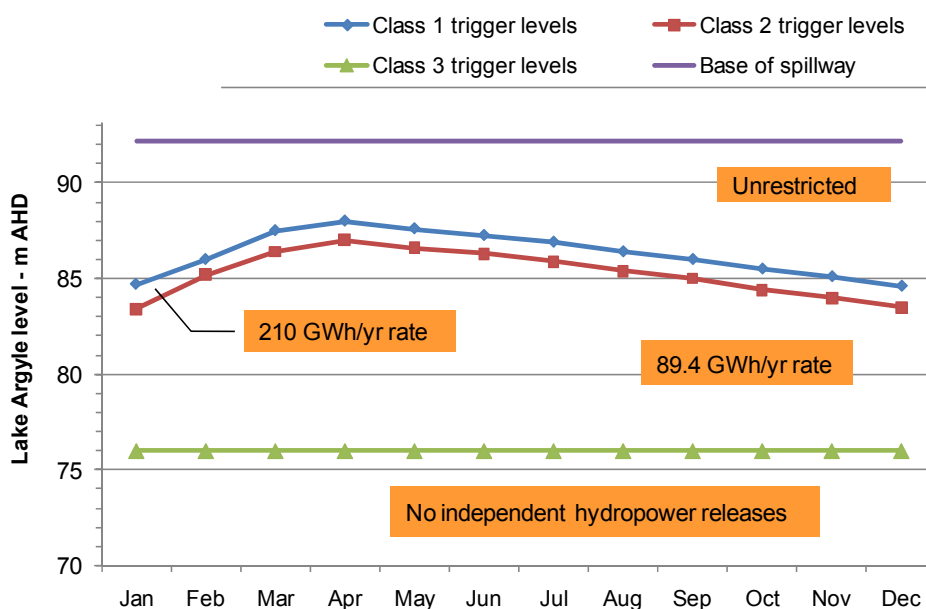


Figure 9 Enhanced hydropower release rules for irrigation demand of 350 GL/yr

Figure 10 shows that as irrigation demand increases, the average electricity generated decreases for both the current and enhanced rules approach. The current rules approach enables Pacific Hydro to generate at least 210 GWh/yr while water levels in Lake Argyle are above 78 m AHD and therefore maintain the minimum guarantee of the Water Supply Agreement. However, only 520 GL/yr can be reliably supplied (at 95%) if the minimum guarantee of the water supply agreement is maintained (Figure 10).

The enhanced rules approach enables more electricity to be generated on average at any given water demand and can supply up to 750 GL/yr of water at the 95% reliability (Figure 10). The enhanced rules approach reduces the severity of irrigation restrictions, especially as entitlements approach the allocation limit.

For more detail on the enhanced rules approach, and how it was developed, see the *Ord surface water allocation plan methods report* (DoW 2012).

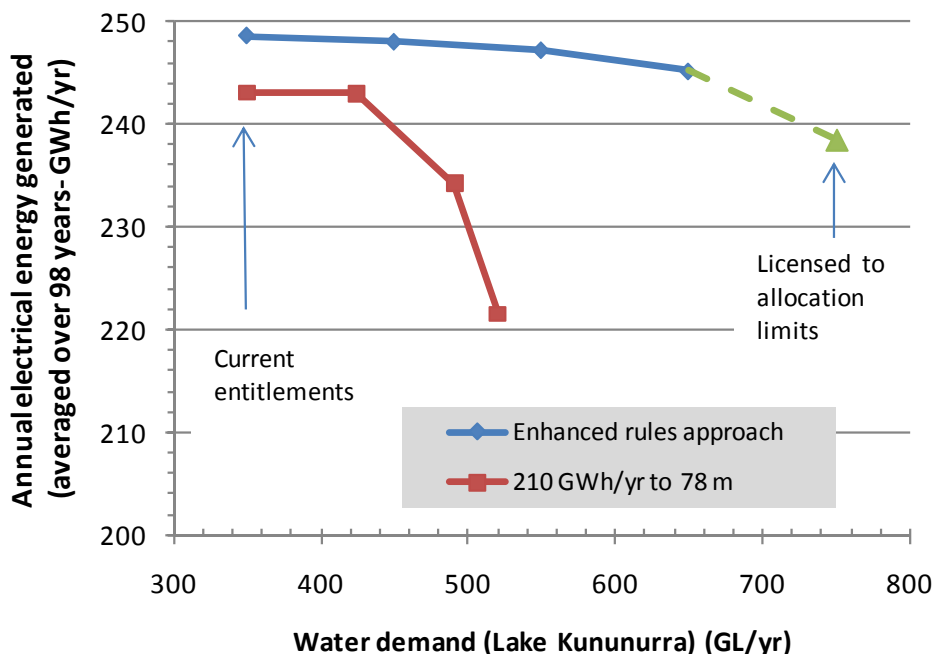


Figure 10 Electricity generated under enhanced and current rules for a range of entitlements

While Water Corporation and Pacific Hydro support a move to the enhanced rules, they intend to update their agreement first. The Water Corporation's dams storage licence is the legal instrument that now defines the water release rules for the power station. Ideally, the water supply agreement would reflect the operating strategy associated with the water licence. The department will implement the enhanced rules approach as soon as Water Corporation apply to introduce them.

The department is, however, prepared to issue annual water entitlements up to 750 GL in the Main Ord Subarea, to support irrigation expansion, regardless of whether enhanced rules have been agreed between the Water Corporation and Pacific Hydro.

Adjusting release rules as extra water entitlements are granted

The department will update the water release rules in the Water Corporation's operating strategy each time we grant new water entitlements of 30 GL/yr or more from the Main Ord Subarea. We will use the Ord River - Lake Argyle reservoir model to define the new levels in the reservoir that will trigger restrictions. The need to adjust the trigger levels for hydropower restrictions is likely to occur each time a new irrigation area of greater than 2,500 ha proceeds.

We have adopted 30 GL/yr as the trigger to adjust the release rules, because we estimate this will change the restriction levels in the reservoir by ~0.2 m when water entitlements equal or are less than 450 GL/yr in the Main Ord Subarea. As we grant water entitlements above 450 GL/yr, smaller increments in entitlements will trigger a revision to the dam release and restriction rules.

Minor adjustments to the levels that trigger restrictions for irrigation and the environment may also be necessary as water entitlements increase and when the enhanced rules approach is introduced.

Limiting specific releases for navigation purposes when lake levels are low

When water storage is low, the efficient use of water becomes particularly important. We consider it inappropriate to allow extra water to be released for navigational purposes at times of low storage, especially when Class 2 hydropower demands apply. Specific navigation releases will not be permitted when lake levels fall below the Class 2 trigger levels for hydropower restrictions under the "enhanced rules approach". Table A4 lists the trigger levels given current irrigation entitlements.

Meeting the environmental water provision

The environmental water provision is measured at the Tarrara Bar gauging station (Figure 3).

The environmental water provision is made up of three components:

- dry season and wet season baseflow (Table 4)
- wet season flow targets (Table 5)
- infrequent wet season flood events (Table 6).

It is a condition of the Water Corporation's licence that the environmental water provision for baseflow and wet season flow targets must be met. It is therefore responsible for releasing enough water through the Ord River and Kununurra Diversion dams to meet these.

The infrequent wet season flood events are generated from runoff, primarily from the Dunham River catchment and are not a condition of the Water Corporation's licence.

Runoff from the Dunham River catchment also provides most of the flow needed to meet the wet season flow targets. However, in some years, and depending on the demand for hydropower and irrigation, additional releases from storage are needed to meet the minimum flows and wet season flow targets (Refer Table B1).

We require the wet season flow event targets to be met in four out of five years. The Water Corporation will need to release additional water from storage to 'top up' catchment inflow to meet the targets, if the targets had not been met in one of the previous four years.

Managing in drought years - environmental and irrigation restrictions

Inflows to Lake Argyle are highly variable and the full storage capacity of Lake Argyle is needed to ensure a reliable supply of water from the Ord River.

The restrictions for hydropower - as discussed above - are not solely a drought measure, but are designed to limit the demand on Lake Argyle before storage levels become very low.

If storage levels do get very low, then we will also apply restrictions to irrigation and the environment. This will reduce the severity of restrictions to hydropower, irrigation and the environment in the following year if dry conditions continue.

Appendix A details the monthly levels that trigger each class and type of restriction, and their respective severities.

Determining restrictions

Before the annual operations meeting, the Water Corporation will project future storage levels in Lake Argyle in two ways:

- up to the end of the current year
- up to the end of the dry season that follows the next two wet seasons (30 months into the future).

It will do this by considering:

- the current storage level
- expected demands (from customers including Pacific Hydro)
- likely inflows to Lake Argyle.

It will then estimate the likelihood and severity of restrictions to irrigation, hydropower and the environment in the next 30 months, and present its projections for discussion at the annual operations meeting.

The department has developed tools to assist the Water Corporation to undertake these projections.

Environmental water

The Water Corporation will determine the likelihood and severity of restrictions to the environment based on the storage levels in Lake Argyle each month (Figure 11).

Class 1 restrictions to the environment will reduce the environmental water provision by 12 per cent and Class 2 restrictions will reduce it by 23 per cent. The different components of the environmental water provision will be restricted in the following way:

- dry season baseflow component – Class 1 and Class 2 restrictions apply (Table 4)
- wet season baseflow component – Class 2 restrictions apply (Table 4)
- wet season peak targets – Class 2 restrictions apply (Table 5).

The flow rates (Table 4) needed to meet the baseflow component of the environmental water provision are a function of the month of the year and class of restriction (Figure 11).

The wet season flow requirements are expected to be achieved by 30 April each year. Flow targets change if Lake Argyle water levels change (from drought to non-drought or vice versa) during the wet season.

Table 4 summarises the minimum flow rate targets for each month under normal and restricted conditions. For more information on how the environmental restrictions were developed and assessed, see the *Ord surface water allocation methods report* (DoW 2012).

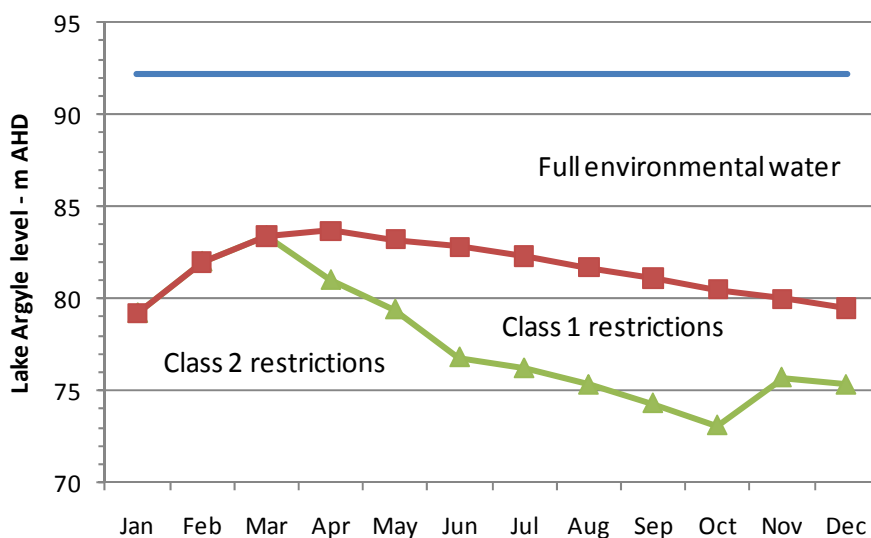


Figure 11 Lake Argyle levels that trigger Class 1 and Class 2 restrictions to the environment - current rules with 350 GL or 750 GL of irrigation demand

Irrigation

The department will apply restrictions to irrigation entitlements if water levels:

- in Lake Argyle on 1 April are less than 79 m AHD
- are predicted to fall below the levels in Appendix A within the current year.

We will implement restrictions using our licensing powers under the *Rights in Water and Irrigation Act 1914*.

We will confirm the likelihood and announce the severity of restrictions to irrigation entitlements two weeks after the annual operations meeting. We will lift restrictions

over that particular year if subsequent wet season inflows are large enough to significantly improve storage levels in Lake Argyle.

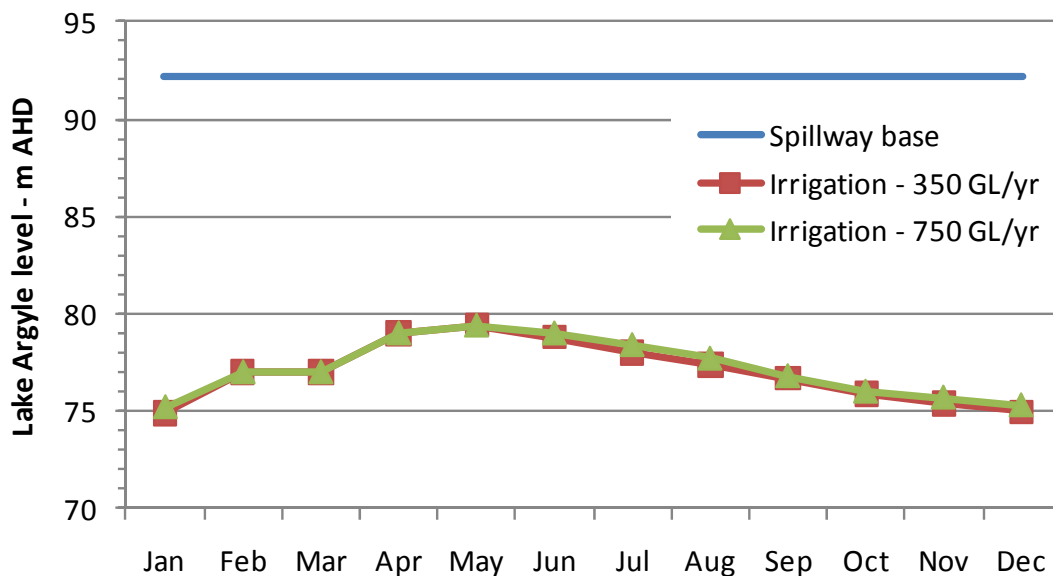


Figure 12 Lake Argyle levels that trigger restrictions on irrigation supply

Operations software

The Water Corporation and Pacific Hydro use software to help them:

- coordinate operation of the power station and irrigation values at Ord River Dam
- account for diversions from Lake Kununurra
- meet the environmental flow regime at Tarrara Bar.

This coordination is essential – particularly when limits on electricity generation apply. Pacific Hydro has access to the spreadsheet software so it can enter the daily amounts of electricity it generates, and plans to generate.

The Water Corporation is responsible for ensuring the power station releases of Pacific Hydro are consistent with the release rules established under its licence. The software is designed to help operators of the dam and power station to meet these obligations. The software can readily accommodate changes to the Water Corporation's operating strategy.

Output from the software is used by Water Corporation to prepare its annual report and assess compliance with power generation restrictions if they applied that year.

Appendix E provides more information on how this software is used.

Annual operations meeting

The department will hold a meeting in Kununurra at the end of each wet season to discuss operating arrangements for the Ord River Dam in the coming year. The operations meeting will be timed for when Lake Argyle is near its maximum for the year (usually before the end of April).

Attendees will normally comprise representatives from:

- the Department of Water
- the Water Corporation
- the Ord Irrigation Cooperative and Sunwater Pty Ltd
- Pacific Hydro
- the Miriuwung Gajerrong Corporation
- self-supply irrigators
- other interested/affected parties.

The meeting will examine:

- the inputs and outputs for Lake Argyle and the Kununurra Diversion Dam in the previous year (from data collected by the Water Corporation)
- dam and power station operations (including maintenance) during the past 12 months and plans for operations scheduled for the coming 12 to 18 months
- any implications of the planned operations on other affected parties (this includes how the Miriuwung Gajerrong people can maximise opportunities to exercise their traditional and customary rights to the waters of the lower Ord River)
- whether drought restrictions will apply to the water available through the coming dry season, and the likely severity of restrictions
- the likelihood of restrictions being triggered during the following dry season
- the compliance of flows at Tarrara Bar with the lower Ord environmental water provision (see Section 4.3)
- issues raised by licensees who hold licences dependent on Lake Argyle.

5.5 Licensing policies

Local licence policies apply to all licences in the Ord area (see Table 8). Local policies complement the department's statewide strategic or operational policies. They are local rules that help to interpret the statewide policy in a given area, and they provide additional guidance for licensing officers where required. They take precedence over statewide policies for the plan area.

Table 8 Licensing policies specific to the Ord area

Policy	Policy detail
Adjusting water entitlements over time	<p>The department will update water service provider licences, and then the Water Corporation's operating strategy, each time that the net increase in entitlements granted from Lake Argyle is 30 GL/yr or more (see Section 5.4).</p> <p>The Water Corporation's operating strategy will be updated with new:</p> <ul style="list-style-type: none"> • power station release rules • trigger levels for hydropower and if necessary, for irrigation and environmental restrictions. <p>Using the Ord River - Lake Argyle reservoir model our Water Resource Assessment Branch will determine the new release rules and trigger levels. The simulations will:</p> <ul style="list-style-type: none"> • be run so that irrigation is restricted in five per cent of years, with a target minimum irrigation supply of 25 per cent in the most severe year • include either the current or enhanced rules for hydropower generation – whichever set of rules are current at the time.
Trading of <i>Rights in Water and Irrigation Act 1914</i> water entitlements	<p>Trading of entitlements is unlikely to occur in the period the plan covers. We use Schedule 1 of the Act and Statewide trading policy 5.11 to guide the assessment of applications to trade water.</p> <p>Licensees must submit metered water use for the previous two years to support applications for trade.</p>
Metering	Licensees with water entitlements greater than 500 000 kL are required to meter their diversions in accordance with the Rights in Water and Irrigation (Approved Meters) Order 2009 and Australian Technical Specifications (ATS 4747).
<i>Water service providers</i>	
Defining and trading of on-farm water entitlements	<p>We will specify the maximum on-farm water entitlements a water service provider may issue to its members. This will be the annual water entitlement of its <i>Rights in Water and Irrigation Act 1914</i> licence multiplied by the target distribution efficiency of the licence.</p> <p>Water service providers define the on-farm entitlements for their customers in a customer contract; or if they are a cooperative, in their articles of association.</p>

Policy	Policy detail
	<p>Water service providers are responsible for managing trades in on-farm water entitlements within their supply area.</p> <p>Water service providers can also trade <i>Rights in Water and Irrigation 1914</i> Act entitlements with other water service providers or licensees under the Act.</p> <p>A customer/member wishing to trade their on-farm entitlement with a customer/member supplied by another water service provider should be able to do so. To trade on-farm entitlements between customers/members in different service provision areas the following steps are required:</p> <ul style="list-style-type: none"> • the members that want to trade must agree on the volume/yr and price of the (on-farm) trade and seek endorsement from their respective water service provider • the service providers must determine the equivalent Rights in Water and Irrigation Act entitlements of the trade and jointly apply to the Department of Water to trade the entitlement in accordance with the licensing provisions of the Act • when agreed and approved by the department and the two water service providers, we will update the relevant 5C licences of each water service provider and then each water service provider will adjust their respective customers' on-farm water entitlements.
Distribution efficiency	<p>We have set an 80 per cent distribution efficiency target for existing water service providers. New water service providers will be required to have an 85 per cent distribution efficiency. This will increase to 90 per cent once a balancing storage connected to the M2 channel is built.</p>
Monitoring and reporting	<p>Water service providers must provide the following in their annual report to the department:</p> <ul style="list-style-type: none"> • annual water diverted and delivered on-farm • distribution efficiency • surface water and groundwater quality monitoring results (required in Stage 1 areas, where no EP Act or EPBC Act conditions apply) • drainage discharge figures and estimates of irrigation return flows.
<i>Water Corporation</i>	
Period of the licence	<p>The duration of the Water Corporation's dam storage licence will be five years. We will adjust the water release and restriction rules in its operating strategy as we license large volumes of water for irrigation expansion.</p>
Release rules	<p>The Water Corporation must release water from the Ord River Dam and the Kununurra Diversion Dam in accordance with its operating strategy. The Water Corporation uses spreadsheet software developed by the department to coordinate dam and power station operations. The software:</p> <ul style="list-style-type: none"> • collates operational data from the dams, power station and flows in the Ord and Dunham rivers • calculates the releases made through the power station and irrigation valves • reports on the power generated and the downstream flows achieved.

Policy	Policy detail
Hydropower restriction rules	The levels that trigger Class 1, Class 2 and Class 3 restrictions for hydropower are to be based on the approach outlined in section 5.4 and the levels detailed in Appendix A. We will use the results of future reservoir simulations carried out for licensing to define the final trigger levels.
Navigational release restrictions	Specific releases from Lake Argyle for navigational purposes will not be permitted when water levels in Lake Argyle fall below those for Class 2 hydropower restrictions, under the enhanced rules approach (Table A4, for current irrigation demand)
Environmental restriction rules	The levels that trigger Class 1 (12 per cent reduction) and Class 2 (23 per cent reduction) restrictions to the environmental water provision are shown in Figure 11 and listed in Appendix A.
Irrigation restriction rules	The levels that trigger restrictions to irrigation are shown in Figure 12 and listed in Appendix A. The Water Corporation assesses the likelihood and severity of restrictions for discussion at the annual operations meeting. If applicable, the department announces the severity of restrictions two weeks after the annual operations meeting.
Annual operations meeting	The Water Corporation will provide the following for the annual operations meeting in Kununurra: <ul style="list-style-type: none"> • data on dam operations from the previous year, and preliminary data from the current wet season • proposed timing of dam maintenance in the coming year • estimate of inflows to Lake Argyle over the recent wet season • information on expected demands from Pacific Hydro and water service providers • documentation on whether flows at Tarrara Bar complied with the lower Ord environmental flow regime • projections of Lake Argyle storage at the end of the year • the likelihood and severity of restrictions at the end of the year and the next two wet seasons.

5.6 Predicted outcomes

Appendix B presents the predicted outcomes of managing Ord River water stored in lakes Argyle and Kununurra in accord with the allocation limits in Chapter 4 and the licensing approach and policies outlined in this chapter.

The appendix details the water:

- stored and released from lake Argyle and Kununurra
- retained in the lower Ord River
- supplied for irrigation
- used to generate hydro-electricity

under a range of demand scenarios that could develop within the period of the plan.

Appendix B also discusses likely ecological impacts of our planned management.

6 Monitoring for the Ord River

The plan's monitoring program sets out how the Department of Water will monitor water resources in the plan area. It will support plan evaluation and understanding of the water resource over time.

The hydrological monitoring program is designed to measure the plan's success. We assess the monitoring information that we collect, as well as that obtained from water licensees, to check how rivers in the plan area are responding. This includes monitoring of regulated (the lower Ord River) and unregulated tributaries (the Dunham River).

An environmental monitoring program has also been included for the Ord area. The program will check that flow in the lower Ord River is sufficient to maintain environmental values.

6.1 Evaluating plan objectives

The department will evaluate this plan's objectives against the performance indicators in Table 10. To do this we will use information from the Water Corporation's annual report, and data from the following streamflow gauges:

- Ord River, Tarrara Bar (809339)
- Dunham River, Flying Fox Hole (8091177).

The location of these gauges is shown in Figure 13. The Water Corporation uses the gauges to manage the release of water from the Ord River and Kununurra Diversion dams, and it cites the data in its annual report.

Table 9 Monitoring in the plan area

Objective	Site	Performance indicator	Frequency
Provide a flow regime in the Ord River below the Ord River and Kununurra Diversion dams that:	Ord River, Tarrara Bar (809339)	Minimum flows and wet season peak flow targets met at Tarrara Bar (Table 4 and Table 5)	Daily
<ul style="list-style-type: none"> meets the monthly dry and wet season environmental flow targets at Tarrara Bar enables sufficient water to be abstracted to meet all water entitlements granted in the Main Ord and Carlton – Mantinea area in 95 per cent of years maximises water supply for hydropower generation within the limits of (a) and (b). 	Dunham River, Flying Fox Hole (8091177)	The water supplied for irrigation and hydropower is checked during the evaluation of plan outcomes (section 7.2)	Annually

The department will use the Water Corporation's annual report to assess whether the environmental water provision has been met at the Tarrara Bar gauging station. The Water Corporation is required to do an interim flow review during each wet season by the end of January.

If the wet season targets have not been met in the current wet and were not achieved in one or more of the preceding four wet seasons, the Water Corporation will be required to release additional 'top up' flows from the Ord River Dam (Refer Action 12, Table 12). This requires an increase in the frequency of flow monitoring at Tarrara Bar and in the Dunham River.

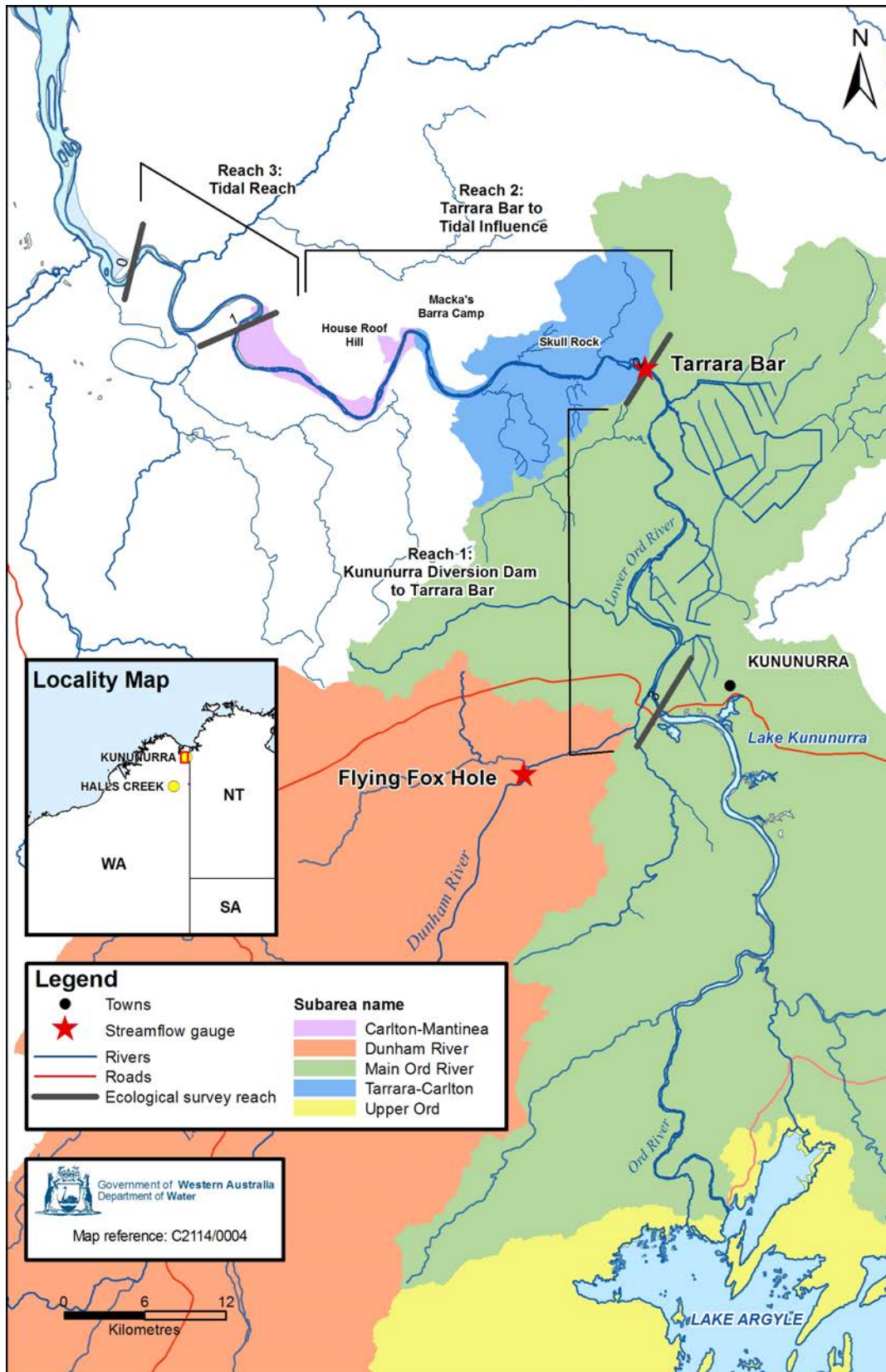


Figure 13 Streamflow monitoring sites and ecological monitoring reaches in the lower Ord River

6.2 Trigger and response mechanisms

Management of water resources in the Ord area will not only require the monitoring program to be implemented, but also management practices to be altered to cater for instances where the trigger values in Table 10 are reached.

The Water Corporation's required response are established as part of their operating strategy for the Ord River and Kununurra Diversion dams. Failure to meet this strategy will result in licence compliance action and/or revision of the release rules for the Ord River and Kununurra Diversion dams.

Table 10 Trigger and responses in the plan area

Trigger	Site	Frequency	Response
Storage levels in Lake Argyle fall within Class 1 or Class 2 environmental restrictions (Appendix A)	Lake Argyle	Monthly (Class 1) Daily (Class 2)	Water Corporation to release water to meet the environmental water provision at Tarrara Bar under either Class 1 or Class 2 restrictions (Appendix A).
Daily flow < 35 m ³ /sec (this may be triggered in dry periods or as a result of dam maintenance)	Ord River, Tarrara Bar (809339)	Daily	The department to set up dissolved oxygen probes: one upstream of Tarrara Bar and one at Carlton Crossing.
Dissolved oxygen equal to or less than 2 mg/L at > 4 m depth in selected deep pools	Sites to be determined within reaches 1, 2 or 3 (Figure 13)	Hourly, once flow is below 35 m ³ /sec	The Water Corporation will release water from the Ord River and Kununurra Diversion dams. The volume and pattern of releases will be determined in consultation with the department.

If restrictions to the environment are triggered, the Water Corporation must release water from the Ord River and Kununurra Diversion dams to meet the environmental water provision flow target that corresponds with Class 1 or Class 2 restrictions (Appendix A).

The releases needed to meet the required flows are defined using an operational spreadsheet, run and maintained by the Water Corporation (see Appendix E).

Before the annual licensees meeting the Water Corporation will project the likelihood and severity of restrictions to the environment for the coming year. The department will validate the projections and announce them within two weeks of the meeting (see Section 5.3).

Environmental monitoring

The department has developed an environmental water provision monitoring program and management framework for the lower Ord River. We will use the monitoring program to check that the water released from the dams, topped up by flows from the Dunham River, is sufficient to maintain the lower Ord River's ecological condition. The program will monitor and assess water quality, fish, macroinvertebrates and vegetation in reaches 1 and 2 of the Ord River (Figure 13). It will be completed by

water quality data by the Ord Irrigation Cooperative from irrigation drains in the Ord irrigation area.

Water quality will be monitored monthly. Before irrigation expansion, fish, macroinvertebrates and vegetation will be monitored annually; and post-expansion, once every three years. More detail on the program is provided in the *Lower Ord River environmental water provision monitoring program and management framework* (Loomes & Braimbridge 2011).

The monitoring program defines ecological triggers and responses for nutrient and physico chemical parameters (Table 6), macroinvertebrates (Section 6.2), fish (Section 6.3) and riparian and in-stream vegetation surveying (Table 10)

The trigger is the point predicted to result in a rapid change in the ecosystem. The response defines what is required from the Water Corporation, Department of Water or the Ord Irrigation Cooperative in terms of investigative, operational or compliance activities if a trigger is breached.

We will review the trigger levels after each ecological monitoring round to ensure they are locally appropriate. The trigger and response framework for the lower Ord environmental monitoring program is summarised in the *Lower Ord River environmental water provision monitoring program and management framework* (Loomes & Braimbridge 2011).

Table 11 Management responses required by Department of Water, Water Corporation and Ord Irrigation Cooperative

Do flows meet the environmental water provision	Has a trigger been breached*?	Actions		
		Department of Water	Water Corporation	Ord Irrigation Cooperative
Yes	Yes	<ul style="list-style-type: none"> • short-term review (<6 months) of ecological flow model – this may require input from expert panel • response based on: <ul style="list-style-type: none"> - severity of impacts - certainty of cause - reference site response • revise operational strategy and amend if required 	<ul style="list-style-type: none"> • provide monitoring data as requested • implement revised operating strategy if required 	<ul style="list-style-type: none"> • provide water quality data if requested • if a breach is detected investigate source, rectify issue and monitor impact
	No	no action required	no action required	no action required
No	Yes	<ul style="list-style-type: none"> • analysis of ecological trigger and EWP component not met • consider action on non-compliance 	<ul style="list-style-type: none"> • show cause of EWP flow breach • provide monitoring data as requested • meet operating strategy and revised operating strategy if required 	<ul style="list-style-type: none"> • provide water quality data if requested • if a breach is detected investigate source, rectify issue and monitor impact
	No	longer-term review of: <ul style="list-style-type: none"> • ecological trigger • EWRs/EWPs • operating strategy • allocation plan 	<ul style="list-style-type: none"> • show cause of EWP flow breach • provide monitoring data as requested • meet operating strategy or meet revised strategy if environmental provision is revised 	no action required

* Trigger levels for different environmental parameters are listed in Appendix D.

7 Implementing and evaluating the plan

The Department of Water will implement the *Ord surface water allocation plan* through:

- licensing to the allocation limits for each subarea in Chapter 4
- adjusting existing licences and issuing new licences according to the allocation and licensing approach in Chapter 5
- undertaking the Ord River monitoring program in Chapter 6
- implementing the actions in Table 12.

7.1 Plan actions

Table 12 lists actions for the department to implement the plan over the next seven years.

They complement the licensing and allocation approach for the Ord area outlined in Chapter 5. The actions were identified during the plan's development and stakeholder consultation.

Table 12 Plan actions

No.	Actions for implementing the plan	Responsibility ²	Timeline
Monitoring and adaptive management			
1	Confirm funding for ecological monitoring program	Water Allocation Planning	2012
2	Review implementation of ongoing flow and biological monitoring programs	Water Allocation Planning and Water Resource Assessment	Annually
Resource assessment			
4	Update flow series in reservoir modelling from 1906–07 to 2003–04 to 1906–07 to 2014-15	Water Resource Assessment	2015
5	Run reservoir model to redefine release rules for Ord River and Kununurra Diversion dams each time a significant volume of water is granted for irrigation expansion (~30 GL while water entitlements are less than 450 GL)	Water Resource Assessment	First modelling expected in late 2012 when on-farm water demand from new Goomig farmland owners is known
Licensing			
6	Finalise operations details of the enhanced rules for hydropower generation with Water Corporation and Pacific Hydro	Water Allocation Planning and Water Resource Assessment	2012

² Departmental branch responsible for the action

No.	Actions for implementing the plan	Responsibility ²	Timeline
7	Facilitate adoption of enhanced rules by Water Corporation and Pacific Hydro	Allocation Planning Branch	2012
8	Each time a significant volume of water is granted for irrigation expansion adjust: <ul style="list-style-type: none"> - irrigation water service provider licences - Water Corporation's licence with new release and restriction rules for the Ord River and Kununurra Diversion dams 	Kimberley Region	Each time that greater than 30 GL of water is licensed by the department
9	Adjust the volume of water reserved for the Northern Territory if land development has not progressed	Allocation Planning	2017
10	Hold a licensees meeting in Kununurra in April each year to announce the likelihood and severity of restrictions and to discuss operation of the dams in the previous and coming year	Kimberley Region	Annually
11	Include a condition on Water Corporation's licence that requires them to implement the biological monitoring component of the lower Ord environmental water provision monitoring program.	Regulation	March 2012
12	Include a requirement in the Water Corporation's operating strategy to 'top up' wet season peak flow events if they have not been met in one of the four preceding wet seasons.	Water Allocation Planning	2014
Resource management			
13	Liaise with the Miriuwung Gajerrong to maximise opportunities for Indigenous people during 'dry out' periods	Kimberley Region	Ongoing
Evaluation statement			
14	Produce and publish an annual evaluation statement	Water Allocation Planning and Kimberley Region	Annually

7.2 Evaluating the plan

Once the plan is in place, we will regularly evaluate whether its outcomes and objectives are being met by publishing an annual evaluation statement. The evaluation will review the performance indicators and consider whether the management strategies have been implemented.

Evaluating plan outcomes

We will check whether the plan is helping to achieve the irrigation, hydropower supply, environmental and cultural outcomes stated within it (Section 2.1).

Licensees will report the irrigation and hydropower outcomes to the department in their annual reports.

The Ord Irrigation Cooperative will report on the volume of water delivered on-farm. The Water Corporation will report on the hydropower generated and its dam maintenance activities. The use of low-flow periods by the Miriuwung Gajerrong and other native title claimants will be discussed at the annual operations meeting in Kununurra.

The plan's environmental outcomes will be measured and reported on through the environmental monitoring program explained in Section 6.2.

We have modelled the likely irrigation and hydropower supply and environmental flow outcomes for a range of future management scenarios. The results of this work are detailed in Appendix B.

Evaluation statement

The annual evaluation statement will assess our progress in implementing the plan and whether the water resources covered by the plan are tracking as set out in the plan's objectives. The plan's evaluation statement will define:

- the allocation status for each resource (e.g. water use compared with the allocation limit defined for each subarea)
- the annual volume of licensed entitlements in each subarea
- whether restrictions were triggered in the previous year, and the severity of restrictions to irrigation, hydropower and the environment
- the status of plan actions due in the evaluation period
- performance against the plan's objectives
- performance against the plan's outcomes
- if the plan needs to be amended or replaced.

Appendix A: Restrictions and release rules

Tables A1 to A5 present restriction policies and water release rules for the operation of the Ord River dams and power station under five demand scenarios. Together with the licensing policies of this plan, these establish how the competing demands on water from Lake Argyle will be managed over the life of the plan.

The restriction policies and release rules were developed using a computer simulation model of the operations of the dams and power station (Smith & Rodgers 2010). As detailed in the *Ord surface water allocation methods report* (DoW 2012), simulations were run iteratively to establish the restriction and release rules needed to manage the Ord River water resource during times of water shortage.

The five tables present a set of restriction rules applicable to each demand scenario. Each table lists the lake levels for each month that trigger restrictions on the demands for water from hydropower, irrigation and the downstream environment. The adjacent column (to the right of the trigger level) lists the severity of that restriction. We defined three classes of hydropower restrictions and two classes of irrigation and environmental restrictions.

For practical licensing reasons, the power station release rules are not identical to the rules used in the simulation model. In the model, water balance calculations were undertaken daily to determine the releases required from Lake Argyle each day. This involved checking the (simulated) lake level each day to determine if any or all of the daily hydropower, irrigation and downstream environmental demands were on restrictions on that day.

Under the licensing approach outlined in Section 5.4, the current and proposed water release rules for the power station will be implemented in the following way:

- Class 1 limits on hydropower are determined on water levels at the start of the month, and apply for the whole month unless Class 2 restrictions are triggered. Class 1 limits are checked again at the start of the next month.
- Class 2 trigger levels are determined each day of the month by linearly interpolating between the trigger level for the first day of the month and the first day of the following month.
- Irrigation restrictions will be determined for a 12-month period based on the storage in Lake Argyle at the end of the wet season and projections of likely lake levels over the following dry season.

Consequently, the hydropower trigger levels of Tables A1 to A5 relate to the first day of each month, and are derived from, but are not the same as, the values used in the simulation model (Appendix A, Smith & Rodgers 2010).

The department worked with Pacific Hydro and the Water Corporation to adapt the reservoir simulation results for use in the licensing approach outlined above.

Table A1 Restriction policies – The recent past scenario (current irrigation, moderate power demand)[†]

Month	Power						Irrigation				EWP			
	Class 1		Class 2		Class 3		Class 1		Class 2		Class 1		Class 2	
	Water level - 1 st of month	Restricted target	Water level - 1 st of month	Restricted target	Water level in the month	Restricted target	Water level in month	Proportion supplied	Water level in month	Proportion supplied	Water level in month	Restricted flow	Water level in month	Restricted flow
	m AHD	MW	m AHD	MW	m AHD	MW	m AHD	%	M AHD	%	m AHD	m ³ /s	m AHD	m ³ /s
Jan	92.20	24.51	78.00	10.12	76.00	0.00	75.20	50	73.50	0	79.20	44.0	79.20	38.5
Feb	92.20	23.22	78.00	11.23	76.00	0.00	77.00	50	73.50	0	82.00	50.2	82.00	43.9
Mar	92.20	24.41	78.00	10.56	76.00	0.00	77.00	50	73.50	0	83.40	50.2	83.40	43.9
Apr	92.20	23.54	78.00	10.64	76.00	0.00	79.00	50	73.50	0	83.70	46.6	81.00	40.8
May	92.20	22.46	78.00	8.76	76.00	0.00	79.40	50	73.50	0	83.20	42.2	79.40	37.0
Jun	92.20	22.40	78.00	8.13	76.00	0.00	79.00	50	73.50	0	82.80	37.0	76.80	32.0
Jul	92.20	23.05	78.00	8.00	76.00	0.00	78.40	50	73.50	0	82.30	37.0	76.20	32.0
Aug	92.20	24.19	78.00	8.39	76.00	0.00	77.70	50	73.50	0	81.70	37.0	75.30	32.0
Sep	92.20	24.96	78.00	10.98	76.00	0.00	76.80	50	73.50	0	81.10	37.0	74.30	32.0
Oct	92.20	24.30	78.00	12.62	76.00	0.00	76.00	50	73.50	0	80.50	37.0	73.10	32.0
Nov	92.20	26.85	78.00	12.89	76.00	0.00	75.70	50	73.50	0	80.00	37.0	75.70	32.0
Dec	92.20	23.85	78.00	10.18	76.00	0.00	75.30	50	73.50	0	79.50	37.0	75.30	32.0

[†] Irrigation demand (Lake Kununurra) - 350 GL/yr, electricity demand - 210 GWh/yr, 210 GWh/yr guaranteed down to lake water levels of 78 m AHD

Table A2 Restriction policies – Current irrigation, high power demand, current release rules[†]

Month	Power						Irrigation				EWP			
	Class 1		Class 2		Class 3		Class 1		Class 2		Class 1		Class 2	
	Water level - 1 st of month m AHD	Restricted target MW	Water level - 1 st of month m AHD	Restricted target MW	Water level - in the month m AHD	Restricted target MW	Water level - in the month m AHD	Proportion supplied %	Water level - in the month M AHD	Proportion supplied %	Water level - in the month m AHD	Restricte d flow m ³ /s	Water level - in the month m AHD	Restricte d flow m ³ /s
Jan	88.05	24.51	78.00	10.12	76.00	0.00	74.90	50%	73.50	0%	79.20	44.0	79.20	38.5
Feb	88.60	23.22	78.00	11.23	76.00	0.00	77.00	50%	73.50	0%	82.00	50.2	82.00	43.9
Mar	90.00	24.41	78.00	10.56	76.00	0.00	77.00	50%	73.50	0%	83.40	50.2	83.40	43.9
Apr	90.80	23.54	78.00	10.64	76.00	0.00	79.00	50%	73.50	0%	83.70	46.6	81.00	40.8
May	90.65	22.46	78.00	8.76	76.00	0.00	79.40	50%	73.50	0%	83.20	42.2	79.40	37.0
Jun	90.35	22.40	78.00	8.13	76.00	0.00	78.80	50%	73.50	0%	82.80	37.0	76.80	32.0
Jul	90.05	23.05	78.00	8.00	76.00	0.00	78.00	50%	73.50	0%	82.30	37.0	76.20	32.0
Aug	89.70	24.19	78.00	8.39	76.00	0.00	77.40	50%	73.50	0%	81.70	37.0	75.30	32.0
Sep	89.30	24.96	78.00	10.98	76.00	0.00	76.70	50%	73.50	0%	81.10	37.0	74.30	32.0
Oct	88.85	24.30	78.00	12.62	76.00	0.00	75.90	50%	73.50	0%	80.50	37.0	73.10	32.0
Nov	88.40	26.85	78.00	12.89	76.00	0.00	75.40	50%	73.50	0%	80.00	37.0	75.70	32.0
Dec	88.15	23.85	78.00	10.18	76.00	0.00	75.00	50%	73.50	0%	79.50	37.0	75.30	32.0

[†] Irrigation demand (Lake Kununurra) - 350 GL/yr, electricity demand - 327 GWh/yr, 210 GWh/yr guaranteed down to lake levels of 78 m AHD

Table A3 Restriction policies – Licensed to allocation limits, high power demand, enhanced rules scenario [†]

Month	Power						Irrigation				EWP			
	Class 1		Class 2		Class 3		Class 1		Class 2		Class 1		Class 2	
	Water level - 1 st of month m AHD	Restricted target MW	Water level - 1 st of month m AHD	Restricted target MW	Water level - in the month m AHD	Restricted target MW	Water level - in the month m AHD	Proportion supplied %	Water level - in the month M AHD	Proportion supplied %	Water level - in the month m AHD	Restricted flow m ³ /s	Water level - in the month m AHD	Restricted flow m ³ /s
Jan	89.20	24.51	89.20	10.12	76.00	0.00	75.20	50%	73.50	0%	79.20	44.0	79.20	38.5
Feb	89.75	23.22	89.75	11.23	76.00	0.00	77.00	50%	73.50	0%	82.00	50.2	82.00	43.9
Mar	90.65	24.41	90.65	10.56	76.00	0.00	77.00	50%	73.50	0%	83.40	50.2	83.40	43.9
Apr	91.28	23.54	91.28	10.64	76.00	0.00	79.00	50%	73.50	0%	83.70	46.6	81.00	40.8
May	91.38	22.46	91.38	8.76	76.00	0.00	79.40	50%	73.50	0%	83.20	42.2	79.40	37.0
Jun	91.15	22.40	91.15	8.13	76.00	0.00	79.00	50%	73.50	0%	82.80	37.0	76.80	32.0
Jul	90.85	23.05	90.85	8.00	76.00	0.00	78.40	50%	73.50	0%	82.30	37.0	76.20	32.0
Aug	90.50	24.19	90.50	8.39	76.00	0.00	77.70	50%	73.50	0%	81.70	37.0	75.30	32.0
Sep	90.10	24.96	90.10	10.98	76.00	0.00	76.80	50%	73.50	0%	81.10	37.0	74.30	32.0
Oct	89.70	24.30	89.70	12.62	76.00	0.00	76.00	50%	73.50	0%	80.50	37.0	73.10	32.0
Nov	89.33	26.85	89.33	12.89	76.00	0.00	75.70	50%	73.50	0%	80.00	37.0	75.70	32.0
Dec	89.13	23.85	89.13	10.18	76.00	0.00	75.30	50%	73.50	0%	79.50	37.0	75.30	32.0

[†] Irrigation demand (Lake Kununurra) - 750 GL/yr, electricity demand - 327 GWh/yr, 210 GWh/yr not guaranteed down to lake water levels of 78 m AHD

Table A4 Restriction policies – Current irrigation, high power demand, enhanced release rules scenario [†]

Month	Power						Irrigation				EWP			
	Class 1		Class 2		Class 3		Class 1		Class 2		Class 1		Class 2	
	Water level - 1 st of month m AHD	Restricted target MW	Water level - 1 st of month m AHD	Restricted target MW	Water level - in the month m AHD	Restricted target MW	Water level - in the month m AHD	Portion supplied %	Water level - in the month M AHD	Portion supplied %	Water level - in the month m AHD	Restricted flow m ³ /s	Water level - in the month m AHD	Restricted flow m ³ /s
Jan	84.65	24.51	83.45	10.12	76.00	0.00	74.90	50%	73.80	0%	78.30	44.0	78.30	38.5
Feb	85.35	23.22	84.30	11.23	76.00	0.00	77.00	50%	73.80	0%	81.00	50.2	81.00	43.9
Mar	86.75	24.41	85.80	10.56	76.00	0.00	77.00	50%	73.80	0%	82.60	50.2	82.60	43.9
Apr	87.75	23.54	86.70	10.64	76.00	0.00	79.00	50%	73.80	0%	82.10	46.6	81.00	40.8
May	87.80	22.46	86.80	8.76	76.00	0.00	79.40	50%	73.80	0%	81.60	42.2	79.40	37.0
Jun	87.43	22.40	86.45	8.13	76.00	0.00	78.80	50%	73.80	0%	81.10	37.0	77.20	32.0
Jul	87.08	23.05	86.10	8.00	76.00	0.00	78.00	50%	73.80	0%	80.50	37.0	76.20	32.0
Aug	86.65	24.19	85.65	8.39	76.00	0.00	77.40	50%	73.80	0%	79.90	37.0	75.30	32.0
Sep	86.20	24.96	85.20	10.98	76.00	0.00	76.70	50%	73.80	0%	79.20	37.0	74.30	32.0
Oct	85.75	24.30	84.70	12.62	76.00	0.00	75.90	50%	73.80	0%	78.30	37.0	73.10	32.0
Nov	85.30	26.85	84.20	12.89	76.00	0.00	75.40	50%	73.80	0%	77.60	37.0	74.50	32.0
Dec	84.85	23.85	83.75	10.18	76.00	0.00	75.00	50%	73.80	0%	77.40	37.0	76.20	32.0

[†] Irrigation demand (Lake Kununurra) - 350 GL/yr, electricity demand - 327 GWh/yr, 210 GWh/yr not guaranteed down to lake levels of 78 m AHD

Table A5 Restriction policies – Licensed to allocation limits, low power demand scenario †

Month	Power						Irrigation				EWP			
	Class 1		Class 2		Class 3		Class 1		Class 2		Class 1		Class 2	
	Water level m AHD	Restricted target MW	Water level m AHD	Restricted target MW	Water level m AHD	Restricted target MW	Water level m AHD	Portion supplied %	Water level M AHD	Portion supplied %	Water level m AHD	Restricted flow m³/s	Water level m AHD	Restricted flow m³/s
Jan	-	-	-	10.12	76.00	0.00	75.20	50%	73.50	0%	79.20	44.0	79.20	38.5
Feb	-	-	-	11.23	76.00	0.00	77.00	50%	73.50	0%	82.00	50.2	82.00	43.9
Mar	-	-	-	10.56	76.00	0.00	77.00	50%	73.50	0%	83.40	50.2	83.40	43.9
Apr	-	-	-	10.64	76.00	0.00	79.00	50%	73.50	0%	83.70	46.6	81.00	40.8
May	-	-	-	8.76	76.00	0.00	79.40	50%	73.50	0%	83.20	42.2	79.40	37.0
Jun	-	-	-	8.13	76.00	0.00	79.00	50%	73.50	0%	82.80	37.0	76.80	32.0
Jul	-	-	-	8.00	76.00	0.00	78.40	50%	73.50	0%	82.30	37.0	76.20	32.0
Aug	-	-	-	8.39	76.00	0.00	77.70	50%	73.50	0%	81.70	37.0	75.30	32.0
Sep	-	-	-	10.98	76.00	0.00	76.80	50%	73.50	0%	81.10	37.0	74.30	32.0
Oct	-	-	-	12.62	76.00	0.00	76.00	50%	73.50	0%	80.50	37.0	73.10	32.0
Nov	-	-	-	12.89	76.00	0.00	75.70	50%	73.50	0%	80.00	37.0	75.70	32.0
Dec	-	-	-	10.18	76.00	0.00	75.30	50%	73.50	0%	79.50	37.0	75.30	32.0

† Irrigation demand - 750 GL/yr, electricity demand – 89.4 GWh/yr (210 GWh/yr guaranteed minimum is not relevant as the electricity demand is only 89.4 GWh/yr)

Table A6 The electricity generated by the Ord River Dam power station under the five scenarios (financial years)

Electricity generation statistics	The recent past scenario		Current irrigation, high power demand, current release rules scenario		Licensed to allocation limits, high power demand, enhanced rules scenario		Current irrigation, high power demand, enhanced release rules scenario		Licensed to allocation limits, low power demand scenario	
Long-term mean (98 financial years)	219.3 GWh/yr		243.1 GWh/yr		238.4 GWh/yr		248.6 GWh/yr		89.4 GWh/yr	
Contributions to the electricity gen'd	% gen'd	% of time	% gen'd	% of time	% gen'd	% of time	% gen'd	% of time	% gen'd	% of time
Limited only by station capacity	19.3%	13.5%	56.6%	46.2%	49.3%	38.9%	82.3%	71.7%	N/A	N/A
<i>Class 1 limits/restrictions</i>										
- to the 210 GWh/yr rate	73.0%	76.1%	38.0%	44.2%	0.0%	0.0%	6.3%	8.0%	N/A	N/A
- from other releases	6.1%	6.0%	3.5%	3.9%	0.0%	0.0%	0.6%	0.1%	N/A	N/A
<i>Class 2 restrictions</i>										
- to the 89.4 GWh/yr (town) rate	0.5%	1.1%	0.4%	1.0%	1.7%	3.9%	0.8%	1.9%	19.2%	19.2%
- from other releases	0.4%	1.0%	0.6%	1.6%	48.2%	54.6%	9.4%	16.3%	78.9%	78.9%
<i>Class 3 restrictions</i>										
- from other releases	0.7%	2.3%	0.9%	3.1%	0.8%	2.6%	0.6%	2.0%	1.9%	1.9%
<i>Years when the amount gen'd is < 210 GWh and water levels are > 78 m</i>										
Number of years	4		5		18		13		N/A N/A	
Av. electricity gen'd	207.6 GWh/yr		208.0 GWh/yr		195.7 GWh/yr		167.8 GWh/yr		N/A N/A	
<i>Water levels are < 78 m</i>										
Number of years	9		10		8		8		8	
Av. electricity gen'd	141.8 GWh/yr		137.8 GWh/yr		135.3 GWh/yr		124.8 GWh/yr		89.3 GWh/yr	

Appendix B: Predicted outcomes of Ord allocation limits and licensing rules

This section presents the modelled storage and flow regime, as well as the irrigation water supply, electricity generation, environmental and cultural outcomes resulting from managing the water stored in lakes Argyle and Kununurra, consistent with chapters 5, 6 and 7.

Water storage, release and flow

Inputs and outputs to lakes Argyle and Kununurra

Table B1 summarises the inputs and outputs from the Ord River and Kununurra Diversion dams under a range of scenarios for irrigation and power demand.

Net evaporation loss from Lake Argyle is a significant component of the input (26 to 28 per cent) and varies by 100 GL/yr between the different demand scenarios.

Flows in the lower Ord River

Table B2 shows the long-term average flows in the lower Ord River (1906-07 to 2003-04) at Tarrara Bar under the five modelled scenarios. It highlights that most of the flow in the lower Ord River is derived from releases from the Kununurra Diversion Dam (79–82 per cent) and the Dunham River (15–20 per cent).

Table B2 and Figure B1 show the annual flow in the lower Ord and how, under the five demand scenarios, the flows are partitioned between runoff and releases for irrigation, hydropower and the environment. It highlights that:

- a large variation in annual flow exists between years
- that annual flow between 2000 and 2004 was well above the long-term average
- that surplus spillage from Lake Argyle dominates lower Ord flows in wet years
- that in average and below-average years, lower Ord flows are dominated by hydropower releases surplus to irrigation and lower Ord environmental water demands, especially under the ‘recent past’ and ‘licensed to 350 GL’ scenarios
- for the ‘high irrigation demand’ cases (750 GL), lower Ord flows are dominated by releases explicitly made to maintain the lower Ord riverine environment, especially in average and below-average years.

The methods report reviews the annual flow characteristics in more detail, including a comparison of seasonal and monthly flow characteristics.

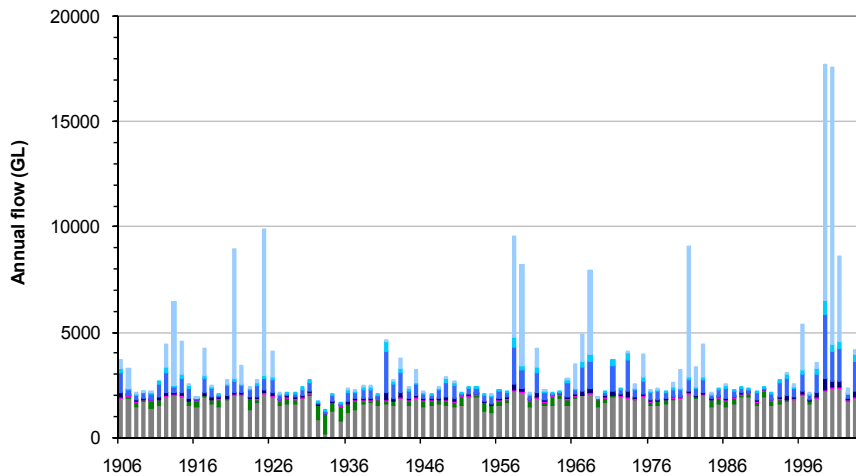
Table B1 Average annual inputs and outputs from Lakes Argyle and Kununurra

Demands	Scenario				
	The recent past - current irrigation, moderate power demand	Current irrigation, high power demand, current release rules	Licensed to allocation limits, high power demand, enhanced rules	Current irrigation, high power demand enhanced release rules	Licensed to limits, low power demand
Irrigation allocation -Main Ord subarea GL/yr	350	350	750	350	750
Hydropower demand GWh/yr	210	327	327	327	89
At Ord River Dam/Lake Argyle (GL/yr)					
Input					
Stream inflow	4278	4278	4278	4278	4278
Output					
Net evaporation	1190	1132	1151	1106	1207
Releases via outlet works (total)	2205	2445	2382	2507	1932
Specifically to meet					
• <i>hydropower demand</i>	2020	2282	1135	2153	188
• <i>Irrigation demand</i>	28	24	434	65	605
• <i>lower Ord environmental needs</i>	157	140	814	288	1139
Spillage	874	699	742	660	1126
Total outflow from Lake Argyle	3080	3145	3124	3167	3058
Change in storage	9	2	3	5	13
At Kununurra Diversion Dam/Lake Kununurra (GL/yr)					
Input					
Inflow from KDD catchment	119	119	119	119	119
Lake Argyle Spillage	874	699	742	660	1126
Releases via Ord River Dam outlet works	2205	2445	2382	2507	1932
Output					
Net evaporation	20	20	20	20	20
Diversions					
– to meet Stage 1 irrigation demand	342	340	341	343	344
– to meet new (irrigation) demands	0	0	390	0	393
Releases under diversion dam gates (total)	2830	2897	2486	2917	2415
The contribution from					
• <i>surplus Lake Argyle spillage</i>	865	693	734	654	1076
• <i>surplus inflows from KDD catchment</i>	117	117	112	116	109
• <i>surplus hydropower station releases</i>	1691	1949	835	1861	106
• <i>specific EWP releases, Lake Argyle</i>	156	138	806	286	1124
Change in storage	7	7	5	6	5

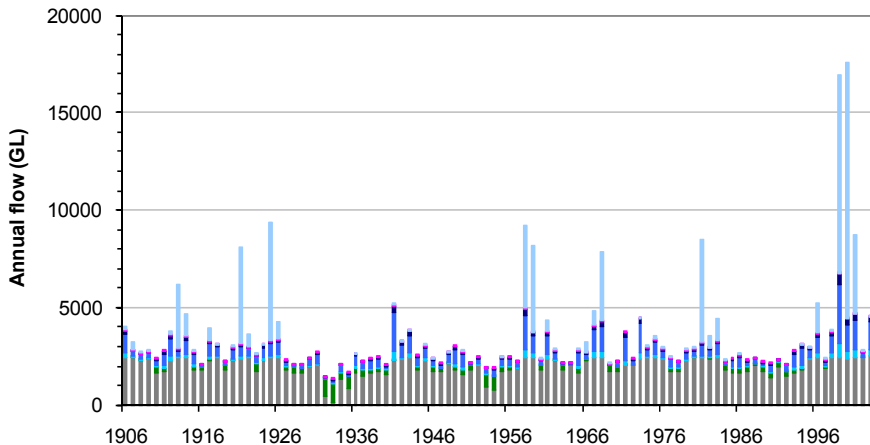
Table B2 Average annual flows of the lower Ord River (Tarrara Bar and tidal limit)

		Scenario				
		The recent past - current irrigation, moderate power demand	Current irrigation, high power demand, current release rules	Licensed to allocation limits, high power demand, enhanced rules	Current irrigation, high power demand enhanced release rules	Licensed to limits, low power demand
Demands (Main Ord subarea)						
Irrigation allocation	GL/yr	350	350	750	350	750
Hydropower demand	GWh/yr	210	327	327	327	89
Ord River at Tarrara Bar (GL/yr)						
Components of the flow						
• Releases from Lake Kununurra		2830	2897	2486	2917	2415
• Dunham River		505	505	505	505	505
• Other local runoff (irrigation area and adjacent creeks)		92	92	92	92	92
• Stage 1 irrigation return flows		51	51	51	51	52
Ord River at the start of the tidal reach (GL/yr)						
Components of the flow						
• Kununurra Diversion Dam releases		2830	2897	2486	2917	2415
• Dunham River		505	505	505	505	505
• Other local runoff (irrigation area and adjacent creeks)		113	113	113	113	113
• Stage 1 irrigation return flows		51	51	51	51	52
• Loss of water abstracted for irrigation		0	0	115	0	115

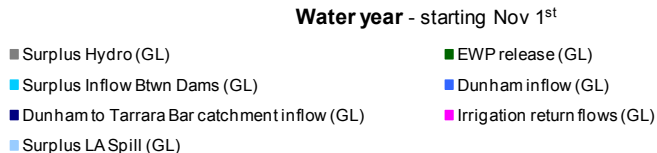
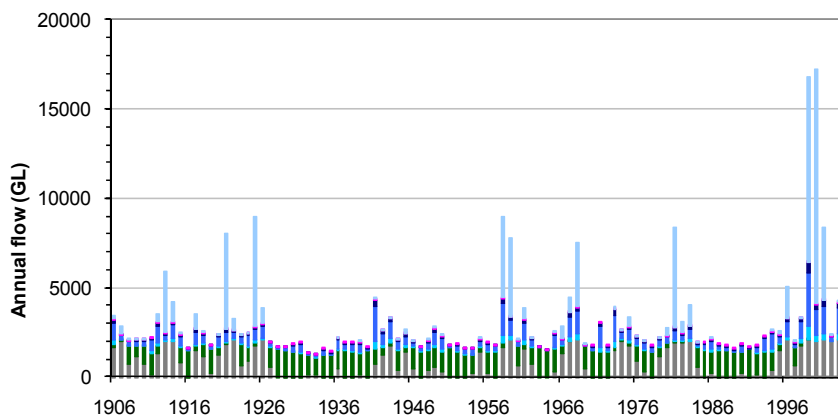
(a) Recent past- current irrigation, moderate power demand (210 GWh/yr)



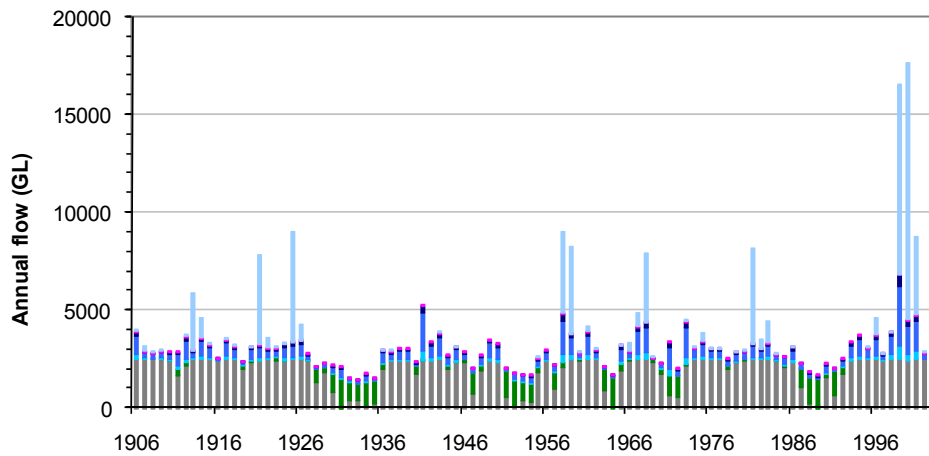
(b) Current irrigation, high power demand, current release rules



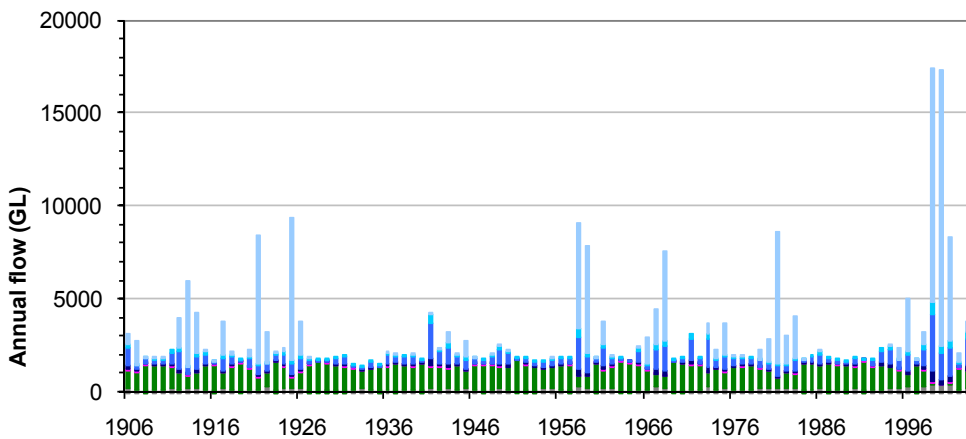
(c) Irrigation licensed to limits – high power demand (enhanced rules)



(d) Current irrigation, high power demand (enhanced release rules)



(e) Irrigation licensed to limits, low power demand



Water year - starting Nov 1st

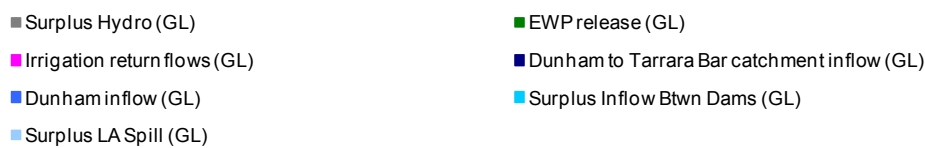


Figure B1 Annual flows in the lower Ord River at Tarrara Bar under five irrigation and hydropower demand scenarios

Irrigation supply

The modelled annual volume of water supplied to irrigation, with irrigation entitlements equalling 350 GL and 750 GL, is shown in Figure B2. The supplied volumes vary between years because demand and supply depends on rainfall over the irrigation area.

The proportion of the irrigation demand supplied in each year is expressed as a percentage of the year's demand (see right axis). This shows the years when irrigation restrictions would have applied (e.g. in the 1930s and 1950s).

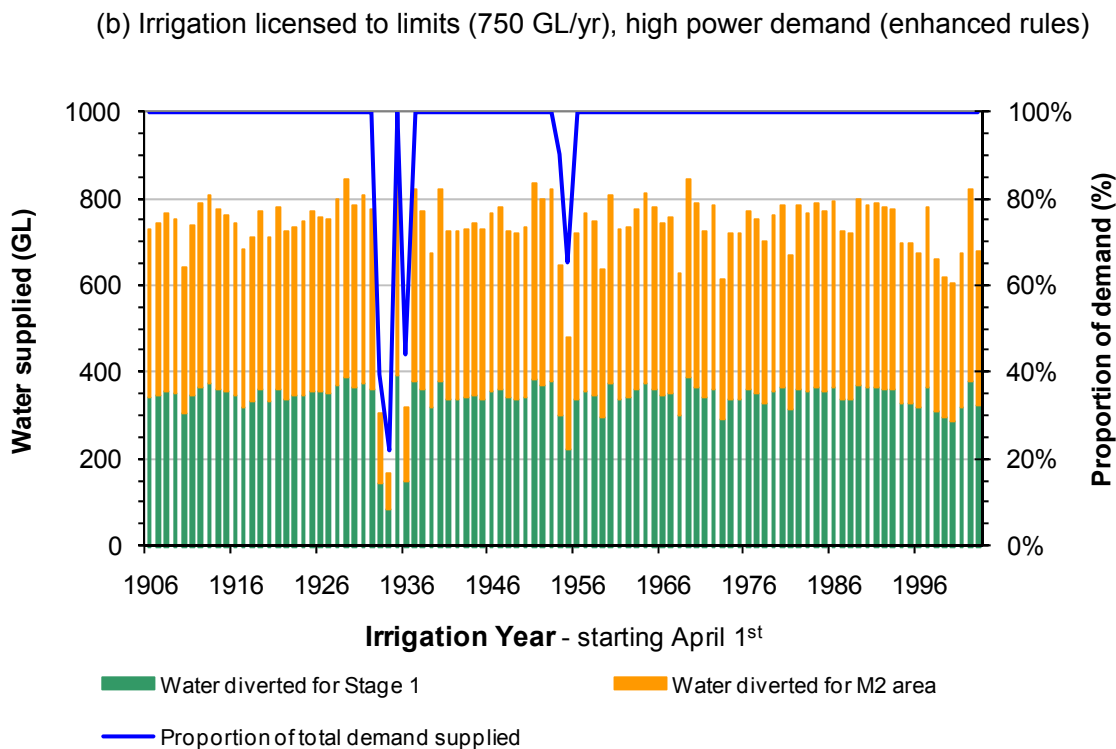
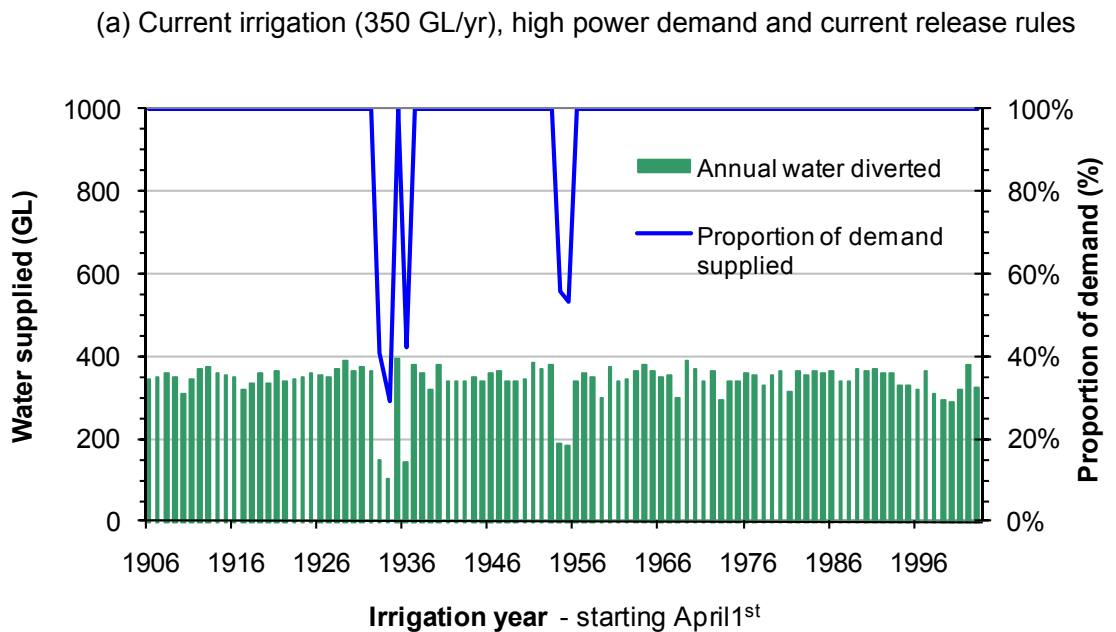


Figure B2 Irrigation water supply and reliability (a) currently licensed and (b) licensed to allocation limits (enhanced rules)

Irrigation reliability

The average water supplied, reliability of supply and severity of the most extreme year of restrictions are shown in Figure B2 for the five demand scenarios. The enhanced rules approach provides less drawdown on Lake Argyle when water levels are already low and result in less severe restrictions in subsequent years with low inflows.

Table B3 Irrigation supplied and reliability of supply for five demand scenarios

Scenario	Average irrigation demand (GL/yr)	Average water supplied (GL/yr)	Probability of not having restrictions [†]	Proportion of demand supplied in the driest year
			%	%
Recent past (current irrigation, moderate power demand (210 GWh/yr))	350	342	96.3	29.5
Current irrigation, current release rules - high power demand (327 GWh/yr)	350	340	95.3	28.3
Irrigation licensed to allocation limits, high power demand (327 GWh/yr), enhanced rules	750	731	95.3	22.9
Current irrigation, high power demand (327 GWh/yr) with enhanced release rules	350	343	95.3	36.1
Irrigation licensed to allocation limits, low power demand (89.4 GWh/yr)	750	737	97.4	29.3

[†] the probability that the annual water supplied equals the annual water demand

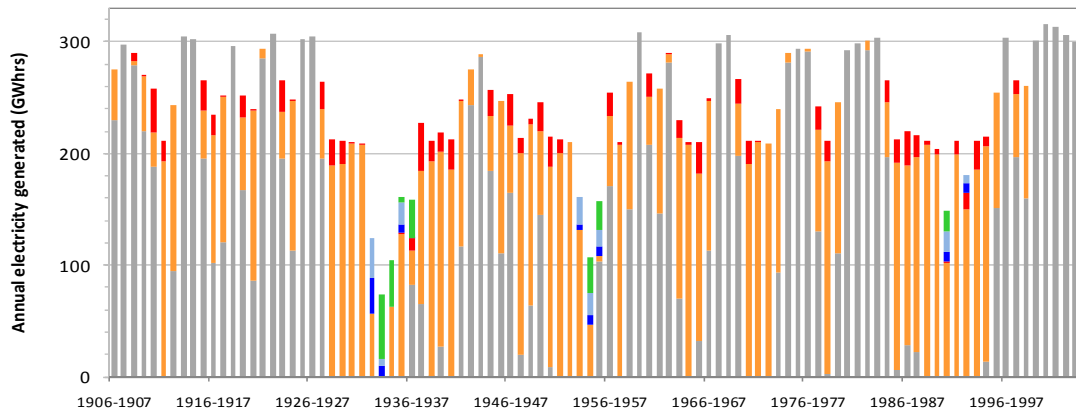
Electricity generation

Table A6 in Appendix A summarises the long-term average electricity generated by the Ord River Dam power station under the five demand scenarios.

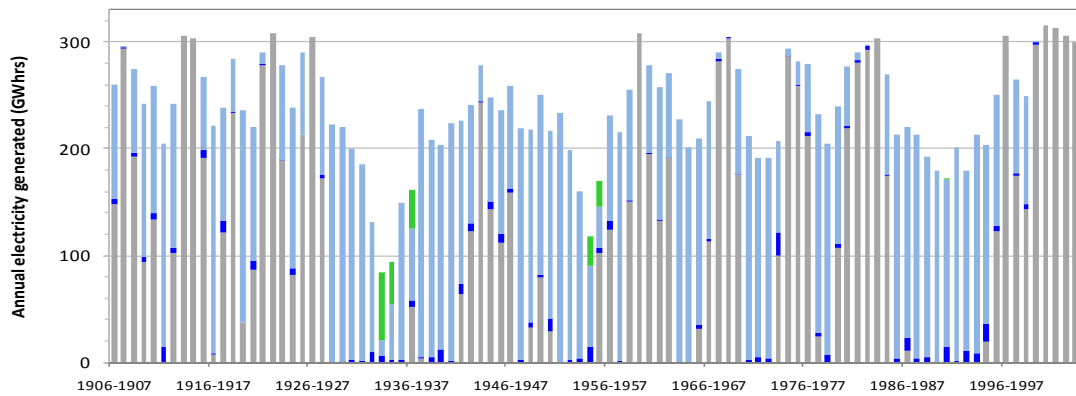
The long-term average electricity generated ranges from 238.4 to 248.6 GWh/yr for the high power-demand projections. This is between 73 and 76 per cent of the region's projected electricity demand (327 GWh/yr).

The differences in the average electricity generated between scenarios is about 10 GWh/yr. This difference is relatively small, but the cost of generating the replacement electricity using alternative diesel power stations is high.

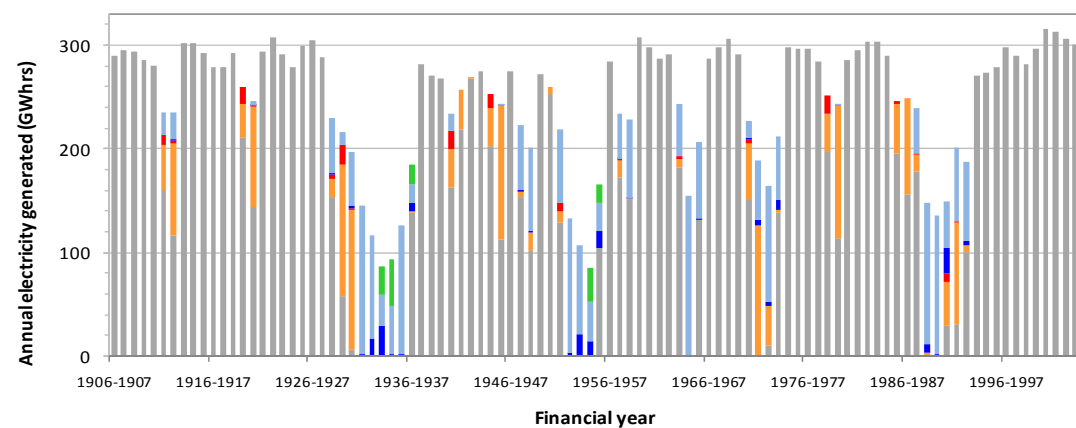
(a) Current release rules with current irrigation (350 GL/yr)



(b) Enhanced rules approach with irrigation at allocation limit (750 GL/yr)



(c) Enhanced rules with current irrigation (350 GL/yr)



Limited only by station capacity
 Class 1 - 210 GWhr/yr rate
 Class 1 - other releases
 Class 2 - 89.4 GWhr/yr rate
 Class 2 - other releases
 Class 3 - other releases

Figure B3 Electricity generated under (a) current rules with 350 GL, (b) 750 GL of irrigation and (c) enhanced rules with 350 GL of irrigation

Environmental water provision

Figure B4 shows the years within the 99-year modelled sequence (1906 to 2004) when the environmental water provision would have been restricted. It shows that restrictions to the environmental water provision would have occurred very infrequently – except in the critical droughts of the 1930s and 1950s and the short drought periods in the mid 1960s and late 1980s to early 1990s.

The occurrence and severity of restrictions to the environment are very similar for the different demand scenarios. Under all scenarios the environmental water provision is unrestricted in more than 90 per cent of years.

Ecological impact during restriction periods

Several flow ecology linkages cannot be fully met when restrictions to the environmental water provision apply. They are:

- inundation of parts of the shallow backwater habitat – for use by small-bodied fish and the juveniles of large-bodied fish
- inundation of areas of deepwater backwater habitat – for use by large-bodied fish and as possible spawning sites during the wet season
- flooding of riparian benches – for use by large-bodied fish as habitat and possible spawning sites during the wet season
- seasonal inundation of lower riparian terraces
- permanent flows that exceed 35 m³/s – providing connection between pools and contributing to dissolved oxygen levels in river pools
- flooding of obstructions to fish passage (Ivanhoe Crossing) in the lower Ord during the wet season.

Dry season shallow backwater habitat

Dry season shallow backwater habitat is likely to be most affected during droughts. Shallow backwater habitat reduces by 25 per cent under Class 1 and 50 per cent under Class 2 restrictions. The maximum depth in the remaining shallow backwaters is expected to be 30 to 35 cm under Class 2 restrictions (~ 70 per cent of the maximum depth at the environmental water requirement flow rate).

Small-bodied fish that prefer backwaters will be forced into deeper pools when backwater habitat dries out. The deeper pools will remain relatively unaffected (in size) during dry periods and will provide important refuges for aquatic fauna. Pools form 85 per cent of the distance along the river between Kununurra Diversion Dam and the Ord River Estuary (DoW 2006).

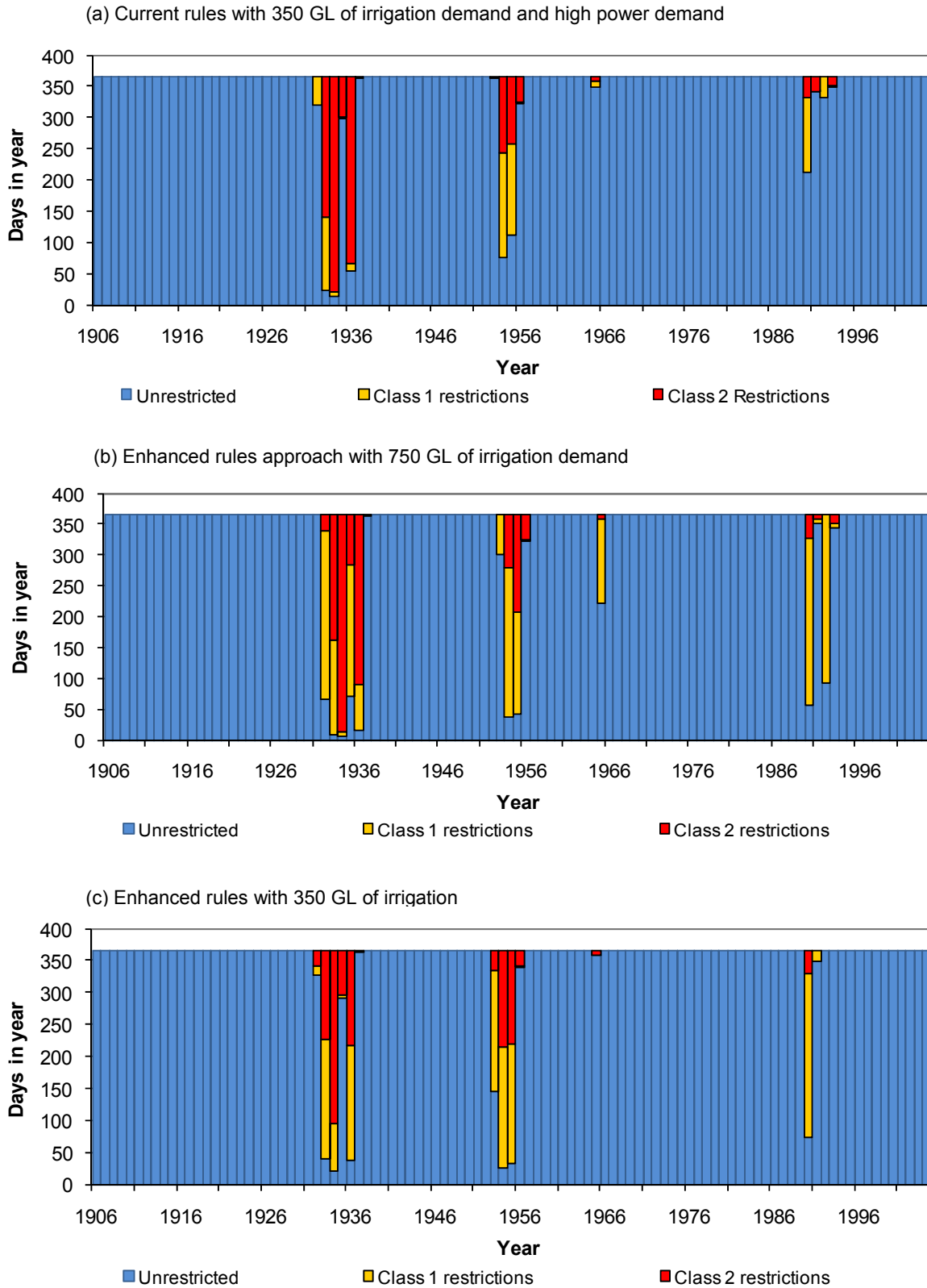


Figure B4 Days the environmental water provision is restricted and unrestricted in each (calendar) year

Predation pressures will increase on the smaller fish forced into the deeper pools and some reduction in juvenile numbers of large- and small-bodied fish is to be expected during droughts. However, given the pools will be largely unaffected and 50 per cent or more of backwater habitat will remain, the changes are expected to be small. No lasting impacts are expected on fish biomass, species richness or abundance.

The risk of anoxia in deep river pools and the potential for fish kills increases at low flows if they occur in combination with extended periods of low wind speeds. The Scientific Reference Panel raised this issue when the environmental water provision was being developed. The department will monitor dissolved oxygen in selected river pools when flows fall below 35 m³/s – as per the trigger and response mechanism outlined in Section 6.2.

Threatened species

Of the 17 endangered species listed in the lower Ord area, three depend directly on the lower Ord riverine environment. These are the:

- freshwater sawfish (*Pristis microdon*)
- dwarf sawfish or Queensland sawfish (*Pristis clavata*)
- freshwater whipray (*Himantura chaophraya*).

The environmental water provision for the lower Ord River has flow ecology linkages specifically related to maintenance of habitat for large-bodied fish including threatened species. These include providing enough water to:

- maintain well-oxygenated deep pool habitat
- inundate deepwater backwater habitat in the wet
- provide connectivity between pools.

The environmental water provision has taken a holistic approach that includes flow ecology linkages to maintain foodwebs and other ecosystem processes. As well as providing enough water to maintain habitat for threatened species, the environmental water provision will provide water to maintain populations of small prey species (of threatened fish). For example, the environmental water provision will maintain:

- areas for algal production to support important small-bodied fish and macroinvertebrates
- backwater habitat for small-bodied fish
- a range of habitat for macroinvertebrates.

The environmental water provision is expected to be fully met in more than 90 per cent of years. Given this, it is unlikely the sawfish and whipray species listed above will be affected by this plan's allocations.

Other endangered fauna in the Ord area includes waterbirds. Changes to waterbird habitat that are directly due to changes in the lower Ord River's flow regime are expected to be insignificant. This is because wet season inundations of riparian

benches and the Ord River floodplain, as well as the extent of open water along the lower Ord River, will not change significantly as a result of this plan's allocations and release rules.

Ramsar values: lakes Argyle and Kununurra

Lakes Argyle and Kununurra and the lower Ord River floodplain were listed as Wetlands of International Importance under the Ramsar Convention in 1990. Water levels in lakes Argyle and Kununurra are maintained at very stable levels over the 99-year period (1906–07 to 2003–04) for the different demand scenarios investigated by the department.

Because very similar fluctuations in lake levels occur under the range of proposed management scenarios compared with the recent past, Ramsar values are expected to be largely unaffected by this plan's allocations.

Ramsar values: Ord River floodplain

The Ord River floodplain's ecology is governed by the macrotidal behaviour of Cambridge Gulf and the Ord River estuary, and the rainfall and local catchment runoff from the Ord Tidal subarea. Overbank flows from the Ord River will not be significantly different, and changes to in-stream salinity and flow as a result of this plan's allocations are expected to be negligible. For further details see Section 8.4.2 of the *Ord surface water allocation plan methods report* (DoW 2012).

Appendix C: Proposed 10 MW power station on the Kununurra Diversion Dam

The electricity generated with and without a 10 MW hydropower station is shown in Table C1. Results are presented for the current rules, with:

- 350 GL of irrigation demand and high power demand
- 750 GL of irrigation demand and high power demand.

Also shown are statistics on the water released and spilled from Lake Argyle, and the severity of irrigation restrictions, with and without the extra power station.

Table C1 indicates that with a 10 MW station at the Kununurra Diversion Dam, the additional electricity generated averages more than:

- 60 GWh/yr under the current licensed situation (350 GL), and
- 50 GWh/yr if all water entitlements were granted (750 GL).

The department would approve the establishment of a 10 MW hydropower station at the Kununurra Diversion Dam provided:

- the station only generated power from water releases the Water Corporation made to meet its existing licensed commitments: no water entitlements would be granted for its operation
- the Water Corporation applied to amend its existing dams storage licence to provide for the new power station, in accordance with the licensing provisions of the *Rights in Water and Irrigation Act 1914*
- the necessary environmental and Aboriginal heritage clearances were obtained.

Table C1 Electricity generated with and without a 10 MW hydropower station at the Kununurra Diversion Dam – (a) 350 GL/yr of irrigation with current release rules, and (b) 750 GL/yr of irrigation with the enhanced rules approach.

Long-term average annual statistics	(a) 350 GL/yr irrigation demand		(b) 750 GL/yr irrigation demand	
	Existing conditions	With additional hydropower station	Existing conditions	With additional hydropower station
Hydropower generated (GWh/yr)	243.1	306.7	238.4	289.6
Water released at Ord River Dam by PHL for power generation (GL/yr)	2387	2188	1511	1457
Water released at the Ord River Dam for the lower Ord (GL/yr)	54	75	642	575
Spillage from Lake Argyle (GL/yr)	699	839	742	858
Average water supplied to irrigation in the worst 5% of years with restrictions (% of demand)	70%	71%	54%	77%

Appendix D: Trigger levels for ecological monitoring parameters

Table D1 Trigger values for macroinvertebrates and fish

Parameter	Trigger
Macroinvertebrates	<p>Ten per cent decline in:</p> <ul style="list-style-type: none"> total number of taxa or community composition high-flow taxa number of sensitive EPT taxa SIGNAL and SIGNALFLOW scores.
Fish	<p>Thirty per cent decline in the following parameters in deep pool habitat and shallow backwaters:</p> <ul style="list-style-type: none"> total number of species abundance of each species. <p>A detectable change in frequency of occurrence or size class distribution of:</p> <ul style="list-style-type: none"> <i>Lates calcarifer</i> (barramundi), <i>Liza alata</i> (mullet), <i>Arius graffei</i> (blue catfish), <i>Arius midgleyi</i> (Midgley's catfish) in deep pools <i>Glossigobius giurus</i> (flathead goby), <i>Nematalosa erebi</i> (bony bream) or <i>Melanotaenia australis</i> (rainbowfish) in shallow backwaters.

Table D2 Trigger values for vegetation

Parameter	Trigger
Species composition	<ul style="list-style-type: none"> Measurable encroachment of terrestrial species. Measurable increase in abundance of exotic submerged/emergent macrophytes.
Species distribution	<ul style="list-style-type: none"> Measurable contraction of riparian vegetation as changes in size/age class structure of more than one species. Measurable contraction of in-stream vegetation, not related to a high-flow event.
Species mortality	<ul style="list-style-type: none"> Greater than 15 per cent reduction in abundance of dominant species.
Species richness	<ul style="list-style-type: none"> Measurable decline of riparian species and/ or increase in terrestrial species. Measurable decline of in-stream vegetation.
Species recruitment	<ul style="list-style-type: none"> No indication of recent (five years) overstorey recruitment.
Community structure	<ul style="list-style-type: none"> Notable change.
Density and cover and abundance	<ul style="list-style-type: none"> Measurable crown dieback in overstorey and/or reduction in cover of understorey.

Table D3 Nutrient and physico-chemical trigger values

Parameter	Locally derived reference values	ANZECC 2000 trigger value
Total nitrogen (TN)	290 µg/L	300 µg/L
Total phosphorus (TP)	18 µg/L	10 µg/L (baseflow)
Filterable reactive phosphorus (FRP)	9 µg/L	5 µg/L
Nitrate (NO _x)	14 µg/L	5 µg/L
Ammonium (NH ₄ ⁺)	29 µg/L	10 µg/L (baseflow)
Salinity	1000 mg/L	1000 mg/L
Turbidity	14 NTU	2 NTU (baseflow)
Total suspended solids (TSS)	7 mg/L	2 mg/L (baseflow)
Dissolved oxygen (DO)	≤2 mg/L	≤2 mg/L

Appendix E: Operations software

The Water Corporation enters daily operational data from its dams, as well as irrigation demand and flow data from the Dunham River and Ord River at Tarrara Bar. It projects the likely flow so it can calculate how much water to release from storage.

When levels in Lake Argyle are high and there are no restrictions, the spreadsheet is updated at the end of each month.

When Class 1 restrictions apply there are monthly limits on generating hydropower. As the month progresses, the Water Corporation updates the spreadsheet with the power generated at least weekly. In doing this it tracks progress against the monthly limit, allowing it to adjust operations to minimise the chance of going over the limit.

When Class 2 restrictions apply it must update the spreadsheet daily because the limits on releases are set daily for the next 24-hour period.

Compliance under Class 2 restrictions will be assessed over four, six and 12 month periods, if the Class restrictions persist for these periods. The software will compare the electricity generated each day with the daily limit and record the degree of over or under-generation for the day. The net over or under generation will be accumulated over the current period of Class 2 restrictions. No over generation is allowed over a 12 month period.

Shortened forms

AHD	Australian Height Datum
DoW	Department of Water
EPA	Environmental Protection Authority
EWP	Environmental water provision
EWR	Environmental water requirement
KDD	Kununurra Diversion Dam
PH	Pacific Hydro

Glossary

Abstraction	Withdrawal of water from any surface water or groundwater source of supply.
Allocation limit	The annual volume of water set aside for use from a water resource. In the Ord area it is the total amount of water that can be licensed from a resource or subarea.
Annual announced allocation	The proportion of an annual water entitlement that is available in a given year.
Annual water entitlement	The amount of water specified on a licence issued under Section 5C of the <i>Rights in Water and Irrigation Act 1914</i> that can be taken between 1 April and 31 March the following year.
Argyle Diamonds	Argyle Diamonds Ltd, operators of the Argyle Diamonds Mine; a wholly owned subsidiary of Rio Tinto Ltd.
Consumptive use	Water used for consumptive purposes considered as a private benefit including irrigation, industry, urban and stock and domestic use.
Diversion (of water)	Taking water from a watercourse, usually by gravity
Environmental water requirement	The water regime needed to maintain the current ecological values (including assets, functions and processes) of water-dependent ecosystems consistent with the objectives of an environmental flow study.
Environmental water provision	The water regime resulting from the water allocation decision-making process taking into account ecological, social, cultural and economic impacts. They may meet in part, or in full, the ecological water requirements.
Fit-for-purpose water	Water of a quality suitable for the intended end purpose. It implies that the quality is not higher than needed.
Goornig farmlands	New farmland being established by the Western Australian Government under the Ord Irrigation Expansion Project. The area is located on the Weaber Plain to the north east of Stage 1 areas.
In-situ water	Represents water that needs to be left in the system, including the water needed to maintain the integrity of the resource and ecological, social and cultural values.

Licence (or licensed entitlement)	A formal permit that entitles the licence holder to take water from a watercourse, wetland or underground source under the <i>Rights in Water and Irrigation Act 1914</i> .
Management area	A defined surface water area or groundwater area proclaimed under the <i>Rights in Water and Irrigation Act 1914</i> .
Ord Final Agreement	A deed for the Compulsory Acquisition of Native Title Rights and Interests (Ord) between the State of Western Australia, the Miriuwung and Gajerrong People (MG), and private interests (Grantee Parties)
Over-allocation	Where the total volume of water allocated out of the resource (that could be abstracted at any time) is over the set allocation limit.
Over-use	Where the actual volume of water abstracted from the resource is over the set allocation limit.
Pacific Hydro	Pacific Hydro Limited, owners and operators of the Ord River Dam hydropower station
Reliability	The frequency with which a water licence holder can access their full annual water entitlement.
Self-supply	Water users (individuals or organisations) who abstract water from a source for their own individual requirements.
Social value	An in-situ quality, attribute or use that is important for public benefit, welfare, state or health.
Social water requirement	The water regime needed to maintain social and cultural values.
Subarea	A subdivision, within a surface or groundwater area, defined to better manage water allocation. Subarea boundaries are not proclaimed and can therefore be amended without being gazetted.
SunWater	SunWater Corporation, a government trading enterprise owned by the Queensland Government and is currently the preferred water service provider for the new Goomig farmlands area. Subject to further negotiations and issuing the necessary licences, SunWater is expected to be the new water service provider for the new area.

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