



**Independent Review
of the
Current and Future Management of Water
Assets in the Geographe Catchment, WA
Final Report**



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with assistance from Dr Bonnie Bonneville**

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Executive Summary

This Final Report contains the finding of an independent review of the management of water-related assets in the Geographe catchment, undertaken by Professor Barry Hart, Director of Water Science Pty Ltd.

The review focused on governance structures and management priorities in three areas: (a) management of the Vasse-Wonnerup Ramsar wetlands, (b) overall water quality management in the Geographe catchment contributing to Geographe Bay, and (c) water quality management of local waterways, including the Lower Vasse River, Vasse Diversion Drain and Toby Inlet.

The review has undertaken considerable consultation with the community, key agencies, local government and industry, including two visits to the Busselton region by Prof Hart and the preparation of two previous reports for comment: an *Issues Paper* released on 5 December 2013 and a *Discussion Document* released on 3 February 2014.

The Final Report contains three main sections covering:

- The water-related assets, issues they face and their current management arrangements,
- An assessment of the effectiveness of the current management against eight assessment criteria,
- Possible future management options, including recommendations and priority actions.

A summary of the key aspects in these sections is provided below.

Assets, issues, current management and assessment of current arrangements

Geographe catchment - Water quality management in the Geographe catchment is directed by an very useful WQIP plan developed in 2009, which is underpinned by the need to introduce a range of (voluntary) BMPs to achieve the desired reduction in nutrient losses from agricultural and urban land. GeoCatch and DoW, with significant contributions from SWCC, are the principal organisations implementing the Geographe WQIP, with useful assistance from DAFWA, CoB and SoC, some industry groups (Western Dairy, fertiliser industry) and SWCC (provide some funding). The focus of the WQIP in the agricultural areas is on implementing three BMPs – riparian zone revegetation and fencing, dairy shed effluent management and fertiliser management. There is evidence that GeoCatch have attempted to focus this implementation in the priority catchments feeding into the Vasse-Wonnerup wetlands (e.g. Upper Vasse/Vasse Diversion Drain, Lower Vasse, Sabina, Abba and Ludlow Rivers). However, there does not appear to be a documented strategic approach to target these catchments.

The WQIP is largely single purpose (reduction of nutrient loads), and is not a catchment management plan. Some obvious improvements have been made in the management of dairy shed effluent, streambank fencing and revegetation, and stock exclusion from waterways. Considerable efforts have also occurred in improving fertiliser management, but there is no evidence yet that this effort has resulted in farmers using less fertiliser. However, overall the implementation of BMPs over the past 4 years has been minimal due primarily to a lack of adequate funding, and in agricultural areas also to the fact that uptake of BMPs by farmers is voluntary. There appears to be no consistent program of incentive payments currently available to assist farmers to introduce BMPs. The program is heavily reliant on State and Federal NRM funding for support. Additionally, there appears to be no regulation (or enforcement) that requires farmers to contain and treat polluted runoff from dairy sheds or to keep cattle out of waterways.

Vasse-Wonnerup wetlands – These Ramsar-listed wetlands are now very different to before European settlement. They now receive much less freshwater inflow as a result of the extensive catchment drainage network, are cut off from the ocean by floodgates, and receive excessive amounts of nutrients from the catchment (Lower Vasse, Lower Sabina and Ludlow Rivers), the sediments and cattle grazing in the immediate vicinity of the wetlands themselves. These high nutrient concentrations are resulting in increased growth of macroalgae, and at times toxic blue-green algae, that are unsightly and can cause additional problems (e.g. fish kills) when they die. However, despite these changes, the wetlands still have high biodiversity and ecological values; they support a great abundance and variety of waterbirds, and have good populations of macrophytes (e.g. *Ruppia megacarpa*), fish and macroinvertebrates. Currently, there is no comprehensive management plan for these wetlands despite the fact that they are Ramsar-listed.

A new emergency 'Fish Kill Mitigation and Response Plan' has been developed and is in place for the 2013-14 summer, with DoW as the coordinator. This new incident response plan has clear trigger criteria, monitoring requirements and agreed response actions, but has yet to be fully implemented. A comprehensive long-term strategic management plan for the Ramsar-listed Vasse-Wonnerup Wetlands is also needed. Management objectives should include: water bird

habitat, biodiversity, ecological condition, cultural values, recreation, aesthetics, flood protection and operation of the floodgates.

Lower Vasse River – This river now receives only a fraction of its original flow, since the major part of the catchment is cut off by the Vasse Diversion Drain. But it does receive an excessive nutrient load from agricultural and urban sources. In Busselton, the Lower Vasse River is maintained as a 'lake' for recreational and aesthetic purposes by a set of barriers (boards) located at the Butter Factory. This 'lake' is eutrophic and regularly experiences algal blooms over summer, which reduces the recreational and amenity value of the 'lake' and causes offensive odours. The current management of the Lower Vasse River, and particularly the 'lake' section in Busselton is far from ideal; there is no comprehensive management plan and no obvious lead agency.

The WQIP provides a useful management plan for the overall Lower Vasse River catchment, focused as it is on the long-term reduction of nutrients from agricultural and urban areas. However, the short-term management of the 'lake' is more problematic. The major algal blooms associated with this part of the river are due to excessive nutrients, a lack of adequate flow, particularly in summer, and the fact that the river is dammed. The question of who should manage the 'lake' section of the Lower Vasse River (CoB or DoW) needs to be resolved.

Vasse Diversion Drain – This Drain captures most of the Vasse River flow, approximately half the flow of the Sabina River, and most of the flow of treated effluent from the Busselton wastewater treatment plant. It is extremely important in providing 1-in-100 year flood protection to Busselton. The Water Corporation effectively manage the drainage and flood-protection functions of the Vasse Diversion Drain, however, but have no legislative requirement to consider the water quality in the drain. Currently, the Vasse Diversion Drain does not achieve the nutrient targets established by the WQIP, and is discharging excessive amounts of TP and TN to Geographe Bay. It is possible that the newly formed Busselton Water Corporation may take over responsibility for the Vasse Diversion Drain (and other drainage assets in the Geographe catchment), and include water quality and nutrient reduction as management objectives in addition to drainage and flood protection.

Toby Inlet - Toby Inlet is highly valued for recreation and aesthetics, but currently experiences regular blooms of macroalgae and phytoplankton, and offensive odours when these algal blooms die. These issues are the result of excessive nutrient inputs to the estuary, and a lack of adequate flushing. The Station Gully Drain and associated causeway, that pass through the eastern end of the Inlet, is a major reason for the poor flushing. This could be largely resolved by the removal of the causeway or the enlargement of the culvert in the causeway. Management of Toby Inlet is minimalist at best. The community-based Toby Inlet Catchment Group have developed a Management Plan for Toby Inlet, and could do a serviceable job of managing the Inlet if they had more funding and greater backup from CoB and DoW.

Possible future management options

After consideration of the roles and responsibilities of the key organisations, three options for possible future management structures were proposed (see Figure for details):

- Option 1 – the establishment of a single Geographe Catchment and Wetland Management Authority that would manage all the assets,
- Option 2 – the establishment of an overall lead agency to coordinate the separate asset management arrangements,
- Option 3 – the establishment of separate asset management arrangements with no coordination.

After consideration of the advantages and disadvantages of each option, this review recommends Option 1 – a single Geographe Catchment and Wetland Management Authority. However, as this option seems unlikely to be favoured by the current WA Government, Option 2 is recommended.

The review has also concluded that which ever management option is adopted, it will need to be adequately resourced for at least a decade in order to make a significant improvement in the condition of the Geographe catchment key water-related assets. It is estimated that funding of the order of \$3-5 million per year will be required.

Recommendations

Rec1: That the Minister adopt management Option 1 (see Figure).

Rec 2: In the event that Rec 1 is not accepted, that the Minister adopt management Option 2 (Figure). The Minister should consider in order the lead coordinating body being (a) DoW, (b) a restructured GeoCatch, and (c) a Ministerial Task Force with transition to a corporate model involving BWC (see Section 4.3.2 for details). Whatever form of lead

coordinating body is agreed, this body should have the necessary powers to be able to exercise its functions effectively. This could take the form of an authority from the Minister for Water, or all three Ministers involved (Water, Environment and Agriculture/Fisheries).

- Rec 3: In the event that Rec 2 is accepted, that the arrangements outlined in Section 4.3.2 be established for the management of (a) the Geographe catchment (including waterways and rural drainage network), (b) the Vasse-Wonnerup wetlands, and (c) the Lower Vasse River and Toby Inlet.
- Rec 4: That high priority be placed on the immediate development and implementation of a non-statutory management plan for the Vasse-Wonnerup wetlands, that incorporates both the VETWG and the emergency 'Fish Kill Mitigation and Response Plan'.
- Rec 5: That until the Vasse-Wonnerup wetlands management plan is established, VETWG be retained (with DoW as chair) to implement the emergency 'Fish Kill Mitigation and Response Plan'.
- Rec 6: That the lead agency for each of the water-related assets report annually to the community on both the asset condition (health) and effectiveness of management (perhaps using a simple Report Card format).
- Rec 7: That an independent review of the Geographe catchment drainage network be commissioned to assess (a) its current and future relevance, including the current relevance of the '72 hour rule', (b) what might be done to make this drainage network more effective at reducing nutrients in addition to its flood protection and land drainage functions, (c) the potential for reengineering the drainage system to reconnect natural waterways adversely affected by drains and to provide more freshwater inflow into the Vasse-Wonnerup wetlands and the Lower Vasse River, and (d) the potential to modify the Station Gully drain so that additional water enters Toby Inlet.
- Rec 8: That the current Geographe Water Quality Improvement Plan be reviewed with a view to updating it and expanding it into a broader Catchment Management Plan, and that the implementation of this new plan be empowered by the Minister for Water.
- Rec 9: That DoW continue to provide the science to underpin the management of the Geographe catchment waterways, Vasse-Wonnerup wetlands and Toby Inlet, including the current water quality monitoring program, catchment modeling, and scientific investigations.
- Rec 10: That a research plan be developed for water-related assets in the Geographe catchment to identify the key knowledge needs, and the organisations able to conduct the necessary research (e.g. universities, CSIRO, DoW, DFAWA).
- Rec 11: That DAFWA (in collaboration with DoW) undertake a program to better assess the effectiveness of the current agricultural BMPs.
- Rec 12: That regulations be introduced to ensure best management practices related to dairies and dairy shed effluent are adopted.
- Rec 13: That the WA Government establish a fund of \$30 million over 10-years to provide core funding for the enhanced management of the water-related assets of the Geographe catchment, including the Vasse-Wonnerup wetlands.
- Rec 14: That as part of this fund, the WA Government consider the options listed in Section 4.4 (namely a bid to the 'Royalties for Regions' fund, introduction of a 'catchment levy' on all ratepayers in the Geographe catchment, introduction of a special 'environmental levy' on urban ratepayers by CoB, introduction of a 'fertiliser levy' with the funds going to assist in the implementation of better fertiliser management in the Geographe catchment, and reintroduce a 'drainage levy' for rural properties to assist in the restructuring of the existing drainage network).

Priority actions

This independent review was commissioned largely because of the concern of the Busselton community at what they saw as the lack of an agreed lead agency, and a lack coordination and action by the agencies involved in the management of the Vasse-Wonnerup wetlands. It will be important that the community are convinced that urgent action is being taken on those issues of concern to them. This need is reflected in the priority actions listed below.

1. Agree to develop and implement a non-statutory strategic management plan for the Vasse-Wonnerup wetlands, that incorporates both the VETWG and the emergency 'Fish Kill Mitigation and Response Plan' (Rec 4). This Plan must include consideration of the most

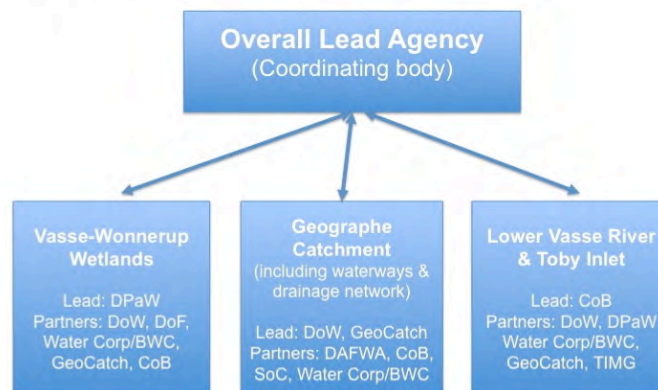
appropriate operation of the floodgates and the desirability and feasibility of dredging the Vasse wetland.

2. Agree that, until the Vasse-Wonnerup wetlands management plan is operational, VETWG be retained (with DoW as chair) to implement the emergency 'Fish Kill Mitigation and Response Plan' (Rec 5).
3. Decide upon the future overall management structure, including its resourcing, and implement the necessary arrangements (Recs 1, 2, 3, 4, 5, 13, 14).
4. Review the existing WQIP with a view to broadening it into a catchment and wetland management plan (Rec 8).
5. Establish an independent review of the Geographe rural drainage network (Rec 7).
6. Introduce regulations to ensure BMP for dairies are adopted (Rec 12).

(a) Option 1



(b) Option 2



(c) Option 3



Figure: Diagram showing the main features of the three management options

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Abbreviations

| | |
|------------|---------------------------------------|
| BMP | Best Management Practice |
| BWC | Busselton Water Corporation |
| CoB | City of Busselton |
| DAFWA | Department of Agriculture and Food |
| DoF | Department of Fisheries |
| DoW | Department of Water |
| DPaW | Department of Parks and Wildlife |
| GeoCatch | Geographe Catchment Council |
| SoC | Shire of Capel |
| SWCC | South West Catchment Council |
| TICG | Toby Inlet Catchment Group |
| VETWG | Vasse Estuary Technical Working Group |
| Water Corp | Water Corporation |
| WQIP | Water Quality Improvement Plan |

*Somebody said that it couldn't be done,
But he with a chuckle replied
That 'Maybe it couldn't' but he would be one
Who wouldn't say so till he'd tried.
So he buckled right in with the trace of a grin
On his face. If he worried, he hid it.
He started to sing as he tackled the thing
That couldn't be done, and he did it!*
Edgar Albert Guest¹

1. Introduction

The Lower Vasse River, Toby Inlet and the Vasse-Wonnerup Wetlands have experienced poor water quality over the past 20-30 years, resulting in persistent algal blooms and occasional fish kills.

The need for better management of the Geographe catchment and associated rivers, wetlands and estuaries was recognised over 15 years ago with the establishment of GeoCatch in 1997. GeoCatch was set up specifically as the management entity to lead and coordinate management of eutrophication (excessive nutrients) in the catchment. Their first action was to develop the *Lower Vasse River Cleanup Program* (including the *Vasse River Action Plan*) in partnership with the Waters and Rivers Commission (now DoW) and the Shire of Bussleton (now CoB). The overall aim of this Program was to improve the ecological health of the Lower Vasse River. The large number of on-ground actions successfully undertaken were reviewed in 2005 (Paice, 2005).

An important learning from this Program was that without whole-of-catchment actions to reduce nutrient loads, it was unlikely that the ecological health of the Lower Vasse River and the Vasse-Wonnerup wetlands would be improved. Fortuitously, at about this time the Commonwealth government commenced a national program under its *Coastal Catchments Initiative*, to fund the development of water quality improvement plans for many coastal catchment around Australia.

Given the experience gained through the *Lower Vasse River Cleanup Program*, the region was well placed to develop the *Vasse-Wonnerup Wetlands and Geographe Bay Water Quality Improvement Plan* (WQIP, DoW 2010a), to provide a whole-of-catchment approach to improving water quality. This WQIP was completed by DoW in 2009, and until recently the implementation of the Plan, largely by GeoCatch and DoW, has been funded by the Commonwealth and Western Australian governments.

The WQIP contains good information on the main sources of nutrients (the main cause of the poor water quality), the high priority management actions to reduce these nutrient loads, and targets to be achieved over the first 10-years and beyond. And although there has been considerable on-ground action aimed at introducing Best Management Practices (BMP) in agricultural and urban areas, it is not surprising that water quality still remains a major concern across the Geographe catchment. Experience in other regions of Australia and overseas suggests that it takes considerable time and investment to reduce nutrients from agricultural catchments – there is no 'quick fix'.

However, despite the usefulness of the WQIP, community and local government concern about the continuing poor water quality has increased over recent years, with this concern significantly heightened by the major fish kill event that occurred in the Vasse-Wonnerup Wetlands in April 2013. Another fish kill occurred in the Vasse Wetland in February 2014.

In response to these concerns, the (then) Minister for Water, the Honourable Terry Redman MLA, announced the decision to undertake an independent review of waterways management efforts in the Vasse-Wonnerup Wetlands and Geographe catchment in August 2013. This recommendation was supported by an interagency workshop, coordinated by DoW in May 2013, as a critical step towards improving water quality management in this catchment.

Professor Barry Hart, Director of Water Science Pty Ltd, was engaged by DoW in October 2013 to undertake this independent review of the management of water assets in the Geographe catchment.

¹ Thanks to Jocelyn Elphick for this ditty.

The Terms of Reference require the review to focus on governance structure and management priorities within three areas:

- Overall water quality management of the catchment contributing to Geographe Bay,
- Management of the Vasse-Wonnerup Ramsar Wetlands, and
- Water quality management of local waterways, including the Lower Vasse River, Vasse Diversion drain and Toby Inlet.

The outcomes of this review were expected to provide:

- An evaluation of the current roles and responsibilities of key organisations involved in managing the above assets, which identified the positive and negative aspects of the current governance frameworks,
- Recommended options for alternative governance model(s) and management arrangements for future management of the three areas of this review, which may include a lead agency for each asset type, management body (with or without statutory responsibility), or an alternative model, and
- Priority actions to improve the management and condition of the three areas.

Two previous reports have been provided for community, key agency, local government and industry comment, these being:

- **Issues Paper** (Hart, 2013) released on 5 December 2013 following a visit by Professor Hart to the Geographe region in the period 13-18 November 2013 (Hart, 2013). This Issues Paper aimed to provide the community and key organisations with confidence that the independent review was underway and progressing well. It contained a summary of the stakeholder discussions and key issues identified by the community and key agencies to date, that were conveyed to Professor Hart when he visited the Geographe region. A small number of comments were received on the Issues Paper.
- **Discussion Document** (Hart, 2014) released on 3 February 2014 to provided the community, key agencies, local government and industry with: (a) information on the water-related assets, the issues they face and their current management arrangements, (b) an assessment of the effectiveness of the current management of these assets, and (c) possible future management options. The Discussion Document was available for 3 weeks to allow comment from the community, agencies, local government and industry. Professor Hart also visited the region in the period 10-13 February 2014 for a further round of discussions based on the information in the Discussion Document. A considerable number of comments and submissions were received (Appendix A).

The feedback and submissions on the Discussion Document were considered in the preparation of this Final Report.

This Final Report covers the water-related assets, the issues they are facing, and the current management arrangements in Section 2, and an assessment of the effectiveness of the current management against eight assessment criteria in Section 3. Section 4 contains governance options (models) for more effective future management arrangement, and then in Section 5 my recommendations for the best management model and a list the priority actions to put this new governance structure in place.

Professor Hart is most grateful for the assistance and information provided by all agencies and organisations, in particular DoW and GeoCatch, and from several members of the community. Dr Kath Lynch coordinated the collection of information, organised my visits, and generally contributed to the smooth running of this review.

2. Water Assets, Issues and Current Management

2.1 General

This section covers the key characteristics, current issues and current management of each of the three components of the study region – the Geographe Catchment, the Vasse-Wonnerup Wetlands and the local waterways (including the Lower Vasse River, Vasse Diversion drain and Toby Inlet).

The Geographe Catchment is located approximately 250 km south of Perth and occupies an area of approximately 2,000 km² between Bunbury and Cape Naturaliste. The catchment is bounded by the Darling Range, the Whicher Range and the Leeuwin-Naturaliste Ridge (Figure 1). Below these ridges is the southern-most part of the Swan coastal plain extending south and west to Dunsborough. This coastal plain is characterised by predominantly sandy-loam soils as well as poorly drained flats and wetlands.

The catchment has been extensively cleared and developed for agriculture. The predominant land uses being dairy, beef cattle grazing, forestry, horticulture and viticulture. Additionally, the region is rapidly becoming more urbanised, experiencing one of the highest rates of urban expansion in Australia, primarily because of the desirable lifestyle and holiday opportunities in the region. The major urban centres in the catchment are Busselton, Dunsborough and Capel. The high urban growth rate is predicted to continue over the next 20 to 30 years.

The Geographe catchment has a number of important water assets, the most important being the Vasse-Wonnerup Wetlands, located just east of Busselton (Figure 1). These wetlands were listed as a Ramsar site in June 1990, largely on the basis that they are an important habitat for waterbirds (WRM, 2007).

There are 16 major waterways in the Geographe Catchment, with all but one (Capel River) being ephemeral and only flowing between June and October in most years (Figure 1). Before European settlement very few of these waterways flowed directly into Geographe Bay. Instead they flowed first into an extensive chain of wetlands stretching along the coast that emptied into the Vasse or Wonnerup estuaries, and then into Geographe Bay (Lane et al., 1997).

Currently, only the Lower Vasse, Lower Sabina, Abba and Ludlow rivers drain into the Vasse-Wonnerup Wetlands, with all other waterways flowing directly into Geographe Bay either through their natural outlets or artificially constructed drains². Additionally, most of the Vasse River and approximately half the Sabina River are diverted directly to Geographe Bay via the Vasse Diversion Drain (Figure 2 & 7).

This review is focused on the Vasse-Wonnerup Wetlands, Toby Inlet and the catchment waterways, particularly the Lower Vasse River and Vasse Diversion Drain.

2.2 Geographe Catchment

2.2.1 System

The general features of the Geographe Catchment system have been summarised above. As noted, the catchment has been extensively developed for agriculture (mainly dairy production and beef cattle grazing), and is becoming more urbanised.

This agriculture and urbanisation, together with associated modification to waterways and the development of an extensive drainage network, has had two major adverse effects on the water assets. First, the ecological and water quality condition of the catchment's waterways are significantly degraded, and second the ecological and water quality condition of the downstream assets, particularly the Vasse-Wonnerup Wetlands, Toby Inlet and the Lower Vasse River, are also significantly degraded.

The major cause of this degradation is the excessive nutrient (mainly total phosphorus (TP) and total nitrogen (TN)) and organic matter loads entering them, but also because of a general reduction in freshwater inflows. The main activities contributing nutrients include: dairy shed effluent, fertiliser over-use, cattle grazing and un-sewered urban areas.

² At the western end of the catchment a network of seasonal streams flow into Toby Inlet before draining into Geographe Bay.



Figure 1: Map showing the Geographe catchment, rivers and wetlands

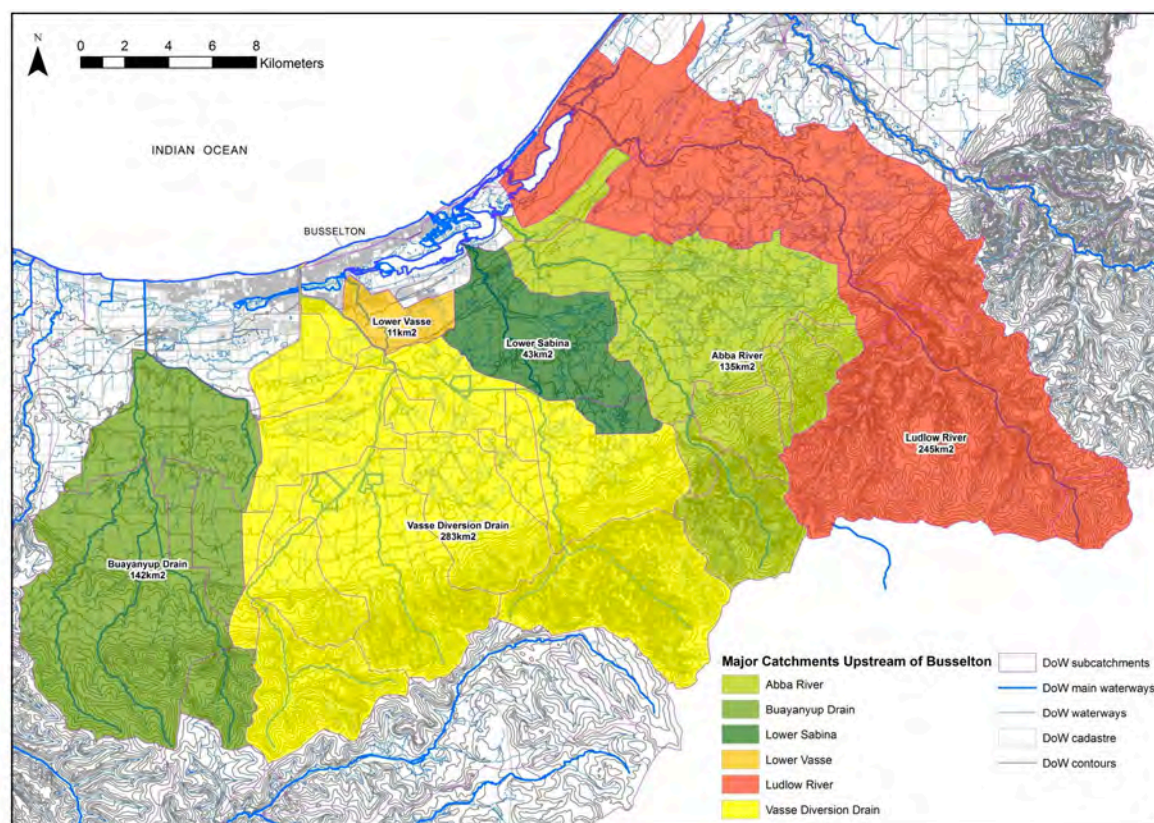


Figure 2: Map showing the rivers entering the Vasse-Wonnerup wetlands

Hydrology and drainage

European settlement resulted in many changes to the catchment's hydrology, particularly because of extensive clearing and drainage of the catchment. Catchment clearing caused increased runoff and large increases in river flows, and made the construction of artificial drainage necessary.

Drainage of the landscape started as early as the 1880s when the Capel River was diverted from the Wonnerup Inlet into Geographe Bay through the Higgins Cut. From this time until the 1950s, a series of hydrological alterations were made, with drainage works escalating during the 1920s and again in the 1950s (WRM, 2007). These works included the construction of floodgates on the Vasse and Wonnerup Wetlands to prevent saltwater incursion, a network of small drains to remove water from farmland, and a series of large arterial drains and river diversions to discharge surface flow directly to Geographe Bay (English, 1994; Water Corp, 2013).

The drainage system enabled farming of coastal areas that were previously inundated during winter, reduced saltwater incursion into pasture that bordered the estuaries, and protected the growing town of Busselton from flooding – thereby allowing it to expand into floodplain areas.

Additionally, over time most of the natural watercourses have been modified through diversion, channel straightening, de-snagging, enlargement of the channel and creation of levee banks. Also, as a result of the artificial drainage systems, many of the catchment's wetlands have been subsumed by agricultural and urban land uses. The remaining wetlands are generally in poor condition due to the impacts of the surrounding land uses and most are located on private land (DoW, 2010a).

The combined effect of catchment clearing, modification of waterways, removal of wetlands and the construction of effective drainage channels, has meant that the capacity of the catchment to retain sediment and nutrients has been significantly diminished. As a result both Geographe Bay and the Vasse-Wonnerup Wetlands now receive large loads of nutrients and organic matter delivered by the waterways during winter (DoW, 2010a).

Land use

The Geographe catchment is an important and productive agricultural area, with the main

agricultural industries being dairy and beef cattle, forestry, horticulture and viticulture.

Additionally, the Geographe region has one of the highest rates of urban expansion in Australia. The desirable lifestyle and holiday opportunities available in the region have created a large rate of growth and development over the past 10 years. The high urban growth rate is likely to continue during the next 20 to 30 years. Population in Busselton is projected to increase from approximately 32,000 residents in 2011 to approximately 50,000 residents by 2031, and in Capel the increase over the same period is projected to be around 13,000 to 18,000 residents.

Water Quality Improvement Plan

As noted earlier, the development of the *Vasse-Wonnerup Wetlands and Geographe Bay Water Quality Improvement Plan* (DoW 2010a), and its implementation since 2009, followed almost a decade of action by GeoCatch, DoW and CoB through the *Lower Vasse River Cleanup Program* (Paice, 2005).

This WQIP is now guiding much of the current management of waterways in the Geographe catchment. As the title indicates, this Plan is focused largely on water quality and not more broadly on the ecological condition of these assets, although some actions in the Plan (e.g. riparian zone revegetation, environmental flows) will contribute to improved ecological health. It should be noted that the relatively narrow focus of these WQIPs resulted from the rather constrained format required by the Commonwealth government.

It is expected that the 5-year review of this WQIP will consider widening its scope to include broader issues of catchment management and waterway health, as is occurring with more recent WQIPs being developed by DoW (e.g. the Leschenault Estuary WQIP, Hughues-dit-Ciles et al., 2012).

However, despite its relatively narrow focus, the current WQIP does a very good job in identifying the main problems (excess nutrients from agricultural and urban areas entering the Vasse-Wonnerup Wetlands and Geographe Bay) and the actions required to reduce these nutrient inputs (introduce Best Management Practices (BMP)). It also provides targets for the reductions in the major nutrient loads (phosphorus and nitrogen) in the catchment rivers, which if met should protect the ecological condition of the downstream waterbodies, such as the Vasse-Wonnerup Wetlands.

A hydrologic and nutrient model was used by the Department of Water to determine current nutrient loads, load targets, load-reduction targets, nutrient sources and priority sub-catchments for remediation in the Geographe catchment (DoW, 2009).

The main nutrient sources in this catchment are cattle grazing for beef and dairy, which contributes on average 25 % and 40 % respectively of the nutrient loads from all sub-catchments (DoW, 2009). This is largely because these farms occupy the majority of the fertilised land area in the Geographe catchment (DoW, 2009). The highest nutrient export rates are from those areas surrounding the Lower Sabina River, the Vasse Diversion Drain, and the Buayanyup River in the centre of the Geographe catchment. High exports also occur in the Gynudup Brook catchment and the coastline in urban regions (DoW, 2009).

Estimated nutrient loads entering the Vasse-Wonnerup Wetlands are approximately 16 tonne/y of phosphorus and 134 tonne/y of nitrogen (DoW, 2010a). The majority of the nutrient loads entering the Vasse-Wonnerup Wetlands are delivered by the rivers that flow into the wetlands (i.e. Lower Vasse, Lower Sabina, Abba and Ludlow) (DoW, 2009). The Lower Vasse and Lower Sabina catchments contribute a disproportionately high load compared with the larger Abba and Ludlow catchments (DoW, 2010a).

Dairy farming activities (e.g. cattle grazing and dairy sheds) upstream are the main source of nutrients (Table 1), particularly in the Lower Sabina catchment where 61% of TP and 81% of TN loads are apportioned to dairy cattle grazing. Beef cattle grazing on the fringes of the Vasse-Wonnerup Wetlands is estimated to account for 10% of the TP and 5% of the TN loads to these wetlands. Point sources, such as dairy-sheds, feedlots, land-fill sites and waste-water treatment plants, are also significant sources of nutrients to the Vasse-Wonnerup Wetlands, particularly from the Lower Vasse and Abba catchments (Table 1). Urban runoff and septic tank seepage were also significant sources of TP in the Lower Vasse River, which flows through the Busselton Township (Table 1).

Future land use changes from cattle grazing to urban centres, are predicted to occur during the next 25 years, and are likely to increase the TP and TN loads due to an increase in fertiliser input

rate (DoW, 2009). Wastewater treatment plants are also expected to double in capacity in the next 25 years (DoW, 2009).

To achieve a healthy Vasse-Wonnerup Wetland ecosystem, the WQIP indicates that TP concentrations in the streams entering the wetlands should be less than 0.1 mg/L and TN concentrations should be less than 1.0 mg/L. When the WQIP was developed it was not possible to set nutrient targets for the Vasse-Wonnerup wetland system because there were no generally agreed management objectives for this system.

Water quality modeling of runoff from the catchment indicates that to achieve these targets, the annual load of TP and TN entering the wetlands each need to be reduced by around 41 % and 55 % of the current loads respectively (to 9.2 tonne/y and 60 tonne/y respectively - see Table 2 for catchment targets). However, it was decided that this was unachievable in the short-term and interim reduction targets have been established, which require a reduction of 23% in the TP load and 36% in the TN load over a 10-year period (to 12 tonne/y and 85 tonne/y respectively).

Priority sub-catchments identified for remediation through on-ground works, such as fertiliser management, dairy effluent upgrades and riparian management, include the catchments of the Lower Sabina River, Lower Vasse River, Ludlow River and Vasse Diversion Drain (Figure 2). Although a number of on-ground works have been undertaken over the last decade, and particularly since 2009, water quality is still poor in most rivers and fail to reach water quality targets (Table 2).

The nutrient concentrations and loads in the different catchment waterways vary considerably depending on land use. To assist in prioritizing management actions, the WQIP categorised the different waterways into one of three categories, related to their current nutrient status, these being (Figure 2):

- Protection – for all waterways that currently meet both the nitrogen and phosphorus criteria,
- Intervention – for all waterways that currently meet the phosphorus criteria, but do not meet the nitrogen criteria,
- Recovery – for all waterways that do not meet either of the nitrogen or phosphorus criteria.

Note that the Lower Vasse River, Lower Sabina River and Ludlow River, all of which flow into the Vasse-Wonnerup Wetlands, are in the most polluted category – these are referred to as 'priority catchments' in this report.

Table 1: Main sources of nutrients (percentage) to rivers that flow into Vasse-Wonnerup wetlands (Adapted from DoW 2009). The top three sources are in bold. Note: some of these figures will have changed due to there being less dairies and other changes.

| Sub-catchment | Current (tonnes/year) | Point Sources | Septic Tanks | Horticulture | Perennial Horticulture | Cattle for Beef | Cattle for Dairy | Other Rural | Lifestyle | Urban | Fixation |
|-------------------|-----------------------|---------------|--------------|--------------|------------------------|-----------------|------------------|-------------|-----------|-------|------------|
| Phosphorus | | | | | | | | | | | |
| Ludlow | 2.9 | 6% | 0% | 3% | 3% | 16% | 38% | 32% | 1% | 0% | - |
| Abba | 4.4 | 24% | 0% | 2% | 0% | 21% | 39% | 14% | 0% | 0% | - |
| Sabina | 3.6 | 8% | 0% | 0% | 0% | 29% | 61% | 2% | 0% | 0% | - |
| Lower Vasse | 4.7 | 36% | 10% | 1% | 0% | 16% | 13% | 10% | 0% | 14% | - |
| Nitrogen | | | | | | | | | | | |
| Ludlow | 23 | 7% | 0% | 1% | 1% | 5% | 63% | 9% | 0% | 0% | 15% |
| Abba | 38 | 17% | 0% | 1% | 1% | 8% | 44% | 10% | 0% | 0% | 20% |
| Sabina | 40 | 4% | 0% | 0% | 0% | 12% | 81% | 1% | 0% | 0% | 3% |
| Lower Vasse | 34 | 11% | 4% | 0% | 0% | 13% | 60% | 3% | 0% | 4% | 7% |

Table 2: Load reduction targets and median concentrations in 2006 and 2012.

| Sub-catchment | | Current load (tonnes/y) | Interim reduction target (%) | Reduction target (%) | 2006 median concentration* (mg/L) | 2012 median concentration* (mg/L) |
|---------------|----|-------------------------|------------------------------|----------------------|-----------------------------------|-----------------------------------|
| Ludlow | TN | 23 | 34 | 55 | 1.1 | 1.6 |
| | TP | 2.9 | - | 21 | 0.08 | 0.14 |
| Abba | TN | 38 | - | 25 | 1.3 | 1.8 |
| | TP | 4.4 | - | 0 | 0.04 | 0.04 |
| Sabina | TN | 40 | 27 | 71 | 2.9 | 2.4 |
| | TP | 3.6 | 32 | 74 | 0.57 | 0.26 |
| Lower Vasse | TN | 34 | 27 | 70 | 1.7 | 2.2 |
| | TP | 4.7 | 38 | 67 | 0.21 | 0.17 |

* Target concentrations are 1.0 mg/L for TN and 0.1 mg/L for TP

The main features of the rivers entering the Vasse-Wonnerup Wetlands are shown in Figure 5 (Note: the Vasse Diversion Drain is discussed in Section 2.5).

Waterway values

As noted above, the current focus of management of the Geographe catchment is largely on water quality, and specifically on reducing the loads of nutrients entering the Vasse-Wonnerup Wetlands and Geographe Bay, but with some activity aimed at enhancing the biodiversity values of rivers (DoW, 2010a).

However, the catchment's waterways all retain important but limited aquatic values, including the presence of marron (in 2 waterways), freshwater fish (in 8 waterways) and freshwater mussels (in 3 waterways) (DoW, 2010a). The waterways with these aquatic fauna are all predominantly larger systems where deep pools provide important summer refuges. Allowing water quality to decline further may pose risks to the long-term survival of these species in the local area, since all are sensitive to poor water quality, especially low oxygen conditions.

Certainly, improvement of water quality will assist in improving the general ecological condition ('health') of these rivers, but this is not sufficient. A healthy river also needs good habitat and a sufficient environmental flow, as is recognised in the WQIP. GeoCatch have developed a broad Catchment Management Strategy for the Geographe catchment (GeoCatch, 2008), but it appears that, apart from the implementation of nutrient-reducing BMPs, other aspects of this strategy have been given lower priority, primarily because of limited funding opportunities for this type of work.

Implementation

Implementation of the WQIP is based largely on the voluntary adoption of Best Management Practices to reduce nutrient inputs from both agricultural and urban areas. A number of BMPs have been identified in the WQIP, which if fully implemented, would significantly reduce the nutrient losses from agricultural land and urban areas.

In agricultural areas, priority has been placed on BMPs for management of dairy sheds and feedlots, fertiliser management, implementing riparian management, and controlling of stock on waterways. However, there does not appear to be monitoring program in place to verify and quantify the effectiveness of these management practices. Soil amendments on sandy soils and perennial pastures, to reduce 'leakage' of phosphorus, have been trialled in other catchments (e.g. Peel Harvey), but not in the Geographe catchment. It seems unlikely that soil amendment would be suitable for the majority of the Geographe catchment because the phosphorus retention index is too high (Pers Comm, Dr Rob Summer, DAFWA, Feb 2014). DAFWA have shown that in most of the Geographe catchment the topsoil is saturated with phosphorus, which runs off when the soil is

inundated, so that simply bringing the shallow subsoil to the surface through tillage would supply a suitable soil amendment.

In urban areas, priority has been placed on management of point sources (wastewater treatment plants, septic tanks), incorporating water sensitive urban design in new residential developments, and limiting fertiliser use in urban areas.

The WQIP recommended an annual capital cost of \$1.6 million over 10-years to implement BMPs to achieve the interim targets (DoW, 2010a). But note that this did not include the major expenditure required in urban areas to address septic tank removal and infill sewerage.

Progress in implementing these BMPs is evaluated in Section 3.2 and Appendix B.

Comment: The Geographe Bay region is typical of many rural areas in Australia where the major land use in the catchment is productive agriculture, while downstream the growing urban population (Busselton) is focused on tourism and recreational use of aquatic assets (Geographe Bay and the Vasse-Wonnerup wetland in this case) that can be adversely impacted by upstream pollution. This dichotomy is not an easy one to manage and will require the community to accept some 'trade-offs'.

2.2.2 Issues

Excessive nutrients

The modeling undertaken as part of the WQIP development showed clearly that excessive amounts of nutrients are generated from the agricultural activities and urban areas in the Geographe catchment, and that these nutrients are significantly impacting on the condition of all water-related assets (DoW, 2009).

The main sources of nutrients have been clearly identified (agricultural and urban), as have the waterways contributing the highest concentrations and loads to the downstream assets (Vasse-Wonnerup Wetlands, Lower Vasse River). Additionally, the management actions (BMPs) to address these nutrient sources have also been identified, and these are (slowly) being implemented. There is a need to establish a robust monitoring program focused on the local implementation of various management practices on small subsections of the drainage system, to inform decisions about future options and expenditure.

Additionally, experience in other regions of Australia and overseas is that 'clean-up' of agricultural land is difficult, needs a long-term (decades) commitment and is costly. Reducing the downstream eutrophication problems (excessive aquatic plant growth) will not occur overnight, and there will be the need for 'symptom' management of the Vasse-Wonnerup Wetlands, and the Lower Vasse River, in the short to medium term.

However, despite the difficult and long-term nature of the 'clean-up' of agricultural land, this does not diminish the need to actively work to reduce the nutrient losses from agricultural activities and urban areas in the Geographe Catchment.

Waterway monitoring

DoW have a comprehensive water quality monitoring program currently in place, but it is concerning that this is totally dependent on external funds. Water samples are taken fortnightly in all major waterways (22 sites) in the catchment during winter when these streams are flowing (DoW, 2012 - Fig. 3.1). The samples are analysed for TN, TP, TSS, Filterable Reactive P, Nitrate + Nitrite-N, dissolved organic N, pH, temperature, dissolved oxygen (DO) and conductivity.

Nutrient concentrations: The TP and TN concentration data are used to calculate compliance with the relevant targets (TP <0.1 mg/L, TN <1.0 mg/L) using a binomial-type compliance method (DoW, 2009). For most of the major streams, there are adequate data available for the six year period 2006-2012 (DoW, 2012). Progress in meeting the targets is reviewed in Section 3.2.

The spatial and temporal coverage of this water quality sampling program are adequate. All major waterways are monitored mostly at a gauging station. However, it is noted that flow measurement in the Lower Vasse River is problematic. For the last year, flow has been measured at the point where water from the Vasse Diversion Drain can be diverted through a pipe (and valve) into the Lower Vasse River.

Nutrient loads: The measurement of nutrient loads is well known to be difficult, given that most of the nutrient transport occurs in a short period of time (in winter). Load estimation requires both nutrient concentrations and flow over major flow events.

The current fortnightly sampling data is used to calculate nutrient loads for catchments that are flow gauged. DoW indicate that they have undertaken considerable research on this matter and have found that use of fortnightly concentration data provides essentially the same load as that produced using daily concentration data (Pers Comm, Malcolm Robb, DoW, Jan 2014). In ungauged catchments, nutrient loads will need to be estimated using an appropriate model for calculating flows.

Biological monitoring: there is some monitoring of the aquatic biota (e.g. macroinvertebrates, fish, crayfish) in the Geographe catchment rivers as part of the DoW river health assessment scheme for south-west Western Australia (Storer et al., 2011). However, the sampling occurs at irregular times depending upon the availability of funds.

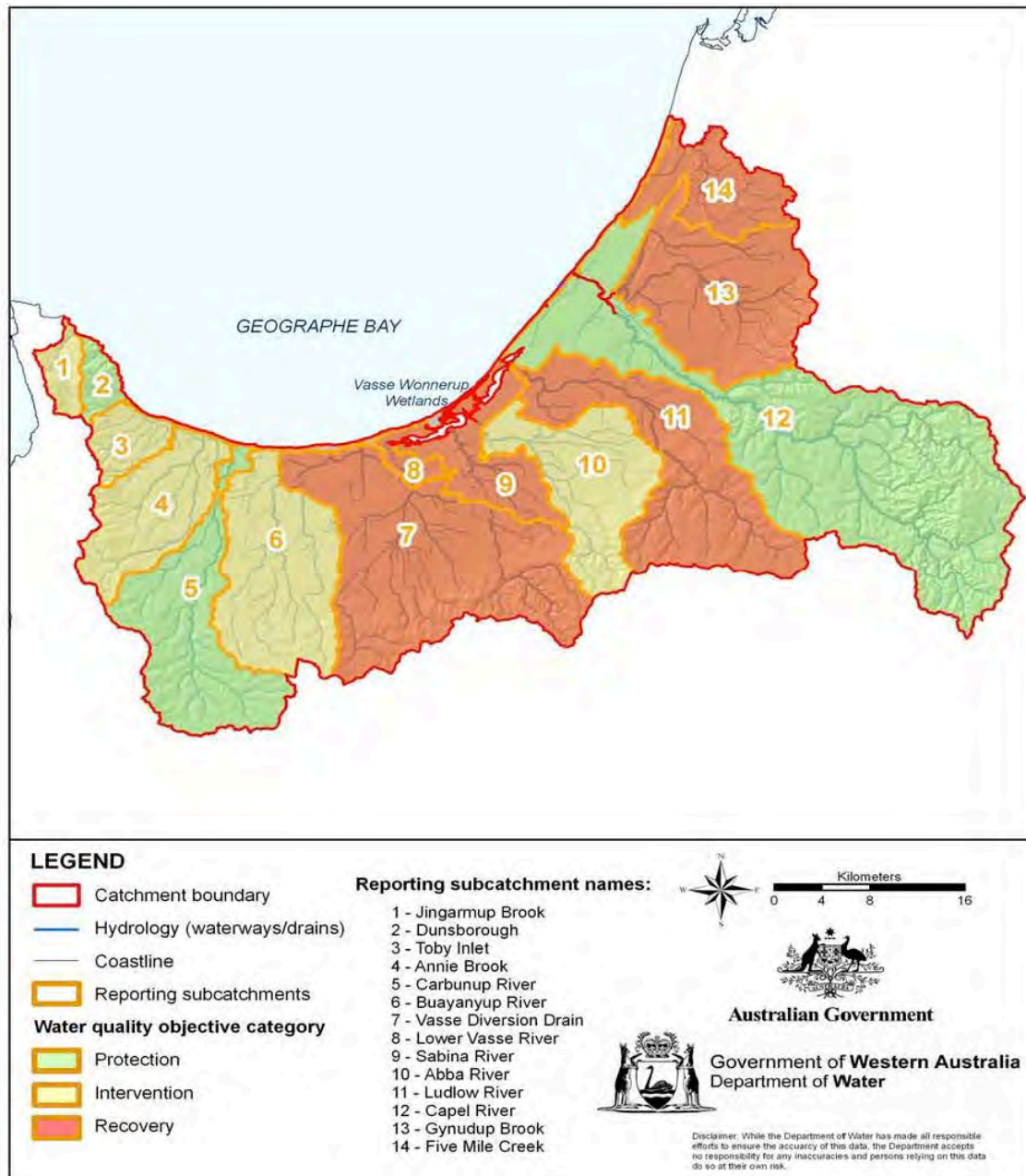


Figure 3: Map showing the catchments prioritised on the basis of their nutrient status (protection, intervention, recovery (priority))

Implementation of the BMPs

The success of the WQIP depends on the effectiveness and uptake of the BMPs identified. Both these aspects are evaluated in Section 2.2.3 below.

Drainage network

The drainage network in the Geographe catchment (known as the Busselton Drainage District) is extensive, covering over 1,000 km² in area with 530 km of drains and managed waterways (English, 1994). The network also includes a large number of assets including bridges, culverts, floodgates and other structures associated with the drains and waterways.

Much of the drainage network was designed and developed over the period between 1910 and 1970, a period of above average rainfall and considerably greater than today (English, 1994). This reduction in annual rainfall has likely made parts of this network less needed than in the past. The situation with the Vasse Diversion Drain is covered in Section 2.5.

Additionally, the drainage network is now old and poorly maintained, largely because farmers (the beneficiaries) are not required to pay a drainage levy.

Additionally, the drains are largely single purpose, to transport water from agricultural land to prevent flooding, and there is no requirement for these drains to achieve a certain water quality. It seems possible that at least part of the drainage network could be managed differently, such that the drains are 'multi-purpose', being managed to also remove nutrients.

There would be value in reviewing the Geographe catchment drainage network to assess its current and future relevance, and to assess what might be done to make this drainage network more effective at reducing nutrients, in addition to its flood protection and land drainage functions. This would require an assessment of the current effectiveness of the drainage system in removing nutrients (no matter how small) and the impact of current drainage maintenance and management practices on water quality, including the various forms that the nutrients are travelling in and which forms are impacted upon by the drainage system. This information could then be used to assess the effectiveness of proposed management practices.

2.2.3 Current management

Roles and responsibilities

DoW, in partnership with GeoCatch, has been the lead agency since 2009 in implementing the WQIP. Other organisations involved in the implementation of the WQIP are DAFWA, CoB, SoC and SWCC.

The major WQIP activities in the Geographe catchment have been focused on the implementation of nutrient reduction BMPs in agricultural (e.g. dairy effluent management, rural fertiliser management, riparian management, stock control) and urban areas (e.g. reducing fertiliser use, ensuring new urban developments incorporate water sensitive urban design, strategic urban stormwater upgrades). Additionally, Geocatch and DoW have sourced funding for a number of research projects (e.g. Murdoch University research on ecological aspects of the Vasse-Wonnerup wetlands and annual seagrass monitoring of Geographe Bay since 2011). A summary of these activities, together with what has been achieved, is provided in Section 2.3.

In addition to implementing the WQIP, GeoCatch also undertakes other broader catchment management activities as described in its Geographe Catchment Management Strategy (GeoCatch, 2008).

DoW has a close relationship with GeoCatch, formalised under a Partnership Agreement signed in 2009, with DoW paying sitting fees, employing staff, and providing technical, strategic and managerial support. DoW have been integrally involved in the development and implementation of the WQIP. Additionally, they undertake fortnightly catchment water quality sampling since 2006, have developed nutrient and water balance models for the Geographe catchment, are developing catchment nutrient reports (currently in draft for release in 2014), and analyse water quality trends (DoW, 2012).

DoW are also the authorising agency for irrigation water licences and are involved in other aspects of resource management in the Geographe catchment.

DAFWA work closely with GeoCatch and DoW in the implementation of rural fertiliser management program. They undertake whole farm nutrient mapping activities. Additionally, DAFWA have contributed considerable knowledge regarding many of the agricultural BMPs, with much of this new knowledge having been published after the WQIP development in 2009 (e.g. Weaver & Summers, 2013, 2014; Weaver & Wong, 2011; Summers & Weaver, 2014; Rivers et al., 2013).

DPaW is responsible for managing a number of Crown land tenures in the Geographe catchment (on behalf of the Conservation Commission of Western Australia). Within the five sub-catchments that flow directly into the Vasse-Wonnerup wetlands, DPaW actively manages 29,370ha (35%) of the catchment area comprising approximately 21,000 ha of State forest and Timber Reserves, 7,510 ha of national park, 676 ha of nature reserves and 190 ha of other crown reserves. The management includes fire, weed control, rehabilitation, recreation opportunities and management of inappropriate uses. DPaW has been undertaking restoration in the catchment, in particular on land adjoining the Vasse-Wonnerup wetlands. These actions collectively contribute towards protecting and improving the health of these wetlands. DPaW has been involved in the Vasse-Wonnerup wetlands for many years, undertaking a range of wildlife surveys and providing advice and support to DoW and the Water Corporation.

CoB is also a partner in the implementation of the WQIP, focusing primarily on strategic urban stormwater upgrades and ensuring the adoption of WSUD in new residential subdivisions.

SWCC are a partner in the implementation of the WQIP, through direct on-ground project implementation and through the provision of funds for dairy effluent upgrades, riparian management, urban stormwater upgrades and rehabilitation, wetland research and best management practice extension programs for farmers and landholders for water quality improvement. Additionally, they are involved in the region-wide urban fertiliser management and behaviour change program.

Implementation of BMPs

Effectiveness: The effectiveness the agricultural BMPs adopted in the WQIP, was based on the considerable amount of research undertaken by the DAFWA and the DoW, in particular into dairy shed management, fertiliser management, soil amendments and riparian buffers.

Since the development of the original WQIP, additional studies have been undertaken to better understand the BMPs and to assess their effectiveness (Gourley and Weaver, 2012; Rivers et al., 2013). This new knowledge should be used to update the BMPs and the cost benefit effectiveness modeling when the WQIP is reviewed in 2015, because some of the BMP's may not be operating as effectively as first thought.

Uptake: Currently, the uptake of BMPs by farmers is voluntary, although there is considerable range of advice and assistance provided by DAFWA and GeoCatch. Many of the incentive packages funded through natural resource management (NRM) programs have ceased, although DAFWA still have a fertiliser management incentive program running until the end of 2015.

A brief review of the implementation of 3 types of BMPs in the Geographe catchment over the past 4 years is provided in Appendix B. Note that DoW are currently undertaking a 5-year review of the implementation of the WQIP and this should be available during 2014.

Summary: GeoCatch and DoW, with significant contributions from SWCC, are the principal organisations implementing the Geographe WQIP. DAFWA are providing assisting in agricultural areas and CoB in the urban areas. Despite the fact that the WQIP identified priority catchment, it does not appear that GeoCatch has a documented strategic approach to target these catchments. Reasonable progress is being made in implementing three BMPs – riparian revegetation and fencing, dairy shed effluent management and fertiliser management.

Despite the fact that here has been Australian Government funding for more than a decade (e.g. Caring for our Country), the investment in implementing these (voluntary) BMPs has been relatively small given the scale of the problem, and it appears that current funding has almost ceased. There has been a large investment of people time in developing capacities, developing partnerships (e.g. with the dairy industry through DairyCatch) and in changing behaviours. Efforts in implementing fertilizer management best practice have been impressive, but this has yet to be translated into measurable reduction in fertiliser use. Surprisingly, there appears to be no regulation (or enforcement) that requires farmers to contain and treat polluted runoff from dairy sheds or to keep cattle out of waterways. Equally surprising is the lack of measurement of the effectiveness of these BMP's, especially at the small scale where their effectiveness can be measured in the short term.

There would be value in an independent review of the Geographe catchment drainage network.

2.3 Vasse-Wonnerup Wetlands

2.3.1 System

The Vasse-Wonnerup wetlands are located east of the township of Busselton in south-west Western Australia. They are now considerably altered from the original wetlands, which consisted of two estuarine lagoons, the Vasse and the Wonnerup, that discharged directly to Geographe Bay. Figure 4 shows the current Vasse-Wonnerup wetlands, and Figure 5 provides a summary of the main features of the rivers feeding into these wetlands.

Changes to hydrology

At the time of first settlement, the *Vasse Estuary* received direct flows from the Abba, Sabina and Vasse Rivers and indirect inflow from Iron Stone Gully, Buayanyup, Caribunup Rivers and other creeks to the west, which discharged into the Broadwater-New River system and then into the Vasse River and the wetlands. All rivers flowed seasonally. These western rivers were diverted to the ocean in around 1915.

Originally, the *Wonnerup Estuary* also received considerable freshwater via direct inflow from the Capel and Ludlow Rivers. The Capel River was diverted directly to the ocean via Higgins Cut some time in the 1880s.

During the 1920s extensive drainage networks were put in place throughout the catchment, increasing the river inflow to the system and resulting in more frequent flooding of low-lying coastal properties (including the Busselton township). In 1927 the Vasse Diversion drain was constructed to divert the upper Sabina River and virtually all the Vasse River to the ocean. Approximately 60% of flow from the Sabina and 90% of flow from the Vasse is diverted to the Vasse Diversion Drain, and the drain has effectively cut off the Broadwater-New River system from the Vasse-Wonnerup.

The Vasse-Wonnerup wetlands now receive around 20% of the pre-European freshwater inflows.

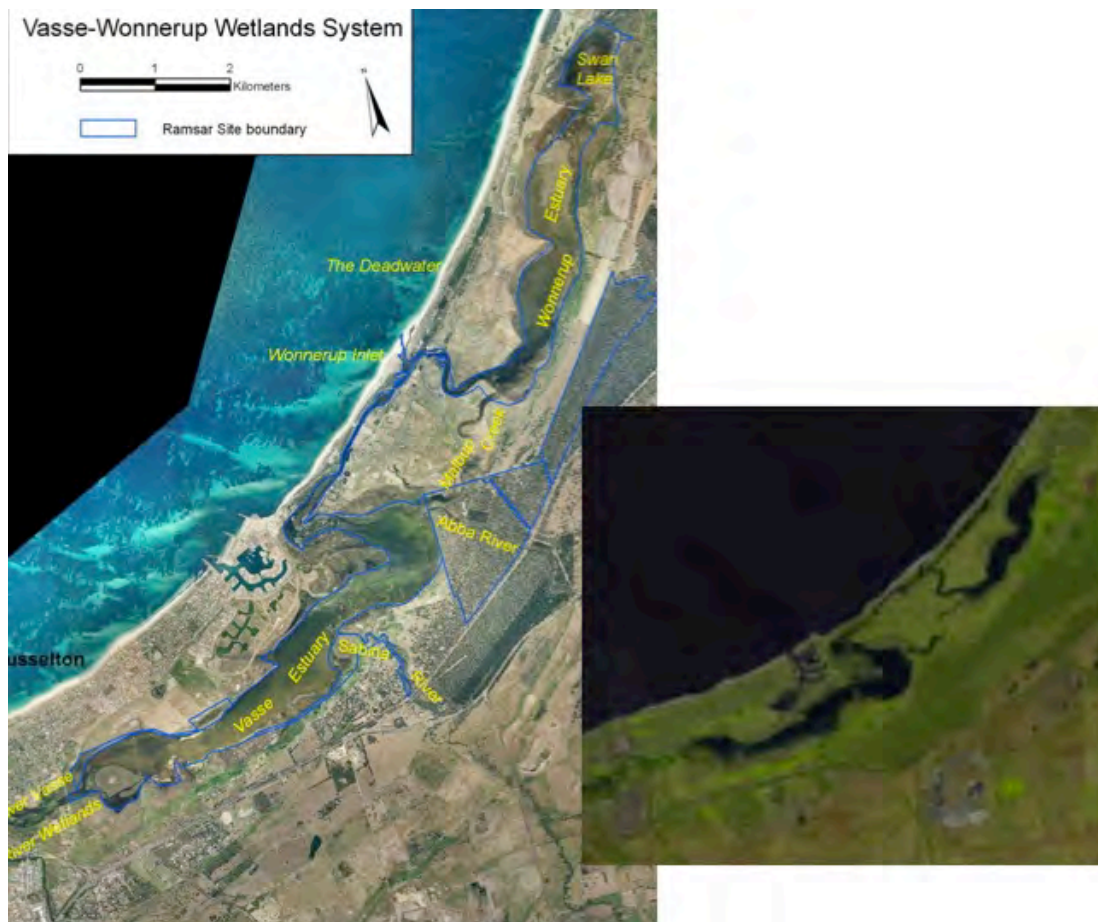


Figure 4: The Vasse-Wonnerup wetlands with Landsat image taken 17 Jan 2014

The wetlands are also now cutoff from the ocean. In the early 1900s, two sets of floodgates were built - one in the Vasse and the other in the Wonnerup. These were rebuilt in 2004. The primary function of the floodgates is to regulate water levels, exclude seawater and minimise flooding of the adjoining lands and Busselton township (Lane et al., 2011).

Ecological values

The Vasse-Wonnerup wetlands have experienced severe problems for many years caused by excessive amounts of nutrients entering them. These problems include: sudden mass fish deaths, blooms of macroalgae (e.g. *Ulva*, *Rhizoclonium*), toxic phytoplankton blooms (e.g. *Microcystis*), nuisance odours and mosquito problems (DoW, 2010a).

However, research undertaken over the past 6-7 years by Murdoch University has shown that these wetlands have high biodiversity and ecological values, despite their high nutrient status (Chambers et al., 2011, 2012; Tweedley et al., 2012, 2013). There is now considerable knowledge on the hydrological, ecological and water quality behaviour of both the Vasse and Wonnerup wetlands as a result of this and other research (McAlpine et al., 1989; Lane et al., 1997, 2007, 2011; WRM, 2007).

The following summary of the key ecological characteristics of the Vasse-Wonnerup Wetlands was provided by Dr Jane Chambers and Dr James Tweedley from Murdoch University and Dr Jim Lane from DPaW.

Despite the nutrient problems, the Vasse-Wonnerup Wetlands, support a great abundance and variety of waterbirds. The area features tens of thousands of resident and migratory birds of a wide variety of species and the largest regular breeding colony of Black Swan in South-Western Australia and as such became listed under the Ramsar Convention in June 1990 (WRM, 2007).

Surveys have revealed more than thirty thousand birds of sixty species inhabiting the wetlands each year. The total number of species recorded in all surveys to date is now almost 90. Waterbirds are present in greatest numbers during the hot, dry months of summer and early autumn, when both 'over-wintering' trans-equatorial migrants and many resident birds gather to feed on abundant plant and animal life that becomes more accessible as nutrient-rich waters recede. Several species - notably the Black Swan - also breed on and around Vasse-Wonnerup. At the peak of breeding, during spring, thousands of swans and cygnets may at times be seen spread out across the wetlands' shallow expanses.



Photo – Wonnerup floodgates (Nov 2013)

The diversity and abundance of waterbirds on which the Ramsar nomination for the Vasse-Wonnerup wetlands is based, is dependent on phytoplankton, macroalgal and macrophyte (charophytes and aquatic angiosperms) communities. As such it is crucial that the quality of this food source be maintained if waterbirds are to be conserved on the wetlands (Chambers et al., 2011).

Quite apart from its importance in supporting waterbirds, the diversity of plant life is unique in south-west. The shallow waters provide conditions suitable to benthic plants across the entire bed, while the water changes in salinity from 2 to 130 parts per thousand (4 times seawater) at different times of the year. Nowhere else is there such an ever changing mosaic of macroalgae and aquatic plants.

The lynchpin maintaining the swans and the ecological condition of wetlands is the seagrass, *Ruppia megacarpa*, which emerges from rhizomes each spring and tolerates a wide range of environmental conditions until late summer. In the clear waters and sandy substrates of the upper Vasse estuary the less tolerant *Lepilaena cylindrocarpa* thrives in years of good water quality and hangs on through the poorer ones. The saving grace of the Vasse Wonnerup wetlands is the charophyte, *Lamprothamnium papulosum*. This plant is actually an algae but looks and acts like a flowering plant, binding the sediments and maintaining clear water. Its high tolerance of harsh conditions, particularly in the Wonnerup Estuary, maintains the dominance of aquatic plants when otherwise the system would be covered in algal blooms.

Each of these macrophytes maintains the good health of the Vasse Wonnerup wetlands, taking up nutrients providing a nursery for fish and a haven for a diverse suite of invertebrates, crucial to a diverse food web. Where macrophytes are present the invertebrate diversity is greater and the type of invertebrates is different – supporting damsel and dragonflies.

However, as the system is nutrient-enriched, particularly in summer, the estuary is often dominated by filamentous green algae, *Cladophora vagabunda*, *Ulva flexuosa* *Ulva paradoxa* and *Rhizoclonium tortuosum*. These algae form floating scums on the water, often browning under the sun and looking unsightly. Of these *Ulva flexuosa*, while forming dense blooms, generally forms in clear water in the lower Vasse Estuary and is less offensive to the eye.



Photo – *Ulva* bloom in Vasse wetland near floodgates (Nov 2013)

The sediment is usually covered in an algal mat comprised of a wide range of algae, most benign although occasionally dominated by cyanobacteria that are potentially toxic. So too the unicellular algae that float in the water column, the phytoplankton; these are generally benign species of green alga, prasinophytes, cryptophytes and diatoms, but in nutrient enriched sites (for example near the Vasse gates) can be dominated by quite a wide range of cyanobacterial species, many toxic.

The structure created by the macroalgae and marine plants provides habitat and a source of food for many invertebrate species, of which 62 have been found in the system to date. The vast majority of these are either small crustaceans, such as water fleas or copepods, or the larvae of aquatic insects. This latter group is particularly diverse containing beetles, dragonflies and water boatmen, as well as some nuisance taxa like midges and mosquitos. The sediments on the bottom of the estuary range from sand in the upper estuaries down to fine mud at the bottom near the floodgates. These sediments are home to a variety of worms, namely oligochaetes (aquatic earthworms) and roundworms (nematodes) in the upper estuaries and polychaetes (bristleworms) further downstream.

*The waters of the Vasse-Wonnerup Wetlands are home to over thirty species of fishes, some of which are of commercial and recreational importance. In particular, the areas downstream of the floodgates, i.e. the Deadwater and Wonnerup Inlet, provide a sheltered, food-rich environment for the juveniles of many key marine species caught in Geographe Bay, such as Mulletts, Whiting, Tarwhine, Tailor and even the occasional Mulloway, while also supporting substantial numbers of the popular recreational species Black Bream (*Acanthopagrus butcheri*). The fish fauna of the Vasse and Wonnerup estuaries are dominated by small bodied fish species such as the hardyheads and gobies. These species are found throughout estuaries in south-western Australia and are tolerant of the wide range of environmental conditions, particularly salinity, which occur throughout the year. Sadly, two introduced freshwater fish species namely the Mosquitofish (*Gambusia affinis*) and the Goldfish (*Carassius auratus*) have been found in the wetlands during periods of low salinity following substantial rainfall.*

The conceptual models depicted in Figure 6 summarise the changes in water level, salinity, water quality and biology in both wetlands over the three seasons – summer-autumn, winter and spring.

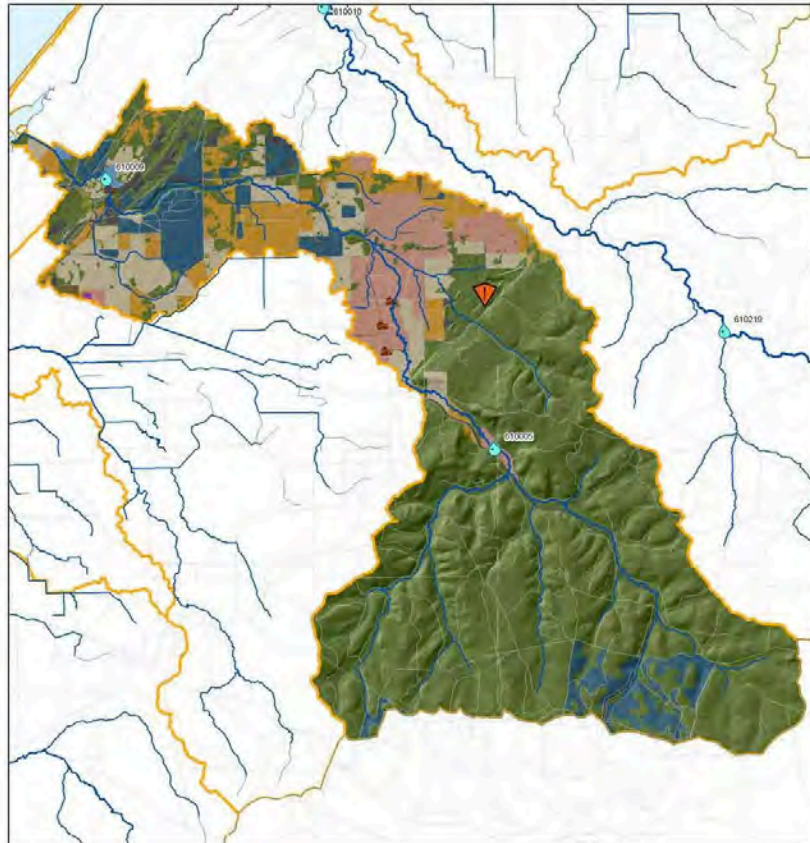
While these wetlands have high biodiversity and ecological values, the Murdoch University researchers warn that they are in a transition zone between macrophyte (good) and phytoplankton (bad) dominance, that is they are close to a tipping point (Chambers et al., 2013). However, this hypothesis is not shared by all aquatic ecologists.

Rather surprisingly, despite the fact that the Vasse-Wonnerup Wetlands are a Ramsar site, and contain high biodiversity and ecological values, the local community generally does not seem to know about them or to value them. But they do know and value Geographe Bay. The community seems focused more on the problems in these wetlands (e.g. fish kills, unsightly algal booms) than on the proper management of these wetland systems for their ecological and biodiversity values.

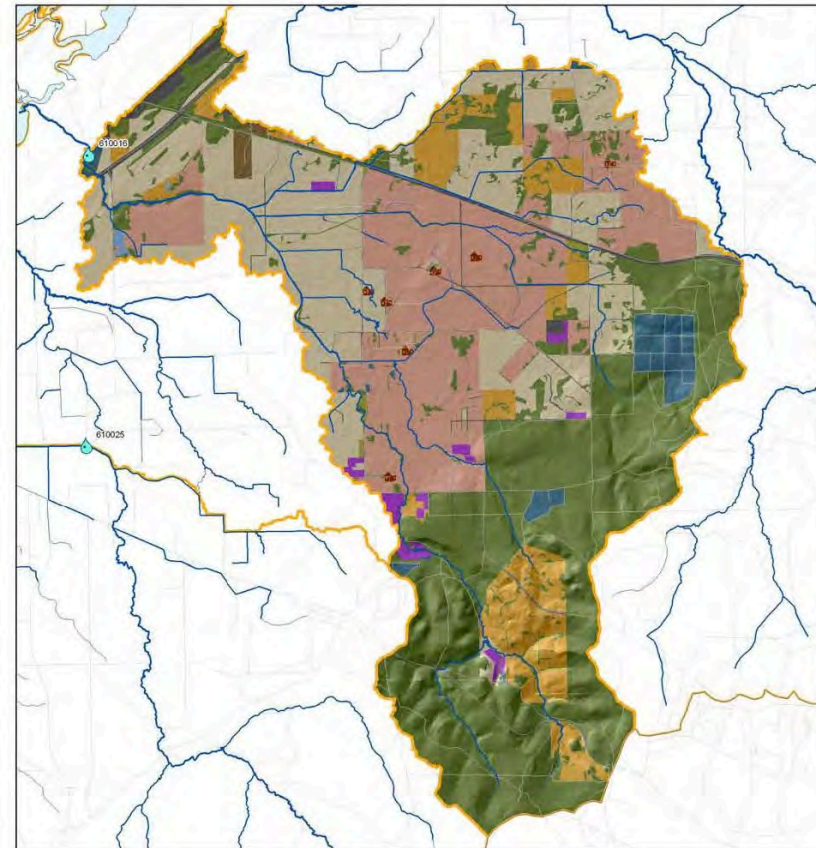
However, some work is being undertaken to increase the community's understanding of wetlands and to facilitate access to the Vasse-Wonnerup wetlands. The CoB established the Busselton Wetland Group in 2005 in response to the WA Planning Commission's *Busselton Wetlands Conservation Strategy* (WA Planning Comm, 2005). Both GeoCatch and DPaW are members of this group.

The Wetlands Group have developed a *Busselton Wetlands Ecotourism Strategy* that seeks to develop a series of trails, bird hides and eventually an interpretive centre. A demonstration wetland, located opposite the CoB offices, is almost completed and should be open to the community early in 2014. DPaW has also developed a bird hide and interpretive facility on the southern edge of the Vasse-Wonnerup wetlands and has involvement in another proposed facility on the northern edge of the wetlands.

Ludlow River



Abba River



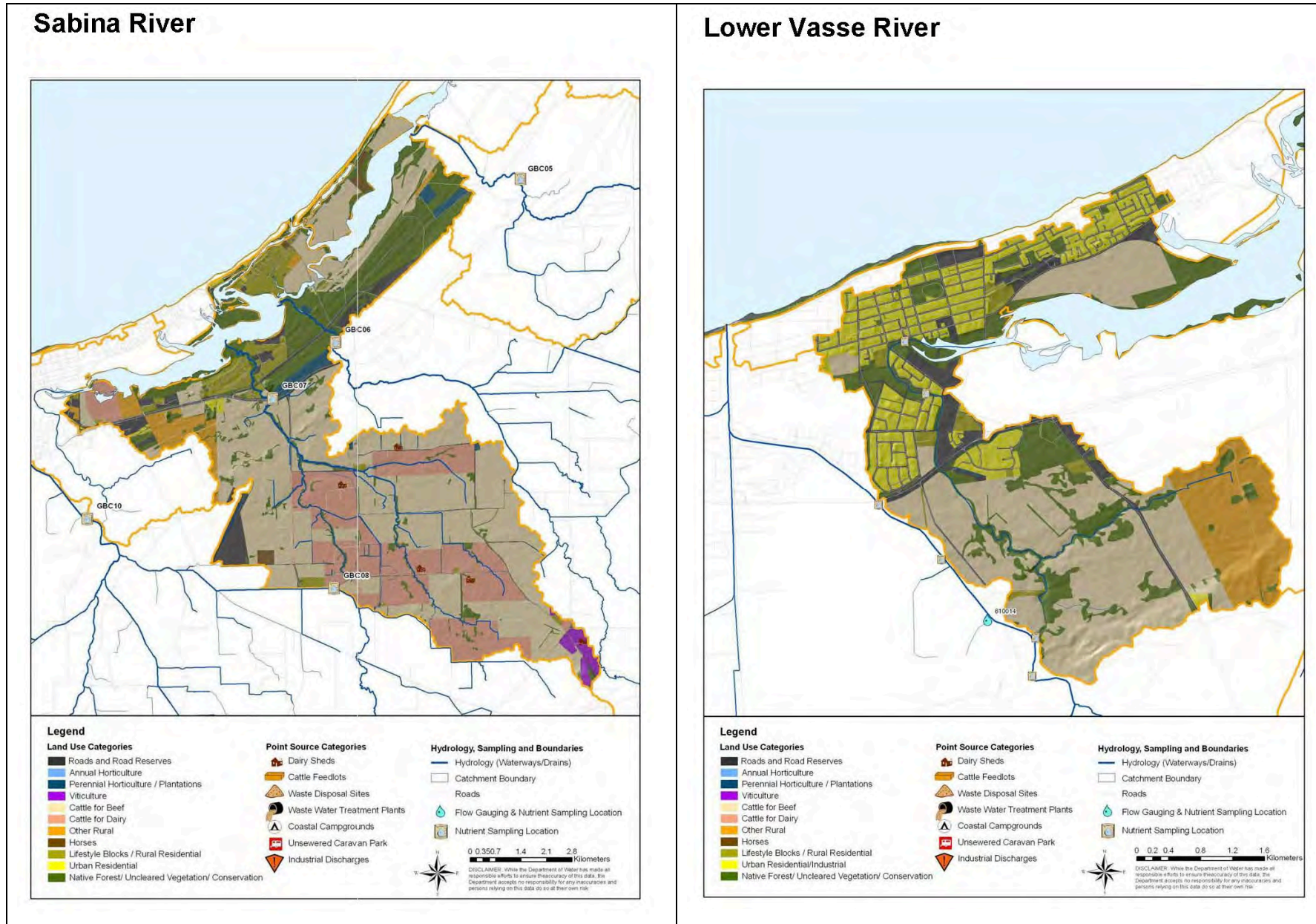


Figure 5: The main catchment features of the rivers entering the Vasse-Wonnerup Wetlands

2.3.2 Issues

Nutrient enrichment

The Vasse-Wonnerup wetlands are eutrophic with high nutrient concentrations. These nutrients come from the inflow of the Lower Vasse, Lower Sabina and Ludlow Rivers during winter, from the sediments and from cattle grazing in the immediate vicinity of the wetlands themselves.

These high nutrient concentrations are resulting in increased growth of macroalgae (e.g. *Ulva*) and at times toxic blue-green algae. These are unsightly and can cause additional problems (e.g. fish kills) when they die.

The wetlands are poorly flushed, with essentially no flow occurring during the summer period when most plant growth occurs.

The Vasse Wetland in particular has accumulated large amounts of organic sediment in the region close to the floodgates, which are a source of nutrients and may also assist in drawing down the dissolved oxygen concentration (Tweedley et al., 2013).

There have been fish kills (most near the floodgates) due to deoxygenation of water column caused by the accumulation of organic sediments and the death of macroalgal and phytoplankton blooms. In recent times, fish kills have occurred in April 2013 and February 2014. It appears the cause of these fish kills may be different, with the April 2013 event due to low dissolved oxygen levels, and the February 2014 event due to an algal species *Prymnesium* spp., known to be toxic to fish (Pers Comm, Dr Kath Lynch, Feb 2014).

At times there are obnoxious odours from the wetlands that annoy local residents, and additionally all wetlands in the region are breeding grounds for mosquito's. There is a high incidence of Ross River virus, at least in Capel Shire.

Short-term solutions

Many 'solutions' have been suggested by community members to 'solve' the fish kill and other problems at least in the short-term. These include: dredging the sediments and 'resetting' the wetlands, operating the floodgates and the opening of the Wonnerup Estuary to the ocean such that oxygenated marine water enters the wetlands at times when dissolved oxygen levels are dropping, modifying the floodgates so that fish can move freely between the wetlands and the 'Deadwater' on the ocean side of the gates, adding a fish ladder to the floodgates, and establishing an oxygenation plant at the floodgates to oxygenate the water when levels are dropping³.

Incident response plan

The community is also concerned that the agencies emergency response action plan to avert fish kills has been poorly coordinated, with no obvious lead agency. The community have noted that an earlier emergency response action plan MOU, developed by the Vasse Estuary Technical Working Group (VETWG) in 2004, was not signed by all organisations.

A new *Fish Kill Mitigation and Response Plan for 2013-14* has been developed by the responsible organisations, and is discussed below in Section 2.3.3.

Comprehensive management plan

The community have also noted that there is no comprehensive management plan for these wetlands, despite the fact that they are Ramsar-listed. Listing as a Ramsar sites does assume that a management plan will be developed for the site⁴, but the Commonwealth Government does not provide and funds for either the development of a plan or the management of the wetland (Pers Comm, C Hepplewhite, Dept Environment, Feb 2014). A major issue is that there is neither a management plan nor any decision on what the main management objectives should be for this wetland system.

2.3.3 Current management

Incident response plan

A consortium of the responsible agencies, chaired by DPaW and including DoW, DPaW, DoF, CoB, Water Corp (known as VETWG), have been operating an emergency response plan to

³ This already occurs in the Swan River estuary where DoW operates two oxygenation plants.

⁴ <http://www.environment.gov.au/resource/wetlands-australia—roles-and-responsibilities>

mitigate fish kills each summer period for well over a decade. Until the fish kills in April 2013 and February 2014, there had not been any fish kills in the Vasse or Wonnerup Wetlands over the previous 10 years. However, this appears to be largely due to the vigilant management of one individual, rather than the result of a well coordinated action plan.

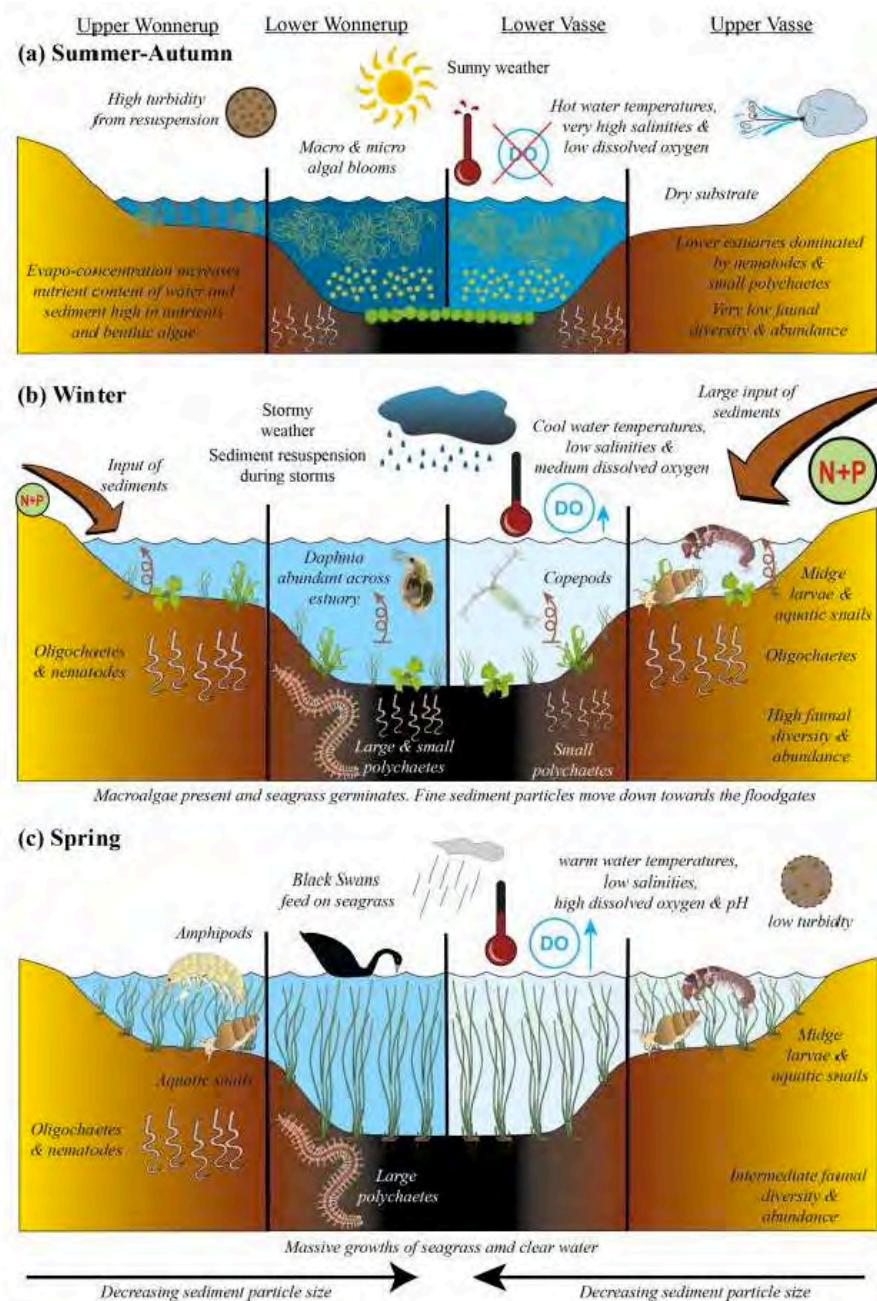


Figure 6: Conceptual model of ecological processes in the four regions of Vasse-Wonnerup during (a) summer-autumn, (b) winter and (c) spring (Note: in summer both the Upper Vasse and the Upper Wonnerup may be dry)

For this current summer period 2013-2014, a new *Fish Kill Mitigation and Response Plan* has been developed (VETWG, 2013). DoW has taken on additional responsibilities and will lead the response during 2013-14 until the outcomes of this independent review are completed.

This new plan seeks to monitor key indicators (e.g. water levels, dissolved oxygen levels, environmental conditions) that can indicate the likelihood of a fish kill occurring, and to then take

appropriate action to reduce the risk of a major fish kill. Actions identified in this Plan include increased frequency of monitoring, opening the Wonnerup Inlet bar, opening the fish gate penstock in the floodgates, and installing pumps to circulate the water.

It appears that the agencies involved have agreed to provide the necessary resources for their component of the plan (DoW – Chair VETWG, coordinate emergency response, water quality monitoring; Water Corp – operate floodgates (fish gates, fish gate penstock, manage estuary water levels, open Wonnerup Inlet sand bar; CoB – coordinate fish kill clean up and disposal if needed, erect signage, hire pumps if needed; DPaW – provide information to DoW regarding optimum water levels; DoF – assist DoW with fish kill response, undertake fish pathology analysis if required).

However, despite this improved new Emergency Response Action Plan, a fish kill occurred in February 2014. Preliminary information suggests that this fish kill occurred because of a toxic alga, and not low dissolved oxygen levels (Pers Comm, Dr Kath Lynch, Feb 2014). If this proves to be the case, VETWG will need to modify the Emergency Response Action Plan to include monitoring of both dissolved oxygen and toxic algal levels, and to develop new action target levels for these.

Comprehensive management plan

As noted above, there is currently no comprehensive strategic management plan for the Vasse-Wonnerup wetlands, despite them being Ramsar-listed. Notably, it was DPaW and GeoCatch that undertook the preparation of the Ecological Character Description (WRM, 2007), a necessary part of Ramsar listing.

The need for such a management plan is obvious and is covered in Section 4.3.2. But before this management plan can be developed there needs to be agreement first on what values are to be managed, and second who the lead organisation should be. Possible multiple management objectives could include the following: Ramsar values such as bird habitat and numbers, water quality, ecological biodiversity, recreation, aesthetics, flood protection, and to maximise floodplain grazing. There are also indigenous cultural values that need to be managed.

Currently, DPaW manage about 35% of the Vasse-Wonnerup Ramsar site, but this does not include any of the waterbody, since this is not yet included in the conservation estate. DPaW are currently preparing a management plan for the southern Swan Coastal Plain⁵, the draft of which should be released in March 2014 (Pers Comm, Laurina Bullen, DPaW, Jan 2014). This draft proposes inclusion of the majority of the Vasse-Wonnerup wetland area, but addition of this area to the conservation estate is dependent on a native title determination.

However, the long-term solution to the issues plaguing the Vasse-Wonnerup wetlands is to significantly reduce the loads of TP and TN entering from the catchment, a task we have noted that is difficult, costly and will probably take decades to achieve.

Because of this, it is likely that there will need to be an annual emergency response plan in place for many years. It would seem sensible if this annual emergency response plan was part of a more comprehensive Vasse-Wonnerup Wetland Management Plan (see also Section 4).

Ramsar reporting

The Vasse-Wonnerup wetlands were Ramsar listed in 1990 largely on the basis of the abundance and variety of waterbirds they support. Apparently, the only Ramsar reporting is on waterbird numbers, which is based on an annual waterbird count undertaken in early February each year as part of the Birdlife Australia Shorebirds 2020 project. The principle aim is to quantify shorebirds numbers and diversity, particularly in relation to JAMBA, CHAMBA and ROKAMBA species. The time of the survey does not necessarily coincide with the peak bird numbers (Pers Comm, Kim Williams, DPaW, Nov 2013).

A requirement of the Ramsar listing is that the Australian Government is obliged to maintain the ecological character of these Ramsar sites. An Ecological Character Description has been prepared for the Vasse-Wonnerup wetlands (WRM, 2007), but it appears that no monitoring is undertaken by DPaW to assess the 'limits of acceptable change' and ensure that the ecological character is being maintained. The Commonwealth Government provide no funds for monitoring of Ramsar wetlands (Pers Comm, C Hepplewhite, Dept Environment, Feb 2014).

⁵ <http://www.dpaw.wa.gov.au/parks/management-plans/draft-plans-in-preparation/102-swan-coastal-plain-south-draft-management-plan>

Summary: The Ramsar-listed Vasse-Wonnerup wetlands are now very different to before European settlement. They now receive much less freshwater inflow as a result of the extensive catchment drainage network, are cut off from the ocean by floodgates, and receive excessive amounts of nutrients from the catchment (Lower Vasse, Lower Sabina, Abba and Ludlow Rivers), the sediments and cattle grazing in the immediate vicinity of the wetlands themselves. These high nutrient concentrations are resulting in increased growth of macroalgae, and at times toxic blue-green algae, that are unsightly and can cause additional problems (e.g. fish kills) when they die.

*However, despite these changes the wetlands have high biodiversity and ecological values; they support a great abundance and variety of waterbirds, and have good populations of macrophytes (e.g. *Ruppia megacarpa*), fish and macroinvertebrates.*

Currently, there is no comprehensive management plan for these wetlands despite the fact that they are Ramsar-listed. A new emergency 'Fish Kill Mitigation and Response Plan' has been developed and is in place for the 2013-14 summer.

2.4 Lower Vasse River

2.4.1 System

Most (approx 90%) of the Vasse River is intercepted by the Vasse Diversion Drain leaving a much smaller Lower Vasse River that flows through Busselton and then into the upper part of the Vasse Wetland (Figure 7). Currently, the Lower Vasse River receives flow from a small catchment, from local stormwater and groundwater, and from a small diversion culvert that can release water from the Vasse Diversion Drain. The Lower Vasse River only flows during winter (June to November), with little or no flow in summer. Even during winter the Lower Vasse River is poorly flushed because of its small flow and very low gradient.

In Busselton, the Lower Vasse River is maintained as a 'lake' for recreational and aesthetic purposes by a set of barriers located at the Butter Factory (Figure 8). This 'lake' is eutrophic and regularly experiences algal blooms (e.g. *Microcystis*) over most of summer, which reduce the recreational and amenity value of the 'lake' and cause offensive odours.

It should be noted that the water quality problems experienced in the Lower Vasse River have been increased because it is dammed up to form a 'lake' in the township region. If it were not artificially backed-up, the river would be dry during summer and there would be less, if any, algal problems.

2.4.2 Issues

Management plan

The need to better manage this system has been in the spotlight for over a decade, starting with the *Lower Vasse River Cleanup Program*, a partnership between GeoCatch, DoW and CoB. This Program successfully implemented a number of on-ground actions (Paice, 2005) in the period between 1998 and up to the introduction of the current WQIP, when it was largely superseded by the latter in 2009.

Members of the community are concerned that there is no comprehensive management plan for the Lower Vasse River, and particularly for the 'lake' section. The WQIP does of course provide a broad plan for the Lower Vasse River, but there is also need for an operational management plan for the 'lake', that ideally would address the dual objectives of achieving good water quality in the 'lake' section, while also preventing flooding in Busselton.

There also appears to be confusion over who is 'responsible' for management of this system. Currently, GeoCatch, DoW and CoB are involved. DoW and GeoCatch are focused on reducing nutrients from the broader Geographe catchment (and protecting Geographe Bay) in line with the recommendations of the WQIP. In contrast, CoB has more local objectives associated with improving the aesthetics of the river and maintaining an artificial 'lake' during summer. Finding a two tiered management approach may be appropriate in this situation.

Lack of flow

As noted, the Lower Vasse River now receives a relatively small flow because most of the catchment is cut off by the Vasse Diversion Drain. As a result there is little capacity for the system to be well flushed. Certainly during summer the system receives minimal if any flow.

There are community concerns about the proportion of flow that goes down the Lower Vasse River compared with that down the Vasse Diversion Drain, with suggestions that if there were greater flows in the river at critical times, the algal problems in Busselton may be less.

The relative flow is controlled via a diversion culvert that can let water into the Lower Vasse River. The culvert inlet is a 900 mm diameter pipe that is controlled by a valve. Currently, City of Busselton staff operate the valve, which is open in most years from June to February-March, although the summer (December to February) flow is very low. Flow generally ceases in late January to mid-February (Pers. Comm., Greg Simpson, CoB, January 2014). These operational 'rules' need to be reviewed.

Vasse Diversion Drain

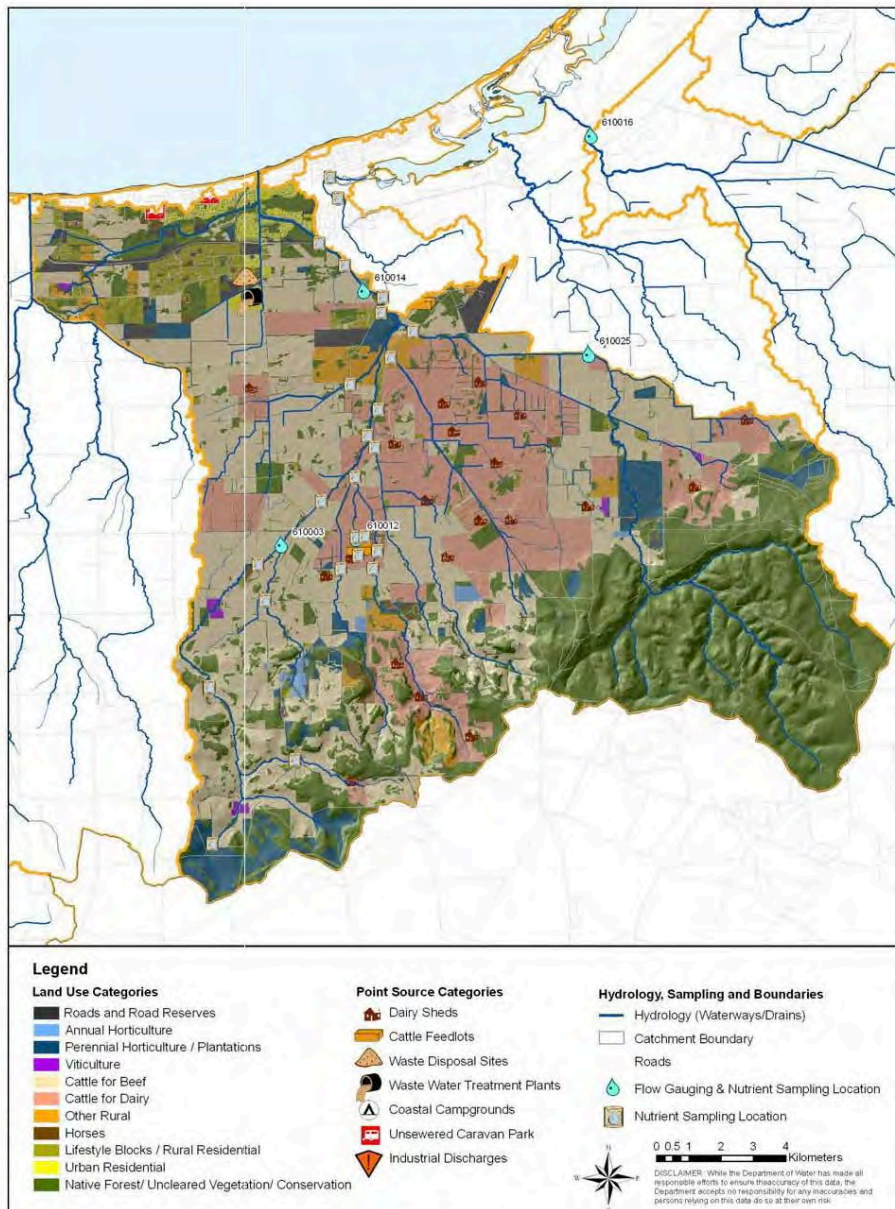


Figure 7: The main features of the catchment of the Vasse Diversion Drain

Additionally, the possibility for increasing the size of the culvert inlet pipe to increase the flow in the Lower Vasse River during summer should be investigated. In the development of the WQIP, DoW investigated the effects of changing the proportion of flow by increasing the size of the pipe (900 mm, 1050 mm and 1200 mm diameter pipes were modelled - DoW, 2009). They concluded that

higher levels of flow were unlikely to alleviate the existing algal problems because flows during the critical period (summer) were not likely to be high enough and there would still be high nutrient concentrations.

Technical solutions

There have been a number of experiments over the past 10 years to find a technical solution to reduce the nutrient concentrations in the Lower Vasse River and thus reduce the frequency of algal blooms (Paice, 2005). For example, in 2001-2002 DoW ran an experiment using 'Phoslock' - a clay-like substance that adsorbs phosphorus. This was very effective in reducing the P concentration, but the effect only lasted until the next rain when high nutrient flows entered the Lower Vasse River (Robb et al., 2003).

Currently, the CoB is experimenting with three nutrient-reduction methods – floating islands of macrophytes, a clay adsorbent, and a bacterial water cleanse method. The effectiveness of these methods will be assessed over the 2013-2014 summer period.



Figure 8: The Lower Vasse River in Busselton

2.4.3 Current management

The current management of the Lower Vasse River, and particularly the 'lake' section in Busselton, is a major concern for the local Busselton community and is far from ideal. There is no comprehensive management plan, and no obvious lead agency.

Currently, CoB operate the boards at the Butter Factory that dam up the Lower Vasse River in Busselton, operate the valve that regulates flow into the Lower Vasse River from the Vasse Diversion Drain, manage crown land adjoining the river, and work with GeoCatch to implement water sensitive design features in urban areas. DoW monitor the Lower Vasse River (at Peel Terrace footbridge) for water quality and phytoplankton during the summer (Figure 8), and partner with GeoCatch in implementing nutrient BMPs in the Lower Vasse River catchment.

In the period 2000-2005, GeoCatch and DoW trialed a number of *in-situ* water quality improvement initiatives as part of the *Lower Vasse River Cleanup Program*. Although some of these initiatives resulted in visual improvements in water clarity, improvements were negated by rainfall and input of

nutrients from the catchment. The key learning of that project was that *in-situ* actions were unlikely to improve water quality in the long term without significant reductions in catchment nutrients.

Since 2006, despite considerable management action undertaken in the Lower Vasse River catchment in an attempt to reduce the loads of nutrients entering the river (e.g. stormwater upgrades, urban fertiliser management), the concentrations of nutrients are still high enough to cause algal blooms in summer.

Not surprisingly, CoB and local Busselton community are still frustrated at the lack of visual improvement in water quality and are seeking support from State Government to actively undertake intervention strategies (e.g. dredging) to improve water quality in the short-term. There is considerable debate on who should lead and pay for those additional works. The question of who should lead the management of the 'lake' section of the Lower Vasse River and pay for additional works (CoB or DoW) needs to be resolved.

Summary: The Lower Vasse River now receives only a fraction of its original flow, since the major part of the catchment is cut off by the Vasse Diversion Drain. The river still receives and excessive nutrient load from agricultural and urban sources. In Busselton, the Lower Vasse River is maintained as an artificial lake for recreational and aesthetic purposes by a set of barriers located at the Butter Factory. This lake is highly eutrophic and regularly experiences algal blooms over most of summer, which reduce the recreational and amenity value of the lake and cause offensive odours.

The current management of the Lower Vasse River, and particularly the lake section in Busselton is far from ideal. Long-term nutrient reduction from the catchment is being addressed through the WQIP by GeoCatch and DoW. However, the question of who should lead the operational management of the lake section of the Lower Vasse River, and pay for additional works (CoB or DoW), needs to be resolved.

2.5 Vasse Diversion Drain

2.5.1 System

The Vasse Diversion Drain was originally constructed in the early 1920/30s to protect Busselton from flooding. It takes most of the Vasse River flow, approximately half the flow of the Sabina River, and also most of the flow of treated effluent from the Busselton wastewater treatment plant (Figure 7). The drain is designed to contain flows up to 140 m³/s or 12,000 ML/d (approximately 1:100 year floods).

As noted the Vasse and Sabina Rivers are both diverted into the Vasse Diversion Drain; the diversion points are approximately 6.4 km and 14.4 km respectively upstream of where the drain enters the ocean.

Some water from the Vasse Diversion Drain can be directed to the Lower Vasse River at the Vasse Diversion Weir, where there is a compensating pipe with a valve that can be opened or closed. City of Busselton staff operate the compensation pipe valve, which is open in most years from June to February-March (Pers. Comm., Greg Simpson, CoB, January 2014), although the summer (December to February) flow is very low (< 0.5 m³/s – ca. 40 ML/d) and generally ceases to flow in late January to mid-February.

Unfortunately, there is currently no capacity for additional flow to be diverted down the Lower Sabina River.

The treated effluent from the Busselton Wastewater Treatment Plant flows first into Queen Elizabeth Drain and then enters the Vasse Diversion Drain at the Queen Elizabeth Avenue Bridge, 1.3 km upstream of where the drain enters the ocean. Currently, the license allows for a discharge of approximately 4.5 ML/d, but flow is considerably less than this during summer and autumn. Licensed discharge to the Vasse Diversion Drain will increase to an average of 6.75 ML/d when the upgraded treatment plant is operational (likely early in 2014). Additionally, the upgraded plant will produce a high quality effluent (TN <8 mg/L, TP <1 mg/L) (Pers Comm, Robin Belford, Water Corp, December 2013).

2.5.2 Issues

Four issues were raised regarding the Vasse Diversion Drain.

The first relates to the size of the Drain where it goes through Busselton. It was suggested that given the changes that have occurred over the past two or three decades (e.g. reduction in rainfall since the drain was designed, recent construction of three upstream retention basins), it may be possible to reconfigure the Vasse Diversion Drain so it is a much less imposing structure particularly where it goes through Busselton (e.g. a pipe rather than open drain).

Unfortunately, this possibility will not be addressed in a review of the Vasse Diversion Drain currently being undertaken by the Water Corporation. The primary objectives of this review are to determine if the Vasse Diversion Drain is able to provide 1-in-100 flood protection, and to review upgrading options, if upgrading is required (Pers Comm, Anne Major, Water Corp, January 2014). A review of the hydrology of the Vasse Diversion Drain and its catchment has been completed (Water Corp, 2013) and the final review is scheduled for completion in June 2014.

The second concern relates to the lack of any water quality requirements on the Vasse Diversion Drain (apart from the licensed discharge of the Busselton Wastewater). The Water Corporation is not required to ensure the Vasse Diversion Drain (actually any drain) achieves a particular *water quality* target; the focus is entirely on water quantity. Increasingly around Australia, Environment Protection Agencies are tightening the controls on 'drains' to include consideration of water quality in addition to flow (e.g. Victorian EPA). The WQIP has implicitly specified a water quality condition on the water discharged from the Vasse Diversion Drain (Concentration - TP concentration <0.1 mg/L, TN <1.0 mg/L; Loads – TP <1.4 tonne/y, TN <38 tonne/y⁶). Currently, these targets are not being met (DoW, 2012).

Since the largest loads of TP and TN in the Vasse Diversion Drain are from beef and dairy cattle grazing in the Upper Vasse and Upper Sabina catchments, the water quality targets will only be met through the large-scale implementation of BMPs in these two agricultural activities. Currently, the Water Corporation has no legislative responsibility to assist with the implementation or monitoring of BMPs.

While on the matter of drains, it has also been suggested that the earlier reasons for the existence of many of these drains in the Geographe Catchment (and particularly those smaller drains on properties) are now less important given that average annual rainfall has diminished significantly, the road network has been substantially improved and the access difficulties that farmers and other non-urban landowners now face on and getting to/from their properties are less of a problem. There is an argument that many, if not most, of the small drains on rural properties serve no useful agricultural purposes and could be decommissioned. The predicted increase in intensity of summer rainfall events associated with climate change will also need to be factored into any hydraulic assessment prior to any possible modification of the system.

The third concern relates to the amount of water captured by the Vasse Diversion Drain. The CoB believes that the Drain captures too much of the Upper Vasse River flow, and deprives the Lower Vasse River of flow which contributes to the annual algal problems in Busselton where it is dammed up.

And fourth, there is concern that this open Drain, which transports effluent from the Busselton treatment plant, poses a potential health risk to the people known to fish and swim in the Drain.

2.5.3 Current management

The Vasse Diversion Drain is currently managed by the Water Corporation. Management of this asset is entirely focused on transporting water from the catchment to the ocean as efficiently as possible, so that Busselton is protected from flooding. There is no consideration of the quality of the water transported.

As noted above, the Water Corporation are currently conducting a review of the Vasse Diversion Drain, the primary objectives of which are to determine if the Drain is able to provide 1-in-100 flood protection to Busselton, and to review upgrading options that may be necessary. It does not appear that this review will consider the possibility of reconfiguring the Vasse Diversion Drain so that it contains some water quality treatment capacity (e.g. off-drain constructed wetlands) and is a much less imposing structure particularly where it goes through Busselton (e.g. a pipe structure rather than open drain).

⁶ These load targets represent a reduction of 71% in the current TP load and 56% in the TN load (DoW, 2010a).

It should also be noted that in November 2013, the Busselton Water Board became a Corporation, which means they now have an opportunity to expand their business from water supply to also encompass wastewater treatment, drainage and floodplain management. There is now the potential for the Busselton Water Corporation to take over the Vasse Diversion Drain (and other drainage assets in the Geographe catchment) and include water quality and nutrient reduction as management objectives in addition to drainage and flood protection. The cost of this change would need to be considered.

Summary: The Vasse Diversion Drain is currently managed by the Water Corporation. It captures most of the Vasse River flow, approximately half the flow of the Sabina River, and most of the flow of treated effluent from the Busselton wastewater treatment plant. It is extremely important in providing 1-in-100 flood protection to Busselton. Currently, the Vasse Diversion Drain does not achieve the nutrient targets established by the WQIP, and is discharging excessive amounts of TP and TN to Geographe Bay. The Water Corporation has no legislative requirement to consider the water quality of the drain, except for the quality requirements of the wastewater discharged to the drain from the Busselton wastewater treatment plant.

It is possible that the newly formed Busselton Water Corporation could take over responsibility for the Vasse Diversion Drain (and other drainage assets in the Geographe catchment), and include water quality and nutrient reduction as management objectives in addition to drainage and flood protection.

2.6 Toby Inlet

2.6.1 System

Toby Inlet and its catchment are located at the western end of the Geographe catchment, close to Dunsborough. The Inlet is a narrow inter-barrier lagoon parallel to the shore, which is separated from the ocean by high beach ridges. It is approximately 4 km long and is highly valued for recreation and aesthetics.

The hydrology of Toby Inlet has been significantly modified by artificial drainage schemes within the catchment. The most recent was the construction of the Station Gully channel that drains much of the region and flow directly through the eastern end of Toby Inlet to the ocean (Figure 9).

Toby Inlet is largely managed by a community group, the Toby Inlet Catchment Group (TICG). This group has been in existence since the early 1990's and are knowledgeable, enthusiastic and have achieved a considerable amount, particularly in terms of revegetation around the Inlet and its catchment.

The TICG have developed a *Management Plan for Toby Inlet Foreshore and Waters* (TICG, 2006), which has been accepted by the CoB. The CoB provides some funds to assist with the management of Toby Inlet, and DoW monitor water quality and phytoplankton levels fortnightly over summer.

2.6.2 Issues

The main issues with Toby Inlet are the regular occurrence of macroalgal and phytoplankton blooms in the inlet, and the occurrence of offensive odours when these algal blooms die. These issues are the result of (a) excessive nutrient inputs to the estuary, and (b) the lack of adequate flushing of the estuary.

Toby Inlet is still receiving too great a nutrient load from the catchment and from septic tanks associated with houses built directly around the Inlet. Additionally, there is evidence that the Inlet has received considerable amounts of sediment from the catchment, which has led to a decrease in water depth and contributed to the existing water quality problems.

But the largest changes to Toby Inlet are to the hydrology. There is now significantly less freshwater flow from the catchment, which has resulted in the regular breaching of the sand barrier between the Inlet and Geographe Bay no longer occurring. Breaching of the bar permits seawater to enter the Inlet, and to 'refresh' the Inlet, for a period of time until the channel again closes.

Additional to this, the construction of the Station Gully Drain now allows flows from this part of the catchment to pass through the eastern end of Toby Inlet via a channel that connects directly to the ocean (Figure 9). This in itself would not necessarily be a major problem except for the

construction of a causeway built on the western side of the Station Gully channel. There is a small culvert connecting the two sections of this wetland, but this is too small and is restricting the interchange of water between the two sections of the Inlet (Figure 9).

It seems that when the Water Corp originally designed the drain, causeway and culvert, the impacts of the lack of flushing of the Inlet were not considered. The TICG would like to see the causeway removed since it appears to serve little purpose, or failing that, that the culvert be significantly enlarged.



Figure 9: Photo of Toby Inlet showing the Station Gully drain, the flow to the ocean and an insert of the causeway and culvert (Note: at this time there was a channel to the ocean from Toby Inlet on the western side of the causeway).

2.6.3 Current management

Current management of Toby Inlet is undertaken by a community group (Toby Inlet Catchment Group), with some assistance from the CoB and technical advice from DoW.

There is now insufficient freshwater flow entering the Inlet to breach the barrier between the Inlet and the ocean. This barrier needs to be artificially opened. There have been two recent occasions when CoB have opened a channel between the ocean and Toby Inlet on the western side of the Station Gully causeway, in 2006 and more recently in February 2014.

The Water Corporation were requested to comment on the advantages and disadvantages of either removing the causeway or significantly enlarging the culvert, but no comment was received.

Summary: Toby Inlet is located at the western end of the Geographe catchment, close to Dunsborough, and is highly valued for recreation and aesthetics. It experiences regular blooms of macroalgae and phytoplankton, and offensive odours when these algal blooms die. These issues are the result of excessive nutrient inputs to the estuary, and a lack of adequate flushing. The reason for the lack of flushing seems to be a combination of the Station Gully Drain and associated causeway, that pass through the eastern end of the Inlet, and the lack of connection between the western section of the Inlet and the ocean. Currently, the only way adequate flushing can be achieved is for a channel between the Inlet and the ocean to be dredged from time to time.

3. Effectiveness of Current Management

3.1 General

This section contains an assessment of the effectiveness of the current management of the water-related assets in the Geographe Catchment. This initial assessment has focused on the three components of the study – the Geographe Catchment, the Vasse-Wonnerup Wetlands and the local waterways (including the Lower Vasse River, Vasse Diversion Drain and Toby Inlet).

A set of criteria have been established for this assessment these being:

- Are the roles and responsibilities of the key organisations clear?
- Is there an obvious lead agency for the water-related asset, and are they leading effectively?
- Is there a well-developed management plan for the water-related assets?
- Does the plan have clear targets and an adequate monitoring program to measure progress?
- Has the implementation of the plan over the past 5 years been satisfactory?
- Does the program have adequate funding?
- Has there been measurable progress in improved water quality and ecological condition of the asset?
- If progress has been less than satisfactory, what are the reasons for this?
- Are the community generally aware of the management arrangements and satisfied with progress?

The assessment of current management of Geographe catchment, Vasse-Wonnerup wetlands, Lower Vasse River, Vasse Diversion Drain and Toby Inlet is provided in the Tables below.

3.2 Geographe Catchment

| Criteria | Assessment |
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| Are roles and responsibilities of the key organisations clear? | <p>No – there is currently no organisation charged, and appropriately funded, with the responsibility for the integrated management of the Geographe catchment.</p> <p>The current management focus is on water quality (nutrients) improvement through the implementation of the WQIP. Since 2009, the WQIP implementation has been led by GeoCatch and DoW with support from DAFWA, CoB, SoC and SWCC.</p> |
| Is there an obvious lead agency for the water-related asset, and are they leading effectively? | <p><i>Recognised lead agency</i> - Yes DoW in partnership with GeoCatch.</p> <p><i>Effectiveness of this leadership</i> – over the period of almost 15 years, between the late 1990s and 2013, GeoCatch, DoW and partners have achieved much, commencing earlier with the Lower Vasse River Cleanup Program and the since 2009 with the WQIP. Particularly impressive has been GeoCatch’s achievements in community engagement and awareness raising, and the development of partnerships with a range of organisations including industry groups.</p> <p>In the time available, it has not been possible to fully assess the effectiveness of GeoCatch’s leadership in implementing the WQIP BMPs. This will be done more effectively in the 5-year review to be completed during 2014. However, from the information I have been presented with it seems GeoCatch have achieved reasonable progress in four areas: improving fertiliser management, improving effluent management from dairy sheds and feedlots, implementing riparian management and stock control, and in reducing nutrient use and risk of export of these nutrients in urban areas. A more detailed summary of progress in these four areas is provided in Appendix B.</p> <p>GeoCatch’s capacity to implement the BMPs identified in the WQIP is highly dependent on funding, which has been both insufficient and difficult for them to obtain - see below.</p> |
| Is there a well-developed management plan for the water-related assets? | <p>Partially - the existing management plan (the WQIP) is, as noted in Section 2.2.1, quite good in what it seeks to achieve. But it is focused on one element of catchment management, namely reducing nutrient loads entering waterways and ultimately the downstream wetlands. In particular, the WQIP does not explicitly address the ecological ‘health’ of the catchment waterways, or indeed the Vasse-Wonnerup wetlands or Toby Inlet.</p> <p>In addition to river health many other aspects of catchment management are not covered by the WQIP, e.g. biodiversity, land management, invasive plants and animals, and erosion. Some of these aspects of broader catchment management are covered in more recent WQIPs (e.g. Leschenault Estuary WQIP, Hugues-dit-Ciles et al., 2012), and there is scope for the Geographe WQIP to be updated when it is reviewed later in 2014.</p> |
| Does the plan have clear targets | <p><i>Nutrient targets</i> – Yes. The WQIP has identified nutrient load reduction targets for each sub-catchment and for the</p> |

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| | <p>an integrated and targeting implementation program impossible to run, and further causes major problems with staff retention and stakeholder engagement. It is clear that the BMP implementation program needs to be more strategic, with a focus on the priority catchment being targetted each year and the BMPs to be implemented in that year; the information in Neville (2008) could help here. But to achieve this will require more stable funding.</p> <p><i>WQ monitoring program</i> – DoW take water samples at 22 sites in the catchment each fortnight during the winter when these streams are flowing. These are analysed for TN, TP, TSS, Filterable Reactive P, Nitrate + Nitrite-N, dissolved organic N, pH, temperature DO and conductivity. The TP and TN data are then compared with the relevant targets (TP <0.1 mg/L, TN <1.0 mg/L). The spatial and temporal coverage of this WQ sampling program are adequate – all major waterways are monitored most at a gauging station.</p> <p>Nutrient loads will be estimated using concentrations and flows (flow either measured in gauged catchment or modelled in ungauged catchments) and the annual loads compared with the targets.</p> <p>There are no ecological ‘river health’ targets for the Geographe Catchment and very little monitoring.</p> <p><i>Monitoring of BMP implementation</i> – this appears to be adequately done for changes/activities that are easily identified (e.g. dairy effluent upgrades, length of stream fenced and revegetated, number of properties with nutrient soil testing), although the information is difficult to obtain (see Appendix B). However, with activities that require behavioural change (e.g. fertiliser management) only qualitative (anecdotal) information is available. The difficulty in reporting on behavioural change in agricultural practice is not unique to this catchment.</p> <p>There is an urgent need to establish a robust monitoring program to verify and quantify the effectiveness of these management practices.</p> |
| <p>Has implementation of the plan over the past 5 years been satisfactory?</p> | <p>The success of the WQIP depends on the effectiveness and implementation of the identified BMPs. In agricultural areas, priority has been placed on BMPs for management of dairy sheds and feedlots, fertilizer management, implementing riparian management, and controlling of stock on waterways. In urban areas, priority has been placed on management of point sources (wastewater treatment plants, septic tanks), incorporating water sensitive urban design in new residential developments, and limiting fertiliser use in urban areas.</p> <p>Currently, the uptake of BMPs by farmers is voluntary, although there has been a considerable range of advice and assistance provided by GeoCatch, DoW and DAFWA, and a variety of incentive packages through natural resource management programs. A brief review of the implementation of 3 types of BMPs in the Geographe catchment over the past 4 years is provided in Appendix B.</p> |
| <p>Does the program have adequate funding?</p> | <p>No - The WQIP recommended that a capital cost of \$16 million over 10-years was needed to implement the BMPs necessary to achieved the interim targets. Neville (2008) recommended a capital cost of almost \$25 million over 20-years. These clean-up costs seem low, although they only reflect the capital costs of implementing the BMPs. The full cost would be much greater than this. As a comparison, in 2001 the Victorian Government allocated \$22 million over a ten year period to improving the health of the Gippsland Lakes; considerably more than this was actually spent considering the investments the East and West Gippsland CMAs also made. DoW has indicated that they have an improved cost-benefit method for agricultural BMPs, and this will be applied to update the figures for the Geographe Catchment.</p> |

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| | <p>It is disappointing that despite embracing the WQIP (e.g. by forming a Partnership between DoW and GeoCatch at the start of the implementation), the WA Government has not adequately funded this project. Over the period 2009-2013, GeoCatch has attracted \$4.2 million from a range of sources. But only around \$1.7 million was obtained from State NRM funding, mostly in three large grants totally \$1.4 million. The bulk of the \$4.2 million funding has been for rather small, project-based programs, which has made it difficult for GeoCatch to develop a strategic approach to the implementation and to retain high quality professional staff.</p> <p>I understand that the current program is essentially unfunded, except for some monitoring, and that the financial viability of GeoCatch is also at risk.</p> <p>A recent study used the INFFER method to assess the costs to achieve the TP reduction targets for the Gippsland Lakes in Victoria (Roberts et al., 2012). Using this analysis and scaling-down the Gippsland Lakes figures to the size of the Geographe Catchment (i.e by 10 for area 20,000 km² vs 2,000 km²) suggests that a 40% P load reduction would need an investment of \$100 million over 25 years, or \$4 million per year. For the 20% P load reduction (close to the short-term target in the WQIP) the figure would be around \$2 million per year</p> |
| <p>Has there been measurable progress in improved water quality and ecological condition of the asset?</p> | <p><i>Improvement in WQ</i> – it is difficult to assess whether an improvement has been achieved as the program has only been in place for less than 5 years. However, water quality monitoring over the period 2006 to 2012 suggests variable results the annual median nutrient concentrations measured during winter (DoW, 2013a). For example, there has been a reduction in the TP concentration in the Lower Sabina River, a pleasing result for this catchment as it has been the target of considerable activity in introducing BMPs. In other catchments, the results are different, e.g. Vasse Diversion Drain TP concentration has remained essentially unchanged, while in the Ludlow River the median TP conc has increased. Unfortunately, there is insufficient data for Lower Vasse River to discern any trends (no water quality data for 2008, 2009, 2010)</p> <p><i>Improvement in ecological condition</i> – the WQIP has no targets and no monitoring for ecological condition. However, even if these were available, it is probably still too early for there to be evidence that the catchment streams have improved ecologically. Assessment sites have been established on the Sabina and Abba Rivers to evaluate changes in ecological condition, especially in relation to riparian zone establishment.</p> |
| <p>If progress has been less than satisfactory, what are the reasons for this?</p> | <p>Progress in implementing the BMPs appears to have been rather slow. However, this is not surprising given that fact that the implementation of the BMPs is voluntary, and there has been insufficient core funding for the implementation. Given these difficulties, GeoCatch has done very well with the dedicated staff they have. However, it is crucial that in the future, GeoCatch develop a 5-year BMP implementation strategy (with targets) and a rolling annual work plan. But again this will only work if there is sufficient core funding for the program.</p> |
| <p>Are the community generally aware of the management arrangements and satisfied with progress?</p> | <p>The community appear generally well aware of GeoCatch’s role in the management of nutrient loads in the Geographe catchment. I received no comments from the community regarding satisfaction or otherwise with progress.</p> <p>Neither the community or others have any information on the cost-effectiveness (\$ expended for each kg of P removed) of the proposed management practices and those already carried out.</p> |
| <p>Summary</p> | <p><i>Water quality management in the Geographe catchment is directed by an excellent WQIP plan developed in 2009,</i></p> |

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| | <p><i>which is underpinned by the need to introduce a range of (voluntary) BMPs to achieve the desired reduction in nutrient losses from agricultural land. This WQIP is largely single purpose (reduction of nutrient loads), and is not a catchment management plan. The WQIP is being implemented by GeoCatch in partnership with DoW and with useful assistance from DAFWA, some industry groups (Western Dairy, fertiliser industry) and SWCC (provide some funding). Sensibly, the focus of the BMP implementation has been in a small number of priority catchments (Upper Vasse/Vasse Diversion Drain, Lower Vasse, Sabina and Ludlow Rivers).</i></p> <p><i>Some obvious improvements have been made over the past decade in the management of dairy shed effluent, streambank fencing and revegetation, and exclusion of stock from waterways; considerable efforts have also occurred in improving fertiliser management. The implementation of BMPs in the Geographe catchment has been difficult due to a lack of adequate funding, and in agricultural areas also to the fact that uptake of BMPs by farmers is voluntary.</i></p> |
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3.3 Vasse-Wonnerup wetlands

| Criteria | Assessment |
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| Are roles and responsibilities of the key organisations clear? | <p>No - Currently, a number of agencies are involved in aspects of the management of Vasse-Wonnerup Wetlands, with this management largely focused on minimising the potential for fish kills (VETWG, 2013). The agencies involved include: DoW, DPaW, DoF, Water Corp and CoB.</p> <p>There is no overall strategic management plan for these wetlands</p> |
| Is there an obvious lead agency for the water-related asset, and are they leading effectively? | <p>No – Currently, there is an incident response plan for 2013-2014 that is primarily focused on minimising the potential for fish kills. There is no strategic management plan for these important wetlands.</p> <p>Up to 2013, when a massive fish kill occurred in April of that year, the Vasse Estuary Technical Working Group (VETWG) was chaired by DPaW (previously known as Department of Conservation). Currently, the VETWG is chaired by DoW, who have been responsible for developing a new fish kill mitigation strategy (VETWG, 2013).</p> <p>In the past, there has been indecision between agencies about the need for particular actions (e.g. opening the Wonnerup Inlet bar, opening the floodgates), who should undertake these actions (e.g. clean up of dead fish), and the urgency for undertaking actions. This has led to community concern regarding the level of coordination between the agencies. The new strategy contains a sensible approach, with each of the agencies responsibilities well identified⁷. However, it remains to be seen if the organisations accept their responsibilities and act swiftly when called upon</p> |

⁷ The new response plan is triggered when trigger criteria (DO, environmental, community concern, fish stress) are breached. During the period December to April, water quality is monitored weekly (note – soon to install continuous monitoring of DO, temp, pH and conductivity). There are three levels of response: (a) trigger criteria breached - green response – activate daily monitoring of water quality and fish, open fish gate pen stock, check Wonnerup Inlet bar, (b) if after 2 days DO is <4 mg/L or signs of fish stress – orange response – activate daily monitoring of water quality and fish, open fish gate pen stock, open Wonnerup Inlet bar, install pumps to circulate water, and (c) a fish kill occurs - red response – activates cleanup and communications (VETWG, 2013).

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| | <p>should an incident occur in 2014.</p> <p>There is no long-term strategic management plan for the Vasse-Wonnerup wetlands – see below.</p> |
| Is there a well-developed management plan for the water-related assets? | <p><i>Incident response plan</i> – Yes. There is a sensible incident response plan for the mitigation of fish kills that is implemented each year between December and April. The organisations involved acted swiftly in responding to the recent fish kill that occurred in February 2014. The response was well managed and well coordinated.</p> <p><i>Long-term strategic management plan</i> – No. There is no long-term plan for the Vasse-Wonnerup Wetlands. The need for such a management plan is covered in Section 4.</p> |
| Does the plan have clear targets and an adequate monitoring program to measure progress? | <p><i>Incident response plan</i> – Provisionally yes. There are clear trigger criteria, response actions and monitoring, but the new plan has yet to be tested in 2013-14 summer period.</p> <p><i>Long-term strategic management plan</i> – No. There are no overall objectives or targets for the Vasse-Wonnerup Wetlands. Management objectives should include: water bird habitat, biodiversity, fish, recreation, aesthetics, mosquitos flood protection and operation of the floodgates.</p> <p>Regarding monitoring, Murdoch University has been funded over the past 5 years to undertake a range of monitoring and research projects that have substantially increased to knowledge-base for the wetlands. The funding has come from both GeoCatch and SWCC.</p> |
| Has implementation of the plan over the past 5 years been satisfactory? | <p>No – there is no strategic plan for the Vasse-Wonnerup wetlands. Equally, the Incident Response Plan, while being reasonably successful (until 2013) in preventing fish kills, has not addressed many of the community issues.</p> |
| Does the program have adequate funding? | <p><i>Incident response plan</i> – No. The program is only funded for 2013-2014. For 2013-2014 the agencies involved have agreed to provide the necessary resources for their component of the plan (DoW – Chair VETWG, coordinate emergency response, WQ monitoring; Water Corp – operate floodgates (fish gates, fish gate penstock, manage estuary water levels, open Wonnerup Inlet sand bar; CoB – coordinate fish kill clean up and disposal is needed, erect signage, hire pumps if needed; DPaW – provide information to DoW regarding optimum water levels; DoF – assist DoW with fish kill response, undertake fish pathology analysis if required. Presumably, the program will need to be re-negotiated for 2014-2015.</p> <p><i>Long-term strategic management plan</i> – No.</p> |
| Has there been measurable progress in improved water quality and ecological condition of the asset? | <p><i>Improved water quality and ecological condition</i> – Murdoch University has been monitoring aspects of the ecological condition of these wetlands since 2006, and over that time has built up a considerably improved knowledge-base on this system. However, this monitoring has been in place for too short a time to unequivocally identify improved ecological condition.</p> <p>Additionally, DoW has implemented an ecological condition monitoring program on a trial basis, and have also progressed a water balance model for the wetlands to allow consideration of water level management options (Pers Comm, Malcolm Robb, Jan 2014).</p> |
| If progress has been less than | <p><i>Incident response plan</i> – progress in ensuring major fish kills do not occur in the future should be assisted by the new</p> |

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| <p>satisfactory, what are the reasons for this?</p> | <p>emergency response plan. This is more clear on the roles and responsibilities of the participating agencies, however still has to be successfully run in 2013-2014 summer. There is also an issue with future leadership since DoW have only agreed to coordinate the plan for 2013-2014 and not necessarily beyond that time.</p> <p><i>Long-term strategic management plan – no plan.</i></p> |
| <p>Are the community generally aware of the management arrangements and satisfied with progress?</p> | <p>The community are generally aware of the incident response plan and its focus on preventing fish kills. DoW and VETWG ran a community meeting in November 2013 to explain the new plan.</p> <p>Given that another fish kill occurred in early February 2014 (possibly due to the effects of a toxic algae), the community are still not satisfied with the performance of the organisations responsible for incident response.</p> <p>It is difficult to tell whether the community is satisfied with the overall management of the Vasse-Wonnerup wetlands, since my impression is that most people are unaware of the wetlands and their values.</p> |
| <p>Summary</p> | <p><i>Currently, there is no comprehensive management plan for the Vasse-Wonnerup wetlands despite the fact that they are Ramsar-listed. A new emergency 'Fish Kill Mitigation and Response Plan' has been developed and is in place for the 2013-14 summer, with DoW as the coordinator. The new incident response plan has clear trigger criteria, monitoring requirements and agreed response actions. However, the fact that another fish kill occurred in February 2014 despite this new plan, suggests there is still more to be learned in managing this wetland system to minimise the potential for fish kills.</i></p> <p><i>A comprehensive long-term strategic management plan for the Vasse-Wonnerup Wetlands is needed, which sets realistic (and agreed) objectives, targets and expectations. The multiple management objectives for this plan should include: water bird habitat, biodiversity, recreation, aesthetics, flood protection and operation of the floodgates. This will require establishing a new water balance model and agreement on trade-offs. The overall goal should be to prevent further decline in ecological health of the system in the short-term, and improvement in system health in the long-term.</i></p> |

3.4 Lower Vasse River

| Criteria | Assessment |
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| <p>Are roles and responsibilities of the key organisations clear?</p> | <p>Clearly, GeoCatch, in partnership with DoW and CoB, are responsible for the implementation of BMPs in the Lower Vasse River catchment.</p> <p>Responsibility for operational management of the 'lake' section of the Lower Vasse River is not clear.</p> |
| <p>Is there an obvious lead agency for the water-related asset, and are they leading effectively?</p> | <p>See above.</p> |
| <p>Is there a well-developed management plan for the water-</p> | <p>Partially – The WQIP has clearly identified that the major issues associated with the Lower Vasse River are due to excessive loads of nutrients from agricultural and urban areas, and GeoCatch, DoW and CoB are working to</p> |

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| <p>related assets?</p> | <p>implement BMPs to reduce these nutrient loads. This is the long-term solution to the algal problems in the 'lake' section of the Lower Vasse River. But, sufficient reduction in nutrient concentrations is not likely to be achieved in times less than a decade.</p> <p>In the interim, CoB should undertake a cost-benefit assessment of two options:</p> <p>(a) removal of the artificial lake and reverting to a dry river bed during summer,</p> <p>(b) continue with the artificial lake, with an 'emergency response management plan, possibly including a number of 'technical' solutions (e.g. reduce the P concentration (e.g. a new inexpensive P-adsorbing nanoclay that should be soon available), altering the physical conditions in the 'lake' to make it more difficult for algae to grow, or dredging the sediments in this 'lake').</p> |
| <p>Does the plan have clear targets and an adequate monitoring program to measure progress?</p> | <p>There are clear long-term targets for both concentrations and loads of TP and TN in the Lower Vasse River.</p> <p>There are no documented objectives or targets for the management of the 'lake' section of the river that is dammed up in the middle of the town.</p> |
| <p>Has implementation of the plan over the past 5 years been satisfactory?</p> | <p>Yes – the implementation of the WQIP has been satisfactory.</p> <p>The short-term management of the 'lake' section needs to be improved.</p> |
| <p>Does the program have adequate funding?</p> | <p>There does not appear to be any targetted funding for these wetlands.</p> <p>In recent years funding has been <i>ad hoc</i> and largely in response to algal bloom incidents.</p> |
| <p>Has there been measurable progress in improved water quality and ecological condition of the asset?</p> | <p>Significant water quality improvement is dependent on the reduction in nutrient concentrations contributed from the catchment (both agricultural and urban areas), and this will take considerable time. There is no evidence that this has occurred despite over a decade of activity with the implementation of BMPs.</p> <p>There is no evidence that the condition of the 'lake' section has improved.</p> |
| <p>If progress has been less than satisfactory, what are the reasons for this?</p> | <p>See above.</p> |
| <p>Are the community generally aware of the management arrangements and satisfied with progress?</p> | <p>The community generally are aware of the lack of management of the Lower Vasse 'lake', but seem not to be aware that damming of the lake in summer is contributing to the water quality problems.</p> |
| <p>Summary</p> | <p><i>The WQIP provides a useful management plan for the overall Lower Vasse River, focused as it is on the long-term reduction of nutrients from agricultural and urban areas.</i></p> <p><i>However, management of the 'artificial lake' formed by damming the river at the Butter Factory is more problematic. The major algal blooms associated with this part of the river are due to excessive nutrients, a lack of adequate flow, particularly in summer, and the fact that the river is dammed. There is a lack of clarity between CoB and DoW as to</i></p> |

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| | <i>who should be responsibility for management of the lake. This review concludes that it should be CoB, and recommends that they undertake a cost-benefit assessment of two options: (a) removal of the artificial lake and reverting to a dry river bed during summer, and (b) continuation with the artificial lake including the on-going costs.</i> |
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3.5 Vasse Diversion Drain

| Criteria | Assessment |
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| Are roles and responsibilities of the key organisations clear? | Yes – the Water Corporation is the responsible organisation. |
| Is there an obvious lead agency for the water-related asset, and are they leading effectively? | Yes - the Water Corporation within the confines of its rural darinage responsibilities. |
| Is there a well-developed management plan for the water-related assets? | No detail provided. |
| Does the plan have clear targets and an adequate monitoring program to measure progress? | No detail provided. |
| Has implementation of the plan over the past 5 years been satisfactory? | No detail provided. |
| Does the program have adequate funding? | No detail provided. |
| Has there been measurable progress in improved water quality and ecological condition of the asset? | No improvement in water quality (nutrient concentrations) in the Drain. A recent isotope study by DAFWA was able to distinguish between nutrients from rural sources and from wastewater discharge, and to confirm that most of the nutrients transported by the Vasse Diversion Drain were fro agricultural activities in the catchment. |
| If progress has been less than satisfactory, what are the reasons for this? | |
| Are the community generally aware of the management arrangements and satisfied with progress? | No feedback was received. |

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| Summary | <i>The Water Corporation manage the drainage and flood-protection functions of the Vasse Diversion Drain. The review received no information on the operational management of this system. Management of this Drain does not consider the quality of the water transported. Currently, the Drain does not meet the nutrient targets established by the WQIP, and is discharging excessive amounts of TP and TN to Geographe Bay. The Water Corporation has no legislative requirement to consider the water quality of the drain. However, it is possible that the newly formed Busselton Water Corporation may take over responsibility for the Vasse Diversion Drain (and other drainage assets in the Geographe catchment), and include water quality and nutrient reduction as management objectives in addition to drainage and flood protection.</i> |
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3.6 Toby Inlet

| Criteria | Assessment |
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| Are roles and responsibilities of the key organisations clear? | It is not at all clear who is the responsible agency. |
| Is there an obvious lead agency for the water-related asset, and are they leading effectively? | No lead agency. |
| Is there a well-developed management plan for the water-related assets? | <p>The community-based Toby Inlet Catchment Group have developed a <i>Management Plan for Toby Inlet Foreshore and Waters</i>, which they indicate has been accepted by the CoB. Just what this involves is unclear, although the CoB does provide some funds to assist with the management of Toby Inlet. DoW also monitors the water quality in Toby Inlet.</p> <p>While it is laudable that this community group have developed a management plan, the effectiveness of this plan will be limited unless better funded and supported by the professional expertise of the relevant agencies (DoW, CoB and probably DPaW).</p> |
| Does the plan have clear targets and an adequate monitoring program to measure progress? | No |
| Has implementation of the plan over the past 5 years been satisfactory? | No – largely ad hoc. |
| Does the program have adequate funding? | No – most of the management is voluntary, with some assistance provided by the CoB and DoW. |
| Has there been measurable progress in improved water quality | Difficult to assess progress since there are no targets and no monitoring. However, anecdotal evidence from a number of residents suggests the condition of Toby Inlet has deteriorated over the past decade. |

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| <p>and ecological condition of the asset?</p> | |
| <p>If progress has been less than satisfactory, what are the reasons for this?</p> | <p>The general lack of progress is largely due to inadequate funding. The Toby Inlet Catchment Group could probably do a serviceable job if they had more resources and greater backup from CoB and DoW.</p> |
| <p>Are the community generally aware of the management arrangements and satisfied with progress?</p> | <p>Yes - the Toby Inlet community group are well aware of the management arrangements, and are highly dissatisfied with the lack of progress.</p> |
| <p>Summary</p> | <p><i>The management of Toby Inlet is minimalist at best. The Inlet experiences regular blooms of macroalgal and phytoplankton, and offensive odours when these algal blooms die. These issues are the result of excessive nutrient inputs to the estuary, and a lack of adequate flushing caused primarily by the Station Gully Drain and associated causeway, that pass through the eastern end of the Inlet. The condition of the Inlet would be improved if the causeway was removed or the small culvert in the causeway was enlarged. The community-based Toby Inlet Catchment Group have developed a 'Management Plan for Toby Inlet Foreshore and Waters', which they indicate has been accepted by the City of Busselton. Just what this involves is unclear, although the City does provide some funds to assist with the management of Toby Inlet. The Toby Inlet Catchment Group could probably do a serviceable job of managing the Inlet if they had more funding and greater backup from CoB and DoW.</i></p> |

4. Possible Future Management Options

4.1 General

The assessment of the current management arrangement for the water-related assets in the Geographe catchment provided in Section 3 of this Final Report, has shown that there is considerable room for improvement. 'Business as usual' should not be considered as a viable option as this would inevitably lead to further deterioration in the condition of the catchment's waterways, including the Vasse-Wonnerup wetlands.

In brief, the water quality in the catchment rivers is slowly being improved through the implementation of the WQIP, but this activity currently has little funding. The implementation of the WQIP is being led by DoW in partnership with GeoCatch, and with assistance from DAFWA, CoB, SoC, some industry groups and farmers. Some obvious improvements have been made over the past decade in the management of dairy shed effluent, streambank fencing and revegetation, and exclusion of stock from waterways; considerable efforts have also occurred in improving fertiliser management. While there is an emergency response plan for the Vasse-Wonnerup wetlands, focused on minimising the potential for fish kills, there is no overall strategic management plan and no obvious lead organisation. Also there is no management plan or designated lead organisation for the artificial lake section of the Lower Vasse River in Busselton. And finally, Toby Inlet has a management plan, but there are limited resources (funds and technical capacity) to implement this plan.

The sections below present first a summary of the roles and responsibilities of the key organisations (including responses they made to the Discussion Document), and then three possible options for the future management of the Geographe water-related assets. The main features of the three options are provided in Figure 10.

In considering future management options, I have taken the view that decisions about which organisation(s) takes a lead role in the management of a particular asset is less about legislation and more about the right fit of that organisation or grouping of organisations. The establishment of leadership and coordination does not require legislation. If a statutory approach is required then an appropriate piece of legislation can be used depending on the ambit of the management structure and organisations involved (e.g. the Water Agency Powers Act can be, and has been, invoked for a wide range of activities).

4.2 Roles and responsibilities of key organisations

This section summarises the current roles and responsibilities of the key organisation involved in management or control of water-related assets in the Geographe catchment. Also provided is a summary of the key points from their submissions to the review.

4.2.1 Department of Water

The Department of Water (DoW) is the lead organisation for the management of waterways in Western Australia. Waterways are defined very broadly to include: rivers, streams, creeks, lakes, estuaries, inlets and wetlands. They also include floodplain and wetland systems that overflow into rivers, as well as wetlands, lakes or swamps that are filled by streams rather than shallow groundwater (DoW web site⁸).

DoW derives its powers from three acts: the *Water Agency Powers Act (1984)*, *The Rights in Water and Irrigation Act (1914)* and the *Waterways Conservation Act 1976*.

The Waterways Conservation Act is potentially very powerful, and quite relevant to this review. Under this Act, DoW has the power to control and manage waterways, and to formulate and implement schemes for their conservation. Currently, five regions have been declared under this Act: Peel-Harvey Estuaries, Avon, Leschenault Estuary and associated rivers, Albany Harbour and associated rivers, and Wilson Inlet and associated rivers. Once a region is declared, DoW is then required to establish a management committee and management program. Such management programs can be discreet or broad in extent, and can also create regulations or by-laws to control particular activities.

The above Acts provide DoW with considerable powers as the water resources manager in

⁸ www.water.wa.gov.au/Managing+water/Rivers+and+estuaries/default.aspx

Western Australia. This includes the allocation and licensing of water for consumptive purposes, and managing the ecological 'health' and water quality of waterways (rivers, wetlands and estuaries). And given the linkage between catchment land use and water quality, DoW should also have a role in catchment management. No other agency has such a comprehensive role in water (quality and quantity) management.

DoW also has a key role in providing understanding and advice on water science, including the monitoring of water quality and quantity, catchment modeling, understand of estuarine and wetland processes, remediation options, and general integration of water-related activities.

However, despite the above comments, the role of DoW in the management and maintenance of water quality and ecological health of the state's waterways is far from clear. It is recommended that DoW provided a clear statement on their role in waterways and catchment management on their web-site.

In the Geographe region DoW has had an active role for many years. They led the development of the WQIP, and have partnered GeoCatch in implementing this plan since 2009. They also have the responsibility for monitoring water quality in the catchment waterways, and for reporting on water quality trends and success of the implementation program. Regarding the Vasse-Wonnerup wetlands, DoW has participated in the VETWG since 1997. They led the development of the new emergency response plan for 2013-2014, and are chairing VETWG for 2013-2014. They also monitor water quality and phytoplankton levels in the Vasse-Wonnerup wetlands and the Lower Vasse River during summer, and provide technical support and advice to TICG and CoB regarding Toby Inlet.

DoW are also a key partner in the WA Fertiliser Partnership 2012-2016⁹, together with DAFWA, DER and the Swan River Trust.

DoW did not make a submission to the review, but DoW officers did provide comment on various drafts.

4.2.2 Geographe Catchment Council (GeoCatch)

GeoCatch is a community-based natural resource management body formed in 1997 as a result of growing concern about the health of the Geographe catchment. GeoCatch is an incorporated and advisory committee established under the *Water Agencies (Powers) Act 1984*, that works with DoW to coordinate catchment management of the Geographe Bay region. It has no statutory basis.

GeoCatch operates in partnership with local government, community, state government agencies, regional NRM (SWCC) and industry to cooperatively manage land and water issues through an integrated catchment management approach. Since its inception, GeoCatch has had a Partnership Agreement with the Department of Water (DoW), which was formalised in 2009, with DoW paying member sitting fees, assisting in employing staff, and providing technical, strategic and managerial support. GeoCatch is dependent on external funding to pay staff and carry out activities, with funding sought from a range of sources, including the Federal and State Governments.

GeoCatch's mission is to work with the community and management agencies to manage the catchment of Geographe Bay and its marine environment, so that natural systems, people and their activities co-exist in a healthy, productive and sustainable way (GeoCatch, 2013c).

GeoCatch initially partnered with DoW in the development and implementation of the Lower Vasse River Cleanup Program, and more recently in the development and implementation of the WQIP. GeoCatch has participated in the VETWG since 2000. They have also sourced funds to contract Murdoch University to monitor macrophytes and other ecological aspects of the Vasse-Wonnerup wetlands.

In their submission to the review, GeoCatch supported the two options proposed in the Discussion Document subject to certain conditions being met. Regarding Option 1 (separate management structure), GeoCatch believe they are best placed to take on the coordinating role, but that in order to achieve this they would need adequate secure funding and resources (core staff salaries, administration and operating expenses) and a mandate (possibly Ministerial authority) to undertake the coordinating role. Regarding Option 2 (new catchment and wetland management authority),

⁹ Note: the Fertiliser Partnership 2012-2016 superceded the 2007 Fertiliser Action Plan (FAP) (see <http://fertiliserpartnership.agric.wa.gov.au/fertiliser-partnership-0>).

GeoCatch believe this option is unlikely to be adopted by the Government since it would require significant changes and new legislation. However, if Option 2 was adopted, they believe it would take a considerable time to implement, and that GeoCatch could play an important role in the transition period.

4.2.3 South West Catchment Council (SWCC)

SWCC is the designated Natural Resource Management regional body for the South West of Western Australia, one of 55 bodies established nationally under the National Heritage Trust (including Caring for our Country) for the purposes of coordinating community-based NRM. In Western Australia, the NRM regions are community-based not-for-profit, non-government organisations, with no legislative or statutory basis, funded by the Federal Departments of Environment, and Agriculture (\$5 mill p.a.) and the Western Australian Natural Resource Management Office (\$0.25 mill p.a.).

The SWCC has a skill-based Board of Management and is responsible for six catchments: Peel-Harvey, Leschenault, Geographe, Cape to Cape, Warren and Blackwood (see web site <http://swccnrm.org.au/>). GeoCatch is a member organisation of SWCC with representation at various levels of SWCCs governance structures. SWCC have and continue to provide funds and implement projects in the Geographe catchment for a variety of NRM projects including for the implementation of BMPs and for research on the Vasse-Wonnerup wetlands.

In their submission to the review, SWCC noted that they favored Option 2 in the Discussion Document as the establishment of a dedicated Catchment and Wetland Management Authority would allow for a coordinated and integrated approach to management of the key assets within the Geographe Catchment, including the Vasse Wonnerup Wetland by a single organization. Regarding Option 1 in the Discussion Document they argued that this has the potential to continue the *status quo*, which was generally described in the recent Australia State of the Environment Report as *'the [WA] state agencies have established coordination mechanisms that might best be described as 'systems to avoid treading on each others' toes', but there is no formal or informal system that has the responsibility of maintaining the environmental values of the marine and coastal ecosystems of Western Australia or providing for systematic reporting on their condition'* (SoE Committee, 2011).

SWCC also strongly support the statement in the Discussion Document (p21) that *'It would seem sensible if this emergency response plan was part of a more comprehensive Vasse-Wonnerup Wetland Management Plan'*, suggesting that this move would contribute to a more integrated and holistic management plan.

Further, SWCC made the following suggestions:

- that it is critical that further funding is made available to the appropriate agencies with statutory responsibility for the Vasse-Wonnerup system to undertake appropriate monitoring and research to adequately manage the system and catchment,
- that information on the status of priority threatened flora and fauna in Geographe catchment, Vasse-Wonnerup wetland and Geographe Bay ecosystems and associated ecosystems services, are not readily available to the public. This information, packaged appropriately, will be essential if the community is to assist in the development of new management plans for these systems.
- that publically available 'report cards' should be regularly prepared to provide an overview of the health of Geographe catchment, the Vasse-Wonnerup wetlands and Geographe Bay.
- that there should be consideration of reinstating natural flow regimes of water-dependent ecosystems and redirecting water from drains (with treatment when applicable) back to natural systems.
- that all management plans should contain a costing for research (if required), monitoring and reporting back to the community.

4.2.4 Department of Parks and Wildlife (DPaW)

DPaW, established in July 2013 (previously Department of Environment and Conservation), operates under the Conservation and Land Management (CALM) Act. Their new Strategic Direction 2013-2014 document list four goals, two which have relevance to management in the GeoCatch region; goal 2 is to 'conserve, protect and manage the state's native fauna and flora based on best practice science', and goal 4 is to 'manage access to the lands and waters under

our care and the state's biodiversity for sustainable uses including tourism and wood production.' (DPaW web site - www.dpaw.wa.gov.au).

DPaW have a major interest in the Vasse-Wonnerup wetlands given that they were responsible for nominating these wetlands for Ramsar listing, and in reporting to the Commonwealth Department of Environment on their ecological condition. These wetlands are recognised by DPaW as an important habitat for both migratory species and wildlife utilising the adjoining conservation reserves and other lands.

DPaW is not able to prepare a statutory area management plan for the wetlands since the area is not vested in or under the care, control or management of the Conservation Commission of Western Australia (CCWA)¹⁰. The CALM Act prevents DPaW from preparing a management plan in these cases. It appears the Vasse-Wonnerup wetlands will not be vested until a Native Title claim over these waters is resolved.

However, this does not prevent DPaW or another organisation from preparing a strategic management plan (as opposed to a statutory plan). While such a non-statutory plan may be prepared to address the management issues, it will not be successfully implemented unless sufficient resources are made available.

The CALM Act also suggests that if the Conservation Commission were to have land placed with it (as opposed to vesting), and have the care, control and management, then a management plan could be prepared by DPaW (also in collaboration with others). For this to happen it would need support of the DPaW, CCWA and the Minister, and of course the resources to undertake the plan preparation and to implement it.

DPaW are also currently developing a high level Management Plan for the southern Swan Coastal Plain¹¹. This plan is intended to guide management for over 80 existing DPaW managed reserves and over 20 proposed reserves in the southern portion of the Swan Coastal Plain. The Vasse-Wonnerup wetlands are one of the proposed new reserves. The management plan will be a strategic document, and provide direction for key issues that require resolution and/or action during the life of the plan.

It appears that the most recent Government position on the management of wetlands in Western Australia is contained in a 1997 document entitled 'Wetlands Conservation Policy for Western Australia' (Govt WA, 1997). However, I could not find a clear statement outlining DPaW's current position on its management responsibility in general for wetlands in Western Australia, and its resourcing for this activity.

DPaW were instrumental in establishing the VETWG in 1997 and chaired the group from that time until 2013. They also manage some land adjoining the Vasse-Wonnerup wetlands that is in the conservation estate.

In their submission to the review, DPaW indicated their agreement that an area management plan for the Vasse-Wonnerup wetlands is needed, but noted that the development of a plan alone does not ensure the required resources to implement it are guaranteed. They did not comment on either Option presented in the Discussion Document as they believe this is a decision at the Ministerial and Government level to determine how they wish to have the wetlands managed.

DPaW also believes that there is an ongoing role for the VETWG, perhaps with some consideration of supplementing the representation with relevant community interests.

DPaW also noted that the Discussion Paper does not clearly recognise aboriginal interests in the Vasse-Wonnerup wetlands, and suggest there should be some mention their cultural values.

4.2.5 Department of Agriculture and Food (DAFWA)

DAFWA administer the *Soil and Land Conservation Act 1945*. This Act is focused on land use impacts, and provides for the regulation of drainage, and soil and land degradation. Land degradation is defined as soil erosion, salinity, eutrophication and flooding and the removal or deterioration of natural or introduced vegetation that may be detrimental to the present or future

¹⁰ Some land around the Vasse-Wonnerup wetlands is vested in the CCWA and is being managed by DPaW.

¹¹ See www.dpaw.wa.gov.au/parks/management-plans/draft-plans-in-preparation/102-swan-coastal-plain-south-draft-management-plan

use of land.

DAFWA participated in the development of the WQIP, particularly through the provision of technical knowledge of BMPs, generated through their extensive research into nutrient losses from agricultural land on the sandy Swan coastal plains soils (e.g. Gourley and Weaver, 2012; Keipert et al., 2008; Rivers et al., 2013; Weaver and Wong, 2011; Weaver and Summers, 2013, 2014).

DAFWA are a key partner in the WA Fertiliser Partnership 2012-2016, and have a commitment to undertake a 5-year review of this Agreement.

Since 2009, they have been a partner with GeoCatch and DoW in implementing the rural fertiliser management BMP. In particular, they have been responsible for undertaking the whole farm soil testing and nutrient mapping for a considerable area of the Geographe catchment.

DAFWA did not make a submission to the review, but DAFWA officers did provide comment on various drafts.

4.2.6 Department of Fisheries (DoF)

DoF administer the *Fish Resources Management Act 1994*, and through this Act have a statutory role in the protection and management of fish, other aquatic resources and their habitats.

DoF has a role in the management of the Vasse-Wonnerup and Toby Inlet ecosystems. Currently, they contribute to the management of the Vasse-Wonnerup wetlands through their membership of VETWG, and play a key role in the response to any fish kills. They would obviously be a key agency in any future more strategic management plan for the Vasse-Wonnerup wetlands.

In their submission to the review, DoF supported Option 2 in the Discussion Document - the formation of a single Geographe Catchment and Wetland Management Authority. This option they believe would provide the opportunity to: (a) identify management priorities on a catchment-wide basis, (b) seek resources that align with management priorities in a transparent and holistic (catchment-wide) manner, and provide clear linkages with regional NRM groups (namely the South West Catchment Council) and thereby increase opportunities for alignment with, and effective delivery of, agreed management priorities.

Further, DoF argued that such an Authority should: (a) include community and local government representation, as well as wetland technical experts, with an independent chair, (b) provide the opportunity for 'expert advice' from relevant State Government agencies, and (c) have secure, long-term funding arrangements.

4.2.7 Water Corporation

The Water Corporation's main role is in flood protection and drainage (urban and rural), and wastewater treatment. In the Geographe catchment they are responsible for the operation and maintenance of the Vasse Diversion Drain, the Vasse and Wonnerup floodgates, the regional sewerage infrastructure, operating the Busselton Wastewater Treatment Plant, and delivering scheme water supply to Capel, Dusborough and many other small towns.

The broad objectives of the floodgate operation are to control: (a) flooding from the Vasse River, (b) flooding from the ocean (surge control), (c) wetland water levels so that surrounding agricultural land is not inundated, (d) water quality conditions in the wetlands during summer and autumn to prevent fish kills.

The operational rules for the floodgates are largely related to water level¹², although in the event of fish stress the fish gates are opened to allow for fish movement. It does not appear that these rules are documented.

The Water Corp have been a member of VETWG since 1997. When the floodgates were upgraded they were instrumental in preparing an MoU on how the floodgates should be operated, but this was not signed by all parties.

During the 2013-2014 summer period they agreed in accordance with the new fish kill mitigation plan, to monitor water levels in the wetlands, operate the floodgates, open the Wonnerup Inlet bar at the start of summer and keep it open as necessary (VETWG, 2013).

The Water Corp did not make a submission to the review.

¹² The rules are: Winter – aim to keep water level <0.8m; Spring – aim to keep water level 0.4-0.8m; Summer – aim to keep water level > -0.1m, If <0.1m gates are opened.

4.2.8 City of Busselton (CoB)

The CoB is a local government area in the south-western region of Western Australia. The CoB covers an area of 1,455 km², almost three-quarters of the Geographe catchment. It has an estimated population of almost 32,000, mostly located in the two largest towns, Busselton and Dunsborough.

The CoB operate the boards at the Butter Factory that dam up the Lower Vasse River in Busselton, operate the valve that regulates flow into the Lower Vasse River from the Vasse Diversion Drain, and manage crown land adjoining the river.

They have been a partner in the WQIP implementation program since 2009, working with GeoCatch to implement water sensitive design features in urban areas and undertaking strategic stormwater upgrades.

The CoB have been a member of VETWG since 1997. During the 2013-2014 summer period they have agreed in accordance with the new fish kill mitigation plan, to coordinate fish kill clean up if needed, coordinate the hire of pumps if water circulation is needed, coordinate traffic and public management in the area of the floodgates and Wonnerup Inlet bar opening, and erect signage as needed (VETWG, 2013).

In their submission to the review, CoB was supportive of a management model that involves a clear, single, 'lead' agency, with overall responsibility for management of Geographe catchment waterways (i.e. Vasse-Wonnerup wetlands, Lower Vasse River, Vasse Diversion Drain, Toby Inlet, and the various other inland waterways that drain into Geographe Bay, plus the associated catchment area). They provided thought on the role of the 'lead' agency, including:

- that the 'lead' agency should have a strong, local on-ground presence, and be directly responsible for as many aspects of the management of Geographe catchment waterways as is reasonably possible,
- that while it may not be possible (practical) for the 'lead' agency to be directly responsible for all aspects of the management of Geographe catchment waterways, there should be clear means by which the lead agency can influence or direct actions of 'supporting' agencies, and draw on their expertise when necessary,
- that the 'lead' and 'supporting' agencies should work to an overall management plan, endorsed by Cabinet and/or of a statutory nature,
- that there needs to be a shift in the balance between the various, sometimes competing, management objectives for the waterways (i.e. amenity, water quality, biodiversity, rural drainage/protection of rural land, flood mitigation, mosquito management/disease control), with more emphasis on amenity and water quality, and less on rural drainage and protection of rural land,
- that there should be consistent funding available for the activities of the 'lead' agency and 'supporting' agencies, including both commitment from the State, as well as contributions from the local community, especially the urban community,
- that the 'lead' agency should be responsible for all of the public 'infrastructure' that influences the flow of water and nutrients into, out of and through the Geographe catchment waterways, except for urban and other road drainage (i.e. they must be responsible for rural drainage, flood mitigation, valves, floodgates and similar, as well as the sand bars at the mouths of the Vasse-Wonnerup wetlands and Toby Inlet), and water quality objectives should be set in relation to management of that infrastructure,
- that the 'lead' agency should be responsible for monitoring of water quality, levels and flows,
- that the 'lead' agency should have powers in relation to land management and regulation of land-use (i.e. encouraging and/or requiring landowners and land managers to reduce the amount of nutrients exported from their land), or there should be a 'supporting' agency with a clear mandate to do so in a much more pro-active way than is currently the case, in partnership with the 'lead agency' (and this should involve genuinely voluntary approaches, but also payments to landowners and regulation),
- that if the 'lead' agency is not the principal land-use regulator, then the Department of Environment Regulation (DER) may be the most appropriate 'supporting' agency to act as the principal land-use regulator (using the licensing powers provided to it in the Environmental

Protection Act).

- that GeoCatch should have a role as a key 'supporting' agency, responsible for working with landowners to achieve voluntary improvements in land management, and
- that DoF and DAFWA should also continue to be important 'supporting' agencies

CoB suggest that the agency that appears most willing and able to be an effective 'lead' agency is Busselton Water Corporation (BWC). BWC have expressed a clear willingness to play a lead role (see Section 4.2.10 below), have a substantial local presence and are a locally based organisation, have shown themselves to be very competent infrastructure managers over a long period of time (and infrastructure management is probably the most important of the various catchment management tasks), have significant financial capacity, their management and board have substantial relevant expertise and a keen interest in the issues, and they have an appropriate governance structure.

Further, CoB believe that much, if not most, of the above can be achieved without legislative change, but if legislative change is needed or desirable then it should occur, but it should also not be a reason to delay the making of changes that can occur without legislative change.

Three final points CoB make in their submission are:

- that an option to provide some funds would be an 'environmental levy' paid as part of water rates (which would be paid principally by water consumers in the Busselton-Vasse urban area, but not by most residents of rural areas),
- that if the 'lead' agency is not the manager of the key downstream water-bodies (i.e. Vasse-Wonnerup wetlands, Lower Vasse River and Toby Inlet), then the manager should be the DPaW, or in the case of the Lower Vasse River and Toby Inlet, either DPaW or the CoB,
- that the State should also ensure that infill sewer occurs in the Busselton LIA and that discharge of treated wastewater into the Vasse Diversion Drain ceases, as soon as possible (these are both currently Water Corporation responsibilities).

4.2.9 Shire of Capel (SoC)

The SoC is a local government area in the south-west region of Western Australia, located between the cities of Bunbury and Busselton. It has an area of around 558 km².

The Capel River flows through the Shire; this is the only river in the Geographe catchment which flows permanently. This river originally flowed into the extensive wetland system which formed part of the upper portion of the Wonnerup estuary and formed part of the extensive wetlands that ran from Bunbury south to Busselton and Dunsborough. This system has been significantly modified by drainage and agriculture, so that now the Capel River discharges directly to the ocean through an artificial channel. The land in the lower Capel catchment is now mostly in private ownership.

The Shire of Capel is a member of GeoCatch and participates in the implementation of the WQIP in their region.

In their submission to the review, SoC supported Option 1 in the Discussion Document, with GeoCatch as the lead, coordinating organisation. SoC believes GeoCatch are well placed to undertake this role since they are well recognised as the lead organisation in catchment restoration with rural landholders, businesses and schools, have experience in developing successful applications to gain external funding, and have access to expertise to implement projects that cover the whole of the Geographe catchment.

However, for this to work, they believe GeoCatch must be adequately funded to do the job of coordinating the updating and implementation of a catchment management plan, including the WQIP. They mention the possibility of accessing corporate funding.

SoC also argue that the development of a new catchment drainage strategy should be undertaken, involving a review of current drainage network, and the possibility of reconnecting some of the natural waterways that have been degraded by drains.

4.2.10 Busselton Water Corporation (BWC)

BWC is not currently involved in waterways management in the Geographe catchment. However, the organisation became a Corporation in November 2013, which means they now have the opportunity to expand their business from water supply to also incorporate wastewater, drainage and floodplain management.

Through the review consultation process, BWC has expressed a willingness to consider a potential future role for them as the 'infrastructure manager' and 'supporting agency' in new management arrangements for the water-related assets of the Geographe catchment. To make these arrangements work would require appropriate structuring and resourcing, but could contribute to significantly improved water quality and ecological outcomes.

If there was sufficient Government will, and subject to evaluation and proving of the concept, BWC could be assigned responsibility to manage all infrastructure associated with the flow of water and nutrients in the Geographe catchment. This includes drains and associated structures, levees, flood retention basins, floodgates and sand bars. It would include all assets associated with flood protection and the rural drainage network within the Geographe catchment. Responsibility could also be assigned to manage water quality objectives in the drainage network in addition to the traditional water runoff and flow objectives.

Central to this model would be the transfer of the existing Rural Drainage Licence within the Geographe catchment from the Water Corp to BWC. Water quality objectives could be incorporated in the licence requirements with funding and resourcing to match such requirements.

4.2.11 Industry

Western Dairy/Dairy Australia

Western Dairy, one of eight Regional Development Programs that are spread through the nation's key dairy areas, operates under the auspices of Dairy Australia. Western Dairy has been operating since 1997 to guide the strategic direction and implementation of dairy research, education and promotion programs in the Western Australian region.

In their submission to the review, Western Dairy and Dairy Australia note that managing the nutrients (fertiliser and effluent) and water quality is one of the biggest challenges for the Australian dairy industry and is a top priority for industry research, development & extension (RD&E) using levy funds and leveraged funding.

Their submission also lists a number of activities Western Dairy have undertaken over the past decade to improve nutrient management and water quality particularly in south-west Western Australia, including publishing a Code of Practice for Dairy Shed Effluent Management, funded the preparation of effluent management plans, assisting in the Whole Farm Nutrient Mapping project, and involvement in the Fert\$mart program aimed at improving fertiliser management.

They indicate that the dairy industry is keen to work with all partners to improve water quality in the Geographe catchment, and see the on-going support for technical expertise (e.g. NRM specialists who understand the complexities of managing effluent, nutrients, plant/soil interactions and water quality, on-farm technical expertise starting with service providers who sell and install effluent infrastructure, and soil scientists, farm advisors and fertiliser agronomists who provide advice to farmers around fertiliser management and plant/soil/water interactions) as important steps for continual improvement of water quality in the region.

WA Farmers Federation Dairy Council

In their submission to the review, the WA Farmers Dairy Council indicate that they exist to act as a voice on behalf of the states farmers and lobby for the best possible outcomes to ensure a sustainable and profitable future for the agricultural sector, and that they aim to support the long term sustainability of the dairy industry.

The WA Farmers Dairy Council believes the current arrangement of industry partnerships with Western Dairy and organisations such as GeoCatch, are the preferred method of using farmer funded levy payments to build research programs and focused best management practice solutions on-farm.

Dairy Council acknowledge the need for an increase in funding for catchment NRM, but noting the current financial pressures on WA dairy farmers, they believe any extra levy charges on the farmers within the Geographe catchment would be an undesirable outcome of this review.

The Dairy Council notes that the dairy industry within the catchment provides considerable economic benefit to the community in terms of jobs on farms and along the food supply chain, supporting local businesses, schools and community groups. They believe that the future management of the water assets in the Geographe catchment should include the agricultural community, recognising they are part of the long-term solution and the need to work collaboratively to ensure improvements on farm and throughout the wider catchment.

Fertiliser industry

The fertiliser industry did not make a submission to this review.

However, a representative of Summit Fertiliser (Ralph Papalia) provided useful information on the range of advice his company provides to farmers on fertiliser use, including subsidised soil testing. He noted that trust in the advice providers was a very important element in farmers accepting advice on fertiliser management.

The fertiliser industry is an active partner in the Fertiliser Partnership 2012-2016¹³ established by DAFWA, DoW, DER and the Swan River Trust.

4.3 Future management options

This section presents and discusses three options for the future management of the Geographe water-related assets. The main features of the three options are shown diagrammatically in Figure 10.

4.3.1 Option 1: Catchment and wetland management authority

This Option would permit the key assets within the Geographe catchment to be managed as an integrated system and by a single 'lead' organisation (Figure 10a).

The establishment of such an Authority would mirror the situation in other Australian states (e.g. Victoria¹⁴, NSW¹⁵, Qld and SA), where a range of slightly different types of catchment (or natural resource) management authorities have been formed. In general, these all have a common goal to provide for the integrated management of natural resources, using catchments as the administrative boundaries.

The Option below is built around the Victorian catchment management framework (see Appendix C), but with the two important wetlands – the Vasse-Wonnerup wetlands and Toby Inlet – also included. This is something the Victorians have not been able to achieve, despite coming very close to merging CMAs and Coastal Boards in 2010.

Structure

A catchment and wetland management authority would be established, with an independent skill-based Board. The Board members would be appointed by the Minister for Water for a period of three years. The composition of the Board would include: an independent chair, 5-6 community members with requisite skills, with agency (DoW, DPaW, DAFWA, Water Corp, BWC) and local government (CoC, SoC) representation as observer status.

The Authority should be closely aligned with DoW, DPaW and DAFWA.

The functions of the Authority would be to:

- develop a five-year Geographe Regional Catchment Strategy encompassing the Geographe catchment, the Vasse-Wonnerup wetlands, Toby Inlet and the Lower Vasse River,
- develop and implement appropriate Management Action Plans for priority assets (e.g. catchment waterways, Vasse-Wonnerup wetlands, Toby Inlet),
- develop and implement an adequate monitoring and reporting program,
- commission necessary research to increase the knowledge-base of the assets.

The Geographe Regional Catchment Strategy should have as its goal to contribute to maintaining (or achieving) the long-term productivity of agricultural land, to sustainable urban development, and to maintaining the health of the environment. The Strategy should include a focus on ensuring that:

- agricultural production and urban development is sustainable,
- the ecological condition of the catchment's waterways (rivers, wetlands, estuaries) are protected, maintained and enhanced,
- the catchment's biodiversity (animals, plants, ecosystems) is protected, maintained and enhanced,

¹³ <http://fertiliserpartnership.agric.wa.gov.au/fertiliser-partnership-0>

¹⁴ www.vcmc.vic.gov.au/

¹⁵ www.cma.nsw.gov.au/

- the catchment's cultural values are protected, maintained and enhanced,
- the catchment's drainage systems are appropriate and effectively managed,
- adequate monitoring and assessment is undertaken and reported, so that the effectiveness of the management can be assessed.

Legislation

It would be preferable if a Geographe Catchment and Wetland Management Authority was established under new state-wide legislation, since the Geographe catchment is not the only one in Western Australia that would benefit from an integrated approach.

However, if the WA Government do not wish to establish the necessary new legislation, there are other options available, e.g. to establish a catchment and wetland management authority under the Water Conservation Act.

Resourcing

Obviously, the establishment of a new Authority will require additional quite substantial resources, and a commitment by Government that this commitment will be sustained for at least 10-years. An estimate of the quantum of the required commitment is around \$3-5 million p.a for this period.

Assessment of the option

Pros – This option would provide a new integrated approach to the management of natural resources in the Geographe region (and perhaps also other regions of Western Australia). There would be a single authority with well defined roles and responsibilities that could develop over time a systems and coordinated approach management of the catchment's resources.

Cons – This option will require new arrangements, preferable also new legislation, to be established by government. It will also require the long-term commitment of a substantial investment portfolio. And it will take some time to establish the Geographe Catchment and Wetland Management Authority as a functioning entity with the necessary skills, expertise and know-how. There is also some possibility that existing agencies may feel that their role is being usurped.

4.3.2 Option 2: Overall lead agency coordinating the separate asset management arrangements

This Option would see the key water-related assets being managed as separate entities, but with an overall coordinating lead agency (Figure 10b). The separate water-related assets to be managed would be the Geographe catchment (including the drainage network), the Vasse-Wonnerup wetlands, the Lower Vasse River 'lake' in Busselton and Toby Inlet. A lead agency has been identified for each of the assets. It is anticipated that this governance structure would allow the management objectives, roles and responsibilities of the key agencies and the resources needed for each asset to be more focused and better defined, with the separate asset management arrangements better coordinated by the overall lead agency.

Overall Coordinating Body (Lead Agency)

Three options for the overall coordinating body are discussed:

- *Restructured Geographe Catchment Council* – In their submission to the review, GeoCatch indicated that they would be prepared to undertake the role of lead agency provided a number of changes were made to their present structure (see Section 4.2.2 above), the most important of these being adequate secure funding and resources (core staff salaries, administration and operating expenses) and a mandate (possibly Ministerial authority) to undertake the coordinating role. Apparently, a somewhat similar coordinating role to that suggested for the 'lead agency' was envisaged for GeoCatch when originally established in 1997. However, the capacity for GeoCatch to deliver on this overall coordinating role has been significantly reduced because of a lack of core funding and a lack of a legislative or Ministerial mandate.

This option is somewhat similar to the management arrangements currently existing for the Peel-Harvey catchment. A restructured GeoCatch could certainly achieve the objective of a effective coordinating body, but only if adequately resourced with a stable and competent staff, and with a legislative or Ministerial authority to achieve the necessary coordination.

- *Busselton Water Corporation* – It was noted in Section 4.2.10 above, that BWC have expressed an interest in exploring the option of them becoming the 'infrastructure manager' of the rural drainage network, with water quality objectives included in their Operating Licence,

and in time possibly assuming a broader ‘waterways manager’ role. If they took on this role they would be playing a critical and central part in the management of the Geographe catchment water assets, and would be potentially well placed to take a ‘lead agency’ role in the overall waterways management. BWC has not evaluated this concept but have indicated they are open to this possibility.

The option of BWC taking a ‘lead agency’ role in the overall waterways management in the Geographe region is attractive, as they have a proven ‘corporate’ structure with a skill-based board, a viable senior management structure, and considerable experience in on-ground infrastructure management. Also they are locally-based and should be more responsive to local needs. If BWC were to evolve to a ‘lead agency’ role, this would mirror the very successful Melbourne Water Corporation (MWC) model, where MWC has responsibility for bulk water supply, wastewater treatment and waterways management (rivers, wetlands, drainage) for the city of Melbourne.

- *Ministerial Task Force* – Government may feel that it is too early to consider BWC as lead agency since they have yet to take on the role of drainage network infrastructure manager, and therefore have yet to show they can do this effectively. To allow for a transition to BWC possibly becoming lead agency, Government consider the appoint of a Ministerial Task Force to perform the function of lead agency for a period of 3-5 years. A possible structure for this Task Force would be: an independent chair and representatives from the key organisations (e.g. DoW, DPaW, DAFWA, DoF, CoB, SoC, GeoCatch), served by an Executive Officer and an Administrative Officer.
- *Department of Water* – As noted above (Section 4.2.1), the role of DoW in the management of the State’s waterways (rivers, wetlands and catchments) and catchments is unclear. However, a reasonable interpretation of the Acts they administer would suggest they have sufficient powers to play a significant role in the management of the State’s waterways (quality and quantity) and their associated catchment should they wish. Certainly, no other agency has such a comprehensive role in these areas.

DoW could assume the role of lead agency for the management of water-related assets in the Geographe catchment. In fact, they are currently undertaking this role in the catchment (implementation of the WQIP), and in the Vasse-Wonnerup wetlands (chairs the VETWG). However, to undertake the lead agency role envisage for this Option, would require the Minister for Water making a commitment that DoW assume the role of lead agency and providing the necessary resources for this to occur. Ministerial support would be vital to ensure the Department makes the necessary commitment of resources to ensure this option works.

However, whatever form of lead agency is decided by Government, it is suggested that such a model would need to include:

- The lead agency and supporting agencies to all have clear accountabilities,
- These accountabilities would need to be tied to a single overall Management Plan,
- Legislation and regulation must be available where required to compel compliance with water quality objectives,
- The lead and supporting agencies would need to be funded and resourced to levels that match the accountabilities and expected outcomes.

In considering the above options, this review concludes that the Minister for Water should consider in order the options for lead coordinating body as: (a) DoW, (b) a restructured GeoCatch, and (c) a Ministerial Task Force with transition to a corporate model involving BWC.

Geographe catchment

Currently, the management of this catchment is informed by the WQIP, with the lead organisations being GeoCatch and DoW. The management plan is largely focused on reducing the load of nutrients from this catchment through the introduction of best management practices in agricultural and urban areas.

The proposed future management arrangements would build upon this existing structure.

Lead organisation – This should be GeoCatch and DoW, with continuing assistance from DAFWA, Water Corp (BWC), CoB and SoC. The current GeoCatch structure (representatives of community,

local government and agencies) seems adequate, but the size (15) should be reduced. The current partnership with DoW seems to be working well.

Management plan – A broader catchment management plan should be developed by building on the current WQIP, but with other elements of catchment management included. These could be: river health, biodiversity, soil & land management, pest plants & animals and drainage. GeoCatch has already developed a Catchment Management Plan (GeoCatch, 2008) that covers most of these elements. They have also developed a number of River Action Plans (e.g. see GeoCatch, 2010). This would also be a good opportunity to develop a catchment drainage strategy, with the capacity to rationalise the current drainage network and consider reconfiguring some of the drains to be multi-purpose, along the lines suggested by the Peel-Harvey Catchment Council (Del Marcos, 2007).

Implementation – The current focus on dairy shed effluent management, fertiliser management and riparian zone fencing and revegetation should be continued, as should the focus on the catchments of the river flowing into the Vasse-Wonnerup wetlands (i.e. Lower Sabina River, Lower Vasse River, Ludlow River and Abba River).

Resources – Both the number of professional staff and funds for BMP investment need to be increased for this Plan to have any chance of success. Funding in the order of \$2.5 million p.a. over the next decade is required. While this funding should focus on the implementation of existing BMPs, these and other BMPs should be measured at the small scale to provide feedback on their success or otherwise.

Pros – This option builds on existing structure. It should be relatively easy to expand the current organisational structure and implementation program that has been in place for 5 years. If this option were accepted the community and government would have greater confidence that management of this important catchment would be improved and that within ten years, the nutrient loads entering the Vasse-Wonnerup wetlands and Geographe Bay would be significantly reduced.

Cons – The success of this option is highly dependent upon sufficient resources being found to fund GeoCatch's activities in implementing BMPs. In those cases where uptake of BMP's is not occurring, there may be a need for mandatory requirement to be introduced.

Vasse-Wonnerup wetlands

These wetlands now receive much less freshwater inflow as a result of the extensive catchment drainage network, are cut off from the ocean by floodgates, and receive excessive amounts of nutrients from the catchment. As a result, there is increased growth of unwanted algae. However, despite these changes the wetlands still have high biodiversity and ecological values; they support a great abundance and variety of waterbirds, and have good populations of macrophytes (e.g. *Ruppia megacarpa*), fish and macroinvertebrates.

Currently, there is no comprehensive strategic management plan for these wetlands despite the fact that they are Ramsar-listed. A new emergency 'Fish Kill Mitigation and Response Plan' has been developed and is in place for the 2013-14 summer.

Lead organisation – This should be DPaW. DPaW will have the statutory responsibility for developing a strategic management plan for these wetlands once they become part of the WA Conservation Estate. And as noted in Section 2.3.3, DPaW already manage about one-third of the Vasse-Wonnerup Ramsar site, but this does not include any of the waterbody. Additionally, DPaW are currently preparing a draft management plan for the southern Swan Coastal Plain, which proposes inclusion of the majority of the Vasse-Wonnerup wetland area into the Conservation Estate. Although this inclusion is dependant on a native title determination, DPaW could lead the development and implementation of a non-statutory management plan for the wetlands in the interim.

Partner organisations should include: DoW, GeoCatch, DoF, Water Corp (BWC), CoB and SoC. The community input would occur via the involvement of GeoCatch.

Management plan – A 5-year comprehensive non-statutory strategic management plan should be developed for these wetlands, with multiple objectives (e.g. waterbird populations, water quality, ecological health, cultural values, recreation, aesthetics and flood protection). There will be many members of the community who will wish to have an input into the development of such a Plan. This Plan should also incorporate the main elements of the current emergency *Fish Kill Mitigation and Response Plan*, and be closely linked to the Catchment Management Plan since the long-term solution to many of the wetlands problems is ultimately dependent on reduction of nutrient inputs.

Given that a strategic management plan will take some time to prepare, the current VETWG and the Fish Kill Mitigation and Response Plan should be continued for a further 2-years (2014-2016), with DoW as the lead agency.

Implementation – The new Plan should commence as soon as possible.

Resources – This option will require DPaW committing adequate resources to wetland management in the Geographe region.

Pros – This option would see the development of a much needed management plan for a Ramsar-listed wetland system. It goes far beyond the current emergency response plans, and would address issues of great relevance to the community, including how best to minimise the possibility of fish kills, obnoxious odours and algal blooms. The Plan could also build on the extensive ecological knowledge obtained over last 5-6 years to protect and maintain water bird habitat and food sources. The establishment of an single lead organisation would also permit other management options to be investigated and perhaps adopted. These could include: redirecting part of the Capel River flow into the top of Wonnerup wetland to provide additional freshwater input at critical times, to redirect more flow into the Lower Sabina River (from the diversion channel taking Sabina River flow to the Vasse Diversion Drain) again providing more freshwater into the Vasse wetland, to modify the operation of the floodgates, to improve controls on cattle grazing on land surrounding the wetlands, and to dredge the Vasse wetland to remove nutrient-laden sediments.

Cons – This option is dependent upon DPaW (or the WA Government) agreeing to take the responsibility for managing this wetland system, and providing adequately resources to make this happen.

Lower Vasse River

The Lower Vasse River is maintained as an artificial lake ('lake') in Busselton for recreational and aesthetic purposes. This 'lake' is eutrophic and regularly experiences algal blooms over most of summer, which reduce its recreational and amenity value and causes offensive odours. The current management of the Lower Vasse River, and particularly the 'lake' section in Busselton is far from ideal; there is no comprehensive management plan and no obvious lead agency.

Lead organisation – This should be CoB, with continuing assistance from DoW. It seems appropriate that CoB manage this 'lake' asset, particularly since they are the organisation that wishes to artificially maintain the river as a 'lake' during the summer period, which provides the ideal condition for the annual algal blooms. There would be value in CoB developing a formal Partnership Agreement with DoW to define the roles and responsibilities of each organisation in managing this section of the Lower Vasse River.

Management plan – CoB should undertake a cost-benefit assessment of two options: (a) the removal of the artificial lake and reverting to a dry river bed during summer, and (b) the continuation of the artificial lake with an assessment of the on-going costs. If the latter option is chosen, an operational management plan needs to be developed for the 'lake' section of the river. This Plan should cover: operation of the water-retaining boards at the Butter Factory, operation of the valve allowing water to flow from the Vasse Diversion Drain to the Lower Vasse River, adequate monitoring of water quality and phytoplankton levels (should continue to be done by DoW), a set of responses dependant on predetermined triggers (e.g. based on DO and/or phytoplankton levels), and actions (e.g. warning notices, clean up) to be taken in the event of an algal bloom.

Implementation – The chosen option should commence as soon as possible.

Resources – If the agreed option is to retain the artificial lake, this will obviously result in increased resources being required by CoB to undertake the required management. There are several options for raising funds, including an increase in rates for Busselton residents or the setting of a special 'environmental levy' (see Section 4.2.8 above). The development of a Management Plan will take several months, and will require input from other organisations and the community. CoB will also need to decide whether they develop in-house skills to manage this asset or contract out the management.

Pros – CoB as the lead agency would make for a clearer line of management responsibility. The cost-benefit assessment of the two options would make it clear to the Busselton residents what is required (including additional resources) in retaining the artificial lake as the preferred option.

Cons - This option is dependent upon CoB agreeing to accept the extra responsibility and adequately resourcing it.

Vasse Diversion Drain

For this Option, the management of the rural drainage network (including the Vasse Diversion Drain) should be linked more closely with the management of the waterways system of the Geographe catchment, and involve new water quality requirements.

The Vasse Diversion Drain, currently managed by the Water Corporation, is an extremely important asset in providing flood protection for Busselton. There is a possibility that in the future the newly formed Busselton Water Corporation may take over responsibility for the Vasse Diversion Drain and other drainage assets in the Geographe catchment.

However, no matter what management arrangements transpire for the Geographe rural drainage network, there should be an independent review of the drainage network to assess (a) its current and future relevance and effectiveness, (b) the relevance of the current '72h rule', (c) what can be done to make this drainage network more effective at reducing nutrients in addition to its flood protection and land drainage functions, and (d) what can be done to reconnect some of the natural waterways that are influenced by drains.

Toby Inlet

Toby Inlet experiences regular blooms of macroalgae and phytoplankton, and offensive odours when these algal blooms die. These issues are the result of excessive nutrient inputs to the estuary, and a lack of adequate flushing.

Lead organisation – This should be the CoB, with close links to DoW, GeoCatch, DPaW, Water Corp and TICG. The CoB may wish to explore the establishment of an MoU between the key groups, similar to that for the Vasse-Wonnerup wetlands and VETWG.

Management plan – An operational management plan should to be developed, to address the key values of these wetlands (e.g. maintenance and protection of water birds, water quality, ecological health, recreation, aesthetics and flood protection). This should build on the existing *Management Plan for Toby Inlet Foreshore and Waters* (TICG, 2006). An initial component of this management plan should be to establish a solution to the lack of adequate flushing of the Inlet caused by the Station Gully Drain and associated causeway. The Water Corporation were requested to comment on the advantages and disadvantages of either removing the causeway or significantly enlarging the culvert; they did not respond. DoW should continue to monitor water quality in Toby Inlet.

Implementation – The new Plan should commence as soon as possible.

Resources – This option will require additional resources being made available to CoB and DoW. Again there are several options for raising funds, including an increase in rates for Busselton residents or the setting of a special 'environmental levy'. The Plan will take several months to develop with input from other organisations and the community. CoB will also need to decide whether they develop in-house skills to manage this asset or contract out the management.

Pros – This option would introduce a much strengthened management plan for this important asset. It builds upon an enthusiastic and knowledgeable community group who have been attempting to manage Toby Inlet for many years, but with minimal resources.

Cons - This option is dependent upon CoB agreeing to accept the extra responsibility and adequately resourcing it.

4.3.3 Option 3: Separate management arrangements

This Option is similar to Option 2 except that there is no overall lead agency with a coordination role (Figure 10c). This represents a minimal change to the existing governance structure, with the key water-related assets being managed as separate entities. However, there are some significant changes to that existing, including: (a) the water-related assets have been organised into three larger assets for management (the Geographe catchment and drainage network, the Vasse-Wonnerup wetlands, and the lower Vasse River and Toby Inlet), (b) a lead agency for each of these assets is clearly identified, and (c) the requirement that a management plan be developed that clearly identifies the management objectives, roles and responsibilities of the key agencies and the resources needed.

The details on each of the water-related assets are the same as in Section 4.3.2.

An advantage of this Option is that it would cost less since there is no overall coordinating lead agency. However, this lack of an overall coordinating body would represent a significant disadvantage manifesting in the potential poor communications between the separate management groups.

4.4 Investment needed

The desired improvement in the 'health' of the Geographe catchment and associated rivers and wetlands is unlikely to occur unless there is focused and effective management action plans, and a long term commitment to appropriately fund the core activities.

It is clear that which ever management option is selected, it will need to be adequately resourced for at least a decade in order to make a significant improvement in the condition of the key water-related assets. An initial estimate is that funding of the order of \$3-5 million per year will be required over at least a decade.

The raising of these funds will be a challenge. Federal funding for NRM activities (e.g. Caring for Country) has been cut back and there is no guarantee that a new scheme will be introduced in the near future. Additionally, funding opportunities in Western Australia are limited, with traditional sources (e.g. State NRM funds) either cut or significantly reduced.

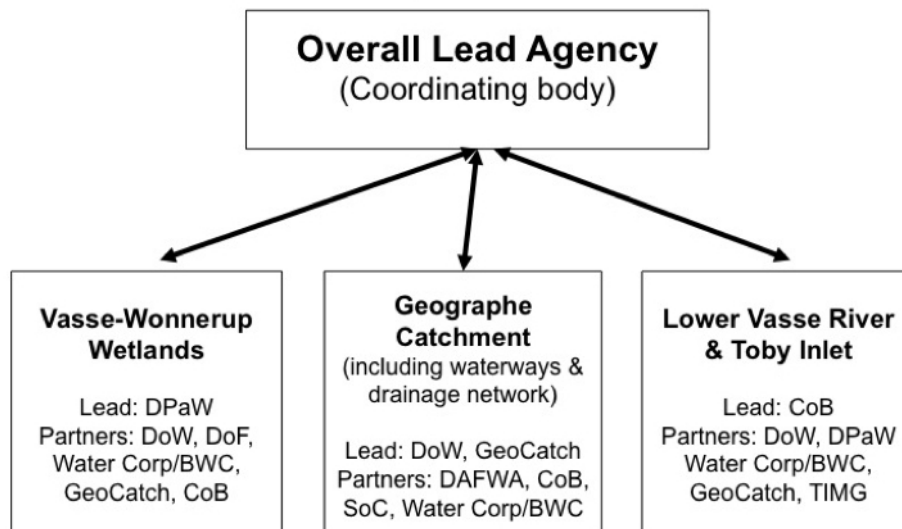
The following options should be considered to raise funds for these activities:

- A special grant by the Western Australian government to fund *Geographe catchment and Vasse-Wonnerup Wetlands Action Plan*,
- Making a bid to the 'Royalties for Regions' fund to provide resources for the improved management of the Geographe catchment and associated waterways and wetlands,
- Introduction of a 'catchment levy' on all ratepayers in the Geographe catchment,
- Introduction of a special 'environmental levy' on urban ratepayers by CoB to assist in managing the Lower Vasse River, the Vasse-Wonnerup wetlands and Toby Inlet,
- The introduction of a 'fertiliser levy' with the funds going to assist in the implementation of better fertiliser management in the Geographe catchment,
- Reintroduce a 'drainage levy' for rural properties to assist in the restructuring of the existing drainage network.

(a) Option 1



(b) Option 2



(c) Option 3

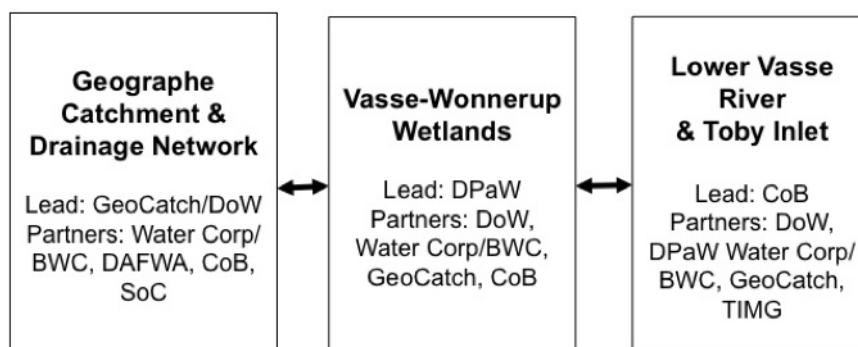


Figure 10: Diagram showing the main features of the three management options

5. Recommendations and priority actions

5.1 Management arrangements

This review has found that, while there are a number of very good aspects of the current management of the water-related assets of the Geographe catchment, there is generally a lack of a coordinated approach, lack of obvious lead agencies, lack of management plans (exception is the WQIP), and an overall lack of sufficient resources to make a difference. There is considerable room for improvement. 'Business as usual' should not be considered as a viable option as this would inevitably lead to further deterioration in the condition of the catchment's waterways, including the Vasse-Wonnerup wetlands.

Three possible future management Options have been presented, these being:

- Option 1: the establishment of a Geographe Catchment and Wetlands Management Authority,
- Option 2: the establishment of an overall lead agency to coordinate the separate asset management arrangements,
- Option 3: the establishment of separate asset management without coordination.

Consideration of only the first two is recommended, since a major concern of the community has been the lack of coordination between the agencies and organisations involved in the management of the water-related assets in the Geographe region.

The recommendations from this review are:

Rec1: That the Minister adopt management Option 1 (Figure 10a).

Rec 2: In the event that Rec 1 is not accepted, that the Minister adopt management Option 2 (Figure 10b). The Minister should consider in order the lead coordinating body being (a) DoW, (b) a restructured GeoCatch, and (c) a Ministerial Task Force with transition to a corporate model involving BWC (see Section 4.3.2 for details). Whatever form of lead coordinating body is agreed, this body must have the necessary powers to be able to exercise its functions effectively. This could take the form of an authority from the Minister for Water, or all three Ministers involved (Water, Environment and Agriculture/Fisheries).

Rec 3: In the event that Rec 2 is accepted, that the arrangements outlined in Section 4.3.2 be established for the management of (a) the Geographe catchment (including waterways and rural drainage network), (b) the Vasse-Wonnerup wetlands, and (c) the Lower Vasse River and Toby Inlet.

Rec 4: That high priority be placed on the immediate development and implementation of a non-statutory management plan for the Vasse-Wonnerup wetlands, that incorporates both the VETWG and the emergency 'Fish Kill Mitigation and Response Plan'.

Rec 5: That until the Vasse-Wonnerup wetlands management plan is established, VETWG be retained (with DoW as chair) to implement the emergency 'Fish Kill Mitigation and Response Plan'.

Rec 6: That the lead agency for each of the water-related assets report annually to the community on both the asset condition (health) and effectiveness of management (perhaps using a simple Report Card format).

Rec 7: That an independent review of the Geographe catchment drainage network be commissioned to assess (a) its current and future relevance, including the current relevance of the '72 hour rule', (b) what might be done to make this drainage network more effective at reducing nutrients in addition to its flood protection and land drainage functions, and (c) the potential for reengineering the drainage system to reconnect natural waterways adversely affected by drains and to provide more freshwater inflow into the Vasse-Wonnerup wetlands and the Lower Vasse River.

Rec 8: That the current Geographe Water Quality Improvement Plan be reviewed with a view to updating it and expanding it into a broader Catchment and Wetland Management Plan, and that the implementation of this new plan be empowered by the Minister for Water.

Rec 9: That DoW continue to provide the science to underpin the management of the Geographe catchment waterways, Vasse-Wonnerup wetlands and Toby Inlet, including the current water quality monitoring program, catchment modeling, and scientific investigations.

Rec 10: That a research plan be developed for water-related assets in the Geographe catchment to identify the key knowledge needs, and the organisations able to conduct the necessary research (e.g. universities, CSIRO, DoW, DFWA).

Rec 11: That DAFWA (in collaboration with DoW) undertake a program to better assess the effectiveness of the current agricultural BMPs.

Rec 12: That dairy sheds become a 'prescribed category' by amending Schedule 1 of the Environmental Protection Regulations 1987 to ensure best management practices are adopted.

5.2 Resourcing

The desired improvement in the 'health' of the Geographe catchment and associated rivers and wetlands is unlikely to occur unless there is focused and effective management action plans, and a long term commitment to appropriately fund the core activities. Which ever management option is adopted, it will need to be adequately resourced for at least a decade in order to make a significant improvement in the condition of the Geographe key water-related assets. An initial estimate is that funding of the order of \$3-5 million per year will be required.

Rec 13: That the WA Government establish a fund of \$30 million over 10-years to provide core funding for the enhanced management of the water-related assets of the Geographe catchment, including the Vasse-Wonnerup wetlands.

Rec 14: That as part of this fund, the WA Government consider the options listed in Section 4.4, namely a bid to the Royalties for Regions fund, introduction of a 'catchment levy' on all ratepayers in the Geographe catchment, introduction of a special 'environmental levy' on urban ratepayers by CoB, introduction of a fertiliser levy with the funds going to assist in the implementation of better fertiliser management in the Geographe catchment, and reintroduce a drainage levy for rural properties to assist in the restructuring of the existing drainage network.

5.3 Priorities actions

This independent review was commissioned largely because of the concern of the Busselton community at what they saw as the lack of an agreed lead agency, and a lack coordination and action by the agencies involved in the management of the Vasse-Wonnerup wetlands.

The review scope has been broader than just the Vasse-Wonnerup wetlands and the recommendations above reflect this broader scope. However, it will be important that the community are convinced that urgent action is being taken on those issues of concern to them.

This need is reflected in the priority actions listed below.

1. *Agree to develop and implement a non-statutory strategic management plan for the Vasse-Wonnerup wetlands, that incorporates both the VETWG and the emergency 'Fish Kill Mitigation and Response Plan' (Rec 4). This Plan must include consideration of the most appropriate operation of the floodgates and the desirability and feasibility of dredging the Vasse wetland.*
2. *Agree that, until the Vasse-Wonnerup wetlands management plan is operational, VETWG be retained (with DoW as chair) to implement the emergency 'Fish Kill Mitigation and Response Plan' (Rec 5).*
3. *Decide upon the future overall management structure, including its resourcing, and implement the necessary arrangements (Recs 1, 2, 3, 4, 5, 13, 14).*
4. *Review the existing WQIP with a view to broadening it into a catchment and wetland management plan (Rec 8).*
5. *Establish an independent review of the Geographe rural drainage network (Rec 7).*
6. *Introduce regulations to ensure BMPs for dairies are adopted (Rec 12).*

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Appendix A: Submissions on the Discussion Document

| Submission | Address |
|---------------------------------------------------------|----------------------|
| Baldock, Michael | Dunsborough |
| Brain, Scott | Perth |
| Bussell, Vern | Busselton |
| Busselton & Districts Residents Association Inc. | Busselton |
| Busselton Dunsborough Environment Centre Inc. | Busselton |
| Busselton Water Corporation | Busselton |
| Busselton Wetlands Project Team | Busselton |
| Chapman, Gregory | Busselton |
| Chapman, Kieran | Kalgup |
| Chartres, Mike | Reinscourt |
| City of Busselton | Busselton |
| City of Busselton Environment Reference Group | Busselton |
| Clemenceau, Diane | Margaret River |
| Dale, David | South Perth |
| Department of Fisheries | Busselton |
| Dunsborough Coast and Land Care Inc. | Dunsborough |
| Elphick, Jocelyn | Busselton |
| Farquharson, Bill | Busselton |
| Farquharson, Margaret | Busselton |
| Fitzgerald, Peter | Bunbury |
| Geographe Catchment Council | Busselton |
| Grist, Rod | Quindalup |
| Hipplewhite, Christopher, Department of the Environment | Perth |
| Lynch, Dr Kath, Department of Water | Busselton |
| Maidment, Geoffrey | Cowaramup |
| Masters, Bernie | Busselton |
| Miles, Shane and Alan | Dunsborough |
| Norton & Sons | Capel |
| Paice, Robyn | Quindalup |
| Robb, Malcolm, Department of Water | Perth |
| Shire of Capel | Capel |
| Skitmore, Peter, Department of Environment Regulation | Perth |
| South West Catchment Council | Bunbury |
| Strong, Margaret | Busselton |
| Summers, Dr Robert, DAFWA | Busselton |
| WA Department of Fisheries | Perth |
| WA Farmers (Dairy Section) | Perth |
| Weaver, Dr Mike, DAFWA | Albany |
| Western Dairy and Dairy Australia | Mundijong, Melbourne |
| Winchcombe, Brian | Dunsborough |

Appendix B: Assessment of the implementation of BMPs in the Geographe Catchment

Implementation of the WQIP is being led by GeoCatch and DoW, with assistance from DAFWA, CoB and CoC. The program is based largely on the voluntary adoption of Best Management Practices (BMP) to reduce nutrient inputs from both agricultural and urban areas. A number of BMPs were identified in the WQIP, which if fully implemented, would significantly reduce the nutrient losses from agricultural land and urban areas.

In agricultural areas, priority has been placed on BMPs for management of dairy sheds and feedlots, fertiliser management, implementing riparian management, and controlling of stock on waterways.

In urban areas, priority has been placed on management of point sources (wastewater treatment plants, septic tanks), incorporating water sensitive urban design in new residential developments, and limiting fertiliser use in urban areas.

Since 2009, priority has been given to activities to improve water quality in recovery catchment as required by the WQIP. Some projects are specific to priority catchments, for example riparian fencing projects to improve water quality¹⁶. Others, such as \$mart Soils, used an eligibility matrix that prioritised farms in recovery catchments, but also included other sub-catchments, depending on farm size and rates of land-holder participation (Pers Comm, D. Mussell, GeoCatch, January 2014).

A review of the progress of the implementation of the various BMPs in the Geographe Catchment is provided under the BMP headings below.

Fertiliser Management

Considerable headway in on-farm fertiliser management in the Geographe catchment has occurred, particularly in the 2011/2012 period, through the \$mart Soils program. \$mart Soils was coordinated by the GeoCatch, with the aim of reducing nutrient run-off from Geographe Catchment farms. The program had particular focus on phosphorus fertiliser application on grazing properties and how farmers can improve their efficiency of application, resulting in reduced runoff into nearby waterways. The program consisted of whole farm soil testing, nutrient mapping, and soil/pasture management workshops carried out for 80 farms, totaling around 18,000 ha of grazing land in the catchment (~25%) (GeoCatch, 2013a).

The priority catchments, Sabina and Ludlow, that flow into the Vasse-Wonnerup Wetlands, had a significant area tested and mapped (52% and 79% respectively) under the \$mart Soils program (Table A1).

A survey of the program participants found that 89% of participants said \$mart Soils influenced their decisions (64% saying it was the main influence) to apply fertiliser. Further, 58% of participants said that they reduced the amount of phosphorus that they applied in that year. A large majority of participants (81%) said that they used the \$mart Soils maps to create a strategy of application. The number of participants who said that they would not apply P to the paddocks on their farm that was green (high P) was high (42%), while 33% said that they applied more to low P paddocks and less to high P paddocks (GeoCatch, 2013a).

Other programs that have been implemented in the past to improve fertiliser management in the Geographe catchment are the:

- Better Fertiliser Management Decision for Grazed Pasture in Australia (Dairy and Beef 2003- 2007),
- Accounting for Nutrients on Dairy Farms (Dairy) ,
- DairyCatch (Dairy) ,

¹⁶ Some riparian zone fencing projects have also targeted ecological values/biodiversity in other (non-priority) catchments.

- Nutrient Smart (Dairy) ,
- Greener Pastures (Dairy),
- DAFWA Fertiliser Action Plan soil testing (Dairy and Beef).

GeoCatch identified that one of the key challenges for these types of programs is presenting a consistent message to land-owners regarding fertiliser management. This involves having consistent, agreed and fully integrated protocols from soil testing to application guidelines. Farmers need to have confidence in the methods, and this is currently limited in the farming community due to mixed messages from NRM groups, government agencies and private fertiliser company consultants (GeoCatch, 2013a).

Dairy Shed Effluent

Effluent management support for dairy sheds in the Geographe catchment has been on-going since 2003. There are approximately 46 dairy farms in operation in the Geographe catchment, with an average size herd of 300-400 cows. Of these, 15 dairy farms received effluent system funding through the 'Upgrading dairy effluent systems in Vasse WQIP' project in 2011-2012. DairyCatch, which ran from 2003 to 2005, also assisted ten farms with upgrades to their effluent systems (but many more south-west region) while the EII (Environmental Improvement Initiative, 2000-2004) project initiated through the Water Corporation funded 26 effluent system upgrades in the catchment (Water Corp, 2007). All but one farm in the WQIP upgrade program (and totaling over 80% of all dairy farmers in the catchment) have been involved in dairy effluent management (EII or DairyCatch) programs in the past (GeoCatch, 2013b, 2014).

Despite the high participation rates of effluent upgrade projects undertaken in the catchment, it is estimated that less than 20% of dairy sheds have an effluent system that is functioning to best management practice standards. Some farmers are working towards BMP systems, but due to financial constraints are having to complete their system upgrades in stages as funds become available (programs such as the WQIP effluent upgrade project supported 'staged' implementation of works). The remainder of farmers who have not recently been involved in effluent management projects are likely to perceive the system upgrades as too financially costly, not a priority (as unregulated), or not relevant to them or their business. There is also a perception that good system design for WA is not readily available and that many past projects have failed to improve effluent management over time due to unsuitable equipment choices, changes in herd size and high maintenance/labour requirements (GeoCatch, 2013b).

An evaluation revealed that effluent system upgrades require \$50,000-\$100,000 in materials and equipment, not including the farmer's in kind labour contributions to install items. The importance of incentive funds was acknowledged by the farmers with the majority making comment that they would not have undertaken their system upgrade if the incentive funds were not available. The project participants were generally motivated to participate in the project due to concern for the impact of effluent on water quality and/or their neighbours and/or to be able to utilise the value of the nutrients contained in effluent to improve pasture and reduce fertiliser costs (GeoCatch, 2013b).

The priority catchments that flow into the Vasse-Wonnerup Wetlands (Sabina and Ludlow), had a significant proportion of dairies upgraded in their catchments (75% and 50%) (Table A2).

Unlike in other states (e.g. Victoria), there are no mandatory requirements to collect and treat dairy shed runoff. However, GeoCatch, in partnership with Dairy Australia, Western Dairy and farmers, developed a Code of Practice for Dairy Shed Effluent Management in 2011 (Dairy Australia, 2012a,b). This code has been successful in setting the standard for effluent management in south-west WA, but it is voluntary and has no legislative backing.

Riparian zone management and stock control

Best practice riparian management is a high priority identified in the WQIP, as modelling shows that stock exclusion alone can contribute significant nutrient management benefits through prevention of direct fouling and erosion. GeoCatch has attracted significant funding to implement best practice riparian management on rural properties, focusing on recovery sub catchments (GeoCatch, 2013c, Table A3).

GeoCatch has facilitated over 362 km of fencing on private land since 1997 equating to over \$4 million in funding incentives allocated to landholders.

Prior to the WQIP, considerable riparian zone management occurred from 1997-2009 through the development and implementation of River Action Plans. RAPs involved a riverbank condition assessment and rating of riparian areas, together with reach-by-reach recommendations to improve riverbank condition. RAPS were developed by GeoCatch for: Capel River in 1999, Vasse River in 2000, Caribunup River in 2000, Sabina, Abba and Ludlow Rivers in 2002, Gynudup Brook and Tren Creek in 2004, Cape Naturaliste Streams in 2005 and 2006, Buayanyup River in 2010, and the Upper Capel River in 2010 (completed by Shire of Capel).

Activity in this area has been significant over the period since 2009 (see Figure A1). Funding priority has been given to landholders in priority sub-catchments since 2010, however interest from landholders in these areas has slowed, indicating that 'saturation point' of voluntary uptake may have been reached with existing landholders. A different approach will be required to complete the required level of fencing in these sub-catchments. Interest in funding for riparian management remains high in other (intervention and protection) sub-catchments.

Urban BMPs

GeoCatch has successfully engaged with the community, as identified in the WQIP, to reduce diffuse urban nutrient inputs. GeoCatch developed the Bay OK program to raise awareness of the water assets in the catchment (waterways, wetlands and Geographe Bay) and link community actions (e.g. fertiliser use) with improving water quality and protecting Geographe Bay. Bay OK seminar series, workshops, information packs, website and facebook page have been coordinated to engage, inform and motivate the local community. Bay OK also works with urban residents to become aware of their 'nutrient footprint' and improve their gardening practices (GeoCatch, 2013c).

Bay OK also has a 'recognition program' component, where businesses and schools can be recognised as 'Bay Friendly' if they meet certain criteria. GeoCatch has completed nutrient audits and management plans for 64 businesses and accredited 25 Bay Friendly Businesses and two Bay Friendly Schools.

Undertaking strategic retrofitting of water sensitive urban design in urban areas was also identified in the WQIP as a priority and has been a significant project for GeoCatch in partnership with local government and the Department of Water. GeoCatch has identified high risk large urban fertiliser users such as public open space and golf courses as a significant source of nutrients. GeoCatch has conducted 26 audits and provided management plans to improve water and fertiliser efficiencies. Fourteen urban drainage upgrades have been undertaken since 2007, reducing nutrients and pollutants leaving urban areas. The project has received two state awards in 2013 for its innovative approach and partnerships.

GeoCatch are now beginning to target new developers to engage new residents at the planning stages of their residential lots to ensure low nutrient options are given consideration. Nutrients from urban residential areas are predicted to increase faster than any other source as the Busselton population expands in the coming decades (GeoCatch, 2013c).

Urban point sources of nutrients include wastewater treatment plants and septic systems. The Busselton wastewater treatment plant discharges wastewater into the Vasse Diversion Drain. Water Corporation's proposed upgrade to the treatment plant has been designed to achieve no net increase in nutrient loads to Geographe Bay (GeoCatch, 2013c).

Table A1: Area of soil tested and mapped by sub-catchment (GeoCatch, 2014)

| WQIP sub-catchment | Total area (beef + dairy) (ha) | Area (beef + dairy) tested and mapped (ha) | Area (beef + dairy) tested and mapped (%) |
|-----------------------|--------------------------------|--------------------------------------------|-------------------------------------------|
| Sabina | 4,653 | 2,410 | 52 |
| Ludlow | 2,977 | 2,340 | 79 |
| Vasse Diversion Drain | 14,307 | 5,783 | 40 |
| Carbanup | 6,172 | 1,245 | 20 |
| Capel | 12,695 | 250 | 2.0 |
| Abba | 6,165 | 1,738 | 28 |
| Toby's Inlet | 793 | 50 | 6.3 |
| Buayanyup | 8,113 | 570 | 7.0 |
| Anniebrook | 4,664 | 598 | 13 |
| Gynudup | 10,417 | 3,376 | 32 |
| Five Mile Creek | 3,568 | 540 | 15 |
| Total | 74,525 | 18,900 | 25 |

Table A2: Percentage completion of effluent management system upgrades for dairies by sub-catchment (GeoCatch, 2014).

| Sub-Catchment | Effluent Management Plan Only | Effluent Management Plan and Upgrade Completed | Total no Dairies in Sub-Catchment | % upgrades completed through WQIP project* |
|-----------------------------------|-------------------------------|------------------------------------------------|-----------------------------------|--------------------------------------------|
| Jingarmup | | | 0 | |
| Dunsborough | | | 0 | |
| Toby Inlet | | | 0 | |
| Lower Vasse | | | 0 | |
| Five Mile | | | 0 | |
| Carbunup | 1 | 1 | 6 | 16 |
| Vasse DD | 2 | 1 | 11 | 9 |
| Sabina | | 3 | 4 | 75 |
| Abba | 1 | 0 | 2 | 0 |
| Buayanup | 1 | 0 | 8 | 0 |
| Gynudup | | 2 | 5 | 40 |
| Capel | | 0 | 2 | 0 |
| Annie Brook | | 1 | 1 | 100 |
| Ludlow | | 2 | 4 | 50 |
| Total | 5 | 10 | 43 | |
| Total upgrades | | | | 23% |
| Total upgrades & plans | | | | 37% |

* does not include dairies that have been upgraded through other projects, or by landowner, however it is considered that these are unlikely to meet best practice

Table A3: Riparian zone fencing and revegetation efforts within the sub-catchments (GeoCatch, 2014)

| WQIP Subcatchment | Riparian fencing (km) | Riparian revegetation (ha) |
|--------------------------|----------------------------------|---------------------------------------|
| Jingarmup | 0 | 0 |
| Dunsborough | 0 | 0.3 |
| Toby Inlet | 0 | 0 |
| Abba | 2.8 | 1.3 |
| Annie Brook | 5.8 | 1.5 |
| Buayanyup | 16 | 7.2 |
| Capel | 111 | 3.7 |
| Carbunup | 4.8 | 3.8 |
| Gynudup | 17 | 4.6 |
| Lower Vasse | 0.6 | 2.7 |
| Ludlow | 3.2 | 6.3 |
| Sabina | 3.3 | 19 |
| Vasse Diversion | 30 | 28 |
| Five Mile | 0 | 0 |
| Total | 94 | 78 |

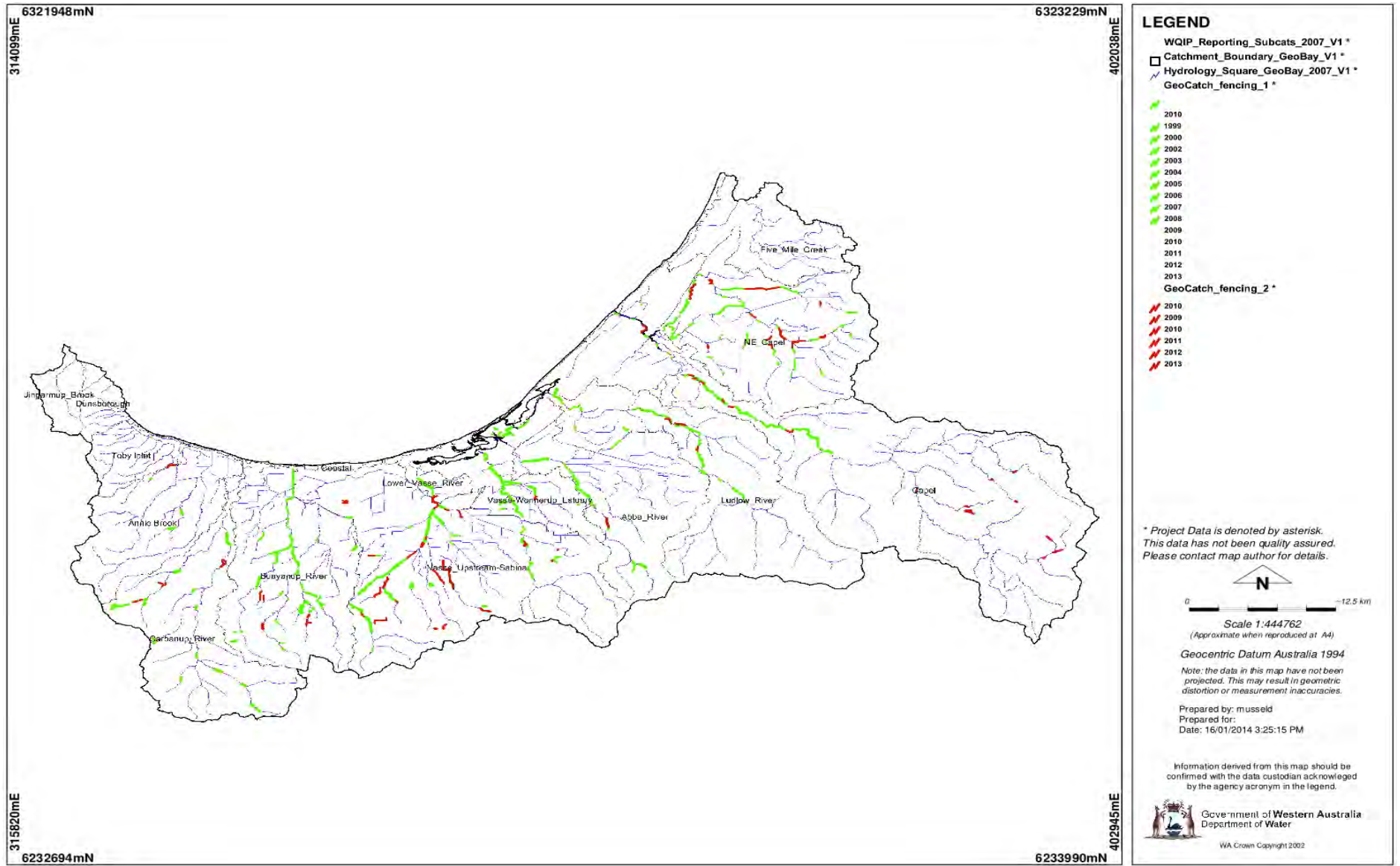


Figure A1: Map showing the length of fencing implemented by GeoCatch: pre-2009 and between 2009-2013

Appendix C: Victorian Catchment Management Framework

The Victorian Catchment Management Framework was established under the *Catchment and Land Protection Act (1994)* with the primary institutions being the Victorian Catchment Management Council (VCMC) and the ten Catchment Management Authorities (CMAs) (Figure A1). The CMAs also have regional waterway, floodplain, drainage and environmental water reserve management powers under the *Water Act 1989*. They are the caretakers of river health.

The major partner of the CMAs is the Department of Environment and Primary Industries (DEPI). They also partner at times with many other institutions and groups who contribute to catchment health, including: local governments, water authorities, educational and research agricultural and industry organisations, Indigenous communities and community groups.

The core objectives of the CaLP Act are to:

- maintain and enhance long term land productivity while also conserving the environment, and
- ensure that the quality of the State's land and water resources and their associated plant and animal life are maintained and enhanced.

The Victorian Catchment Management Council (VCMC) is the State's peak independent advisory body on catchment management. In order to determine if the objectives of the CaLP Act are being met, the Act requires Council to deliver an assessment of the condition and management of land and water resources in Victoria every five years (VCMC, 2012).

Every six years the CMAs are required to prepare a Regional Catchment Strategy (RCS) in accordance with guidelines established by the VCMC. An asset-based approach has been adopted (e.g. see WGCMA, 2013). The RCS is the overarching regional strategic planning framework, under which are found a range of sub-strategies and action plans for the region. The priorities established in the RCS are used to inform the development of future regional sub-strategies and action plans. RCS's aim to encourage an integrated collaborative approach to managing natural resources, to strengthen partnerships and to reduce duplication of effort.

The process of developing an RCS involves first defining the significant natural assets within the main thematic asset class (aquifers, biodiversity, coast, estuaries, marine, rivers, soil/land, and wetlands) according to a set of significance criteria, undertaking a risk assessment process and then grouping the significant assets according to their interaction as a system in the landscape.

The groups of significant natural assets have been named 'landscape priority areas'. This approach recognises the interaction between the various assets in the landscape, their interdependence as a system, and allows for an integrated management approach to be developed. The landscape priority areas represent groupings of significant natural assets at most immediate risk, which are a priority for attention during the life of the Strategy.

Importantly, action may also need to be taken in areas outside and in-between the landscape priority area boundaries in order to achieve an improvement in condition of those assets located within the landscape priority areas. For example, to gain an improvement in the Gippsland Lakes and Hinterland landscape priority area, the West Gippsland CMA identified on-ground action needed within the Macalister Irrigation District (which is adjacent to the landscape priority area) to ensure sediments and nutrients remain on-site to benefit both agricultural production within the district and improve river health and the quality of water entering the Gippsland Lakes system (WGCMA, 2013).

Progress towards implementation is monitored throughout the life of the RCS, generally with a mid-term review undertaken and reported.



Figure A1: Map of the Victorian Catchment Management Authority boundaries