GOVERNMENT OF WESTERN AUSTRALIA

Department of **Water and Environmental Regulation**

Department of **Primary Industries and Regional Development**

Revitalising Geographe Waterways science and monitoring plan 2022-2024

HEALTHY ESTUARIES WA

Revitalising Geographe Waterways

VASSE task FORCE

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1. Introduction

1.1 Purpose

The Department of Water and Environmental Regulation (the department) published a detailed *Catchment to Coast Science, modelling and monitoring plan 2016–2019* in 2017. It outlined the monitoring, modelling and science of the Revitalising Geographe Waterways (RGW) program.

This plan was developed with input from the Vasse Wonnerup Science Advisory Group and their review of the research priorities of the Vasse Wonnerup wetlands' ecological character description and past Geographe catchment monitoring programs. The science projects, monitoring and actions outlined in the plan were central to the RGW program and were used to update management of the Toby Inlet sand bar and Vasse surge barrier, and inform management plans for the Toby Inlet, Vasse Wonnerup wetlands, Lower Vasse River and the Geographe Drainage network.

In 2019 the department undertook an external end-of-program evaluation for the RGW program (Eberhard and Roberts, 2019). As part of this evaluation the *Catchment to Coast Science and modelling and monitoring plan 2016–2019* was reviewed in consultation with the Vasse Wonnerup Science Advisory Group. As an outcome of this review, the RGW science and monitoring program has been updated for a further two years (2022–2024) and will be implemented through funding from the State Government's Revitalising Geographe Waterways and Healthy Estuaries WA programs. The updated plan also includes recommendations from the external evaluation relating to the RGW science and monitoring program.

Management informed by the best-available science and knowledge is fundamental to ensuring healthy waterways in the Geographe catchment. The science and monitoring outlined in this plan will contribute to the RGW program by:

- **monitoring water quality and health of our waterways:** Targets and indicators will be established and monitored for water quality and ecological components of key waterways over the life of this plan; monitoring against targets will enable government agencies and the community to better assess health of Geographe waterways over time
- **increasing our understanding:** Through the science program we will increase our knowledge and understanding of our local waterways and their key ecological components and how they respond to changes in water levels and water quality
- **evaluating our actions:** Monitoring programs will enable us to assess the impacts of our current land management practices and evaluate how successful the management initiatives of the RGW program have been at improving water quality and waterways health

- **informing our decision-making:** Information gained from the program will be used to inform adaptive management of Geographe waterways.

The RGW Science and Monitoring 2022–2024 plan will be implemented through collaborative partnerships between state and local government agencies, universities, and catchment groups.

1.2 Geographical focus

The plan covers the waterways, wetlands, and coastal waters of the Geographe catchment (Figure 1). Waterways within the catchment have been separated into five areas:

1. Geographe catchment and waterways
2. Vasse Wonnerup wetlands
3. Lower Vasse River
4. Toby Inlet
5. Geographe Bay.

Each section includes a summary of science and monitoring projects completed under the Revitalising Geographe Waterways Program from 2015–2021 and planned 2022–2024 projects and actions.

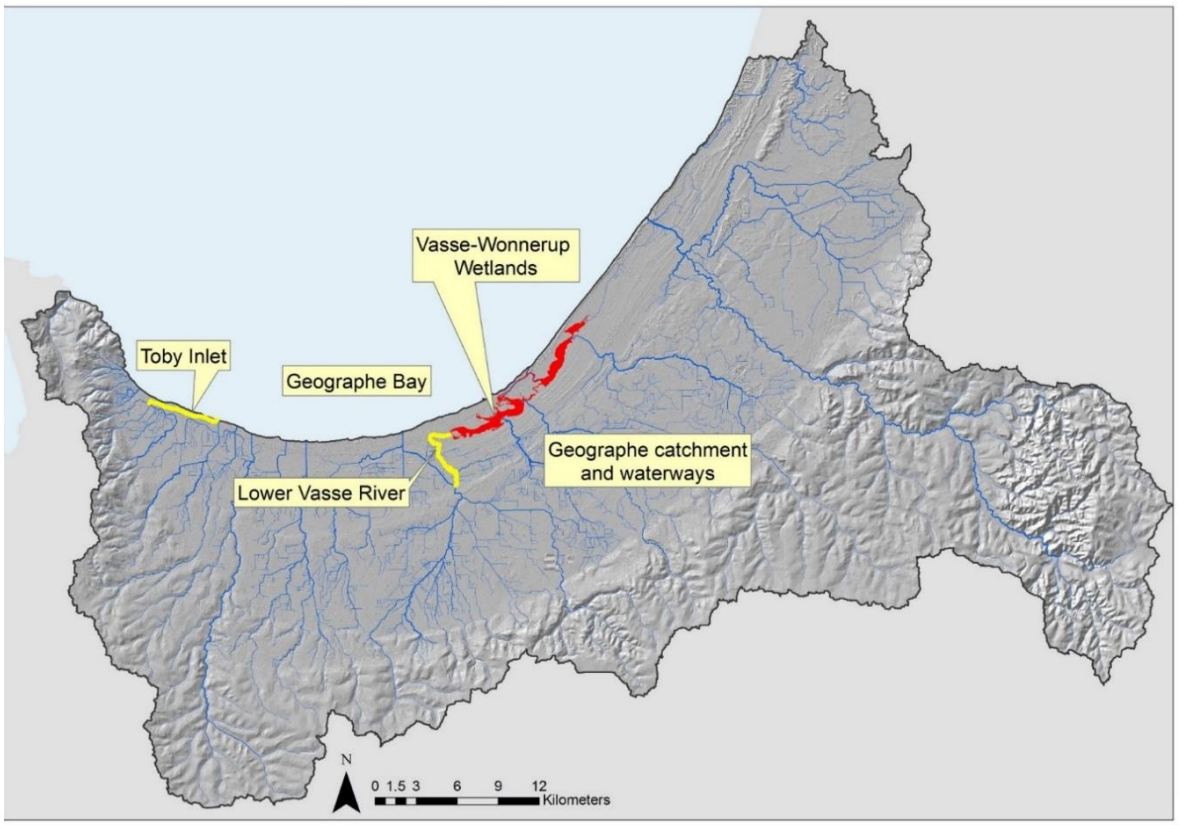

Figure 1 Overview of waterways, wetlands and coastal waters covered in this plan

2 Geographe catchment and waterways

2.1 Snapshot

The Geographe catchment is about 250 km south of Perth, bounded by the Whicher Range to the south, Darling Range to the east and the Leeuwin–Naturaliste Ridge to the west. Sixteen waterways collect flow from across the Geographe catchment, discharging either directly to Geographe Bay or via coastal wetlands and estuaries (Department of Water, 2010). Many of these waterways provide habitat for native freshwater fish, macroinvertebrates, and aquatic plants, while also providing ecological linkages for terrestrial fauna. Waterways in the Geographe catchment do not flow during summer, except for the Capel River.

Photo 1 Aerial view of the Geographe catchment and urban expansion

Before European settlement very few waterways in the Geographe catchment flowed directly into Geographe Bay. In their natural state, waterways flowed into an extensive chain of wetlands stretching along the coast that flowed into the Vasse and Wonnerup estuaries. Hydrological modifications in the catchment's lower reaches began 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 changes were made, including construction of floodgates to prevent saltwater incursion, a network of small drains to remove water from farmland and a series of large arterial drains and river diversions for discharging surface flow directly into Geographe Bay (Department of Water, 2010). The Vasse Diversion Drain was constructed in 1924 and diverts flow of about 65 per cent of the Upper Sabina River and 90 per cent of the Upper Vasse River directly to Geographe Bay.

Clearing in the catchment and drainage modifications have resulted in large increases in river flow and erosion problems in many of the catchment's waterways. These changes, combined with the increased nutrient loads entering the waterways from agricultural and urban land uses, have resulted in water quality problems.

2.2 Geographe catchment and waterways science and monitoring 2015-2021

Key science and monitoring programs undertaken within the Geographe catchment and waterways between 2015 and 2021 include:

- continuation of a catchment-wide water quality sampling program established in 2006. Eighteen sites sampled fortnightly for physical parameters and nutrients since 1996, by the department and its predecessor agencies (Figure 2). Water quality trends in Geographe waterways can be found at the Geographe waterways website
- four soil amendment field trials established to evaluate the success of the soil amendment Iron Man Gypsum in reducing phosphorus loss from high-risk land uses. Trials were established on a turf farm, intensive dairy farm, rural drain, and urban sports oval. For further information see Healthy Estuaries WA's Soil amendment factsheet
- updates to the Geographe Bay catchment hydrological and nutrient model; a technical report will be available in 2023
- river health assessments undertaken in seven waterways in the catchment (Annie Brook, Mary Brook, Sabina River, Station Gully, Vasse River, Capel River and Carbunup Rivers) providing baseline information and ecological data of the catchment's waterways.

Photo 2 Carbunup River riparian vegetation

Photo 3 Ecological sampling as part of rivers health assessment in the Geographe catchment

2.3 Science and monitoring 2022-2024

The science and monitoring projects to be conducted in the Geographe catchment and waterways from 2022–2024 are outlined in Table 1.

A key aspect of the science program will be a continuation of fortnightly water quality monitoring across the catchment (see figure 2) to assess water quality trends over time. Monitoring sites have been rationalised after a review of the water quality program.

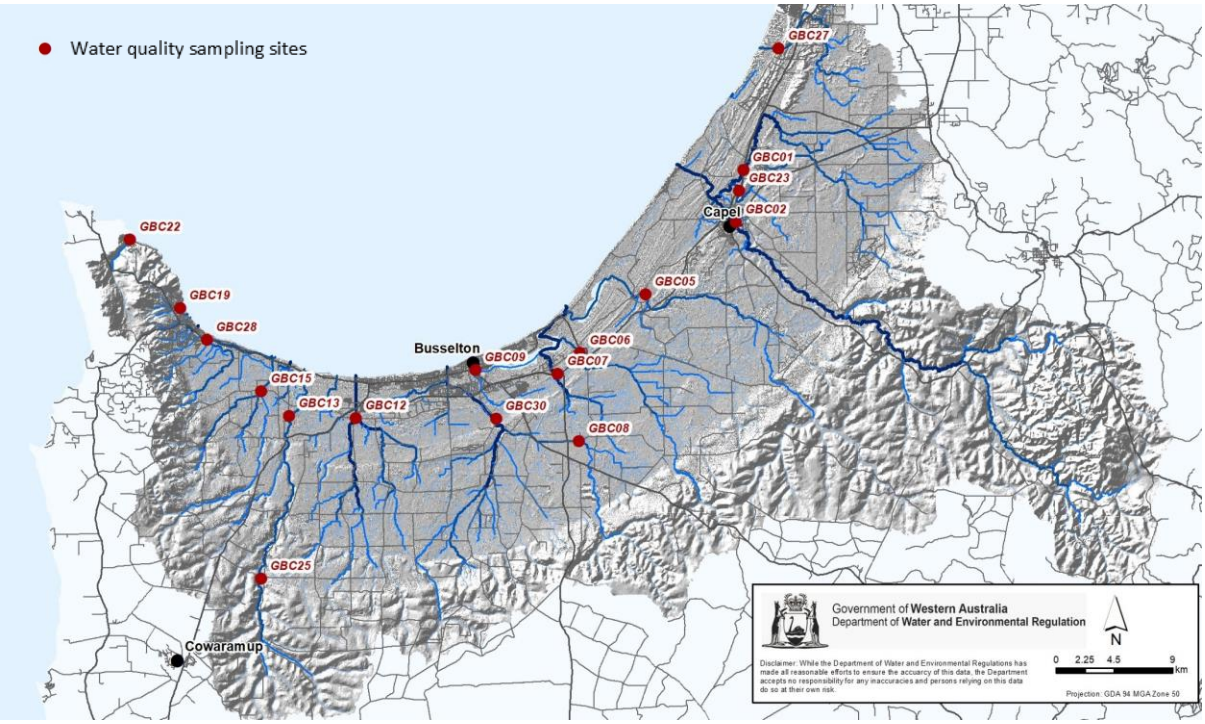

Figure 2 Water quality monitoring sites in the Geographe catchment

Monitoring of one soil amendment paddock trial at the dairy farm will continue to assess longer-term effectiveness of soil amendments in reducing phosphorus loss.

Several new trials will be established in the catchment to assess best management practices (BMPs) to reduce nutrient loss from rural areas and better understand lag times of nutrients in the catchment. These will include trials to assess drainage BMPs and phosphorus application (Table 1).

The Vasse Wonnerup wetlands and Geographe Bay water quality improvement plan (WQIP) will also be updated during the life of this plan. The WQIP will include water quality and ecological targets that will be monitored through this plan.

Photo 4 Uptake field trials of phosphate application against production

Table 1 Science, monitoring and modelling for Geographe catchment and waterways 2022–2024

Monitoring program	Lead agency & partners	Objectives	Sites	Timing	Parameters investigated	Timeframe	Further information
Catchment water quality monitoring	DWER	To monitor trends in water quality over time and assess effectiveness of water quality BMP programs	18 sampling sites across Geographe catchment (see Figure 2)	Fortnightly	Physical parameters and nutrients	2022–2024	Water quality data is available on the DWER website at www.water.wa.gov.au/maps-and-data/monitoring/water-information-reporting For water quality trends in Geographe waterways visit rgw.dwer.wa.gov.au/geographe-waterways/
Drainage BMPs	DWER, DPIRD, Water Corporation	To better understand the role of drains in nutrient transport	22 sites monitored across the catchment. Drainage BMP trials at 1–2 sites in Geographe catchment to be established in 2022	One off	Physical parameters and nutrients	2022	
Rural landuses and BMPs	DWER, DPIRD	To assess nutrient runoff from high-input agricultural land uses	BMP trial sites to be established in 2022	Fortnightly	Physical parameters and nutrients	2023–2024	
Subsoil drain Best Management Practice trial	DWER	To characterise seasonal patterns of nutrient loss via subsoil drains compared with runoff loss from undrained soils, and quantify N and P loads via subsoil drains	Seven drain monitoring points (three subsoil drain outlets, two open drain sites, two paddock runoff drains) Four bores	Monthly surface water Annually groundwater	Physical parameters, nutrients, dissolved metals and anions	2022	
uPtake	DWER, DPIRD, Fertiliser Industry	To develop phosphorus response curves for South West WA soils to better define the relationship between soil P levels and productivity	Six sites in the Geographe catchment	Monthly in June–November (2022)	Pasture cuts	2022- 2023	estuaries.dwer.wa.gov.au/uptake
Split P applications	DWER, DPIRD, Fertiliser Industry	To evaluate the best timing of P applications to maximise productivity and minimise loss to the environment	Two sites in the Geographe catchment	Monthly	Pasture cuts Lysimeter nutrients	2022-2023	estuaries.dwer.wa.gov.au/uptake
Soil amendment trials	DWER	To evaluate the longer-term success of soil amendment products in reducing nutrient loss from an intensive dairy paddock	Iron Man Gypsum (IMG) amendment soil trial	Fortnightly	Physical parameters and nutrients Pasture cuts – soil sampling	2022–2024	

3 Lower Vasse River

3.1 Snapshot

The Lower Vasse River flows through the centre of Busselton into the internationally significant Vasse Wonnerup wetlands. The river is highly valued by the community and has long been an iconic town feature and focal point for recreational and social events. Improving the visual amenity of, and water quality in, the Lower Vasse River is a priority for the wider community.

The Vasse River flows predominantly in the winter months, with little or no flow in summer. In recent decades poor water quality has negatively affected the lower sections of the river, characterised by annual blue-green algal blooms. The blooms reduce the amenity and recreational values of the Lower Vasse River. Despite poor water quality over summer months the river retains important ecological and social values.

Photo 5 Aerial view of the Lower Vasse River

3.2 Lower Vasse River science and monitoring 2015-2021

A key aim of the science and monitoring program for the Lower Vasse River was to identify actions to reduce algal blooms over summer months. Initiatives including assessing options to increase flows and water treatment trials were supported by water quality and ecological monitoring to improve knowledge of the Lower Vasse River. This work contributed to the development of the *Lower Vasse River Water Management Plan*, which was published in May 2019.

Key science and monitoring programs undertaken within the Lower Vasse River between 2015–2021 include:

- continuation of a Lower Vasse River water quality sampling program established in 2006 (water quality trends over time)
- seasonal phytoplankton sampling at two sites during the algal season (November–April) as part of the State Algal Strategy (phytoplankton trends over time)
- development of the Reconnecting Rivers model investigating options for increasing flows into the Lower Vasse River
- water quality treatment trials with phosphorus binding clay to reduce algal blooms over summer months.
- investigations of Mexican waterlily in the Lower Vasse River
- river health survey of three sites on the Vasse River
- a water circulation trial to assess potential of artificial water circulation to reduce blue-green algae
- Sediment removal feasibility study to determine the volume and composition of sediments in the Lower Vasse River
- Carter's freshwater mussels survey to assess the distribution and abundance of the species throughout the lower section of the lower Vasse River

Photo 6 Vasse clay trial in the Lower Vasse river

3.3 Science and monitoring 2022-2024

The science and monitoring projects to be undertaken in the Lower Vasse River from 2022–24 are summarised in Table 2.

Fortnightly water quality monitoring (see Figure 3) in the Lower Vasse River at three sites will continue to track water quality and phytoplankton over time and seasonal changes in river health. A new groundwater monitoring program to estimate flow and nutrient export from groundwater to the Lower Vasse River will be established.

Initiatives of the City of Busselton, including surveys of Carter's freshwater mussel (*Westralunio carteri*) and sediment characterisations, will inform future management of the river and support implementation of the Lower Vasse River Waterway Management Plan.

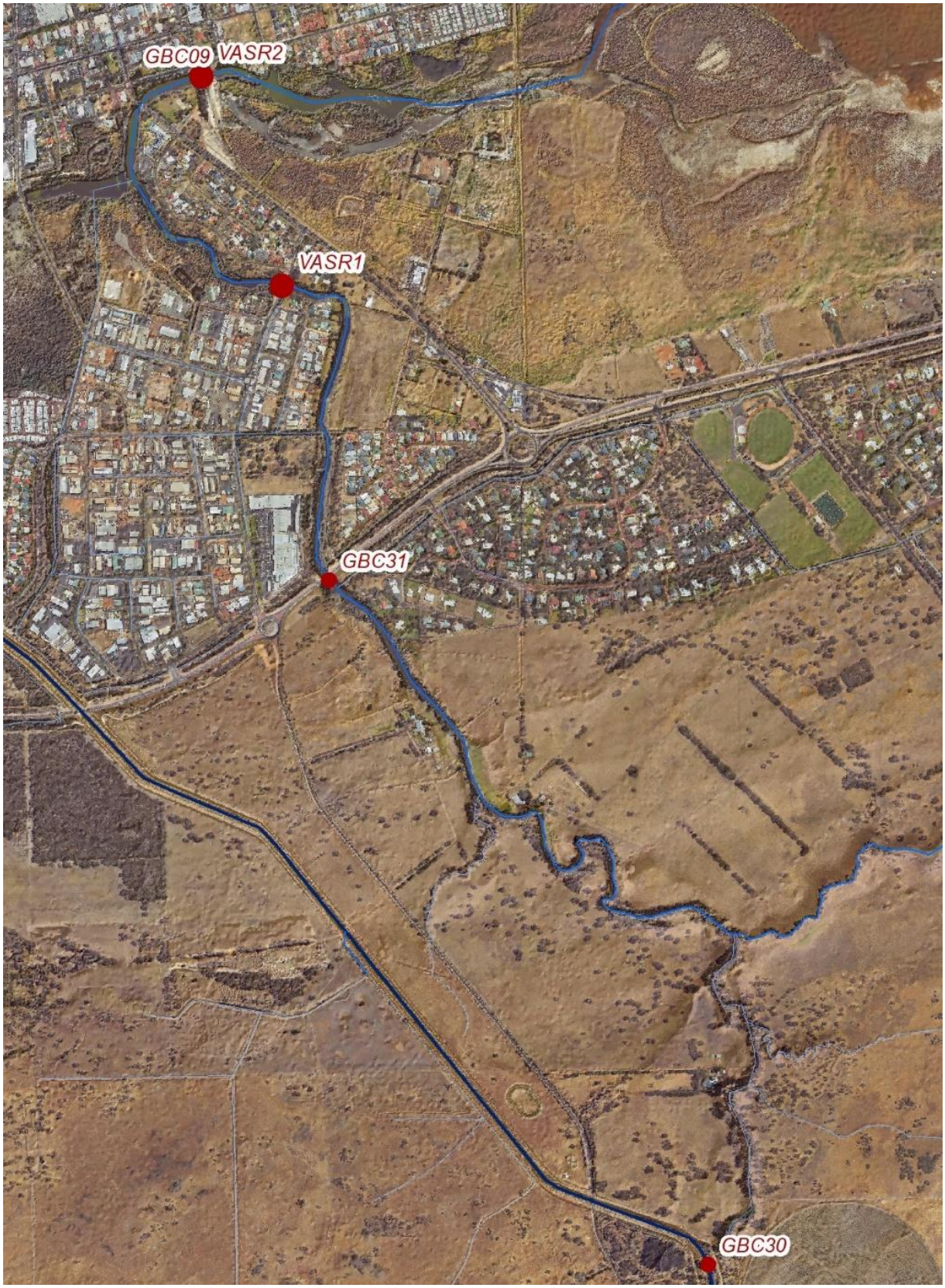

Figure 3 Map of the water quality sampling points in the Lower Vasse River

Table 2 Science, monitoring and modelling for Lower Vasse River 2022-2024

Monitoring program	Lead Agency	Objectives	Sites	Timing	Data to be collected/Parameters investigated	Timeframe	Further Information
Catchment water quality monitoring program: Lower Vasse River	DWER	To monitor trends in water quality over time	Two sites in Lower Vasse River including GBC31, GBC09 (also called VASR2) One site at the Vasse Diversion drain site including GBC30	Fortnightly (including State Algal Strategy data) Sampled weekly	Physical parameters and nutrients E. coli at GBC31 year-round	Ongoing	Water quality data is available on the DWER website www.water.wa.gov.au/maps-and-data/monitoring/water-information-reporting
State Algal Strategy and Public Health Program	DWER	To monitor water quality and phytoplankton during the summer high-risk fish kill and algal bloom period to provide early warning of potential fish kills and determine the health risk posed by phytoplankton To determine whether saltwater incursion is occurring into the Vasse River.	Three sites within Lower Vasse River (GBC31, VASR1, VASR2)	Between November and May VASR2 continuous logger	Physical parameters, nutrients phytoplankton and *E.coli* (E.coli at GBC31 and VASR1 only)	Ongoing	
Groundwater	DWER/City of Busselton (CoB)	Estimate flow and nutrient export from groundwater to the Lower Vasse River	Bores at four sites monitored, including installation of new bore	2021–2023	Nutrients, water level and physical parameters	2021–2023	

4 Vasse Wonnerup wetlands

4.1 Snapshot

The Vasse Wonnerup wetlands are within an extensive low-lying coastal depression 14 km north-east of Busselton in the South West of Western Australia (Figure 4). The wetlands consist of the Vasse and Wonnerup estuaries and their exit channels, the Wonnerup Inlet, and the seasonal connection between the two estuaries known as Malbup Creek. The Deadwater and Swan Lake are associated wetlands.

Figure 4 The Vasse Wonnerup wetlands

Water flow into and out of the wetlands has been dramatically altered since European settlement. Drainage networks have been constructed throughout the catchment and several rivers that formerly discharged to the Vasse and Wonnerup estuaries have been diverted directly to the sea. Currently the Lower Vasse, Lower Sabina and Abba rivers flow into the Vasse Estuary, while the Ludlow River flows into the Wonnerup Estuary before discharging into the Wonnerup Inlet which is intermittently open to Geographe Bay.

In 1908 floodgates (surge barriers) were installed on the exit channels of the Vasse and Wonnerup estuaries to regulate flow, exclude seawater and minimise flooding of the adjoining agricultural land and Busselton township (Lane et al., 2011). In 2004 new surge barriers were installed that include a fish gate to allow fish to move

between the estuaries and the Wonnerup Inlet and to allow exchange of water between the two systems. The surge barriers automatically open when the water level in the estuary is higher than the Wonnerup Inlet.

Photo 7 Summer aerial photo of Vasse Channel leading to the Vasse Inlet

Salinity in the Vasse and Wonnerup estuaries ranges from fresh to hypersaline over an annual cycle. Rivers flush both estuaries to fresh in winter. During summer salinities rise dramatically from fresh to saline/hypersaline because controlled inflow through the surge barriers, leakage through the barriers and evaporation. Strong annual and interannual variances occur in nutrient enrichment, water quality and water depths.

4.2 Vasse Wonnerup wetlands science and monitoring 2015-2021

The Vasse Wonnerup wetlands were the focal point of considerable research, trials and monitoring during 2015–2021. The science program focused on improving understanding of the ecology of the wetlands and impacts of water levels and water quality, developing models to assess the potential impacts of altering the current water regime, and evaluating management actions to reduce the risk of fish kills and improve water quality. Information gained from the science and monitoring program and estuary models was used to update the guidelines for the operation of the Vasse surge barriers and inform the development of the Vasse Wonnerup Operational Plan.

Photo 8 Flock of stilts on the Wonnerup Wetlands in early summer

Key science and monitoring programs undertaken on the Vasse Wonnerup wetlands between 2015–2021 include:

- a trial of a mini oxygenation plant in the Vasse estuary channel
- sediment investigations in the Vasse estuary channel
- fine-scale vegetation and vegetation risk mapping for the Vasse Wonnerup wetlands system
- monthly waterbird monitoring
- seasonal integrated ecological monitoring: aquatic plants, macroinvertebrate, fish, and waterbirds
- development of an estuary model for the Vasse Wonnerup wetlands
- seawater inflow trials in the Vasse estuary (report available 2022)
- monthly water quality monitoring at 14 sites throughout the wetlands
- population status of the Black bream study following the fish kill in April 2013
- investigations of fish movement through the Vasse Surge barrier
- annual aquatic plant biomass and species composition
- Statistical analysis of the Vasse Wonnerup wetlands integrated ecological monitoring program.

Photo 9 Bream monitoring as part of the Vasse Wonnerup acoustic tracking with Murdoch scientist Jadon Wilder (Credit: Steve Beatty)

4.3 Science and monitoring 2022-2024

The science and monitoring projects to be undertaken in the Vasse Wonnerup wetlands from 2022–2024 are summarised in Table 3.

Water quality and ecological monitoring (see Figure 5) will continue to improve adaptive management of the wetlands by improving understanding of the relationship between surge barrier management, salinity, water levels and ecology of the wetlands.

The department will undertake two sediment studies on the wetlands: a study on sediment drying and re-wetting to assess the influence of drying on nutrient retention; and a sediment removal feasibility study at Estuary View Drive to reduce smells over summer months. These studies will help inform water regime and water level management in summer months and help determine the feasibility of dredging sediments in the Vasse Estuary.

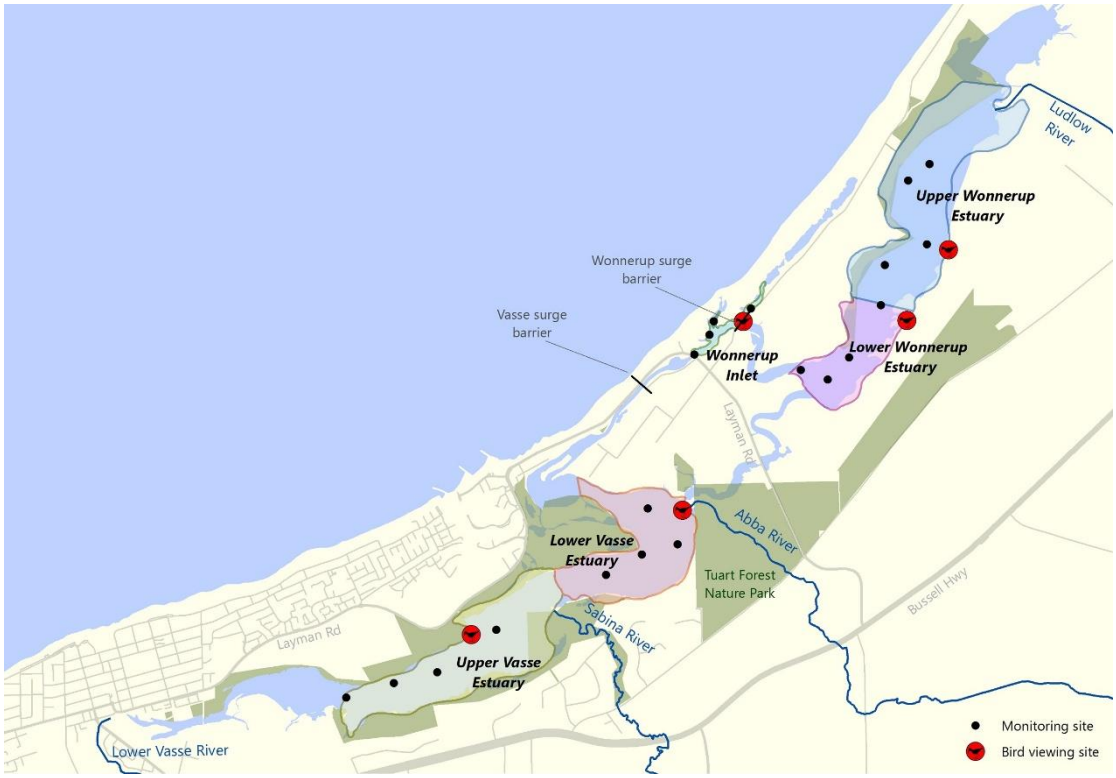

Figure 5 Key water quality sites sampled within each habitat zone for the Integrated Ecological Monitoring program.

Underpinning the Vasse Wonnerup science program is the ongoing comprehensive water quality monitoring program to measure changes in water quality over time, determine the health risk posed by phytoplankton blooms and support the fish kill mitigation and response program.

The analysis of the three-year Integrated Ecological Monitoring program (including fish, waterbirds, benthic invertebrates and macrophytes) together with the water quality data will strengthen understanding of the linkages between ecological parameters across a range of habitats as the seasons, water levels change and water regimes. The program will also develop wetland ecological health indicators for black bream, aquatic plants and macro-invertebrates.

Photo 10 Sediment sampling at Estuary View Drive for sediment removal feasibility study

Table 3 Science, monitoring and modelling for Vasse Wonnerup wetlands and Vasse Estuary channel 2022–2024

Monitoring program	Lead agency	Objectives	Sites	Timing	Data to be collected/Parameters investigated	Timeframe	Further information
Vasse Wonnerup water quality program	DWER	To monitor trends in water quality over time	Six sites in the Vasse Estuary and six sites in the Wonnerup Estuary (figure 6) Vasse: VW 17,20,23,26,29 VWFord Wonnerup: VW5,8,11,14, WONE1, WONE1DS	Monthly	Physical parameters, phytoplankton and nutrients Seasonal (quarterly) physical profiles of each estuary at 250 m intervals	2022–2024	Water quality data is available on the DWER website ' water.wa.gov.au/maps-and-data/monitoring/water-information-reporting
State Algal Strategy and Public Health Program	DWER	To monitor water quality and phytoplankton during the warmer months to provide early warning of potential fish kills and determine health risks	Seven sites within Vasse and Wonnerup estuaries VW23, JRP and WONE1, VASE1, VASE4, and VASE1DS	Fortnightly in agal season (November –May)	Physical parameters phytoplankton	2022–2024	
Fish kill mitigation monitoring program	DWER	To provide continuous and instantaneous data to support the fish kill mitigation and response program	Four in-situ telemetered buoys continuously monitoring physical parameters in the Vasse Estuary	Data logged at 15-minute intervals all year	Physical parameters	2022–2024	Data available at River Monitoring Stations in Western Australia | Department of Water and Environmental Regulation for sites 610019, and 610022, 6101227 and 610230
Impacts of sediment drying and on organic wetland sediment	DWER	Controlled experiment on sediment to examine changes in nutrient retention because of drying	Sites to be established in 2023	Summer 2022–23	Nutrients and organic carbon	2022–2024	
Sediment sampling at Estuary View Drive for sediment removal feasibility study	DWER	To provide accurate information on grain size, moisture content, composition and sediment depth in the area of proposed dredging	Estuary View Drive in front of James Richardson Park	2021	Sediment grain size and moisture content TOC, TN, TP Metals, pesticides, hydrocarbons and acid sulphate soil (ASS) parameters.	2021–2023	
Annual waterbird monitoring	Birdlife Australia (Shorebirds 2020)	To collate baseline data on shorebirds and raise community awareness through participation	Lower Vasse Estuary Upper Vasse Estuary Lower Wonnerup Estuary Upper Wonnerup Estuary Wonnerup inlet	Annually (February) and ongoing	Waterbird counts: species and abundance	Ongoing	

Monitoring program	Lead agency	Objectives	Sites	Timing	Data to be collected/Parameters investigated	Timeframe	Further information
Monthly bird monitoring	DBCA	To monitor the temporal and spatial distribution and abundance of waterbirds within the Vasse Wonnerup wetlands. To report on Ramsar status	Lower Vasse Estuary Upper Vasse Estuary Lower Wonnerup Estuary Upper Wonnerup Estuary Wonnerup inlet.	Monthly	Waterbird counts: species and abundance Behavioural observations Observations of anthropogenic disturbance	2022–2024	
Annual macrophyte monitoring	DWER	To develop and sample aquatic plant indicators to monitor aquatic plant health over time.	Sixteen sites in the Vasse and Wonnerup estuaries	Annually in November	Aquatic plant biomass/percent volume inhabited (PVI) and species composition	2022–2024	
Bream monitoring	Murdoch	To develop indicators for i) the body condition of adult Black Bream and ii) the recruitment of juvenile Black Bream in the Vasse Wonnerup To monitor fish health over time and produce an annual Black Bream Health Report card	Bream sampling at four sites in Deadwater and Wonnerup Inlet and four sites in the Vasse Exit Channel	Annually in November and January	Black Bream size, weight and abundance/catch rate	2022–2024	
Fish movement through the surge barrier	Murdoch	To better understand movement of fish patterns through the fish gates and drivers for fish passage in relation to environmental variables	Surge barrier	Year round with passive integrated transponder (PIT) monitoring system	Fish passage through surge barrier during annual fish gate operation periods	2022–2024	
Annual macroinvertebrates monitoring	Murdoch	To develop and sample benthic macroinvertebrate indicators to monitor invertebrate health over time	Eight sites within each of the five regions (Wonnerup Inlet, Vasse Exit Channel, and upper and Lower Vasse and Wonnerup)	Annually	Abundance of each species (or taxon) in each sample	2022–2024	

5 Toby Inlet

5.1 Snapshot

Toby Inlet is east of Dunsborough in the South West of Western Australia. The inlet is a narrow inter-barrier lagoon running parallel to the shore and separated from the ocean by high beach ridges (Pen, 1997). The estuary is of ecological and social importance, providing habitat for fish, waterbirds and frogs, as well as a recreational area for residents and tourists.

The catchment has a long history of clearing and drainage modification to allow for productive farming in the area. The most recent drainage modification was the construction of the Station Gully channel that drains the Annie Brook subcatchment and flows directly to the ocean with the outlet at the eastern side of Toby Inlet.

Overall, the system's hydrology has been significantly altered from its natural state – with consequences for the water quality and ecological health in the inlet. Nutrients and sediments from the catchment and urban development surrounding the estuary have also had a significant impact on estuary health.

5.2 Toby Inlet science and monitoring 2015-2021

The focus of science and monitoring in the Toby Inlet from 2015–2021 was the development of the Reconnecting Toby Inlet hydrodynamic model and collection of data to support this development. The model investigated the feasibility of reconnecting Toby Inlet to the ocean to increase tidal flushing to maximise circulation and improve water quality in the inlet. Outcomes of the modelling included the seasonal opening of the Toby Inlet entrance to the ocean by the City of Busselton. A key project for water quality improvement in the Toby Inlet was the connection of 126 properties to a deep sewerage area on the western side of Toby Inlet, in the Quindalup dunes between Toby Inlet and Geographe Bay.

Water quality monitoring, ecological surveys, and modelling outputs undertaken through the Revitalising Geographe Waterways program were used to inform the *Toby Inlet Water Management Plan* (City of Busselton, 2019).

Key science and monitoring programs undertaken on the Toby Inlet from 2015–2021 include:

- continuation of the Toby Inlet water quality sampling program established in 2005
- seasonal phytoplankton sampling at four sites during the algal season (November–April) as part of the State Algal Strategy
- development of the Reconnecting Toby Inlet hydrological model
- the fish and invertebrate survey of the Toby Inlet

- the Influence of sandbar openings on fish communities in the Toby Inlet study (Tweedley et al., 2018)
- the Toby Inlet sediment investigation (Hasting and Paice, 2020).

Photo 11 Fish survey to monitor fish species and population in Toby Inlet with Murdoch Scientists Kurt Krispyn (left) and Dr Alan Cottingham (right) holding nets (Credit: Tom Hoy)

5.3 Science and monitoring 2022-2024

Table 4 summarises the science and monitoring projects and programs to be undertaken for the Toby Inlet from 2022–2024.

Photo 12 Toby Inlet sand bar opened to the ocean

Continuation of the Toby Inlet water quality monitoring program (Figure 8) will be the focus for the Toby Inlet over the next two years to assess the effectiveness of recent sewerage connections and changed sandbar management of the Inlet.

Figure 6 Water quality monitoring sites in the Toby Inlet

Table 4 Science, monitoring and modelling for Toby Inlet 2022-2024

Monitoring program	Lead Agency	Objectives	Sites	Timing	Data to be collected/Parameters investigated	Timeframe	Further information
Catchment water quality monitoring: Toby Inlet	DWER	Water quality data will be used to monitor trends in water quality over time	One site in the Toby Inlet	Fortnightly	Physical parameters and nutrients	2022–2024	Water quality data is available on the DWER website www.water.wa.gov.au/maps-and-data/monitoring/water-information-reporting
State Algal Strategy and Public Health Program	DWER	Monitor water quality and phytoplankton during the summer high-risk fish kill and algal bloom period to provide early warning of potential fish kills and determine the health risk posed by phytoplankton	Four sites in the Toby Inlet	Fortnightly in algal season (November–April)	Physical parameters, phytoplankton, and nutrients	2022–2024	
Toby Inlet water quality monitoring	DWER	Monitor water quality over a year to better understand season variation in Toby Inlet	Four sites	Fortnightly	Physical parameters, phytoplankton, and nutrients	2022–2024	

6 Geographe Bay

6.1 Snapshot

Geographe Bay is highly valued by the local community and visitors to the area. The bay provides habitat for a diverse combination of tropical and temperate species, and its values have been recognised by its inclusion in the Ngari Capes Marine Park.

For this plan, Geographe Bay is defined by the nearshore seagrass meadows within southern Geographe Bay from Dunsborough to Capel, aligning with the coastal boundaries of the Geographe catchment. Two key ecological themes are considered in this plan: water quality and seagrass meadows.

The nearshore shallow waters of Geographe Bay support extensive seagrass meadows that serve important ecological functions. Seagrass stabilises sediments, provide habitat for fish and use nutrients in the water column (Limbourn and Westera, 2006). Seagrass meadows of nearshore Geographe Bay in 2–4 m water depth are dominated by *Posidonia sinuosa* (McMahon and Walker, 1998). *Amphibolis antartica* is found on the edges of these meadows and on limestone outcrops (McMahon and Walker, 1998).

Geographe Bay receives ephemeral surface flow from 16 waterways that dissect the catchment. Of these, the Lower Vasse, Lower Sabina, Abba and Ludlow rivers drain into the Vasse Wonnerup wetlands before discharging through the Wonnerup Inlet into Geographe Bay. Geographe Bay also receives flow from groundwater sources. There is concern that the nutrients flowing into Geographe Bay from the catchment may put the bay's nearshore water quality and marine ecosystems at risk.

6.2 Geographe Bay science and monitoring 2015-2021

Seagrass and water quality monitoring were the focus of science and monitoring in Geographe Bay from 2015–2021. The Keep Watch seagrass monitoring program, established in 2012, continued to monitor seagrass health at eight sites in the nearshore Geographe Bay. The Keep Watch program is a collaborative effort between GeoCatch, Edith Cowan University, Water Corporation, Department of Biodiversity Conservation and Attractions (DBCA) and the department. This program continues to enhance our understanding of the linkages between nutrient enrichment from the catchment and the health of Geographe Bay, using seagrass communities as indicators of change. Results from the past eight years show seagrass meadows in Geographe Bay to be in good condition. DBCA also undertook seagrass monitoring at greater depths as part of the Ngari Capes Marine Park monitoring plan.

Key science and monitoring programs undertaken in Geographe Bay from 2015–2021 include:

- continuation of the DWER's Geographe Bay water quality sampling program established in March 2012

- the Keep Watch seagrass monitoring program
- continuation of the DBCA seagrass monitoring program since 2012
- continuation of the Water Corporation Busselton Ocean water quality monitoring established in 2000.

Photo 13: Aerial view of nearshore Geographe Bay and the Busselton Jetty

6.3 Science and monitoring 2022-2024

Table 5 summarises the science and monitoring programs to be undertaken in Geographe Bay from 2022–2024.

The Keep watch program will continue to assess the health of seagrass meadows in Geographe Bay in relation to the potential threat associated with nutrient loads from the catchment. Seagrasses generally respond rapidly to environmental change, providing a useful indicator to the state of the marine environment (Van Niel et al., 2009). This monitoring is an essential part of the science program, assessing potential impacts to the marine environment linking the land to the sea. This program will be complemented by the mapping of seagrass meadows in Geographe Bay to assess the health and distribution of meadows over time.

Photo 14 Seagrass shoot monitoring in Geographe Bay as part of the Keep Watch monitoring program (Source: Kathryn McMahon)

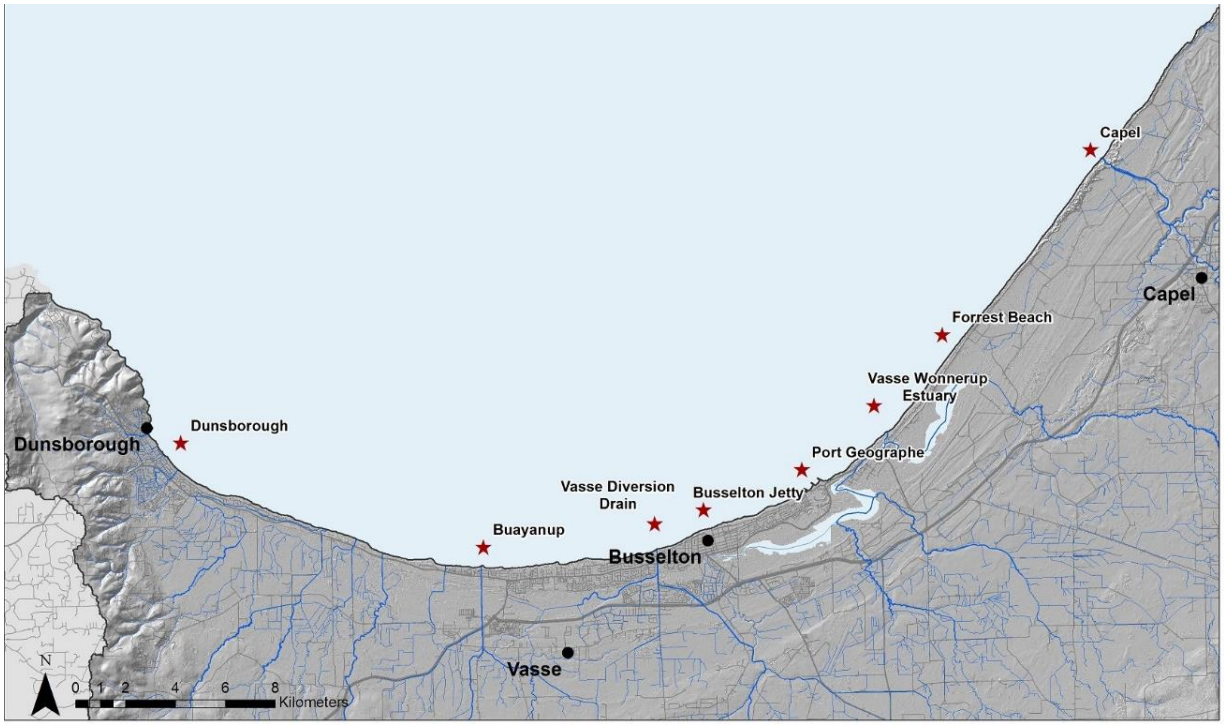

Figure 7 Map of Geographe Bay showing the Keep Watch seagrass monitoring sites

Table 5 Science and monitoring for nearshore Geographe Bay 2022-2024

Monitoring program	Lead Agency	Objectives	Sites	Timing	Data to be collected/Parameters investigated	Timeframe	Further information
Water quality sampling: Geographe Bay	DWER	To monitor trends in water quality over time and support seagrass monitoring data	One site at Busselton Jetty	Fortnightly	Physical parameters and nutrients	2022–2024	Water quality data is available on the DWER website www.water.wa.gov.au/maps-and-data/monitoring/water-information-reporting
Keep Watch annual seagrass health monitoring program	GeoCatch Edith Cowan University	To assess the health of seagrass meadows in Geographe	Eight sites in nearshore Geographe Bay (see Figure 7 for site locations).	Annually	*Posidonia sinuosa* health (including shoot density) and *Amphibolis antarctica* nutrient content Parameters include shoot density seagrass leaf nutrient content and epiphytic algal cover	2022–2024	Link to latest seagrass report on the GeoCatch website rgw.dwer.wa.gov.au/applying-science/keep-watch-seagrass-monitoring/
Seagrass monitoring	DBCA	To assess the health of seagrass in Geographe Bay	17 sites in Geographe Bay	February/March	*P.sinuosa* shoot density, canopy height and % cover photo quadrats	2022–2024	N/A
Water quality monitoring	Water Corporation/DBCA	To monitor trends in water quality on seagrass health	12 sites in Geographe Bay	Quarterly to every three months	Physical parameters and nutrients	2022–2024	N/A
Geographe Bay seagrass mapping	DBCA and DWER	To assess the extent and health of seagrass meadows in Geographe Bay in relation to the potential threat associated with the predicted nutrient loads from the catchment, and to assess change over time at each site using several assessment triggers	Geographe Bay to the boundary of Ngari Capes Marine Park	Summer 2022 to create baseline	Seagrass habitat extent through high satellite imagery Shoot density information, canopy height, mean biomass and volume through ground truthing	To be repeated in 2029	N/A

7 Communicating the plan

7.1 Science communication through Revitalising Geographe Waterways 2015-2021

Improving awareness, collaboration, and confidence in the community in the management of Geographe waterways has been a priority for the Vasse Taskforce and Revitalising Geographe Waterways program.

The implementation of the *Catchment to Coast Science, modelling and monitoring 2016–2019* has added value to previous investment by the department and partners. It has fostered collaboration and built partnerships and managers' skills and knowledge in the management of the key waterways in Geographe catchment both from a water quality and waterway health perspective. The plan has provided a detailed science, monitoring and modelling program to tackle water quality problems and waterway health of Geographe waterways through a collaborative process with advice from the Vasse Wonnerup wetlands Science Advisory Group.

The plan has been key to inform state and local government agencies, universities, catchment groups and members of the community about the program's science activities. Over the past five years, the implementation of the science plan has produced best available science, provided comprehensive baseline information, and filled key knowledge gaps on Geographe catchment and waterways, the Lower Vasse River, Vasse Wonnerup Wetlands, Toby Inlet and Geographe Bay assets. The information gained has informed and guided management actions and key waterway management plans for the Toby Inlet, Lower Vasse River, Vasse Wonnerup wetlands and Geographe Drainage network.

Key communication and collaboration activities undertaken from 2015–2021 include:

- development of the *Catchment to Coast Science, modelling, and monitoring plan 2016–2019*
- establishment of the *Vasse Wonnerup Wetlands Science Advisory Group* to provide technical advice on research and science for the wetland system
- establishment of the Vasse Wonnerup wetlands, Toby Inlet, Lower Vasse River and Sustainable Agriculture collaboration groups to bring together managers, scientists and community members to guide projects and develop management plans
- development of the Revitalising Geographe Waterways website as a one stop shop for information on Geographe waterways and science
- publication of 19 project factsheets and 12 technical reports to ensure information gained from the program is accessible to the community and partners

- more than 13 science and community updates providing the latest science delivered through the program, reaching and increasing the knowledge of more than 670 community members in the Geographe catchment
- Revitalising Geographe Waterways annual reports 2016, 2017 and 2020-22 to update the community on the program's progress, and a Revitalising Geographe Waterway one final report summarising four years of achievements to the community.

7.2 Communication plan 2022-2024

Communicating and sharing the science and monitoring findings of this plan will continue to be a focus over the next two years. Timely and effective communication to both the community and waterway managers will support an enhanced understanding of Geographe waterways and inform adaptive management if required. Effective communication will be critical to engaging all stakeholders to work towards common objectives. Scientific results from this plan will be reported in various formats, including technical reports and papers, factsheets, community seminars, video presentations, and social and traditional media.

This will ensure managers and the community are kept informed of the findings of science and monitoring programs. During the life of this plan water quality targets and ecological indicators will be developed. These will form the basis of regular reports on the conditions of key waterways and progress to meeting water quality targets. A condition statement and report card for the Vasse Wonnerup estuaries will be developed. Reports and summaries of water quality subcatchments and the Toby Inlet will be produced and updated annually.

GeoCatch will coordinate the communication of the science and monitoring, and broader Revitalising Geographe Waterways program, through two annual updates.

8 Annual review and reflection

The science and monitoring research programs will be reviewed annually and evaluated at the end of the 2022–2024 RGW program. The review will be a collaborative process with advice from the Science Advisory Group. A review of each project/program will be undertaken answering the following key questions:

- Is the project/program still relevant?
- Is the methodology used in the program current and is it working effectively to meet the program/project objectives and outcomes?
- Are there any problems with the output of the current program that may limit its use for management decisions, modelling inputs or research outcomes?
- Are there any information gaps that could be addressed by modifying the existing program?

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