THE COASTAL HYDROPOLIS - JURIEN BAY, A CASE STUDY

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Introduction

Society is on the move and no more so than those seeking a sea-change. The coastline of central and northern Western Australia has many features which make it particularly attractive to the sea-change lifestyle; remoteness, beautiful landscapes, beaches, outstanding climate, financial viability and the company of like-minded people. One of the challenges in these remote areas is managing the scarce water resource. This paper describes the extensive work on one such small coastal town that is undergoing a sea-change and how it has adapted to effectively managing its water resources.

Jurien Bay is situated approximately 200km north of Perth, in one of the most striking and biologically diverse regions of WA. It is fast becoming a unique holiday destination, with the Jurien Bay Marine Park to the west, the Lesueur National Park to the east and the Pinnacles Desert in the Nambung National Park to the south and within a region recognised internationally as a biodiversity hotspot. It has an annual rainfall of 560mm per year

Set against this context the state government in the Central Coast Region Strategy recognised that development in the central coast would be focussed on Jurien Bay and that this town would be come the major service centre on the central coast

The Ardross Group of Companies is in the process of developing it's significant coastal landholding at Jurien Bay known as *Turquoise Coast*. It will contribute approximately 9,000 lots over the next thirty years extending the current population of 1,300 people to 25,000. No other private or government development agency will have this scale of impact on the town's development.

Like elsewhere in the State, potable water resources are not plentiful and with the existence of a shallow groundwater aquifer containing a thin freshwater lens, means that water conservation efforts are required at a scale that involves a total water management approach to achieve a quality outcome.

Planning Context

In order for Ardross to undertake the development of their land a number of key steps had to be undertaken which involved the combined approach of government and community. These included:

- environmental approvals - EPA Bulletin 1031 was published in 2001 (in response to a referral by Ardross of its landholding to EPA for strategic advice under Section 16(j) of Environmental Protection Act (1986)) which required the preparation of a Water Management Plan (WMP);

- preparation of the Turquoise Coast Structure Plan which employed the principles of Liveable Neighbourhood and Sustainability, the outcomes of which had a number of environmental benefits e.g. reduced greenhouse gas emissions by limiting the need for car trips, solar passive urban design and lot layout etc; and

- preparation of a Water Management Plan which incorporated the efficient use of source water, the reclamation of treated wastewater wherever possible and the paradigm shift to an emphasis on local infiltration systems and “at source” controls.

Planning for the Turquoise Coast Structure Plan involved extensive community consultation, which included explanations on the provision for water and wastewater infrastructure as it was being established through the WMP in parallel. The Turquoise Coast Structure Plan (accompanied by the WMP) was approved by the West Australian Planning Commission (WAPC) in November 2003.

Water Management Plan
As part of the development of the Water Management Plan it was important to get the water conservation and management strategy right as it has the largest impact on environmental conservation and recycling programs as illustrated in Figure 1.0 below.

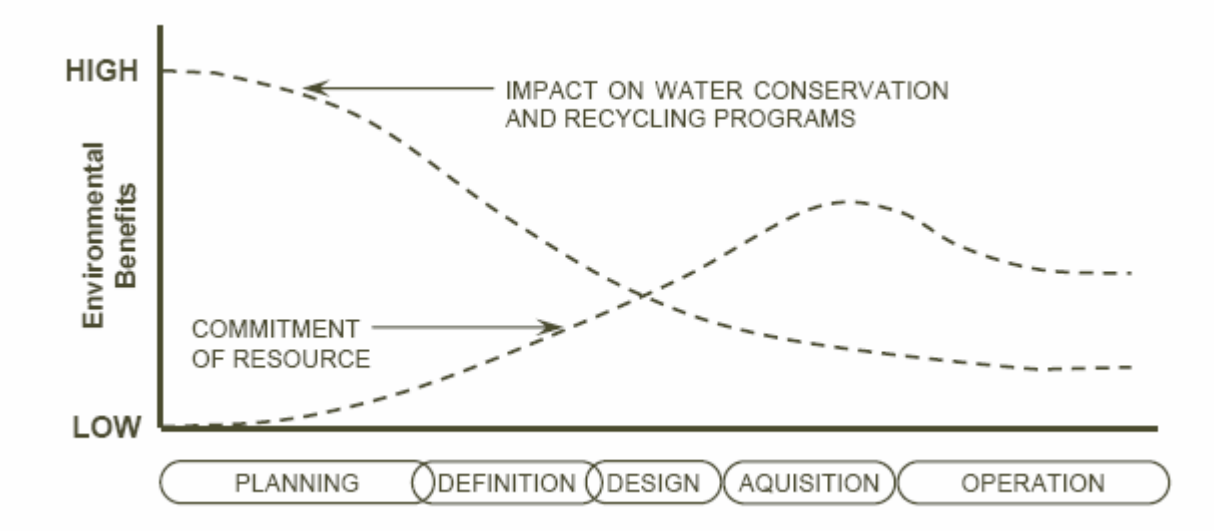

Figure 1.0

The Water Corporation and the Ardross Group’s approach towards water management planning was one that promoted the general philosophy of sustainability. As such, the WMP incorporated the efficient use of source water, the reclamation of treated wastewater wherever possible and the paradigm shift to an emphasis on local infiltration systems and “at source” controls.

Water utilities traditionally have managed and planned water, sewerage and stormwater schemes separately. This limits the ability to see them as resources and achieve the benefits gained from their consideration as a whole.

Jurien Bay’s holistic WMP exhibits the following key features:
- total Water Cycle Management objectives including water use efficiency, reuse and recycling;
- consistent directions towards sustainability with clear actions that acknowledge the interdependencies of different water services and different environments; and
- multi criteria analysis that consider environmental, technical, financial, social and public health aspects in assessing options.

A clear understanding of the interdependencies between water services and different environments is necessary to ensure a consistent direction towards sustainability.

Figure 2.0 is a simplistic representation of the major environments and hydraulic interconnections in the Jurien Bay area.

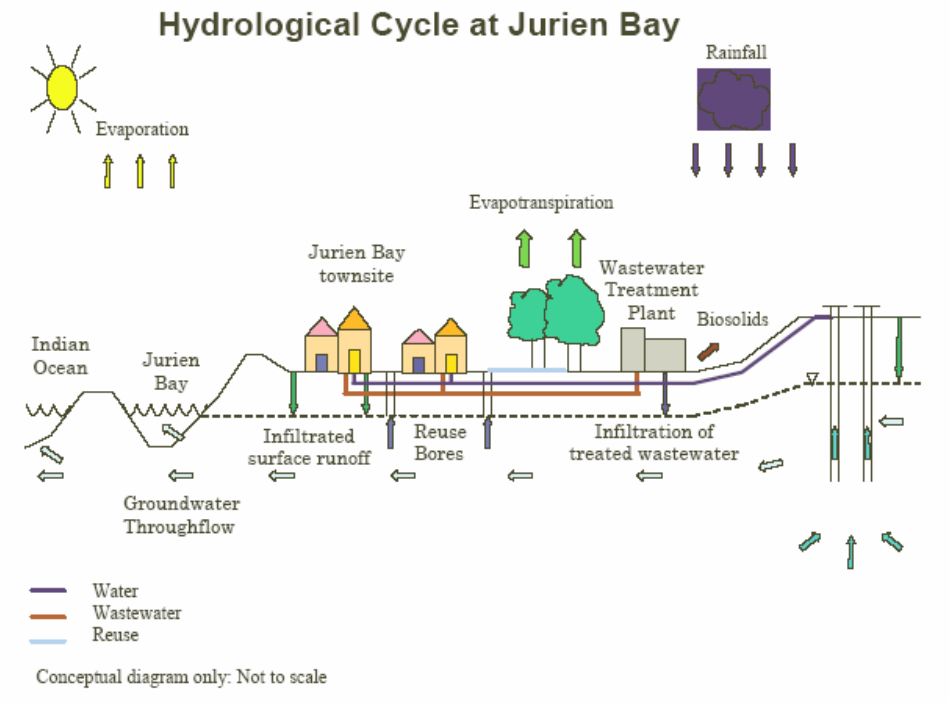

Figure 2.0

Targets and indicators to measure the success of the water conservation and management initiatives included in the WMP were developed. They covered the:

- environment that is effected;
- parameter which is measured;
- frequency of measurement; and
- responsibility for the measurement and any mitigation.

The most important environments affected by the WMP include on-site conservation wetlands, on-site groundwater, the marine environment and regional groundwater. The parameters measured include water quality, vegetation and water levels, with frequencies of measurement being monthly, quarterly or annually.

The water supply and distribution, wastewater treatment and stormwater management plans were based on considerations from findings of major investigations:

- drilling Investigations;
- groundwater modelling;
- hydrogeological assessment; and
- Ecological Water Requirements report.

In addition, a report by CSIRO that predicted changes in rainfall for the southwest of Western Australia including the Jurien Bay area was used to ensure that the water supply would be sufficient should the CSIRO predictions eventuate. The report concluded that this area will be drier than last century and indicates the potential risks of reduced water resource availability.

The hydrogeological assessment of groundwater flows and capture areas for various water supply, wastewater and drainage groundwater situations was based on the extensive drilling investigation. Regional and local groundwater models, developed from the hydrogeological investigation results, assessed environmental impacts of drinking water production, drainage management, treated wastewater infiltration and reuse. The models estimated likely changes in groundwater flows, levels and quality pre and post development.

The Ecological Water Requirement study found that groundwater abstraction from the Tamala Limestone aquifer in the northern and southern borefield locations pose the lowest risk to the ecology. Furthermore water abstraction from the Lesueur Sandstone bores would provide significant economic advantages but the impact on the subterranean fauna would be of higher risk to the ecology and it is expected that it will result in significant drying of the Old River Cave. The recommended borefield configuration relies mainly on abstraction from the northern borefield.

Modelling of nutrient concentrations, reuse bore abstractions and applications were important drivers for determining Wastewater Treatment Plant locations, treatment technologies and infiltration pond locations.

The monitoring undertaken during the initial investigations provided a baseline for measurement of the performance of the WMP. It will provide feedback on the impacts associated with the management activities, confirm the performance of the recommended management strategies in operation and trigger implementation of mitigation strategies should unexpected perturbations be observed.

A feature of the water management planning has been the employment of a “whole of catchment” approach so as to ensure applicability at the “micro scale” of development.

This approach:

- has influenced strategic management programmes developed by the WC, as the Corporation now makes suggestions to developers and Local Authorities that they prepare integrated water management plans;
- is currently used in assessing the proposed introduction of sustainability tools such as BASIX and METRIX; and
- has a high level of applicability to land use planning, especially in regional areas of Western Australia, where land ownership is less fragmented.

The inputs from stormwater drainage and wastewater treatment were identified as the potential major contributors to groundwater quality.

Catchment-sourced nutrients (i.e. from fertilisers) were modelled as diffuse inputs into the local groundwater. Modelling scenarios were developed to investigate the direct impacts on groundwater quality associated with differing:

- road layouts and infiltration concepts (conventional vs central swale); and
- levels of catchment management (pro-active vs less-active).

The central vegetated swale drainage system provides at-source control through on-site infiltration of stormwater. Passive treatment of nutrients occurs within the aquifer via the processes of adsorption and denitrification.

This system offers a number of water quality benefits including:

- eliminates street lawns, thereby reducing nutrient inputs;
- nutrient uptake by vegetation in the swales; and

- enhances streetscape and combined with front landscaping incentives and requirements, encourages residents to use native vegetation in private landscape areas.

Considering that front gardens tend to be maintained to a higher standard than rear gardens, the reduced front setbacks limit the extent of water and fertiliser application that would normally be associated with the higher maintenance standard.

In other words, environmental outcomes secured through design of the urban form. This design outcome was adopted by the Ardross Group and is discussed in more detail in the next section.

Examining the "most likely" scenario of a second wastewater treatment plant located east of the development combined with the swale drainage system that is being employed, showed that the amount of total nitrogen entering the coast will increase by less than 5 tonnes/year year (less than 10% increase from the existing 45 tonnes/year).

The corresponding small change in dissolved inorganic nitrogen would be difficult to detect and should result in no perceptible change in primary producer or biomass or community structure. The comparative magnitude of the inputs at Jurien Bay is at least four orders of magnitude less than that for other Perth coastal waters.

The WMP's ongoing implementation will be funded through developer contributions to headworks, building incentives, direct establishment of the landscaped swale drainage system in accordance with water sensitive urban design principles, and a financial commitment by Ardross to ongoing maintenance and monitoring.

Urban Design Initiatives

Urban design initiatives were employed to create a development that established a relationship to the coastal setting and the water conservation objectives. In order to complement the existing environment, the development had to create its own character in sympathy with the environment which included an adjoining marine park. This particularly involved maintaining the quality and dynamics of the existing groundwater regime.

Some of the philosophy behind the design initiatives included:

- integration of the natural environment with development by using private space (front yards) to complement the native vegetation in the median swales, foreshore reserve and public open spaces;
- promotion of built form construction in keeping with the coastal "feel" of the area, and not replicating "suburbia";
- concentration on the reduction in scheme water usage, through limiting turf plantings and mandating native plantings in front gardens;
- ensuring foreshore reserve works are carried out that blend recreational functions with conservation objectives, within sensitive foreshore environments;
- direct interface with the Jurien Bay Marine Park and its suite of nearby islands. The subdivision is designed so that roads run down to the coastal reserves, maximising the relationship between the development and the ocean;
- using the relatively flat nature of landscape and narrow margin between the land's surface and the water table to influence the road pattern and swale drainage system employed. The subdivision is designed to return stormwater to the ground as close as possible to the point where the rain falls; and
- in addition to the interplay between land and sea, the area is also characterised by coastal heath vegetation. The landscaping of median swales and front gardens

ensures that the streets will create fingers of heath leading up from the coastal reserves into the subdivision, maintaining the resident's relationship with the coast.

The lack of defined streams and the highly transmissive nature of the Beachridge Plain on which the development is situated meant that to achieve a post-development water regime that resembles the natural water regime, infiltration of stormwater would need to occur "at source". The entire road layout and streetscape moves away from traditional layouts by incorporating an innovative swale network to manage stormwater runoff.

Consequently, an innovative central vegetated swale drainage system that provides non-structural, at-source control through infiltration of stormwater was created as the basis of the development. Road carriageways grade towards the central median swales, distributing the infiltration of stormwater throughout the development area and obviating the need for both piped drainage and infiltration basins (Figure 3). In general, each street contains and infiltrates its own 10-year ARI storm event, with the overflow for larger storms migrating to public open space areas catering for over 100-year ARI storm events.

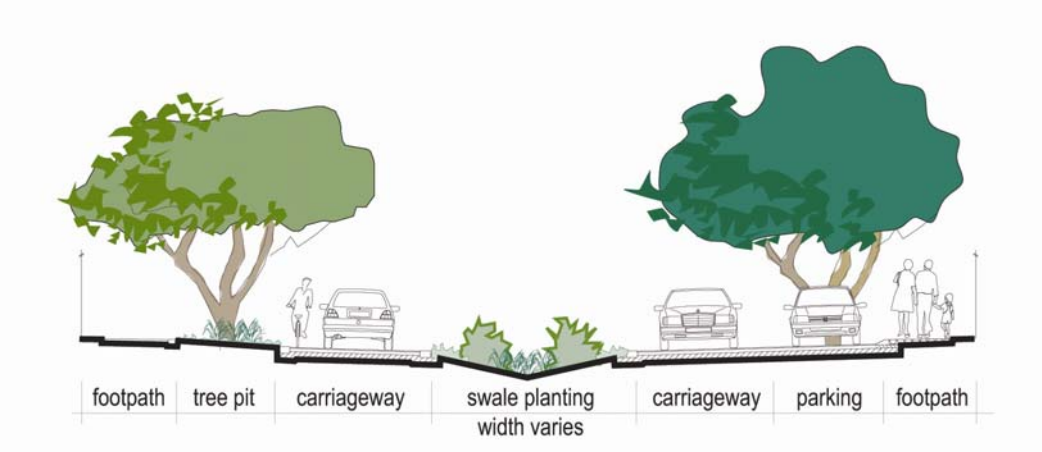

Figure 3.0 – Streetscape section showing drainage swale and planting treatment

This system is true at-source infiltration, with most stormwater infiltrating within five metres of where it fell. Nutrient uptake by vegetation and at-source infiltration mean that both the quantity and rate at which nutrients reach receiving bodies is reduced. The use of indigenous and native vegetation in the swales means that supplementary watering is not required after the initial two-year establishment period, when vegetation water requirements are met through rainfall runoff. The swale drainage system has proved to contain adequate capacity

Construction costs (excluding land component) have been shown to be equivalent to those for conventional street and associated piped stormwater drainage systems.

The landscape theme consists of three themes grading back from the foreshore, they are Heath, Heath / Scrub and Scrub / Woodland. The species have been chosen to reflect the existing vegetation patterns surrounding the development, in an attempt to link the development with its environs. Furthermore, by using a mixture of indigenous and native species, the long term maintenance and establishment of these species will be minimal, as these species are tolerant of the existing conditions.

The main thoroughfare roads and gateway statements to major tourist and urban activity zones are slightly different. The planting palette for this layer consists of a mixture of native Australian and exotic species to strengthen and highlight significant locations.

Figure 4.0 – Artist Impression of view from Stage 1 looking towards Jurien Bay Marine Park

In addition to the subdivision pattern and central drainage swale other initiatives included:

- design Guidelines and Covenants – close cooperation with the Local Authority is ongoing to ensure that the design philosophy is adhered to now and into the future,
- Restrictive Covenants and Design Guidelines legally obligate purchasers (and successors in Title) to have 3.0m front setbacks (reduced from R-Code setback of 7.5m) and all planting in the front of houses to be from the approved plant list, which comprises indigenous and native plants. Considering front gardens tend to be maintained to a higher standard than rear gardens, the reduced front setback and plant types limit the extent of water and fertiliser application that would normally be associated with the higher maintenance standard. These environmental outcomes are secured through design of the urban form. Restrictive covenants are on the Titles for all lots created in the development and affect successors in Title
- incentive rebates of $3,000 for front garden landscaping, and $750 for provision of a rain water tank, are offered to buyers who build within two years of settlement. Approximately 50 percent of all scheme water is used to reticulate lawns and gardens, and with the approved native plants being selfsustaining two years after their establishment, these initiatives result in significant water savings;
- construction water – due to the sensitive nature of the groundwater, Ardross has ensured that any dewatering activities are monitored for variations in salinity levels, with results reported to the Department Environment and Conservation (DEC). Any water required for dust suppression is sourced from screened bores which draw brackish water from far enough below the freshwater lens that this precious and fragile resource is not disturbed.

A detailed site water balance has been undertaken by the Water Corporation. The majority of the scenarios in the water balance model indicate that there is a net recharge to the ground.

For the entire development of the first stage of Turquoise Coast known Beachridge Estate (approx 3,000 people) the following water demands on scheme water are forecast (conservations will be achieved due to “hardwiring” or implementing the WMP):

1. Demand without WMP actions: ***0.75 GL/a***
2. Treated wastewater reclamation and urbanisation: ***0.55 GL/a*** *(down 0.20 GL/a)*
3. With setback and other waterwise initiatives: ***0.47 GL/a*** *(down 0.28 GL/a)*

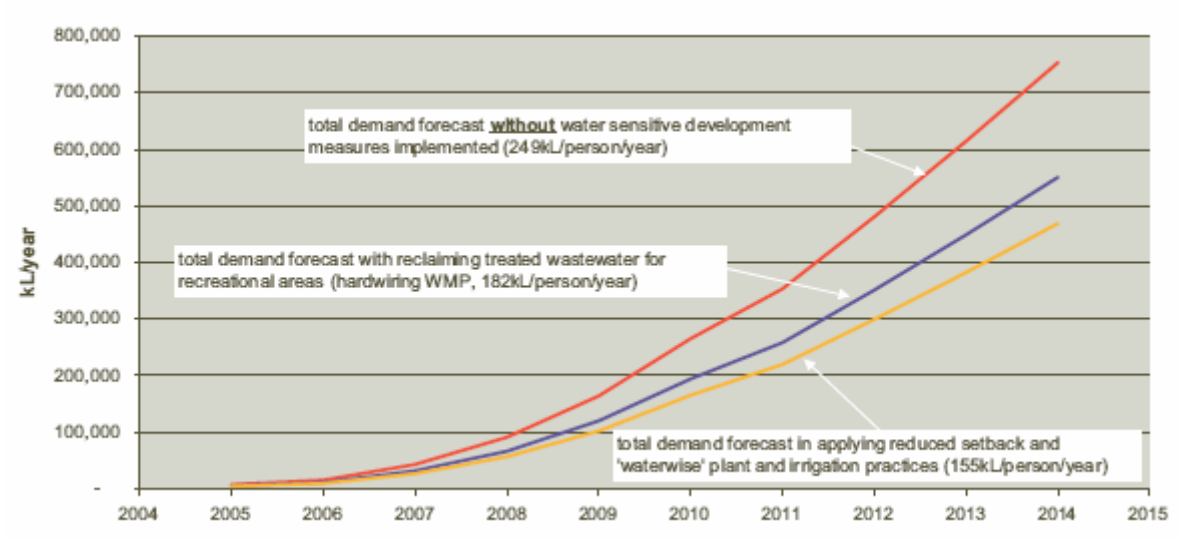

Figure 5.0 – Beachridge Estate Scheme Water Demand Forecast

Hardwiring has been achieved through combination of Residential Design Guidelines, Restrictive Covenants and developer funded financial incentives.

The wider community environmental benefits accrue in terms of:
• reduced impact on the Jurien Bay Marine Park via reduced nutrient export, re-establishment of native vegetation and the extent of prohibition on the establishment of turfed gardens (less scheme water and fertiliser use); and
• reduced ecological effects derived from selection of aquifer as scheme water source

Over time, and once the wastewater flows reach a critical point, the re-use of treated wastewater on active recreation areas will reduce the overall water take-up for landscaping purposes.

Conclusion
Upon full development of the Structure Plan, analysis has concluded that a demand reduction from 7,000,000 kL per year, to 4,300,000 kL per year would result through implementation of the Jurien Bay Water Management Plan (WMP).This overall approach to water management, pioneered by the Water Corporation and Ardross, guarantees a high level of environmental protection for the surrounding conservation lands, national parks and adjacent Jurien Bay Marine Park.