Section B

ASSETS, GOALS & TARGETS

B1.0 A Strategic Approach

The vision for the Torbay catchment was developed by the Torbay Catchment Group. The vision for Watershed Torbay and the Torbay Catchment Restoration Plan is to have:

"an environmentally clean, balanced ecology supporting a prosperous community in which people respect each other's use of the catchment and waterways"

Community forums held during 2002 as part of the Watershed Torbay project, identified environmental, social and economic characteristics of a preferred future for the Torbay catchment (Appendix 2). The project vision (Appendix 3) was developed from ideas raised at the forums.

The Torbay Catchment Restoration Plan project steering committee has endorsed the Vision Statement. The demonstration project is based on a strategic approach to catchment management to achieve the vision.

The strategic process for integrated catchment management planning adopted for the project is represented in Figure B1. Goals are identified in relation to each of the seven Management Themes. These set the level of community expectations about outcomes from the demonstration project.

Specific objectives with targets have been set to achieve the goals. These are derived from science-based information and are Specific, Measurable, Achievable, Relevant and Time-bound (SMART). Targets for resource condition change are identified for each of the Management Themes, for example there are targets for the quality of water in wetlands. These are derived from science-based information and are set at levels that are considered to be achievable over a 20-25 year period. While these targets may not always meet community expectations, they are an assessment of what can realistically be achieved based on current research findings. New information could lead to decisions for change in the targets for resource condition. This may be for a higher level of resource protection or improvement, or lower to a more achievable level.

Targets for management action with sets of Actions are listed in Section C (the Action Plan). These are also derived from science-based information to ensure that the proposed actions will result in the targeted resource condition change. The reasons for taking the proposed actions are provided in this section (Section B). The reasoning provides the linkage between the goals, targets and actions. This is important because it may be a long time before results are measurable for resource condition change (e.g. water quality) but we need to be assured that the actions taken will eventually lead to the targeted change.

It is also important to measure the level of management actions in association with Monitoring and Evaluation (Section D) for resource condition change. Measures for implementation of management actions and indicators or resource condition change are identified in Section D. Figure B1 also shows how monitoring will continue to influence priorities for actions through ‘adaptive management’ processes.

For the Vision of the Torbay Catchment Restoration Plan to have lasting relevance, there is a need for ongoing sharing of ideas, values and information. Knowledge, understanding and communication involve the whole community - including government agencies, industry interest groups, community groups and individuals. There needs to be commitment to understanding the range of opinions, values or responsibilities in order to gain respect for the legitimate needs of others who live or have interests within the catchment.

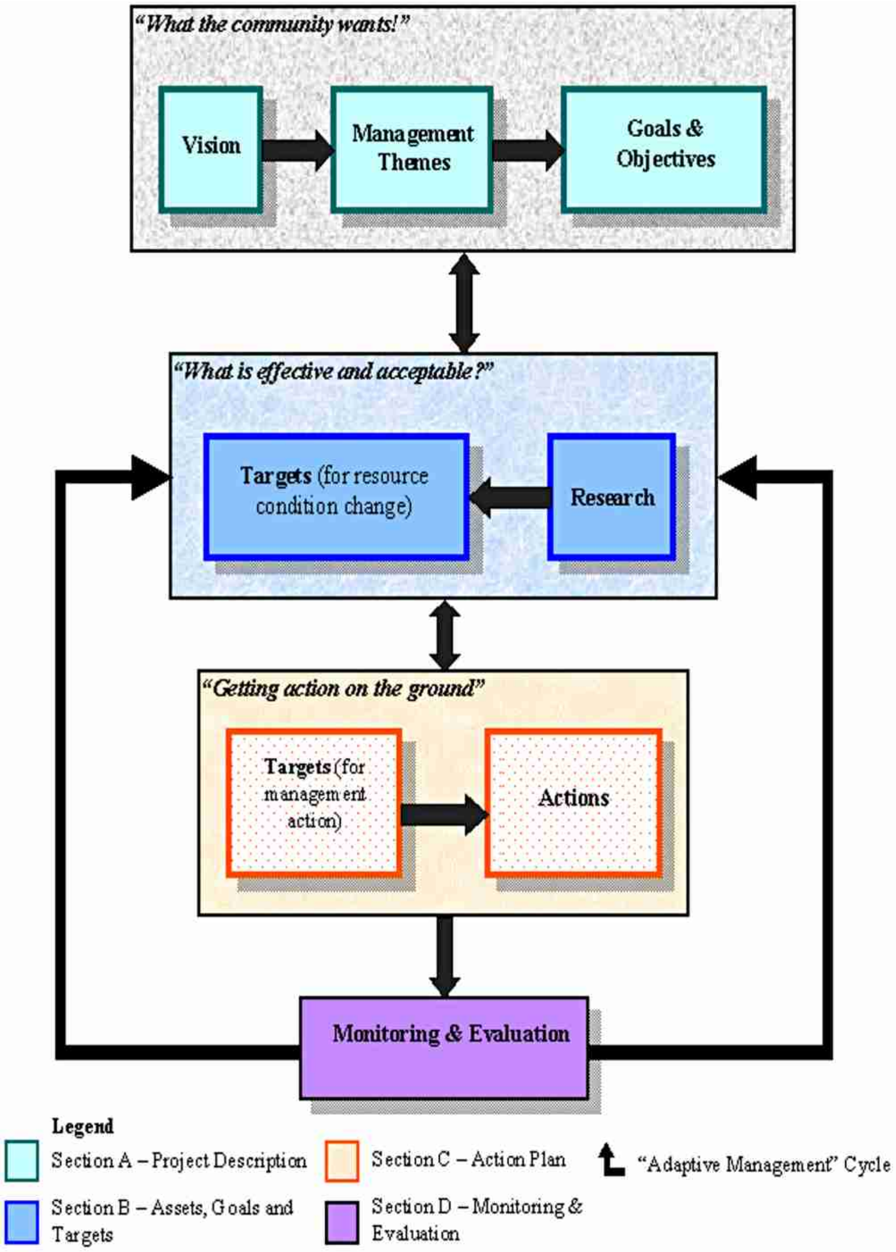

Figure B1 - Strategic processes for integrated catchment management planning.

B1.1 Identifying Priority Assets and Values

The community has expressed concern about a range of issues that are affecting the natural resource, infrastructure and heritage assets, values or specific features of the catchment. The high priority assets and values that are considered to be at risk are listed below:

Land

- Current landuse (assuming that it is appropriate)
- Soils and soil/water management opportunities (specific to land use e.g. seed potato production)
- Existing residential development.

Water Resources

- Torbay Inlet
- Lake Powell (an A-Class Reserve which maintains a high conservation value because of bird species richness and numbers, some of which are rare or endangered species. The lake is listed on the Register of the National Estate, Australian Heritage Commission).
- Lake Manarup
- Marbellup Brook, primarily for existing private water supplies and future supply options.
- North Creek (although this is now primarily an excavated drain)
- Potable quality water (both surface and ground)
- Beach-inlet (and associated marine-estuary dynamics).

Biodiversity

- 'Unique South Coast wetlands system' – a small association of 'tannin stained' wetlands.
- Lake Powell – a listed wetland of national significance (Register of the National Estate)
- Waterways and remnant riparian vegetation in 'pristine' condition
- Reserves (coastal and catchment) – National conservation estate, road and rail reserves
- Natural vegetation associations (including those associated with wetlands)
- Fish stocks
- Birds associated with wetlands
- Threatened/endangered species and ecological communities
- Declared Rare Flora (DRF)
- Native vegetation on public and private land.

Infrastructure, Culture and Heritage

- All constructed drains and wetlands
- Fencing for landscape management
- Flood control mechanisms
- Road, rail and access tracks
- Locally characteristic infrastructure heritage (e.g. distinctive bridges)
- Aboriginal sites of significance
- Community facilities, including local halls
- Recreational opportunities, especially within waterways and constructed drain systems and coastal areas.
- Tourism opportunities (e.g. with the Bibbulmun Track).

The actions proposed in the Torbay Catchment Restoration Plan are for the purpose of protecting or enhancing the assets and values of the landscape and community.

B2.0 Goals, Objectives and Targets for Management Themes

There are seven Management Themes. These encompass the range of issues and expectations expressed by the community about managing natural resources to protect or enhance community and landscape assets and values within the Torbay catchment. The Goals and Objectives for these themes are listed below, followed by development of a strategic approach to management actions in order to achieve targeted outcomes. Two themes, those related to planning and communication, do not have Resource Conditions Targets set as they are not seeking to achieve specific environmental outcomes.

B2.1 Theme One: Water Quality and Algal Blooms

The availability of good quality water is a fundamental requirement to sustaining communities and environment. Since European settlement, there has been a gradual decline in the catchment's water quality. Algal blooms are the most obvious sign that waterways are unhealthy. As well as being a health risk, algal blooms smell bad and look ugly, resulting in an unpleasant living environment for nearby residents and detract from a growing tourism industry.

Managing water quality and algal blooms was a key driver in establishing the Watershed Torbay project, and is therefore a principal focus.

Goal (2025): Water in Lake Powell, Lake Manarup and Torbay Inlet is suitable for the survival and growth of native aquatic plants and animals, and algal blooms are minimal. Water in Marbellup Brook remains suitable for drinking. Other waterways and waterbodies are suitable for recreation, domestic and agricultural use.

Objectives: The source and pathways for mobile nutrients, sediments and contaminants within the catchment are known and managed so that:

- There are no fish kills due to poor water quality
- The incidence of algal blooms is reduced
- The transport of nutrients, sediments and contaminants into waterways and wetlands in minimised
- Management practices are adopted that minimise public health and environmental risks for drinking water from Marbellup Brook.

Torbay Inlet and Lake Powell are recognised as being two of the most nutrient enriched wetlands in Western Australia (WRC, 2004a). Both wetlands have frequent algal blooms, which are sometimes toxic and have occasional fish kills as a result of high nutrient loads. Algal blooms also occur in waterways, including Marbellup Brook. Compared with other wetlands internationally, the poor health of the Torbay catchment water bodies is unexpected because use of land for farming is relatively recent and fertiliser applications for agriculture are relatively low (Weaver, Neville & Deeley, 2003). Recent work (AGSO, 2005) has shown that the release of nutrient from sediments in both Lake Powell and Torbay Inlet are much higher than any other sites measured in Australia.

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Nutrient enrichment, shallow depths and high light 'brightness' provide suitable conditions for algal blooms, including the potential for toxic species of blue-green phytoplankton (e.g. *Nodularia spumigena, Microcystis* and *Anabaena*).

Table B1 provides the estimated frequency of algal bloom occurrence in affected Torbay catchment waterbodies.

Waterbody	Toxic blooms	All blooms
Lake Powell	6 months/year	6 months/year
Torbay Inlet	2 months/year	3 months/year
Marbellup Brook	3 months/year	5 months/year

Table B1- Frequency of algal blooms in Torbay catchment waterbodies.

The nutrients causing algal bloom are phosphorus (P) and nitrogen (N). Silica is also a significant determinant of algal blooms, particularly in Torbay Inlet (WRC, 2004a). The key aquatic systems 'driver' of algal blooms varies according to conditions and is not always well understood.

The high level of nutrients in Torbay Inlet and Lake Powell are likely to be from a range of sources including:

External Diffuse Source

- Leaching of nutrients from sandy profile soils and to a lesser degree erosion of nutrient enriched soil used for extensive agriculture
- Discharge of nutrients in groundwater to wetlands
- Release of nutrients due to oxidation of acid sulphate soils.

External Point Source

- Discharge of nutrients from intensive industries (including wastewater treatment plants, dairies, piggeries and annual horticulture)
- Leaching from residential septic systems
- Waterbird faecal contamination.

Internal Point Source

- Release of nutrients from lakebed sediments.

The proportional contribution of nutrient load provided by different sources through different transport pathways and processes is not fully known. Current research initiatives will provide increased understanding of nutrient sources, particularly from release of nutrients from lakebed sediments and oxidation of acid sulphate soils.

The pathways for nutrients from the source to the waterbodies are also a significant issue for management decisions. The pathways considered are:

- Soil-water processes (considered further in the 'Farming systems' theme)
- Surface water flow (nutrient transport in solute and particulate form)
- Sediment transport
- Groundwater movement
- Lakebed sediment processes.

The sources and pathways of nutrients in the Torbay catchment are described below.

B2.1.1 Nutrients from Surface Water Flows

Water quality and stream flow has been continuously measured at six gauging stations within the Torbay catchment since January 1997 (Figure B2).

Figure B2 - Location of stream gauging stations within Torbay catchment.

Surface flows into Torbay Inlet are from two major tributaries: Torbay Main Drain and Marbellup Brook. Flow rates vary seasonally, with highest flows in winter and the lowest flows in summer. Median winter flow in the Torbay Main Drain is 78 ML (megalitres)/day and Marbellup Brook is 72 ML/day. Median summer flow for Torbay Main Drain 0.3 ML/day and Marbellup Brook is 16 ML/day. Marbellup Brook provides significant surface flows to the estuary all year round. Both major tributaries to Torbay Inlet contributed the highest loads and nutrient concentrations.

There are four tributaries to Lake Powell: Seven Mile Creek, Five Mile Creek, Cuthbert Drain and Grasmere Drain.

Seven Mile Creek provides the highest surface flows with median flows of 5 ML/day in summer and 18 ML/day in winter. Seven Mile Creek currently receives excess water from surface runoff and groundwater discharge from the Water Corporation's Albany Effluent Irrigated Tree Farm (AEITF) where secondary-treated effluent from the Timewell Road wastewater treatment plant is irrigated throughout pasture bays and tree lots.

Flows are substantially lower for Cuthbert Drain, Grasmere Drain and Five Mile Creek. Minimum and maximum average daily flows for the creeks range between 1 – 6 ML/day, 1-2ML/day and 1-8 ML/day respectively for the three tributaries). All tributaries are seasonally variable.

Nutrient loads delivered to Torbay Inlet and Lake Powell by their major tributaries have been calculated from continuous flow data and fortnightly water quality data collected from 1997 to 2002 (Table B2). The significance of Torbay Drain and Marbellup Brook to the nutrient load in Torbay Inlet is demonstrated by the high annual nitrogen (N) and phosphorus (P) loads from their stream flow.

Tributary	Nitrogen load (Tonnes /year)	Phosphorus load (Tonnes /year)	Catchment Area (hectares)
Torbay Drain	30.4	2.4	5300
Marbellup Brook	18.8	2.2	13100
Seven Mile Creek	5.7	0.8	2850
Five Mile Creek	3.6	1.0	1350
Cuthbert Drain	4.0	0.3	1250
Grasmere Drain	1.1	0.1	520

(Source: WRC, 2004a)

Table B2 - Nutrient loads for Torbay catchment tributaries.

The relative proportional contribution of nutrient load varies with catchment size. Five Mile Creek has a small percentage of total stream flow but a relatively high proportion of total phosphorus load (Table B3).

Tributary	% flow	% TN load	% TP load	% Total area
Torbay Drain	38	49	38	53.8
Marbellup Brook	41	31	31	21.8
Seven Mile Creek	11	8	11	11.7
Five Mile Creek	5	6	16	5.5
Cuthbert Drain	3	4	2	5.1
Grasmere Drain	2	2	2	2.1

Table B3 - Proportion of flow and loads by sampling point (1997-2000).

Analysis of surface water nutrients over a five year period (1997-2002) for the six tributaries shows no significant trend, except for total nitrogen in Seven Mile Creek which has a slightly declining trend (WRC, unpublished data). See Appendix 4. The decline in nutrients in Seven Mile Creek is thought to be due to the ceasing of direct discharge of treated wastewater to the creek.

B2.1.2 Land Use as a Source of Nutrients

The relative proportion of nutrients derived from a range of land uses within Torbay catchment is shown in Table B4. The high contribution from point sources is confirmed by analysis of case studies for a piggery, a dairy and an annual horticultural enterprise (Neville, 2003). The distribution of these land uses within Torbay catchment was shown previously in Figure A7.

Land use	Total Nitrogen (TN) (%)	Total Phosphorus (TP) (%)
Dairy	32	46
Grazing	45	34
Annual Horticulture	15	13
Peri-urban	3	2
Piggery	1	2
Plantation	3	2
Remnant vegetation	1	<1
Cropping	<1	<1
Un-sewered urban	<1	<1
Wetland	<1	<1
Sewered urban	<1	<1

Table B4 - Proportional contribution of different land uses to TN and TP generated at source for the whole catchment.

The following figures (B3 & B4) show the potential for nutrient loss from these land uses. The analysis is based on an assessment of land use nutrient generation rates and other catchment features, including soil type.

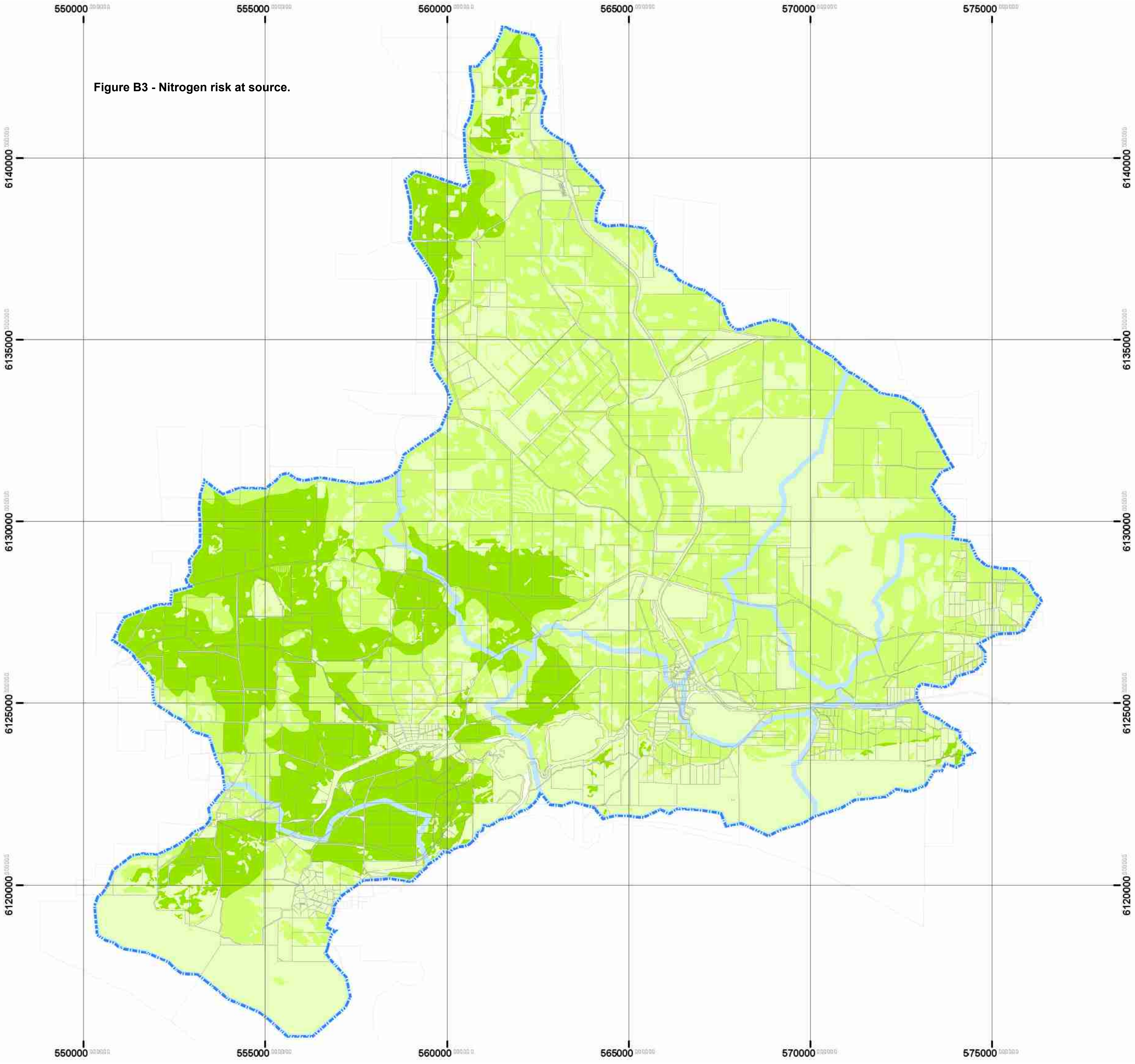

Figure B3 - Nitrogen risk at source.

WATERSHED Torbay

Nitrogen Risk at Source

Estimated nitrogen delivered to waterways.

Legend

Primary Subcatchments

Nitrogen Delivery

- Low (0 - 5 kg/ha)
- Medium (5 - 20 kg/ha)
- High (20 - 60 kg/ha)

Data Sources - Nutrient Risk mapping
Lakes and other hydrological features from hydrology extracted from 1:25,000 topography maps (DLI 2005).
Cadastre from DLI (2005).

Estimates of nutrient risk- nitrogen and phosphorus at source, nitrogen and phosphorus export - have been modeled using SSPRED, the support system for Phosphorus Reduction Decisions.
(Ecotones & Associates for DoE, 2006).

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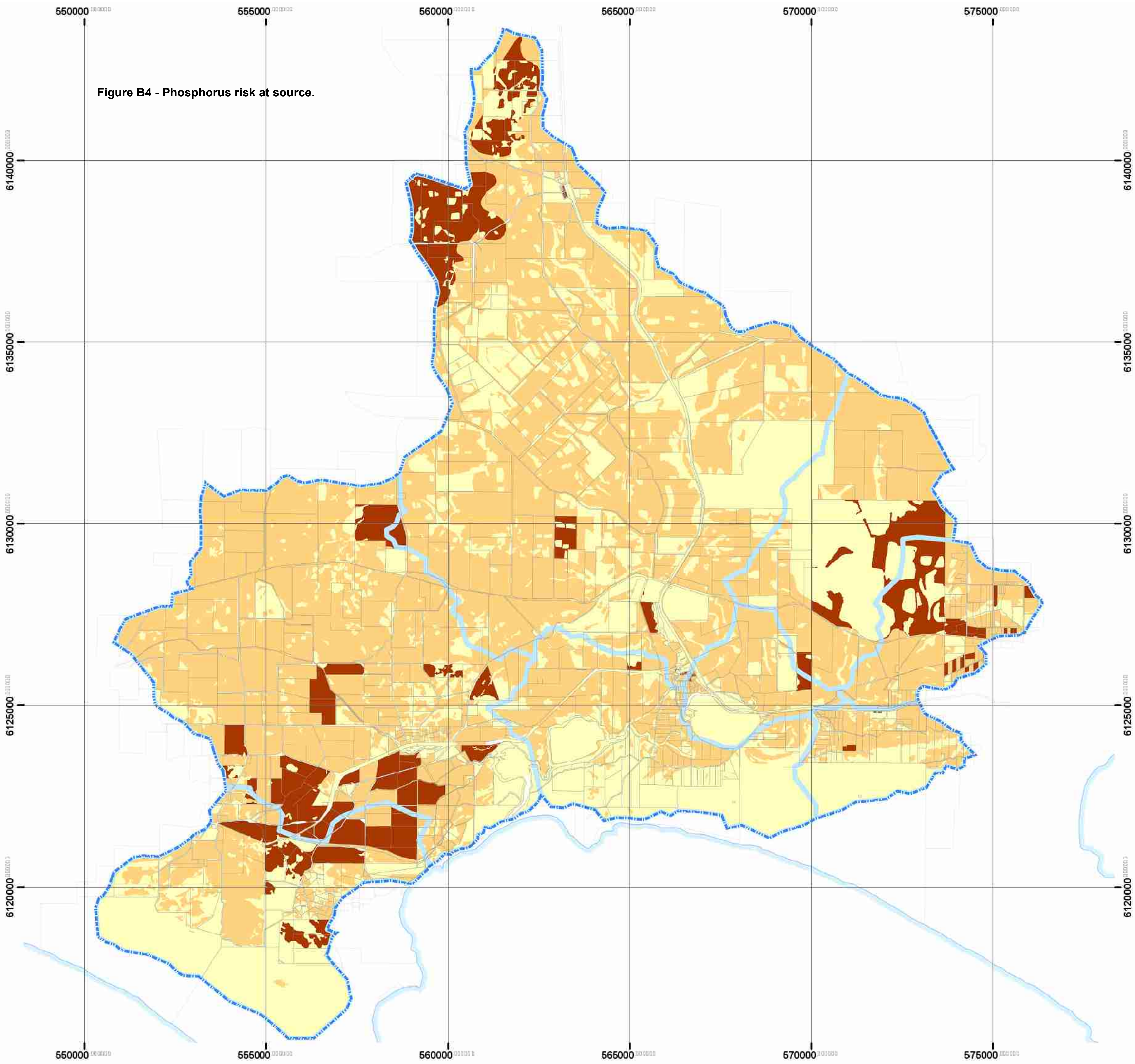
Department of Environment

ECOTONES & ASSOCIATES

Analysis and mapping using ArcGIS 9.1

Figure B4 - Phosphorus risk at source.



WATERSHED Torbay

Phosphorus Risk at Source

Estimated phosphorus delivered to waterways.

Legend

Primary Subcatchments

Phosphorus Delivery

Low (< 0.25 kg/ha)

Medium (0.25 - 2 kg/ha)

High (2 - 5 kg/ha)

Data Sources - Nutrient Risk mapping
Lakes and other hydrological features from hydrology extracted from 1:25,000 topography maps (DLI 2006).
Cadastre from DLI (2005).

Estimates of nutrient risk- nitrogen and phosphorus at source, nitrogen and phosphorus export - have been modeled using SSPRED, the support system for Phosphorus Reduction Decisions.
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While the Department of Environment has made all reasonable efforts to ensure the accuracy of this data, the Department Accepts no responsibility for any inaccuracies, and persons relying on this data do so at their own risk.

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Analysis and mapping using ArcGIS 9.1

B2.1.3 Point Sources of Nutrients

Wastewater from Albany

Wastewater from Albany is piped to the Timewell Road wastewater treatment plant located within the Five Mile Creek sub-catchment. Secondary treated effluent from this treatment plant is then piped out to the AEITF located within the Seven Mile Creek sub-catchment, and used to irrigate pasture bays and plots of Tasmanian Blue Gums (*Eucalyptus globulus*). The quality of effluent used on the Eucalyptus plantation is approximately 23 mg/L TN and 8–10 mg/L TP.

Water and nutrient excess from the AEITF discharges into Seven Mile Creek and eventually into Lake Powell, via Grasmere Drain. The concentration of TN discharged from the tree farm is less than 2 mg/L and TP is less that 0.1 mg/L (measured at the Gunn Road gauging station). The volume of run-off is approximately 0.5–1.5 ML/day. (Note: discharge concentrations were higher in 2005 due to storm exports TN=1.4 to 2.2, TP=0.3) The contribution of nutrients from the AEITF delivered to Lake Powell via Seven Mile Creek is shown in Table B5. The TN load is generally maintained at about 500 kg/year (8.7% of total Seven Mile Creek TN load) and TP is maintained at about 50 kg/year (6.25% of total Seven Mile Creek TP load). This is expected to increase as loading on the tree farm increases. This is considerably less than the nutrients discharged from the land prior to the tree farm establishment when it was used for agriculture.

Year	Estimated TN in Surface runoff (kg/year)	Overall TN load[4] (kg/year)	Estimated TP in surface runoff (kg/year)	Overall TP load[4] (kg/year)
1997[1]	339	530	30	43
1998[1]	312	533	26	42
1999[1]	368	573	26	41
2000[1]	318	623	14	48
2001[2]	225[3]	373	10.9[3]	28.9
2002[2]	146[3]	302	8.3[3]	26.3
2003[2]	482[3]	644	45.5[3]	63.5
2004	420	550[5]	52	60[5]

1 - Data from Brown & Root (2001) independent review.

2 - Data from CYMOD (2004) independent review, TP groundwater data is estimated average over three year period.

3 - Calculated from HYDSYS hydrological analysis of actual flows and weekly analysis results.

4 – Overall load includes the estimates of surface flow contributions derived from water quality sampling and modelled estimates of groundwater contributions of nutrients.

5 - Estimated.

Table B5 - Annual TN and TP loads from the Albany Effluent Irrigated Tree Farm delivered to Seven Mile Creek.

The volume of wastewater from Albany is forecast to double within 20 years. The AEITF is expected to have reached hydraulic capacity by somewhere between 2006-09. Under current license conditions, the AEITF has reached the total nitrogen application limit, however there are indications that the nitrogen assimilation capacity of the tree farm may be higher (Water Corporation, 2003). Water Corporation are currently considering a range of options to accommodate the increased wastewater in the short term.

Wastewater from Elleker

There are 104 septic tanks in the town of Elleker (2005 data, City of Albany). The nutrient load entering Lake Powell from the septic tanks has not been established.

Since the 1991 flood, new residential development on properties lower than 1.5m AHD require an 'alternative' effluent disposal system that minimises nutrient loss. The April 2005 floods further illustrate the need to prevent residential development in the floodplain.

Intensive agricultural industries

Nutrient balance analysis of a dairy, a piggery and annual horticulture within the Torbay catchment shows that intensive industries have potential for very high exports of nutrients from the enterprise site as these industries have high levels of nutrient surplus, or un-utilised nutrients in their production systems (Neville, 2003). Site conditions, particularly soil structure and the phosphorus retention capacity of soils, can influence the rate at which any phosphorus surplus is exported from a site. The analysis provides input : output ratios for phosphorus and nitrogen.

Figure B5 shows the components of ratio calculations. For example, a 5.5 kilogram phosphorus input into a farming system resulting in one kilogram leaving the property in produce gives a ratio of 5.5:1. In this situation, the remaining 4.5 kilograms of phosphorus either increases soil storage or is discharged from the property, potentially adding to waterway nutrient loads. Figure B6 also shows that nutrient surplus can also be calculated from information about inputs and outputs.

The input : output ratios calculated for intensive industries in the Torbay catchment (Neville, 2003) shows the P ratio for the dairy was 5.5:1, the piggery 3.7:1 and annual horticulture 5.8:1. The N ratios were considered a less reliable index of nutrient use efficiency due to nitrogen fixing by legume-based pastures and nitrogen loss by volatilisation.

Attaining a P input : output ratio of 1:1 is desirable; however a ratio of 1.5:1 is suggested in the international literature as acceptable. These measurements provide a useful basis for intensive industries to target but may not be easily applied to individual properties. The nutrient surplus per hectare may provide a better way of determining nutrient loss for an individual enterprise.

Recent soil testing was undertaken in the catchment as part of a Watershed Torbay initiative to improve fertiliser management practices in the catchment.

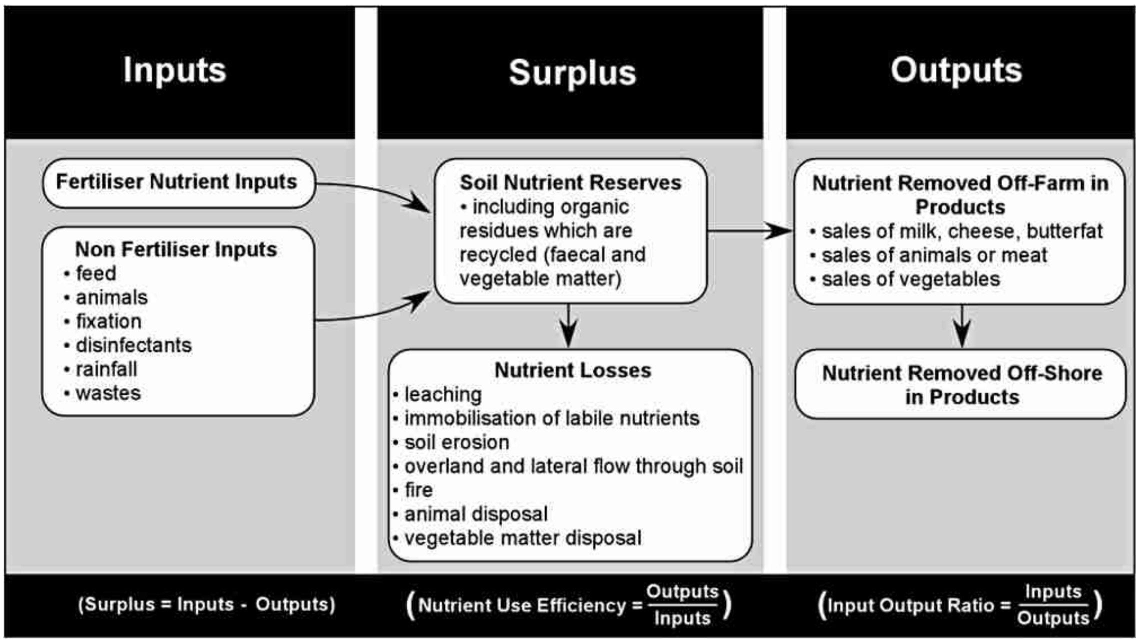


Figure B5 - Component of Nutrient Ratio and Nutrient Surplus calculations.

B2.1.4 Acid Sulphate Soils as a Source of Nutrients

A potentially significant source of nutrients to water bodies in the Torbay catchment is due to oxidation and progressive degradation of organic matter in soils (WRC, 2004b). Conceptual assessment of geochemical processes suggests that up to 50% of the total nitrogen load and up to 80% of the total phosphorus load in wetlands could be sourced from acid sulfate soils, however this estimate requires field verification.

B2.1.5 Groundwater as a Source of Nutrients

Groundwater was monitored at 24 locations in the lower catchment from May 2003 – May 2005 as a part of a research project. Water level was measured in all bores monthly. Nitrogen and phosphorus concentrations were measured for 12 of the bores every three months. The location of the bores is shown below in Figure B6.

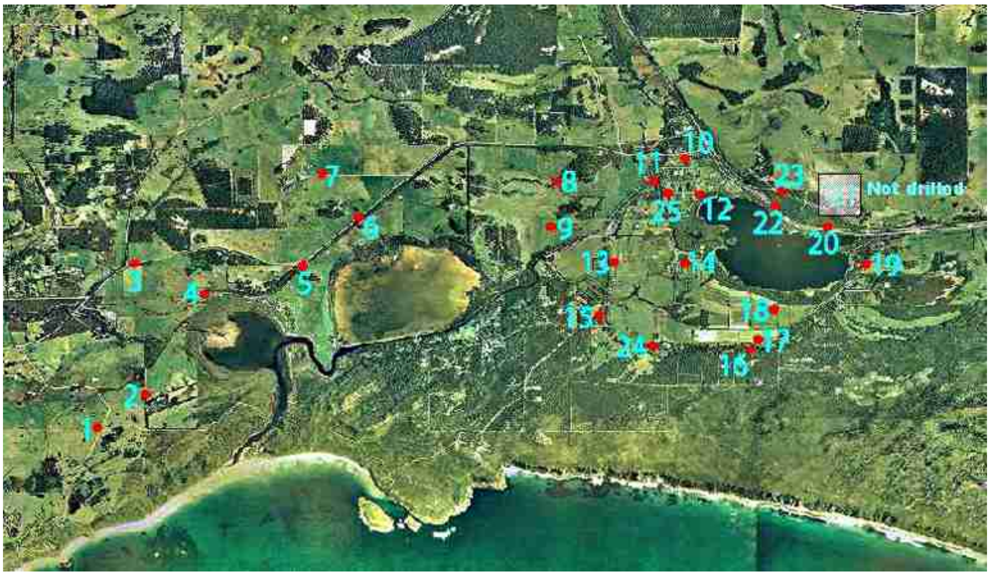


Figure B6 - Location of groundwater monitoring wells in the Torbay catchment.

Contoured water-table elevations (Figure B7) indicate that groundwater flows from the north, west and east to surface water bodies in the lower part of the Torbay catchment.

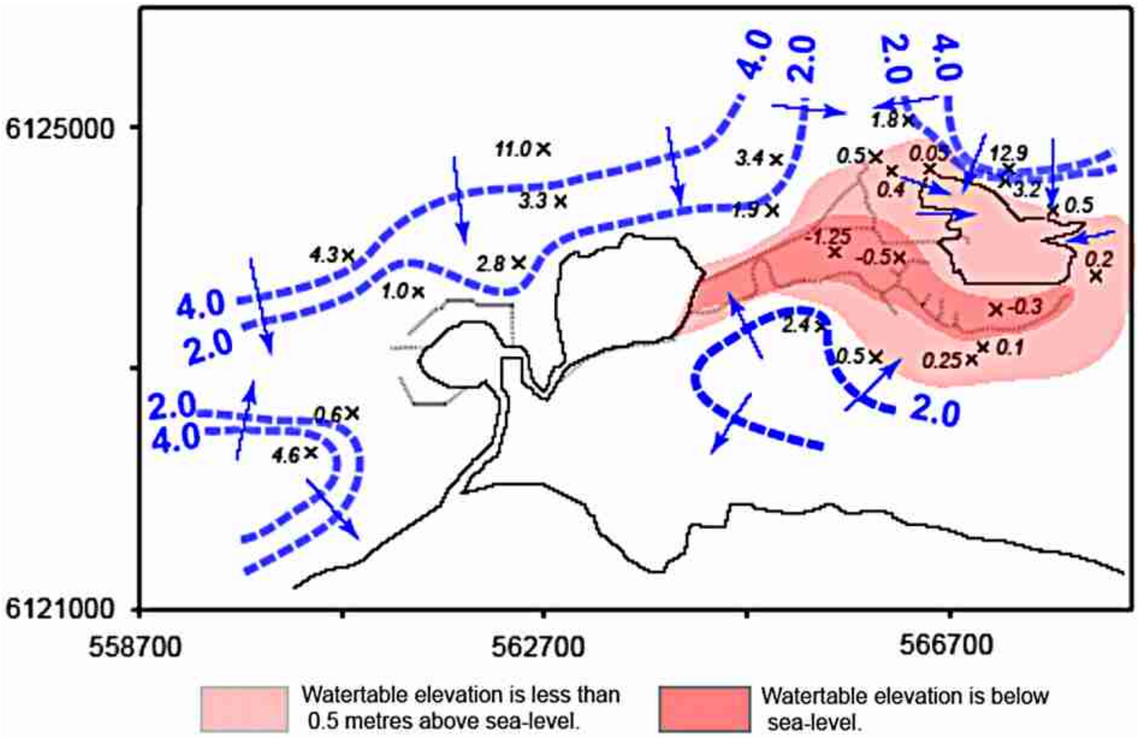


Figure B7 - Groundwater elevation (m AHD) and direction of groundwater flow when the water-table is low due to the sandbar at the mouth of Torbay Inlet being open (Source: WRC, 2004b).

The existing drainage management scheme (described in Section A5.0) is the most important factor controlling groundwater flow within the lower part of Torbay catchment. This particularly affects water levels in Lake Manarup and Torbay Inlet when the sandbar across the mouth of the estuary is closed. The water-table difference contours (Figure B8) show that there is a large area of seasonal groundwater mounding beneath Torbay Inlet when the sandbar is closed.

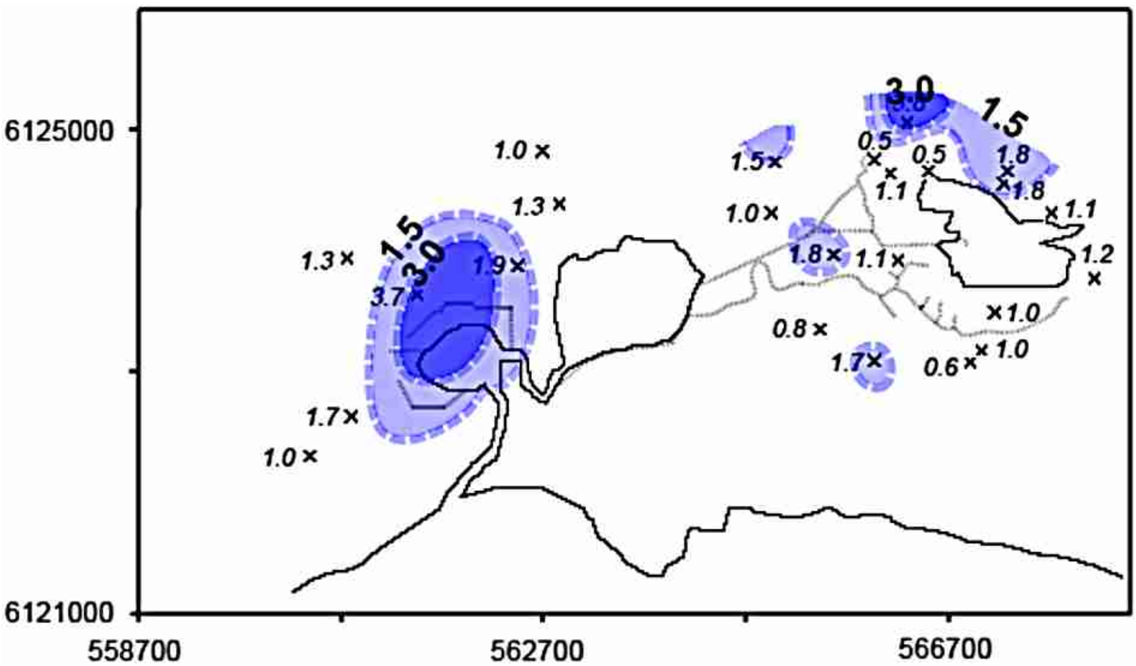


Figure B8 - Area of potential groundwater mounding due to recharge when the sandbar at the mouth of the Inlet is closed (Source: WRC, 2004b).

Initial indications from groundwater analysis suggest that transmission of nutrients in groundwater to water bodies is a relatively low proportion of total nutrient loads.

Groundwater was found to be acidic where disturbed acid sulfate soils occur. These soils could also be a source of potentially toxic metals and other contaminants to waterbodies. This could occur, via leaching of these materials from disturbed soils into groundwater and from discharge into drains. Potentially toxic materials include aluminium, cadmium, selenium, mercury, copper and zinc.

Sulfuric acid is formed from oxidizing acid sulfate soils. The potential for leaching acid from soils at risk where there are fluctuating water tables is considered to be high (WRC, 2004b).

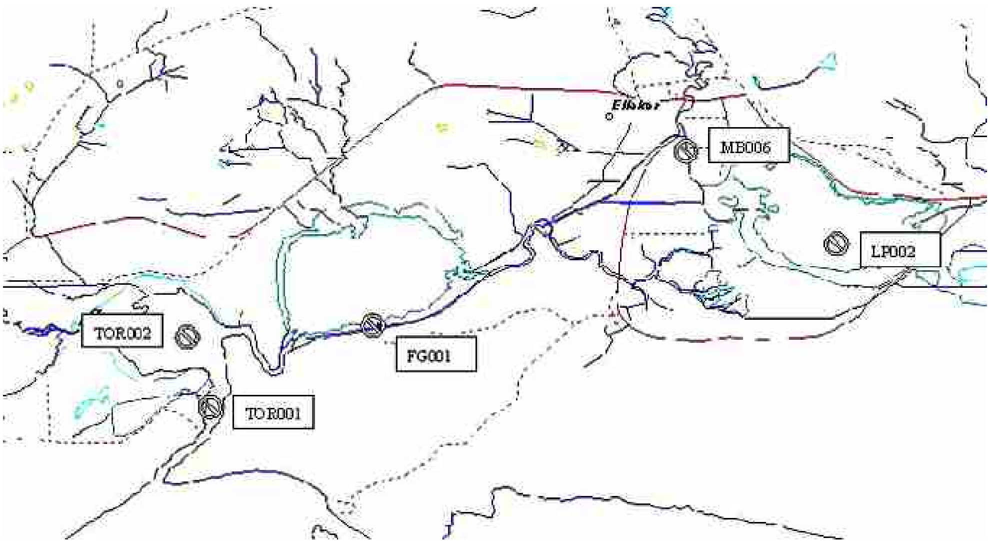
B2.1.6 Lakebed sediments as a source of nutrients

Given the shallow nature of both Torbay Inlet and Lake Powell (average depths 0.5 m), the status of sediment nutrients is likely to be an important factor influencing water quality and primary productivity. Measurement of sediment pore water nutrients found ammonia and orthophosphate concentrations were very high, indicating sediment-water fluxes of nitrogen and phosphorus are highly likely in these water bodies (WRC, 2004a).

Investigations of sediment-water nutrient fluxes in Torbay Inlet and Lake Powell were completed by Geoscience Australia in April 2005. This work found extremely high flux rates in both waterbodies.

B2.1.7 Nutrient Processes with Torbay Inlet and Lake Powell

Water quality monitoring in both Torbay Inlet and Lake Powell has been carried out at a monthly frequency throughout the year since October 1999, at the sites shown in Figure B9. During summer and autumn, when algal blooms are occurring, sampling is increased to a fortnightly frequency.



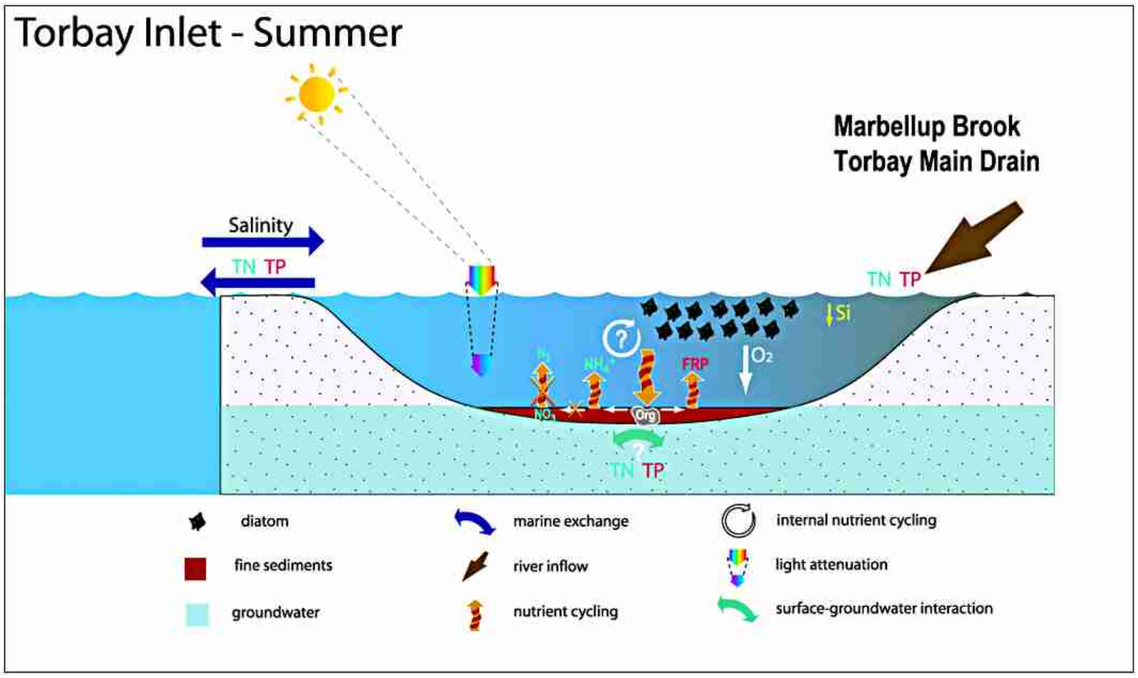
(Source: WRC, 2004a)

Figure B9 - Location of water quality monitoring sites for Torbay Inlet and Lake Powell.

Torbay Inlet

Prior to winter 2002, phytoplankton assemblages in Torbay Inlet were dominated by a combination of cyanophytes (blue-green algae, including Nodularia species), chlorophytes and diatoms. Since winter 2002, phytoplankton assemblages in Torbay Inlet have been dominated by diatoms throughout the year. This change in phytoplankton assemblages in Torbay Inlet is likely to be due to a combination of environmental factors, including bar status ie. the frequency of marine connectivity and salinity. High salinity in Torbay Inlet favours the presence of diatoms. Vertical stratification (i.e. layers of fresher water near the surface and saline water near the bed) was evident in Torbay Inlet.

Figure B10 shows a model of summer nutrient processes, including the marine influence, favouring the strong presence of diatoms within the phytoplankton assemblage. The main nutrient sources are from Torbay Main Drain and Marbellup Brook. The growth of summer phytoplankton assemblages is limited by water column silica concentrations (WRC, 2004a).



(Source: WRC, 2004a).

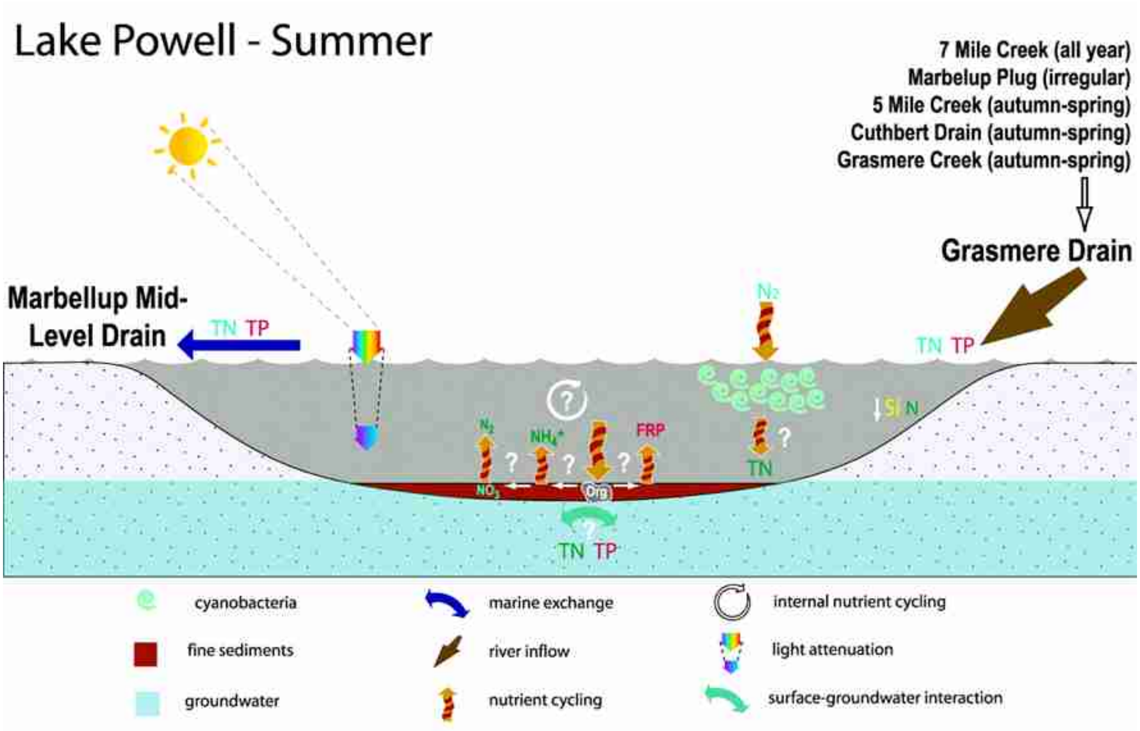
Figure B10 - Conceptual model of water quality processes in Torbay Inlet during summer.

Lake Powell

Phytoplankton assemblages in Lake Powell were dominated by cyanophytes during summer/autumn, and by a mix of cyanophytes, chlorophytes and diatoms during winter and spring throughout the monitoring period (1999–2004). Ammonia and orthophosphate concentrations were consistently lower in Lake Powell than in Torbay Inlet. Salinity was also lower in Lake Powell but dissolved oxygen concentrations were higher.

Phytoplankton growth in Lake Powell is limited by nitrogen and silica, with partial phosphorus limitation.

Figure B11 shows a model of summer nutrient processes in Lake Powell.



(Source: WRC, 2004a).

Figure B11 - Conceptual model of water quality processes in Lake Powell during summer.

B2.1.8 Marbellup Brook Stream Flow Quality

The suitability of Marbellup Brook for public drinking water is dependent upon it meeting quality and health standards. There is concern about incompatible land uses within the Marbellup Brook sub-catchment, including industrial and residential development and intensive animal industries. The risk is to public health standards by the potential for water-borne pathogens. The Marbellup Brook sub-catchment was declared the Marbellup Water Reserve in 1986 under the Country Areas Water Supply Act 1947.

An analysis of the management options to reduce this risk suggests that adoption of Best Management Practices through voluntary support schemes is favoured (McGuire, 2002). Other options include:

1. Restricting land use through altering classification for land use controls from Priority 3 to Priority 2 for Public Drinking Water Source Areas (WA Planning Commission, 2003), or
2. Post-contamination water treatment.

The first of these options is considered too onerous on landholders and the second option too expensive for government (McGuire, 2002). However, the protection planning currently underway is likely to recommend greater land use controls. A risk evaluation undertaken by the Water Corporation (Water Corporation, unpublished) show much of the existing catchment is consistent with Priority 2 classification.

The opportunity exists to undertake Best Management Practice actions within the Marbellup Brook sub-catchment that reduce nutrient flows to water receiving bodies (Lake Powell and Torbay Inlet) and provide ecosystem services through increased public health standards for future public water supplies.

B2.1.9 Water Quality and Algal Blooms: Targets for change

The most significant water quality issues within the Torbay catchment are the high nutrient loads in stream flow and the very high occurrence of algal blooms in wetlands and waterways. The community and partners of the Watershed Torbay project expect to reduce the incidence of algal blooms so that water is suitable for maintenance of healthy aquatic ecosystems, and if required, for human use. The cause of algal blooms is the high nutrient load within wetlands and waterways. Reduction in the incidence of conditions suitable for blooms will require a reduction in nutrients, however the extent to which reductions can be achieved in the various waterbodies through nutrient management remains uncertain. A target is set for the preferred reduction in algal bloom incidence in order to provide guidelines for research and management.

As further information is gathered, particularly on the impacts of nutrients from acid sulfate soils, further targets for water quality improvement for groundwater may be set.

A short rationale on how targets have been set for each of the waterways is given below.

Torbay Main Drain (Torbay Inlet Sub-Catchment)

Torbay Main Drain contributes 38% of Torbay catchment's total flow to Torbay Inlet, but 49% of the TN load and 38% of the TP load. Both TN and TP concentrations are high. However, most of the nutrients are in organic or particulate form, and intervention by way of streamlining is considered to be reasonably achievable. Given the large loads from this drain and sub-catchment, ambitious targets have been set, with TN proposed to meet south west streams water quality guidelines of 1.2 mg/L.

Marbellup Brook (Marbellup Brook Sub-catchment)

Marbellup Brook is the other significant contributor of flow, comprising 41% of the total flow of Torbay catchment. However, water quality is relatively good, with low TN (below south west streams guidelines) and moderate TP concentrations. However, given the high flow, loads are very large. While much of the riparian zone within Marbellup sub-catchment is intact, there is considerable potential to improve first and second order stream quality. Several point sources occur in this sub-catchment, and there are opportunities to improve water quality from these, as well as reducing nutrient inputs from broad acre agricultural sources through fertiliser management. Current TN concentrations are considered to provide a benchmark for other streams in Torbay catchment. The TP reduction target is to south west streams guideline values of TN of 1.2 mg/L, and TP of 0.065 mg/L.

Seven Mile Creek (Seven Mile Creek Sub-catchment)

Seven Mile Creek has shown a downwards trend for TN from 1997-2005. TN concentrations are low, but TP concentrations remain high. The proportion of soluble phosphorus is also higher than that of Marbellup Brook. However, TP loads are low given that this system contributes only 5% of the total flow of Torbay catchment. The creek does contribute 25% of the flow to Lake Powell. Moderate reduction targets have been set, recognising the relatively good riparian zone conditions but room for improvement in fertiliser management to reduce soluble phosphorus.

Grasmere Drain (Seven Mile Creek Sub-catchment)

Grasmere Drain contributes 2% of the total Torbay catchment flow and proportional loads of both TN and TP. However, both TN and TP concentrations are high, although there has been a very small downward trend in TN over the 8 year period of 1997–2005. The

TN target has been set at south west streams guideline values and an ambitious TP reduction target has been set. Soluble phosphorus concentrations are a relatively high component of TP for this sub-catchment.

Five Mile Creek (Five Mile Creek Sub-catchment)

Five Mile Creek contributes only 5% of the total Torbay catchment flow but a high 16% of TP loads. It also contributes 50% of the TP load to Lake Powell. TP concentrations are extremely high, with about 60% of the phosphorus being in soluble form. This is not consistent with other streams in the catchment. Nitrogen concentrations are also high. An ambitious TN reduction target has been set to a target below south west streams water quality guidelines. However, this is considered achievable given the comparison with the local benchmark set by Marbellup Brook, and the current downward trend in TN concentrations.

Prior to setting targets, given the very high TP concentrations in this creek, it is considered important to better understand the sources of P, and whether they are related to the legacy of the Timewell Road wastewater treatment plant discharge to the creek up to 1995. This work forms an action in this plan.

Cuthbert Drain (Five Mile Creek Sub-Catchment)

Cuthbert Drain contributes 3% of the total Torbay catchment flow, 4% of the TN load, and 2% of the TP load. Concentrations of TN are high, but TP meets ANZECC water quality criteria (these criteria can be found at). TN concentrations are likely to be related to acid sulphate soil processes. No reduction in TP concentration has been proposed given it currently meets ANZECC guidelines, but an ambitious TN reduction is proposed.

The Targets for resource condition change for Theme One: Water Quality and Algal Blooms are:

1.1 *Reduce by a third the incidence of algal blooms in Torbay Inlet, Lake Powell and Marbellup Brook by 2025*

1.2 *Median nutrient concentrations (mg/L) discharged from the sub-catchments meet the following targets by 2020:*

Sub Catchment	**Current median concentration** (TN/TP)	**Target median concentration** (TN/TP)
Torbay Drain	1.80 / 0.110	1.20 / 0.090
Marbellup Brook	0.68 / 0.077	0.60 / 0.065
Seven Mile Creek	1.00 / 0.130	0.68 / 0.100
Five Mile Creek	1.35 / 0.460	1.00 / to be set
Cuthbert Drain	2.45 / 0.059	2.00 / 0.059
Grasmere Drain	1.40 / 0.200	1.20 / 0.150

1.3 *The quality of water in Marbellup Brook meets national criteria for public drinking water supply (NHMRC & ARMCANZ, 1996) by 2015.*

Note: Guideline values used for Torbay catchment are for the SW Streams, TN of 1.2 mg/L, and TP of 0.065 mg/L.

B2.2 Theme Two: Water Quantity

Water quantity in the Torbay catchment is significant for three reasons:

1. The potential allocation of drinking quality water for the Lower Great Southern Water Supply Scheme.
2. Ongoing adequate self supply for catchment land holders.
3. Ensuring adequate water quantity to maintain ecological functions in waterways and wetlands (ecological water requirement).

Goal (2025): Water is allocated for sustainable use while ensuring that adequate water is provided to all waterways and wetlands to protect their environmental values.

Objectives:

- Flow in Marbellup Brook is adequate to maintain ecological requirements,
- Water regimes in Lake Powell, Lake Manarup and Torbay Inlet are suitable for the survival and growth of native aquatic plants and animals,
- The drainage district is managed to meet the needs of current land uses, future land uses, and the environment, and
- Those who benefit from the use of the catchment to provide environmental services contribute to the costs of restoration.

The stream flow of creeks within each sub-catchment is measured at gauging stations (as shown in Figure B2). The Marbellup Brook has the greatest average annual flow of 16 gigalitres (GL).

Water consumption in the City of Albany is increasing and total demand is expected to double from the current consumption of 5 GL within the next 25 years (Water Corporation, 2000). The current primary source area is the Werillup Hill aquifer, which is now at full sustainable use levels. Additional water sources are required. One favoured proposal is to allocate up to 5 GL from Marbellup Brook for direct supply to Albany, or to recharge the Werillup Hill aquifer.

The function of aquatic ecosystems is determined primarily by the quality of water, as well as the period and duration of stream flow. Modification to stream flow can substantially impact on basic river ecological health. Ecological Water Requirements (EWR's) are defined as "the water regimes needed to maintain ecological values of water dependent ecosystems at a low level of risk". Determination of EWR's for Marbellup Brook will be important for stream flow allocation for public water supply.

With proposals to allocate water for public use and with possible alterations to the current operating strategy of the drainage system, there is a need to ensure sufficient stream flow is available for environmental requirements. This is important for Lake Powell, Torbay Inlet and Lake Manarup. It is also significant for in-stream ecological functions of waterways.

B2.2.1 Water Quantity: Targets for change

The requirement for allocation of water from Marbellup Brook for public water supply is expected to occur within ten years. The targets for resource condition change are set for this time period and apply to both water allocation and environmental water provision.

1. *By 2015 major wetlands and waterways are receiving adequate water throughout each year to maintain ecological functions.*
2. *Use of surface and groundwater resources for private and public benefit is maximised within identified sustainable yield.*

B2.3 Theme Three: Drainage Management

The Albany Drainage District was established to provide benefits for agriculture and horticulture through reduced flood risk. It now provides additional benefits for urban residential development and public infrastructure protection. The drainage district is proclaimed under the State Government Land Drainage Act 1925.

A description of the functions of the drainage system in the Torbay catchment is provided in Section A. A full description of the drainage system, community expectations, industry benefits and flexibility of management is provided in the Source Document for the Watershed Torbay drainage management sub-committee (Viv Read & Assoc., 2003).

Goal (2025): Drainage in the Torbay district is managed to best meet the needs of current land uses, future land uses, and the environment.

Objectives:

- The impact of flooding on horticulture is minimised,
- Flooding in residential areas is minimised,
- The potential adverse effects of drainage management on fisheries is minimised (including commercial fisheries and native fish species),
- The impact of drainage management on algal blooms is minimised, and
- The drainage system is managed to prevent or minimise sedimentation of receiving water bodies.

The current drainage infrastructure systems in the Torbay Main Drain, Seven Mile, Five Mile and Lake Manarup sub-catchments has converted the natural single level hydraulic system into three separate levels as shown in Figure B12.

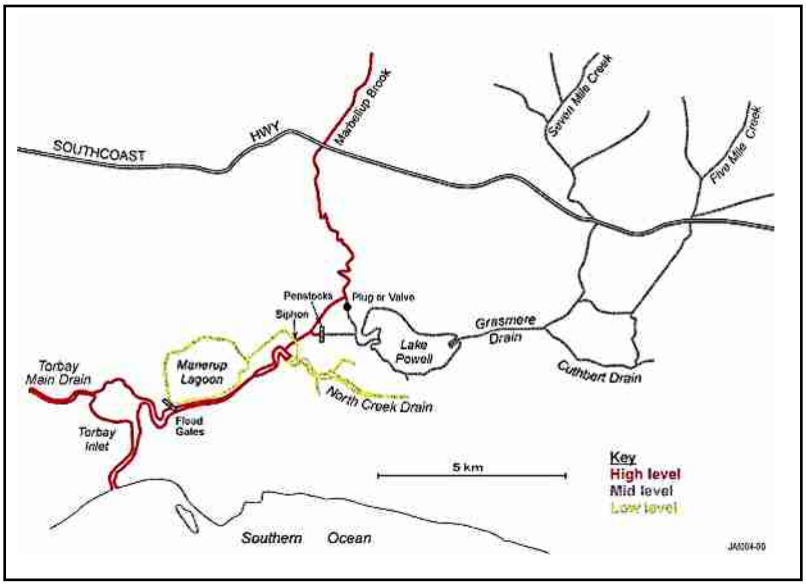


Figure B12 - The three-level Torbay drainage system (adapted from Adeney, 2001).

The original purpose was to increase the suitability of land within the valley floor for horticulture and to protect rail and road infrastructure from occasional flooding and saltwater intrusion. Floodwaters were reduced during the growing season. In addition, groundwater levels were controlled to ensure optimal soil moisture for horticulture during the growing season for the land south of the current Lake Powell water body and in the Cuthbert horticultural area.

The drainage system was initially operated by farmers within the district following installation during the 1950's. With further clearing of natural vegetation for agriculture, surface water run-off rates increased causing additional flooding. In 1969, the waterway between Torbay Inlet and the sand bar was excavated to increase its flow capacity and reduce the risk of flooding. Since then, the drainage infrastructure has been managed by state government water management agencies.

The drainage reserves extend for 35km throughout the lower Torbay Catchment. Private drains feed into the public arterial drains. The drains within the catchment are generally in need of maintenance to control bank erosion and slumping, and sediment transport. This may require some new management practices, including strategically designed revegetation. Sediment transport, particularly in response to some maintenance actions, has caused a high level of deposition in the receiving water bodies causing loss of water body depth. A sediment delta is conspicuous in Torbay Inlet caused by high sediment loads from the Torbay Main Drain.

The three systems are:

(1) The High-level System

Marbellup Brook is diverted away from Lake Powell by installation of an earth bund (the Marbellup Plug) via an excavated drain (the Marbellup High Level Drain) that bypasses Lake Manarup and discharges into directly into Torbay Inlet.

A small volume of Marbellup Brook stream flow is discharged through a control valve built into the Marbellup Plug to Lake Powell via the original Marbellup Brook waterway.

Under this system, the water level of the lower reaches of Marbellup Brook (up-stream to the weir near the Lower Denmark Road), the Marbellup High Level Drain and Torbay

Inlet has the same water level. These are the only areas that have unimpeded estuarine influence when the sand bar is open.

(2) The Mid-level System

Constructed drains in the Five Mile Creek and Seven Mile Creek sub-catchments confluence with Cuthbert Drain to form Grasmere Drain, which discharges directly into Lake Powell. Check structures in the main drains and drains on private land are used to control groundwater levels for horticulture.

The water level in Lake Powell is controlled by penstocks and floodgates located at Bridge 45 on the Elleker Grasmere Road, along the excavated drain (the "penstock drain") from the lake. The penstocks restrict the inflow to the lake from the High Level system when the water level is high and possibly saline, and restrict outflow from the lake when water levels in the lake are maintained to control the soil moisture of adjacent horticultural land. The penstocks are operated manually.

The floodgates at Bridge 45 open automatically when the water level in Lake Powell exceeds 0.8 metres AHD. The penstocks are opened to allow outflow to the High Level system.

(3) The Low-level System

A constructed drain (North Creek Drain) from Ewart Swamp discharges into North Creek, which in turn flows to Lake Manarup via an uncontrolled siphon. This arrangement allows excess surface water from horticultural land near the Elleker Grasmere Road south of Lake Powell to drain into Lake Manarup. For this to operate, the water levels in Lake Manarup need to be maintained at a low level (less than 0.2 metres AHD). As Lake Manarup is of similar level to Torbay Inlet and subject to tidal influence or high water level inflow, penstocks and floodgates are installed at the lake outlet to Torbay Inlet. The penstocks are manually operated to maintain low water levels in the lake but also to allow inflow to the lake from Torbay Inlet as required.

B2.3.1 Drainage System Control Mechanisms

The three-level drainage system has four main control points:

1. The Marbellup Plug Valve allows a small proportion of Marbellup Brook stream flow to enter Lake Powell as environmental flow. The valve can be closed as required.
2. The Bridge 45 Penstocks and Floodgates are the main control mechanism between the High Level and Mid-Level systems. They are used to:
   - maintain water levels in Lake Powell as required for horticulture
   - restrict saltwater intrusions into Lake Powell when the High Level system is under tidal influence
   - enable flood flow discharge from Lake Powell when the level exceeds 0.8 metres.
3. The Lake Manarup Penstocks and Floodgate control inflow from Torbay Inlet into Lake Manarup, up to 0.8m AHD (the level for minimum flood risk) when low water levels in the lake are required.
4. The Bar is the sand bar that forms naturally across the Torbay Inlet channel on the beach due to wave action sediment processes. The bar breaches naturally anywhere between five to ten times each year when water levels are at approximately 1.1 metres AHD. The period for which the bar stays open varies from a few days to several months. Many factors affect this period, including rainfall, prevailing wind strength and direction, and sea swell.

There are several seasonal periods when the bar is artificially breached if it has not occurred naturally. This is done to expedite the drainage of flood-waters from adjacent land up-stream, or to lower water storage levels (for example, in Lake Manarup) to provide future flood detention capacity. The control of bar openings is a critical operating decision.

B2.3.1.1 Seasonal Operating Options

The current operation is based on the requirement to manage water levels for horticulture, however other factors are considered in operating systems decisions including:

- Minimise risk of flooding in residential areas, particularly the area near Woodides Road
- Increasing the depth of water in Lake Manarup according to local community requests
- Reducing mal-odours from Marbellup Brook downstream of the Marbellup Plug.

There are two seasonal strategies for operation:

1. The Summer Operating Strategy

The aim is to maintain water levels in Lake Powell at approximately 0.8 metres AHD. The control mechanism is the Bridge 45 penstock.

The water level in Lake Manarup is maintained at a low level during the potato-growing period so that the Low-level system can function for flood detention should a high rainfall event occur that may cause flooding.

The Marbellup Plug valve usually remains open during summer to allow some stream flow in Marbellup Brook in response to local community complaints about mal-odours.

2. The Winter Operating Strategy

The aim in winter is to avoid flooding and to minimise water detention in Lake Manarup and Torbay Inlet. To achieve this, the bar is artificially opened, normally during May, and kept open until the end of October. This may require the bar to be artificially breached five to ten times during this period.

Lake Manarup is kept as low as possible for as long as possible during this winter period so that it has adequate capacity to hold run-off from the Low Level system during the potato growing season (November to April).

The Bridge 45 penstocks are also kept open all winter to drain excess water from Lake Powell.

The Marbellup Plug valve generally remains open throughout winter.

B2.3.1.2 Drainage System Operation Criteria

Operating decisions for the three-level system are based on a range of factors. Criteria for these are described.

1. Inundation due to Rainfall and Preceding Events

Late winter rains or summer rains following a wet winter may cause increasing floodwaters in Torbay Inlet and Lake Manarup that may increase the risk of flooding to horticultural crops and residential areas. This may require a decision to release water from the drainage system by breaching the bar. There is now an expectation by horticulturalists that land used for horticulture is not inundated for a period of more than 72 hours during the potato-growing season. This expectation relates to inundation of the Cuthbert horticultural area and land south of Lake Powell in the Lake Manarup catchment.

2. Horticultural Soil Water Requirements

Horticulturalists adjacent to Lake Powell observe the soil moisture status of their land during the growing period. If the water levels in Lake Powell are low and there is a risk of plant wilt, the Bridge 45 penstocks will be raised to contain inflow from Grasmere Drain.

3. Critical Flood Levels

Critical levels are the levels above which flooding will occur. They are known for a range of locations within the drainage system. These levels are: 1.4 metres AHD at Torbay Inlet, 0.2 metres for Lake Manarup and 1.0 metre for Lake Powell.

4. Bar Breaching conditions

Tides in Torbay range from 0.4–1.3 metres in amplitude. While the oceanic conditions in the bay vary considerably, the preferred conditions for breaching the bar are with a receding high tide and low swell.

The complexity of the system and proposed changes led to development of a computer-based water balance model by the Department of Environment (Aditya Jha, pers. comm.), as shown in the conceptual diagram below. The model simulates the three levels of the drainage system and allows estimation of the effects of transfer of water from one level to another, as may occur due to change in the drainage operating system. It accounts for water level, stored volume and surface area of each water body separately or via connected hydraulic structures (i.e. the control mechanisms described in Section A5.0). The model does not account for nutrient loads or other water quality measures in its current form.

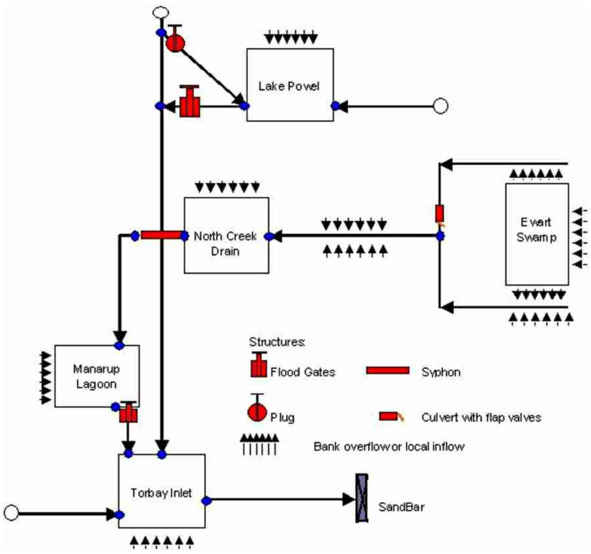


Figure B13 - Conceptual flow diagram of Torbay drainage network with control mechanisms.

The water balance model has provided a visual image of how the drainage system can be operated differently under a range of operational strategies.

Detailed bathymetric and land survey information undertaken during 2002 and 2003 for the waterbodies and drainage system has enabled calculation of the volume of the waterbodies. Lake Powell has a total volume of 1.62 x 106 m^3 (at 1.2m AHD) and so with known inflow, the frequency of filling is 2.3 times annually. For Torbay Inlet, the total volume is similar (1.44x106 m^3) but the frequency of filling is 16 times annually. The bathometry for the High, Mid and Low level systems is shown in Figure B14 a, b and c.

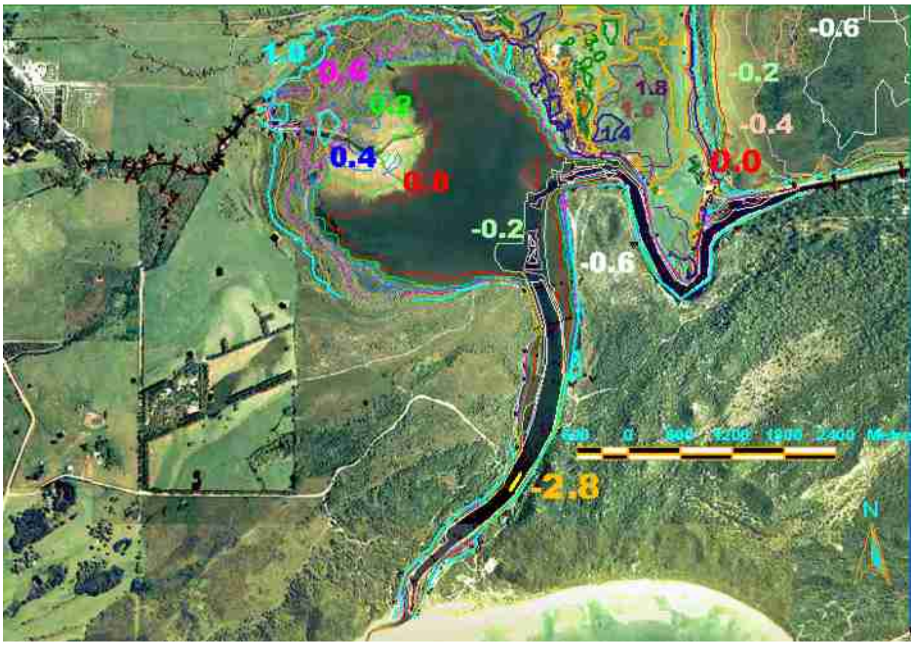


Figure B14(a) - Bathymetric levels (metres AHD) for Torbay Inlet (the High-level drainage system)

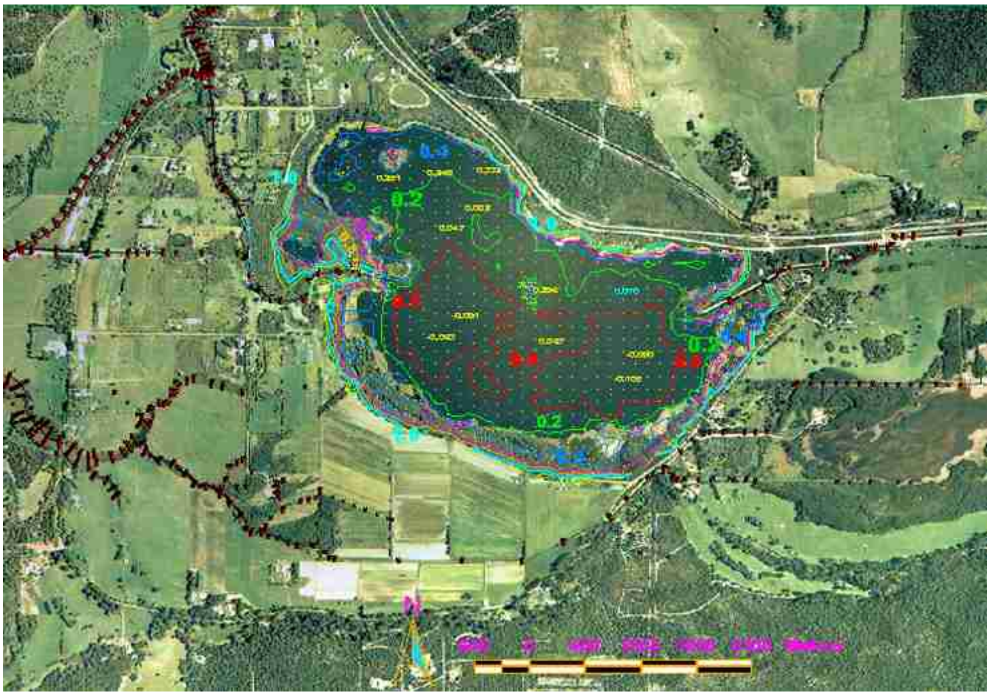


Figure B14(b) - Bathymetric levels (metres AHD) for Lake Powell (the Mid-level drainage system)

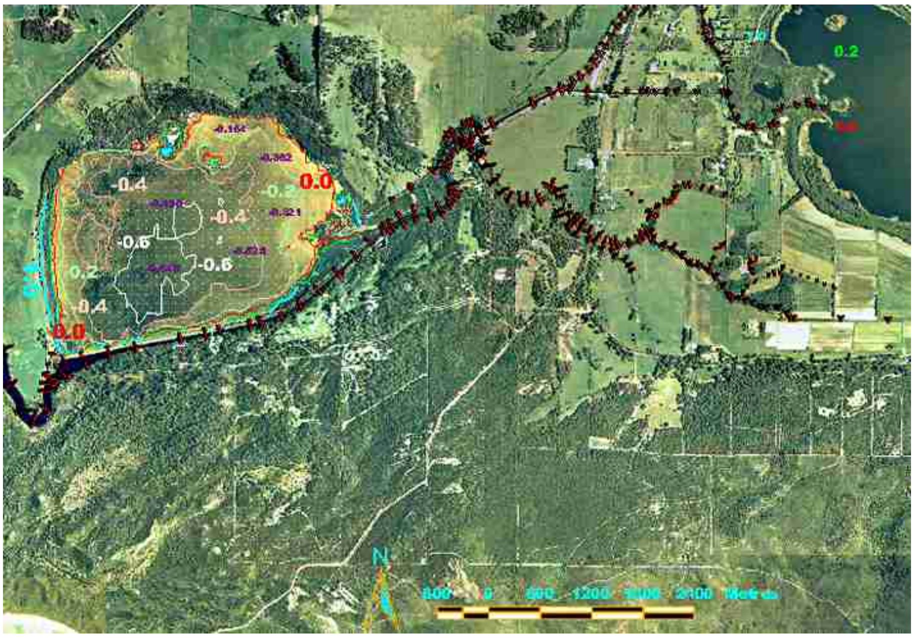


Figure B14(c) - Bathymetric levels (metres AHD) for Lake Manarup (the Low-level drainage system)

The water balance model has used the bathymetric and land survey information to calculate the volume of the water bodies at a range of water levels. Figure B15 provides an example for the High-level drainage system.

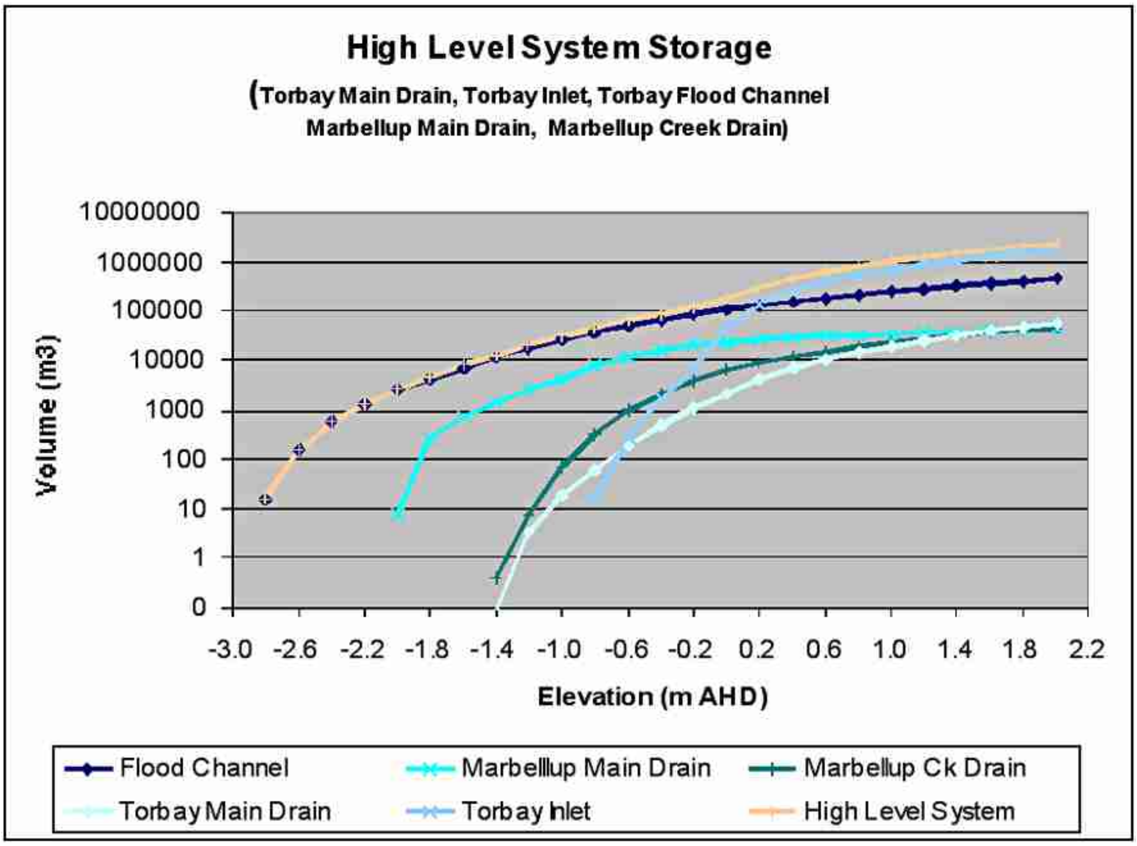


Figure B15 - Water body volumes in the High-level drainage system.

B2.3.2 Management scenarios for the drainage operating system

The community has expressed concern about the effect of the drainage system on environmental and public amenity values. A drainage management sub-committee, established as part of the Watershed Torbay project, recognised opportunities for possible changes to operation of the drainage system to provide multiple benefits to the community. The scenarios for management change to the current operating system are:

1(a) Current Operating Strategy

The current drainage operating system continues. While this option does not address community concerns, it does provide flood protection for the potato industry, residential areas and public infrastructure.

1(b) Current Operating Strategy with bar open during commercial fishing season

This option assumes greater flexibility of bar opening periods than has previously occurred based on negotiated arrangement with commercial fishing licensees.

2 Remove all controls

This entails reverting to a single hydraulic system by removal of all floodgates, penstocks, plugs and siphons. While this may appear to have appeal for enhancing the wetland systems, it is recognised as being unacceptable due to the flood risk to agricultural and residential areas, and public infrastructure. The land currently used for potato growing would no longer be suitable for production.

3(a) Pump North Creek to Marbellup High Level Drain (High System)

Mechanical pumping of North Creek (Low level system) stream flow (either total stream flow or peak flow volumes) to bypass the siphon and discharge flow into the High-level system (i.e. directly into Torbay Inlet) instead of Lake Manarup. The lake would then not be required for flood mitigation purposes and could be filled directly from Torbay inlet through Lake Manarup floodgates.

3(a)(i) Continuous sandbar opening

Installation of culverts or other structures to allow continuous stream outflow or ocean inflow. The cost of installation and maintenance would be relatively high for this option.

3(a)(ii) One-way (out) sandbar opening

This option would restrict ocean inflow to Torbay Inlet. This would be unacceptable as the frequency of blue-green algal blooms would increase without the current level of saline inflow.

3(a)(iii) Remove Lake Manarup floodgates

If North Creek (Low-level system) is pumped to the High-level system, then the Lake Manarup floodgates could be removed so that the lake is continuously connected to Torbay Inlet. Alternatively, the gates could remain but be left open. This would provide management flexibility if there is a future need to prolong water detention in the lake, or to prevent ocean inflow.

3(b) North Creek Bridge Gates & Pump (Low-level System)

This option is based on North Creek flowing into Lake Manarup (the Low-level system) while water levels in the lake are low, and would require installation of gates and pump at the North Creek bridge on Elleker Grasmere Road. When the lake water levels rise, the gates would be shut and North Creek stream flow would be pumped over the gate into Lake Manarup. This option allows Lake Manarup to be managed as a wetland ecosystem without the risk of flooding to horticultural and residential areas.

4 Remove Marbellup Plug or enlarge valve diameter & allow continuous flow

Removal of Marbellup Plug would return Marbellup Brook stream flow to Lake Powell as a part of the Mid-level system. This would reduce the incidence of mal-odours downstream of the plug.

5 Connect Lake Powell to the "High-level system" (Via Gate 45)

5(a) Remove Marbellup Plug, remove 'Gate 45' and install Lake Powell floodgates

This option would have the benefits of Option 4 as well as the additional potential for flushing Lake Powell with Marbellup Brook stream flow. Control of water levels in Lake Powell (to benefit potato production and ecosystem management within the Lake Powell Nature Reserve) would be provided by construction of floodgates at the Lake Powell outflow point. The floodgates and penstocks on Bridge 45 would no longer be required.

5(b) Replace Marbellup Plug with control gates

Under Option 5(a), stream flow from Marbellup Brook would be diverted from Lake Powell when the proposed gates are closed. This could increase the risk of flooding to residential areas (e.g. near Woodides Road) unless a substantial levee is maintained to contain the diverted flows. This risk could be reduced by installation of additional control gates at the current location of Marbellup Plug. With these gates closed, Marbellup Brook stream flow would be diverted to the High-level system so reducing the risk of flooding in residential areas.

5(c) Install weir downstream of Marbellup Plug (on Marbellup Creek Drain)

Installation of a permanent weir would provide a mechanism to prevent saline (tidal) inflow to Lake Powell if Marbellup Plug is removed. The required height of this structure could significantly reduce the function of the High-level system if this is required (i.e. with Option 5(b)). The suggested weir may disadvantage native fish migration.

6 Connect the "Mid-level System" with the "Low-level System"

6(a) Install floodgates to Lake Powell

Floodgates could be installed at the inflow to Lake Powell and a diversion drain constructed to take this inflow to North Creek. This would provide the option to divert flows with high nutrient levels away from the lake but would increase the flood potential for North Creek.

6(b) Increase North Creek flow capacity

The flood risk potential in Option 6a, could be reduced by increasing the North Creek channel capacity.

6(c) Construct a drain south-west from Lake Powell to North Creek

This option is proposed to increase the potential for flushing nutrients from Lake Powell. The proportion of the water body that would flush with this option is not known. The potential for flooding the horticultural and residential areas could increase.

7 Construct levees to increase the water retention capacity of the waterbodies

7(a) Lake Powell

Increasing the volume of Lake Powell could increase the flushing potential of the water body although the effectiveness of this is uncertain. High water levels would assist in the control of the introduced Typha (Bullrush) but may threaten the native sedges. Construction of the proposed levees would cause significant disturbance within the Nature Reserve, and would increase the difficulty of managing soil moisture conditions for horticultural land to the south.

7(b) Lake Manarup

Increasing the volume of Lake Manarup could assist in restoring the water body as a functioning wetland ecosystem. Initially, the ecosystem functions could be restored by increasing inflow to the lake with its current capacity. This could prove adequate and levees to increase the lake volume may not be required.

7(c) Existing drains entering Lake Powell and Torbay Inlet

The existing levees of these drains could be increased to reduce the potential for flooding of adjacent land.

The water balance model is able to show the relative benefits to be derived from increasing the water body capacity with construction of levees.

B2.3.2.1 Criteria to consider for change to operation of the drainage system

The current operating system for the drainage considers a range of biophysical and social factors for decisions of control or regulation of water levels. If the objectives of the operating strategy are to alter, consideration needs to be given to these and other factors may influence the decision or be affected by it.

1. Inundation due to rainfall and preceding events

Late winter rains or summer rains following a wet winter may cause increasing floodwaters in Torbay Inlet and Lake Manarup that may increase the risk of flooding horticultural crops and residential areas. This may require a decision to release water from the system by breaching the bar. There is an expectation by horticulturalists that land used for horticulture is not inundated for a period of more than 72 hours during the potato-growing season. This relates to inundation of the Cuthbert horticultural area and land south of Lake Powell.

2. Horticultural soil water requirements

Horticulturalists adjacent to Lake Powell observe the soil moisture status of their land during the growing period. If the water levels in Lake Powell are low and there is a risk of plant wilt, the Bridge 45 penstocks will be raised to contain inflow from the Grasmere Drain.

3. Critical Flood Levels

Critical levels are the levels above which flooding will occur. They are known for a range of locations within the drainage system: - 1.4 metres AHD at Torbay Inlet, 0.2 metres for Lake Manarup and 1.0 metre for Lake Powell.

4. Bar Breaching conditions

Tides in Torbay range from 0.4–1.3 metres in amplitude. While oceanic conditions in the bay vary considerably, the preferred conditions for breaching the bar are a receding high tide and low swell.

5. Local Community Concerns

The main areas of community concern are:

- Algal blooms in Lake Powell and Torbay Inlet
- Low water levels in Lake Manarup (unsuitable for fish stocks, water birds and wind mobilised sediments within the lake when it is dry)

- Mal-odours from Marbellup Brook below the Plug, and on occasions from Lake Powell
- Acidic discharge water from the Low Level system into Lake Manarup
- Poor quality of water for public recreation in drains and some waterways.

6. Acid Sulphate Soils

Since the drainage options workshop in September 2004, the Department of Environment has documented the extent of acid sulphate soils and the connection of these to the release of nitrates and phosphates when disturbed (DoE, 2004b). Previously, Ewart Swamp was considered the main source of acidic stream flow however the document notes that all soils derived from estuarine deposits (i.e. those soils from Torbay to Princess Royal Harbour) are potential acid sulphate soils. It is not yet clear how this may impact on decisions about the drainage operating systems, but it is likely to be significant.

B2.3.3 Assessment of options for management of the drainage operating system

Table B6 provides a list of the community services or landscape features associates with the three levels of the drainage system. It also provides an estimate of the preferred water level range to maintain these services or features. This information provides objective criteria for evaluation of proposed changes to the drainage operating system.

Information based on water balance modelling and workshop processes allowed an assessment of the management options for the drainage operating system to be assessed according to a set of criteria. Table B7 shows the outcomes of this assessment. The options to be further considered are:

- 3(a) Pump North Creek to Marbellup Creek Drain (High Level system)
- 3(a)(iii) Remove Lake Manarup floodgates (connect High and Low Level systems)
- 3(b) Install North Creek Bridge floodgates and pump (Low Level system)
- 4 Open Marbellup Plug (connect High and Mid-level systems)
- 5(a) Remove Marbellup Plug, remove “Gate 45” and install Lake Powell floodgates.

Construction of levees remains an option although was not assessed. The water balance model will assist in assessment of the benefit of levees in association with other preferred options.

Drainage System	Community service / Landscape feature	Preferred water level range	Comments
Low Level System	Lake Manarup– Maintain water to prevent dry blow of lake bed.	Minimum = -0.2 – 0.0 m AHD	Most of the lake has water coverage with - 0.2 m. of lake bed. 0.0m gives coverage of all of lake bed.
	Lake Manarup – Maintain good water levels suitable for wading bird habitat.	Minimum = -0.2 m AHD would provide minimum depth over 50% of the lake bed. Minimum = 0.0 m AHD would provide minimum depth over 80%+ of lake bed.	Assume 0.2 m water depth is ideal for wading birds (needs to be confirmed). Depth required for other water birds to be established.
	Maximise environmental values of Lake Manarup		Environmental Water Requirements to be developed.
	Maximise environment values of Ewart Swamp		Environmental Water Requirements to be developed.
	Farmland flooding between Torbay Inlet and Lake Manarup	Maximum = 1.2 m AHD would provide for 0.2 m depth to groundwater.	
	Prevent groundwater flooding of potato crops south of Lake Powell	Maximum = 0.2 AHD would provide for 0.2 m depth to groundwater.	Confirmation required that that this level is suitable flood protection for potato production.
	Avoid surface flooding of potato crops in summer	Maximum = -0.4 to -0.2 AHD would ensure some flood retention capacity, but ideally –0.6 to –0.4 AHD	
	Prevent summer salt water ingress to Lake Manarup during bar opening times.		Penstocks closed in summer to prevent salt water intrusion.
	Prevent flooding of Woodides Road residences		
	Prevent flooding of houses in Ewart Swamp		
Mid Level System	Ensure sufficient groundwater moisture for potato crops in summer	Range 0.6 – 0.8 m AHD in summer.	Confirmation required that that this level is suitable soil moisture control for potato production.
	Lake Powell – maintain water depths suitable for wading birds during summer period.	Minimum 0.4 m AHD would provide minimum depth over 70-80% of lake bed. Minimum 0.6 m AHD would provide minimum depth over 100% of lake bed.	Assume 0.2 m water depth is ideal for wading birds (needs to be confirmed). Depth required for other water birds to be established.
	Lake Powell – maintain water depths to maximise environmental values of wetland including management of Typha spread		Environmental Water Requirements to be developed. Water regimes to be considered to maximise Baumea articulata.
	Lake Powell – Lake bed drying to aid denitrification and minimise algal blooms	Achieve minimum water level of 0.0m AHD would provide for 60-70% lake bed drying.	
	Prevent flooding of surrounding properties, especially houses.	Maximum of 1.0 m AHD	Confirmation required that that this level is suitable flood protection for potato production and residential areas.
	Maintain water regime in Marbellup Creek below Plug to minimise algal booms		Need to establish the level of flow through the Marbellup Plug to minimise algal blooms and mal-odours.
High Level System	Torbay Inlet - maximise salt water regime to Inlet over summer to avoid algal blooms		Maximise bar openings through late winter and early-mid summer. Maximise water levels prior to bar opening to lengthen bar open period.
	Prevent flooding of surrounding land.	Maximum of 0.8 m AHD for Torbay Main Drain maximum of 1.4 m AHD for area between Lake Manarup and Torbay Inlet.	Need to confirm areas of agricultural land prone to flooding.
	Minimise bar openings during February March	Achieve minimum of –0.3 m AHD is possible in mid-late summer so that bar closes and sufficient flood retention capacity in case of summer rainfall	A level of -0.3 m AHD was achieved in 2003 at end of summer causing substantial bed drying of Torbay Inlet. The consequences of this are not clear.
	Torbay Inlet – maintain water levels to minimise algal bloom potential		
	Torbay Inlet – maintain water levels to maximise environmental values of Inlet		Environmental Water Requirements to be developed.

Table B6 - Criteria for assessment of the options for management of the drainage operating system within the Torbay catchment.

Options	Assessment Criteria (see above)											
	1	2	3	4	5	6	7	8	9	10	11	***Decision*** (Out, Unsure, OK)
1 Do nothing new	X	X	X	√	√	√	X	X	√ ?	√	-	Remains an option
2 Remove all controls	√	√	√	X	X	√	√	√	√	X	-	Not being considered further due to impact on horticultural industry and residential flooding.
3 North Creek options												
3a Pump North Creek to Marbellup High Level Drain (High System)	X	?	X	-	-	√	-	-	-	-	X	To be modelled
3a(i) Continuous sandbar opening	-	X	X	-	-	-	-	√	√	X	X	Out due to difficulties in maintaining the sandbar open.
3a(ii) 1-way (out) sandbar opening	-	X	X	-	-	-	-	X	XX	X	X	Out – as above
3a(iii) Remove Lake Manarup floodgates	-	√	√	-	-	-	-	√	√	X	√	To be included in modelling.
3b North Creek Bridge floodgates and pump (Low System)	X	X	√	√	√	√	X	√	X	X	X	To be further considered and modelled
4 Open Marbellup Plug	√	-	-	X	X	-	√	√	√	-	-	Keep it in and model it to get sense of proportion and volume of water
5. Connecting Lake Powell to the 'High Level' system.												
5a. Remove Marbellup Plug, Remove "Gate 45" and install Lake Powell floodgates	-	-	-	-	X	-	√	√	√	-	-	To be modelled. Risk of increased flooding (may require levees to be constructed).
5b. Replace Marbellup Plug with control gates												Not to be considered further (reasons are not clear).
5c. Install weir downstream of Marbellup Plug (on Marbellup Creek Drain).												Not to be considered further (reasons are not clear).
6. Connect 'Mid level System' to 'High Level System"	X	X	X	X	X	-	X	X	-	-	X	Not to be considered further (unless specifically proposed and assessed by external proponent).
7. Construct levees												
7a Lake Powell												
7b Lake Manarup												
7c Drains entering Lake Powell and Torbay Inlet.												

Code: X =bad, √ =good, - =neutral, ? = uncertain

Table B7 - Evaluation of management options for the drainage operating system within the Torbay catchment.

Code to Assessment Criteria

1. Lake Powell ecosystem health
2. Torbay Inlet ecosystem health
3. Lake Manarup ecosystem health
4. Grasmere potato farm flooding and soil moisture
5. Residential flooding
6. Commercial fishing
7. Marbellup "midges & mal-odours"
8. Waterway recreation [recreational fishing, suitable for use by kids (water quality criteria) and paddling].
9. Fish migration
10. Flooding of agricultural land (other than land used for horticulture)
11. Cost and ease of operation.

B2.3.4 Drainage Management: Targets for change

The three level drainage system in the lower Torbay catchment has been operating since the 1950's, providing benefits to horticulture and for flood protection. Ceasing operation and removal of the drainage infrastructure is not considered as an option because of the advantages that the current operating system currently provides. Changes that are made to the infrastructure or operating system should also consider the impact on the condition of all natural resource and heritage values.

The targets for resource condition change to be achieved by adopting alternative drainage practices to the current system are set with the understanding that:

- The health of the receiving water bodies is not worse
- The current benefits to primary producers remain as long as required
- Residential and infrastructure flood protection remains
- Marine and inland fish passage and spawning is not restricted
- Social values including lifestyle and recreation values are improved, not diminished
- The cost and difficulty of operation is not significantly greater. (Note: additional costs for construction of new works, changed operation or increased maintenance will require an additional allocation of funding from the State Government).

The frequency with which Torbay Inlet is connected to the ocean depends upon breaching of the sandbar. Phytoplankton assemblages in Torbay Inlet change from a mix of cyanophytes, chlorophytes and diatoms to an assemblage dominated by diatoms when there is increased salinity. The latter is preferred from an amenity perspective (i.e. reduced green and blue-green algal blooms). Maintenance of high salinities (e.g. >15,000–20,000 mg/L) within the estuary is preferred. This requirement will affect decisions about changes to the frequency with which the sandbar is opened.

Considering these factors, changes in the drainage infrastructure and operating system would be expected to achieve the following resource condition targets:

The Targets for resource condition change for Theme Three: Drainage Management are:

1. By 2025 Lake Manarup, Lake Powell and Torbay Inlet are restored as functional wetland ecosystems (as indicated by successful breeding populations of waterbirds).
2. Sediment transport in drains and sediment deposition in Torbay Inlet and Lake Powell is reduced by 50% by 2010.
3. The quality of water in all parts of the drainage system is suitable for direct contact recreational use by 2025.

B2.4 Theme Four: Habitat and Biodiversity Management

The South Coast region of Western Australia is recognised for high nature conservation values. Biodiversity is the term that represents all natural living things across the landscape. It includes genetic diversity, species diversity, structural diversity (the variety of physical growth forms, especially for vegetation) and the diversity of living assemblages (the variety of biotic communities). The regional context for biodiversity on the south coast is described in Southern Prospects 2004-9, a regional strategy for natural resource management (SCRIPT, 2004). This identifies the importance of natural vegetation, wetlands, waterways and coastal ecosystems within the region. An analysis of vegetation types for the region lists those that are least represented in reserves or private remnant patches. The strategy also identifies threatened species and ecological communities within the region and the key threatening processes of habitat fragmentation and weed invasion. A range of targets and associated actions are proposed, many of which are relevant to the Watershed Torbay Catchment Restoration Plan.

Goal (2025): Biodiversity values are enhanced through improvement in the habitat of wetlands, waterways, the bush and the coast.

Objectives:

- Minimum water quality and depth for aquatic ecosystem functions in wetlands is maintained
- The condition of foreshore vegetation and in-stream habitat is maintained or improved
- The habitat value and habitat connectivity for native fauna is improved and increased
- Population sizes and diversity of native freshwater fish and crustacean are maintained
- Requirements for fish passage and spawning in waterways are maintained
- Representative and adequate areas of pre-European vegetation types are retained
- The impact of exotic pest animal species on native fauna is reduced
- The impact of weeds on native vegetation and aquatic ecosystems is reduced.

B2.4.1 Natural vegetation types

The Torbay catchment has 36% of the total catchment area of 32 000 hectares remaining as natural vegetation. Table B8 shows the extent of ten vegetation types in the catchment and compares the proportion that remains with original occurrence for each type. This shows a significant reduction in the area of freshwater lakes (due to reduction in the area of Lake Powell for horticultural use). However, some terrestrial vegetation types are little altered.

Sedgeland communities are of particular importance. At a state level, the total area of sedgelands remaining is 59% of the original extent, with 27% of that remainder occurring within the South Coast region (SCRIPT, 2004). Table B8 shows that only 25% (2074 ha) of the sedgeland vegetation type originally occurring in Torbay catchment currently remains. Drainage of land for agriculture has affected substantial areas of sedgeland.

Vegetation Type	Pre-European Extent (Ha)	Vegetation Removed Ha (%)	Vegetation Present (Ha)	Vegetation within 50km of the catchment (Ha)
Bare areas; freshwater lakes	319	257 (80%)	62	236
Low forest; jarrah	652	112 (17%)	540	13705
Low forest; jarrah, *Eucalyptus staeri* & *Allocasuarina fraseriana*	12932	8665 (67%)	4267	16961
Medium forest; jarrah-marri	4442	3158 (71%)	1284	66911
Mosaic: Medium forest; jarrah-marri / Low forest; jarrah	2065	1753 (85%)	312	3846
Sedgeland; reed swamps, occasionally with heath	8177	6103 (75%)	2074	3371
Shrublands; Acacia scrub-heath unknown spp	2750	332 (12%)	2418	12104
Shrublands; mixed heath	384	1 (0%)	382	5678
Shrublands; tallerack mallee-heath	0.2	0.2 (100%)	0	262
Tall forest; karri (*Eucalyptus diversicolor*)	334	173 (52%)	162	7254
TOTAL	32,056	20,556 (64%)	11,500	130,328

(source: SCRIPT, 2004)

Table B8 - Remnant natural vegetation in Torbay catchment.

B2.4.2 Species at risk

The State's Threatened Fauna database (managed by CALM) shows species at risk in the Torbay catchment to be:

- Australasian Bittern (Vulnerable)
- Baudin's Cockatoo (Vulnerable)
- Carnaby's Cockatoo (Endangered)
- Western Ringtail Possum (Vulnerable)
- Western Whipbird (Vulnerable)

The endangered Western Ground Parrot was recorded near Cosy Corner in 1983. Other Priority species are the Black Bittern, the Forest Red-tailed Black Cockatoo, the Western Bandicoot and the Western Brush Wallaby.

Threatened flora species within the catchment include:

- *Caladenia plicata*
- *Synaphea incurva*
- *Lysinema lasianthum*
- *Chorizema reticulatum*
- *Microtis pulchella*
- *Schizaea rupestris*
- *Rhodanthe pyrethrum*
- *Laxmannia jamesii*

B2.4.3 Regional Reserves and Macro-corridors

Conservation reserves within Torbay catchment are shown in Figure B16. Reserves within the region are managed according to the South Coast Management Plan (CALM, 1991) with specific management plans prepared for each reserve as required. Management guidelines are currently being prepared for Lake Powell. A management plan for south coastal reserves has been initiated.

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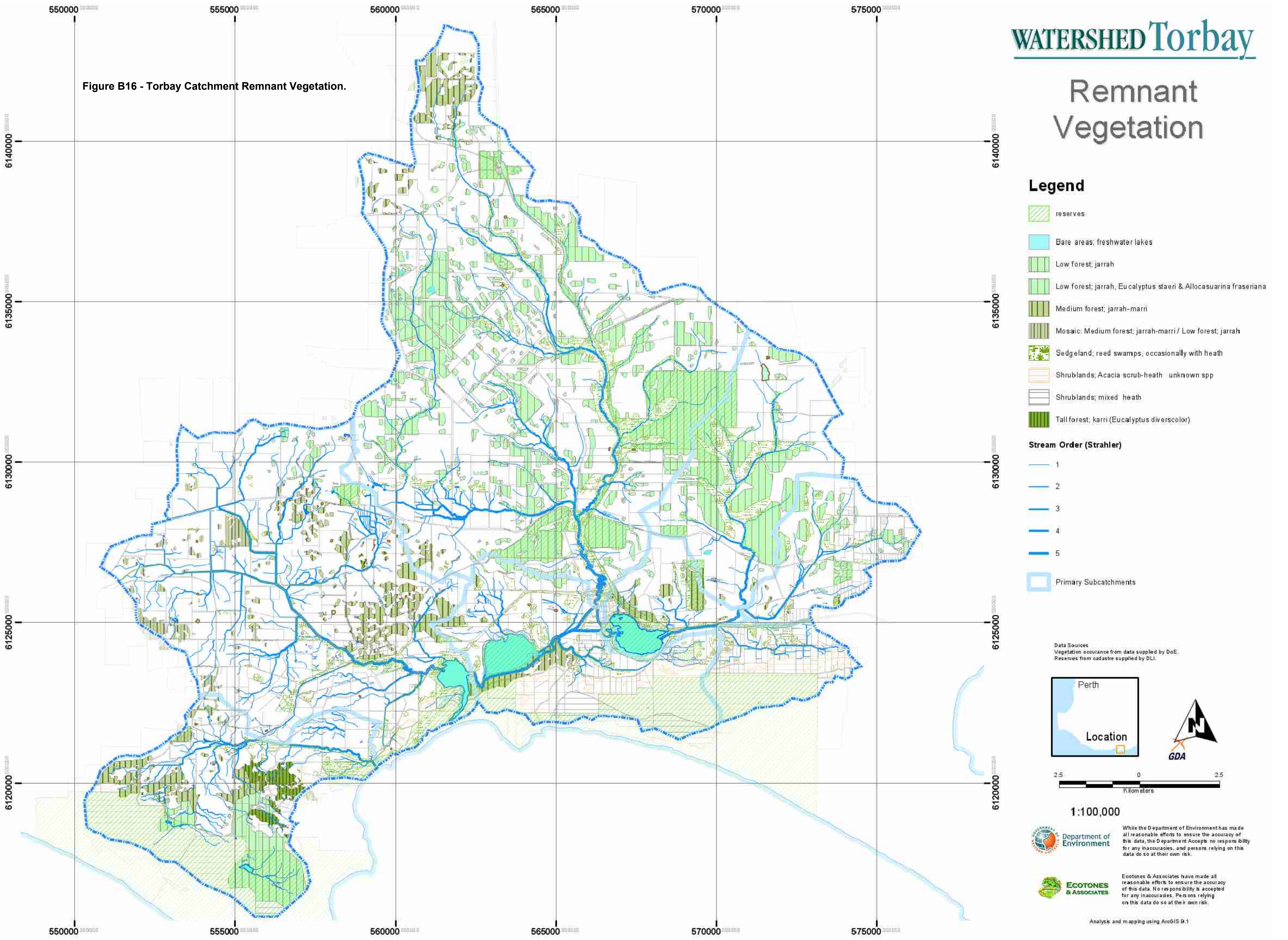

Figure B16 - Torbay Catchment Remnant Vegetation.

The regional priorities for conservation identified by both CALM and the City of Albany are for connectivity of remnant vegetation particularly as habitat value for wildlife. The opportunities for strategic corridors within the region are well recognised (SCRIPT, 2004). Strategic zonation based on spatial analysis of remnant woody vegetation for the Torbay catchment is currently being developed and mapped. Classification of zones was developed as a part of the (draft) South Coast Macro-corridors Project (Watson and Wilkins, 1999, Sanders & Watson, in prep). The zones are:

Strategic Zone A: Contains areas of woody vegetation where patches greater than 30 hectares in size are spaced no greater than one kilometre apart and potentially form the most strategic link between major protected areas.

Strategic Zone B: Contains areas of woody vegetation where patches greater than 30 hectares in size are spaced no greater than one kilometre apart and potentially provide good nodes of habitat which are in close proximity (<1km) to Strategic Zone A.

Strategic Zone C: Contains areas of woody vegetation where patches greater than 30 hectares in size are greater than one kilometre from the woody vegetation in Strategic Zones A & B. The vegetation within Zone C potentially provides habitat value for wildlife at the local scale but requires closer assessment to determine potential values for a regional scale macro-corridor network (Sanders and Watson, in prep.).

Analysis shows the high potential for adding to biodiversity and habitat value through bio-geographic planning for corridors. The connectivity in the Marbellup sub-catchment and in the coastal areas suggests these to be preferred for consideration. This is a significant management strategy to address the key regional threatening process for biodiversity – fragmentation of habitat. This threat may be due to clearing for agriculture or the many other causes of vegetation decline, including fire, weed dominance, salinity and pathogens.

B2.4.4 Wetland Ecosystems

Although considerably altered from natural conditions, the lakes, inlet and other wetlands in the Torbay catchment are recognised for high biodiversity and habitat values. Targets and actions for retention or enhancement of these values through water quality and quantity management are outlined for Theme 1 (Algal Blooms and Water Quality) and Theme 2 (Water Quantity). Theme 3 (Drainage Management) includes actions to return Lake Manarup to a functioning ecological system.

Lake Powell is of particular interest as it occurs within an 'A-Class' Nature Conservation Reserve and is recognised as a wetland of regional significance (Environment Australia, 2001). Lake Powell is listed on the Register of the National Estate in Australia's inventory of natural heritage places of significance. The lake currently has very high water bird species diversity and abundance despite the high incidence of toxic algal blooms within the water body.

A potentially significant threat to Lake Powell is through the spread of the introduced Bulrush (*Typha orientalis*) which currently is well established around the margin of the lake. Lower water levels and high nutrient levels have favoured establishment of Typha, although it currently coexists with the native macrophyte Baumea articulate. B. articulata appears to have a stable distribution in fringing vegetation at higher elevations. T. orientalis is not considered detrimental to lake ecology at present as it utilises nutrients within the lake and provides valuable habitat, however it could further dominate to the detriment of the lake ecosystem. Monitoring the extension of Typha at 5-year intervals is suggested (Bourne, 2002). Management options include physical removal of Typha from the system followed by safe herbicide use. Manipulation of water levels is probably ineffective as a control option as the water body is now quite shallow. A reduction in nutrient inputs may assist, however lake bed sediments probably have very high residual nutrient loads.

B2.4.5 Waterways and Artificial Drains

Foreshore assessments have been completed for all the waterways in the Marbellup Brook, Torbay Main Drain, Seven Mile and Five Mile sub-catchments. An assessment for the Cuthbert Drain sub-catchment is to be completed. The condition of foreshore vegetation for waterways and artificial drains in the Torbay catchment has been assessed according to standard criteria (Pen and Scott, 1995). Table B9 below describes the assessed grades and the description assigned to the foreshore. Table B10 shows the foreshore condition in the sub-catchments.

Assessed Grade of waterway (Riparian Zone Condition)	Description
A	A condition - Pristine to slightly degraded
B	B condition - Degraded
C	C condition - Erosion prone to eroded
D	D condition - Eroding ditch or weed infested drain.
DR	Drain
DRSW	Drain Swale
DRWC	Drain – Water Corporation managed
NA	Not Classified
SW	Swale

Table B9 - Standard grades for waterway assessment.

Waterway grade	Five Mile Creek		Seven Mile Creek		Marbellup Brook		Torbay Main Drain		Total	
	km	%	km	%	km	%	km	%	km	%
A		0	15.3	56	35.8	28	1.2	1	52.3	16
B	8.3	47	5.4	20	42.4	34	4.4	3	60.5	18
C	1.3	8	2	7	12.6	10	21.4	13	37.3	11
D		0	-	0	19.1	15	15	9	34.1	10
DR	3.8	22	1.3	5	-	0	25.1	16	30.2	9
DRSW		0	-	0	-	0	9.4	6	9.4	3
DRWC		0	-	0	-	0	38	23	38	11
SW	4.1	23	3.5	13	16.3	13	47.2	29	71.1	21
Total	17.6	100	27.6	100	126.3	100	161.6	100	332.9	100

Table B10 - Foreshore condition by sub-catchment.

From the above table it can be determined that 16% of all waterways in the Torbay catchment are classified as pristine, with the majority of this classification found in the Seven Mile sub-catchment. The largest category of waterway, is swales at 21%. Drains comprise 9% of all waterways in the catchment.

Table B11 provides a description of stream order classification that has been used during the foreshore assessment of waterways. Strahler's system of stream classification has been used. Tables B12 & B13 shows stream order and sub-catchments information. It is the same data presented with two different perspectives. Table B12 shows the percentage of each stream order (1st, 2nd 3rd etc) within each sub-catchment. Table B13 shows the distribution of each stream order over the sub-catchments.

Stream Order	Description	Simple Classification
1	Head stream – where the stream begins to show in a paddock	Small Streams
2	Minor Stream - formed when two 1st order streams join	
3	Major stream - formed when two 2nd order streams join	Larger Streams/Rivers
4	Major stream - formed when two 3rd order streams join	
5	River - formed when two 4th order streams join	

Table B11- Stream Order description.

Sub-catchment										
	Five Mile Creek		Seven Mile Creek		Marbellup Brook		Torbay Main Drain		Total	
Stream Order	km	%	km	%	km	%	km	%	km	%
1	9.1	51	20	67	71.4	57	87.3	54	187.8	56
2	5.5	30	3.3	11	26.121		41.9	26	76.7	23
3	3.4	19	6.7	22	18.5	15	21.3	13	49.9	15
4	-	0	0	0	10.3	8	3.5	2	13.8	4
5	-	0	-	0	-	0	7.6	5	7.6	2
Grand Total	18.0	100	30	100	126.3	100	161.6	100	335.9	100

Table B12 - Sub-catchment –percentage by stream order.

First order streams comprise 56% of all waterways. Fifth order streams, the highest stream order found in the Torbay catchment, is restricted to the Torbay Main Drain sub-catchment, where it comprises 5% of the waterways in the sub-catchment.

Stream Order												
	1		2		3		4		5		All Orders	
Sub-Catchment	km	%	km	%	km	%	km	%	km	%	km	%
Five Mile Creek	9.1	5	5.5	7	3.4	7		0		0	18.0	5
Seven Mile Creek	20.0	11	3.3	4	6.7	14	0.0	0		0	30.0	9
Marbellup Brook	71.4	38	26.1	34	18.5	37	10.3	74		0	126.3	38
Torbay Main Drain	87.3	46	41.9	55	21.3	43	3.5	25	7.6	100	161.6	48
Total of surveyed sub-catchments	187.8	100	76.7	100	49.9	100	13.8	100	7.6	100	335.9	100

Table B13: Stream Order - percentage by sub-catchment.

Torbay Main Drain and Marbellup Brook sub-catchments, being the largest sub-catchments, contain the majority of waterways in Torbay, with 48% and 38% respectively.

During the foreshore assessment, the fencing status of the waterway was recorded. See tables below of fencing status by foreshore condition (B14 & B15) and fencing status by stream order (B16 & B17).

Foreshore Condition																			
		A		B		C		D		DR		DRSW		DRWC		NA		SW	
Sub-catchment	Fencing	km	%	km	%	km	%	km	%	km	%	km	%	km	%	km	%	km	%
All Surveyed Sub-catchments	Both sides Fenced	5.2	10	3.9	6	5.8	16	0.9	3	3.7	12	0.1	1	14.9	39	0	0	0.1	0
	One side Fenced	9.5	18	7.4	12	5.0	13	0.3	1	4.0	13	0	0	4.1	11	0	0	0.7	1
	No Fence	37.6	72	49.2	81	26.5	71	32.9	96	22.4	74	9.3	99	19	50	2.9	100	70.4	99
	Total length (km)	**52.3**	**100**	**60.5**	**100**	**37.4**	**100**	**34.1**	**100**	**30.2**	**100**	**9.4**	**100**	**38.0**	**100**	**2.9**	**100**	**71.1**	**100**

Table B14 - Torbay catchment fencing status by foreshore condition.

Foreshore Condition																			
		A		B		C		D		DR		DRSW		DRWC		NA		SW	
Sub-catchment	Fencing	km	%	km	%	km	%	km	%	km	%	km	%	km	%	km	%	km	%
Five Mile Creek	Both sides Fenced	0.0	-	0.5	6	0.0	0	0.0	-	0.7	18	0.0	-	0.0	-	0.0	0	0.0	0
	One side Fenced	0.0	-	2.2	27	0.0	0	0.0	-	2.2	56	0.0	-	0.0	-	0.0	0	0.0	0
	No Fence	0.0	-	5.6	67	1.3	100	0.0	-	1.0	26	0.0	-	0.0	-	0.4	100	4.1	100
	Total length (km)	0.0	0	8.3	100	1.3	100	0.0	0	3.8	100	0.0	0	0.0	0	0.4	100	4.1	100
Seven Mile Creek	Both sides Fenced	1.9	12	0.1	2	0.0	0	0.0	-	0.0	0	0.0	-	0.0	-	0.0	0	0.0	0
	One side Fenced	1.9	12	0.0	0	0.0	0	0.0	-	0.0	0	0.0	-	0.0	-	0.0	0	0.0	0
	No Fence	11.6	75	5.3	98	2.0	100	0.0	-	1.3	100	0.0	-	0.0	-	2.5	100	3.5	100
	Total length (km)	15.3	100	5.4	100	2.0	100	0.0	0	1.3	100	0.0	0	0.0	0	2.5	100	3.5	100
Marbellup	Both sides Fenced	2.8	8	1.1	3	0.0	0	0.0	0	0.0	-	0.0	-	0.0	-	0.0	-	0.0	0
	One side Fenced	7.6	21	5.2	12	1.2	10	0.3	2	0.0	-	0.0	-	0.0	-	0.0	-	0.0	0
	No Fence	25.4	71	36.1	85	11.4	90	18.8	98	0.0	-	0.0	-	0.0	-	0.0	-	16.3	100
	Total length (km)	35.8	100	42.4	100	12.6	100	19.1	100	0.0	0	0.0	0	0.0	0	0.0	0	16.3	100
Torbay Main Drain	Both sides Fenced	0.5	42	2.2	49	5.8	27	0.9	6	3.0	12	0.1	1	14.9	39	0.0	-	0.1	0
	One side Fenced	0.0	0	0.0	0	3.8	18	0.0	0	1.9	7	0.0	0	4.1	11	0.0	-	0.7	1
	No Fence	0.7	58	2.2	51	11.8	55	14.1	94	20.2	80	9.3	99	19	50	0	-	46.5	98
	Total length (km)	1.2	100	4.4	100	21.4	100	15	100	25.1	100	9.4	100	38	100	0	0	47.2	100

Table B15 - Sub-catchment fencing status by foreshore condition.

Sub-catchment	Stream Order	Low Order (1&2)		High Order (3-5)	
		km	%	km	%
All Surveyed Sub-catchments	Both sides Fenced	16.2	6	18.4	26
	One side Fenced	21.6	8	9.4	13
	No Fence	226.7	86	43.5	61
	Total length (km)	264.6	100	71.3	100

Table B16 - Torbay Catchment fencing status by stream order.

Sub-catchment	Stream Order	Low Order (1&2)		High Order (3-5)	
		km	%	km	%
Five Mile Creek	Both sides Fenced	0.5	4	0.7	20
	One side Fenced	2.2	15	2.2	63
	No Fence	11.8	81	0.6	17
	Total length (km)	14.6	100	3.4	100
Seven Mile Creek	Both sides Fenced	2.0	8	0.0	0
	One side Fenced	0.2	1	1.7	25
	No Fence	21.1	91	5.1	75
	Total length (km)	23.2	100	6.8	100
Marbellup Brook	Both sides Fenced	1.8	2	2.1	7
	One side Fenced	10.3	11	4.0	14
	No Fence	85.4	88	22.6	79
	Total length (km)	97.5	100	28.7	100
Torbay Main Drain	Both sides Fenced	11.9	9	15.6	48
	One side Fenced	8.9	7	1.6	5
	No Fence	108.4	84	15.2	47
	Total length (km)	129.2	100	32.3	100

Table B17 - Sub-catchment fencing status by stream order.

Marbellup Brook Sub-Catchment

There are 126 km of waterways in the Marbellup Brook sub-catchment. Table B10 shows that 28% are considered ‘pristine’ and 34% are ‘good’ (WRC, 2001). Significantly, Marbellup Brook is the only sub-catchment that does not have any drains. Table B12 determines that there are 71km of first order streams which is 57% of all streams in the sub-catchment. The following Marbellup Brook foreshore condition map (B17), identifies the condition of all the waterways in the sub-catchment and makes recommendations for management.

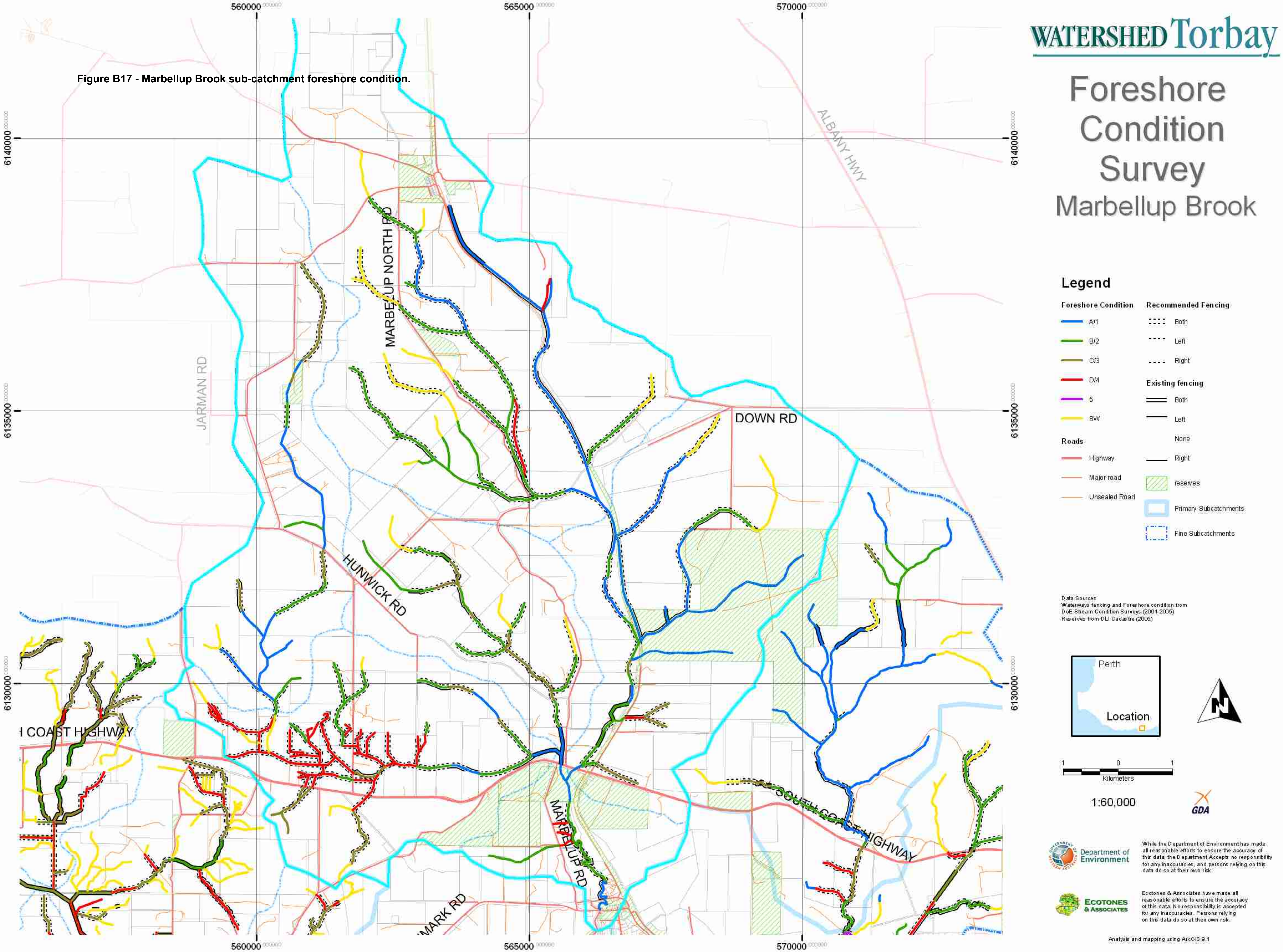

Figure B17 - Marbellup Brook sub-catchment foreshore condition.

Torbay Main Drain Sub-Catchment

The Torbay Main Drain sub-catchment has extensive artificial drainage over 35% of the sub-catchment area. There are 73 km of drains and 89 km of natural waterways. Only 1% of waterways are considered 'pristine' as shown in Table B10.

The Torbay Main Drain is the only sub-catchment which has fifth order streams. There are 7.6km of fifth order stream in the sub-catchment

The following Torbay Main Drain foreshore condition map (B18) identifies the condition of all the waterways in the sub-catchment and makes recommendations for management.

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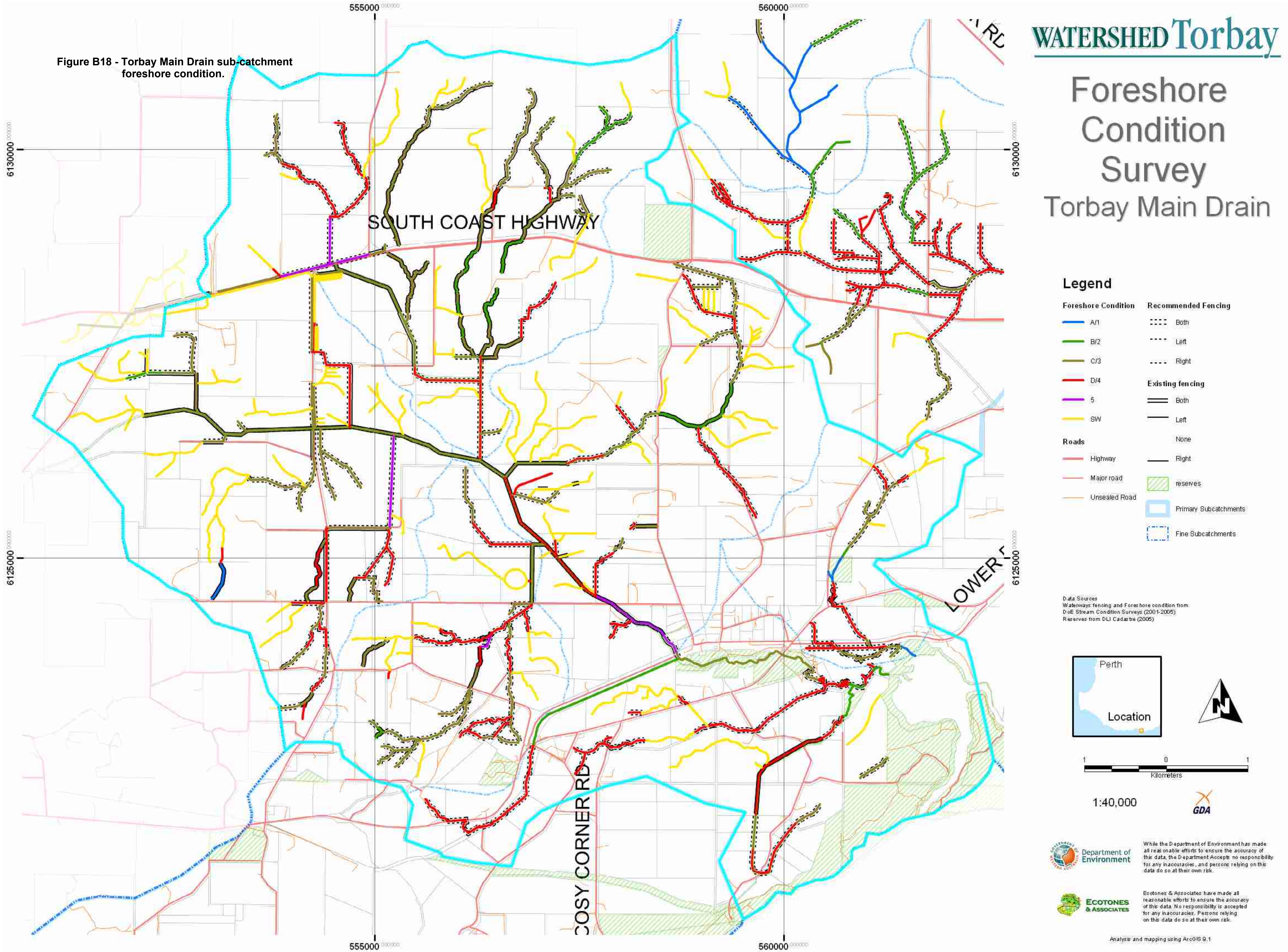

Figure B18 - Torbay Main Drain sub-catchment foreshore condition.
555000
560000
6130000
6125000
SOUTH COAST HIGHWAY
COSY CORNER RD
LOWER
WATERSHED Torbay
Foreshore Condition Survey
Torbay Main Drain
Legend
Foreshore Condition
A/1
B/2
C/3
D/4
5
SW
Roads
Highway
Major road
Unsealed Road
Recommended Fencing
Both
Left
Right
Existing fencing
Both
Left
None
Right
reserves
Primary Subcatchments
Fine Subcatchments
Data Sources
Waterways fencing and Foreshore condition from
DoE Stream Condition Surveys (2001-2005)
Reserves from DLI Cadastre (2005)
Perth
Location
1 0 1
Kilometers
1:40,000
GDA
Department of Environment
While the Department of Environment has made all reasonable efforts to ensure the accuracy of this data, the Department Accepts no responsibility for any inaccuracies, and persons relying on this data do so at their own risk.
Ecotones & Associates
Ecotones & Associates have made all reasonable efforts to ensure the accuracy of this data. No responsibility is accepted for any inaccuracies. Persons relying on this data do so at their own risk.
Analysis and mapping using ArcGIS 9.1

Five Mile Creek Sub-Catchment

The Five Mile Creek sub-catchment is the smallest sub-catchment , and contains only 17.6 km of waterways. Nearly half of all the waterways in the catchment, 47%, are classified as being in good condition (B).

The following Five Mile Creek foreshore condition map (B19) identifies the condition of all the waterways in the sub-catchment and makes recommendations for management.

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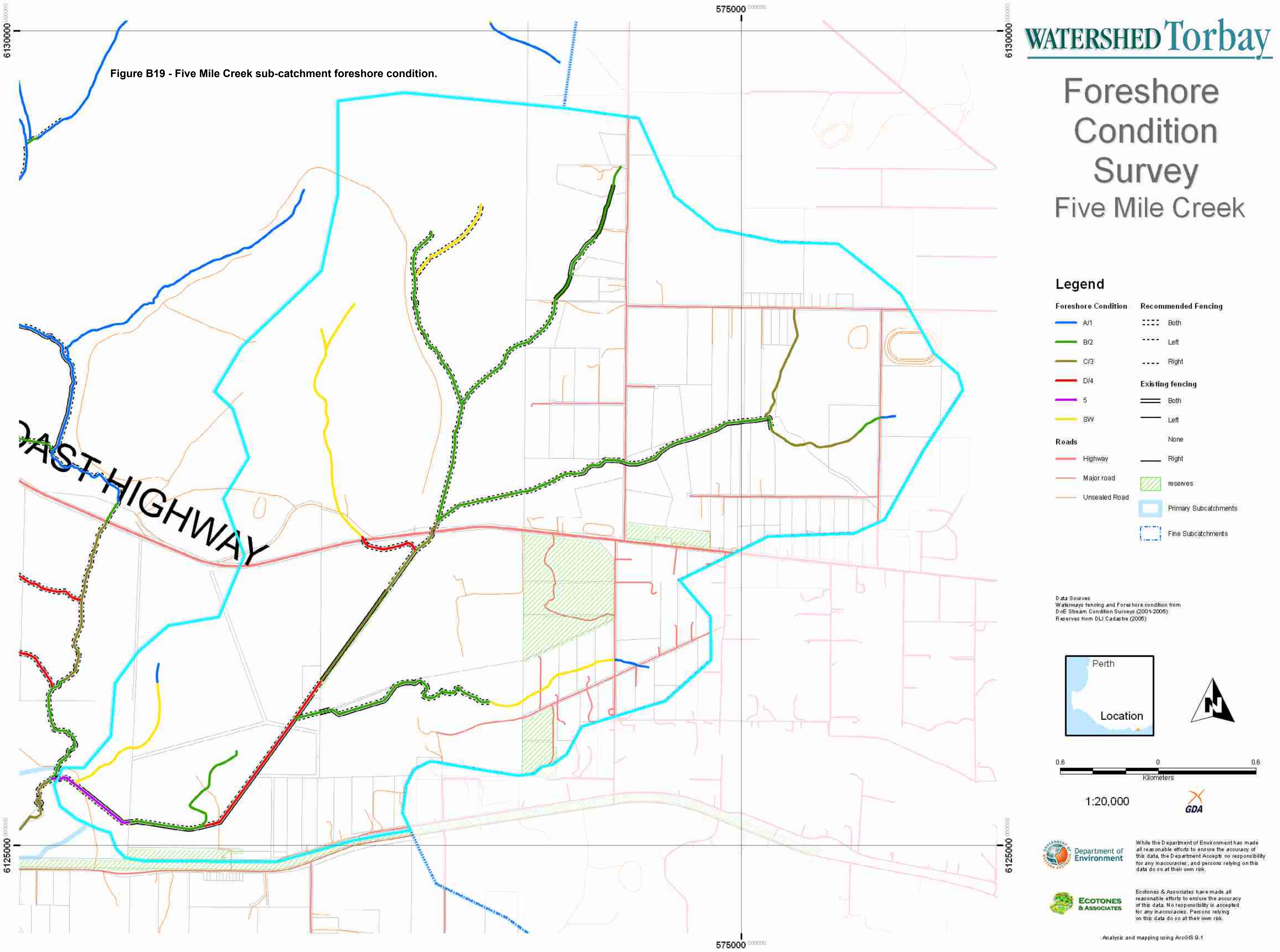

Figure B19 - Five Mile Creek sub-catchment foreshore condition.

Seven Mile Creek Sub-Catchment

The Seven Mile Creek sub-catchment has the highest percentage (56%) of pristine waterways of all the four sub-catchments. It also has the highest percentage (67%), of first order streams of the sub-catchments.

The following Seven Mile Creek foreshore condition map (B20) identifies the condition of all the waterways in the sub-catchment and makes recommendations for management.

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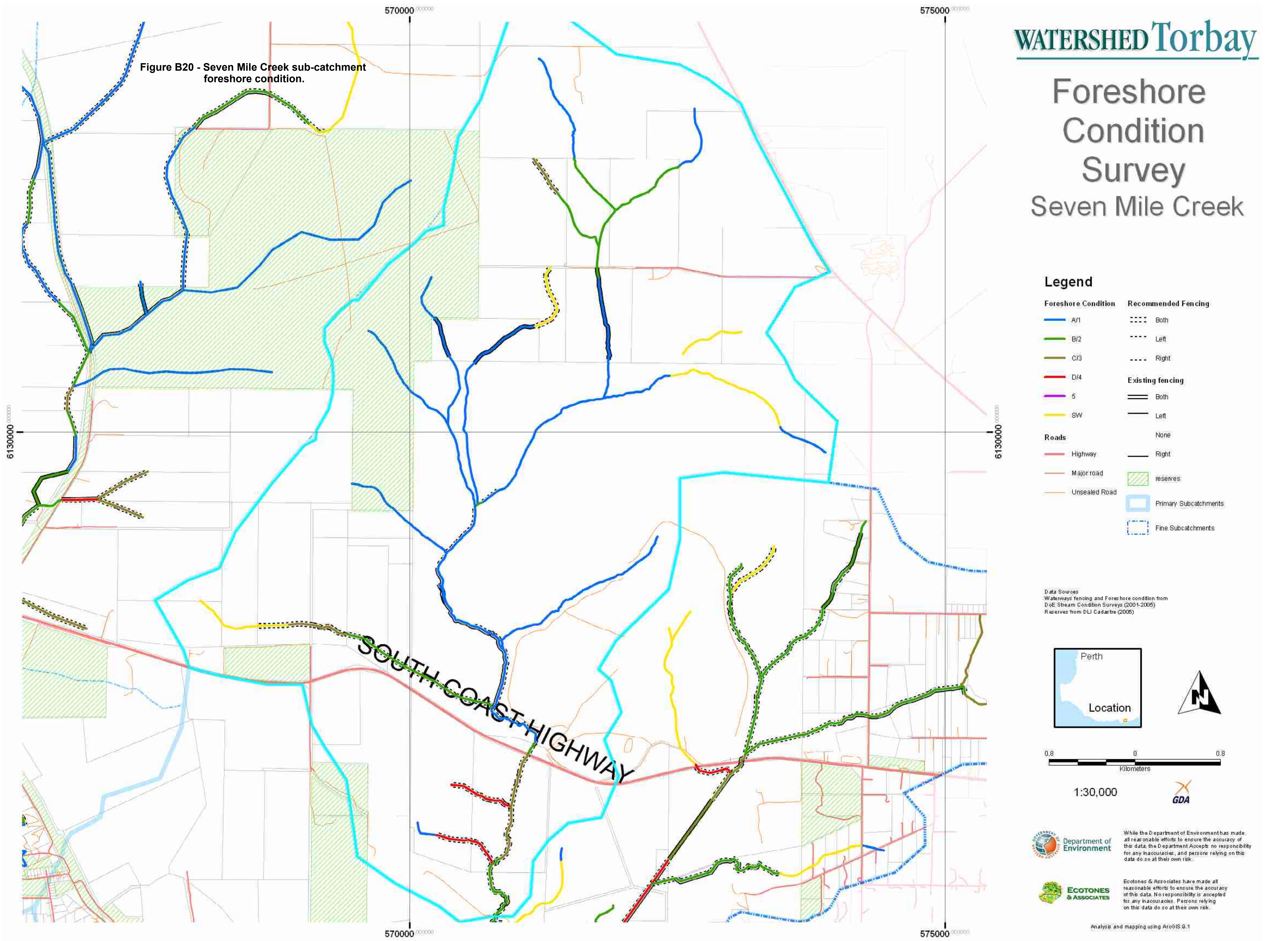

Figure B20 - Seven Mile Creek sub-catchment foreshore condition.

Environmental Weed Control

Environmental weeds are a priority issue of the Torbay Catchment Group. The Environmental Weeds Strategy for City of Albany Reserves (City of Albany, 2001) provides guidelines for best practice actions that are relevant to the Torbay catchment. Control of Watsonia (Watsonia sp), Victorian tea tree (Leptospermum laevigatum), Bulrush (Typha orientalis) and Taylorina (Psoralea pinnata) are priority weeds for the Torbay Catchment Group.

B2.4.6 Habitat and Biodiversity: Targets for Change

The biodiversity and habitat values and assets, as identified in Section B2.4, includes the wetlands systems, pristine riparian vegetation, the reserves and private remnant vegetation, water birds, fish stocks and threatened or endangered species. The Department of Conservation and Land Management (CALM) has lead responsibility for management of nature conservation reserves and recovery of threatened or endangered species and ecosystems. A key focus for biodiversity and habitat management for the Watershed Torbay Catchment Restoration Plan is on wetland and waterway ecosystems.

The Targets for resource condition change for Theme Four: Habitat and Biodiversity Management are:

1. *By 2005 major wetland systems have suitable water quality and adequate water depth for sustainable ecosystem functions.*
   (NOTE: actions for this target are included in Themes 1, 2, 3 & 5).
2. *All ‘pristine’ foreshore vegetation (Class A) is permanently maintained and all ‘good’ foreshore vegetation (Class B) is returned to ‘pristine’ condition by 2025.*
3. *All third and fourth order waterways have established permanent foreshore vegetation by 2010.*
4. *Identified waterway corridors are established for wildlife habitat as a part of a regional ‘macro-corridor’ by 2015.*
5. *Sedge lands and other vegetation types with inadequate regional representation are being managed for permanent protection by 2015.*
6. *All major wetlands have permanent functioning foreshore vegetation ecosystems by 2015.*
7. *Populations of native fish and crustacea are maintained or are increasing to sustainable numbers within aquatic ecosystem communities by 2025.*

B2.5 Theme Five: Farming Systems

Farming is an established feature of landscapes within the Torbay catchment and the community wants it to remain that way. The dominant agricultural use is grazing for cattle. There are relatively small areas used for annual horticulture, and approximately 5% of the catchment is used for commercial tree crops, predominantly Eucalyptus globulus grown for export woodchips.

Viability of the agricultural industry within the catchment is important for private investment capacity in natural resource management, however more than 70% of landholdings are less than 100 hectares and the majority (about 80%) of residents derive most of their income off-farm. Requirements for change in farming systems towards industry sustainability and improved environment outcomes should take into account the high level of non-viable agricultural land use.

Goal (2025): The farming communities have adopted 'best practice' systems for sustainable land use, resulting in measurable agricultural and environmental benefits.

Objectives:
- Sustainable farming systems are developed to maximise the efficiency of use of fertilisers, chemicals and energy
- Farm nutrient loss is reduced
- Soil loss from farms is reduced
- The impact of weeds on agricultural production is reduced.

The Water Quality and Algal Blooms management theme identified the use of land for grazing as a significant diffuse source of nutrients contributing an estimated 34% of total phosphorus and 45% of total nitrogen load from the catchment.

Intensive animal industries and annual horticulture are a part of landscapes with extensive agricultural land use. These industries are point sources and are estimated to make a high contribution to total catchment nutrient load.

Developing sustainable farming systems that provide net environmental benefits requires integration of intensive and extensive agriculture with other landuses, particularly the increasing requirements for tourism, recreation and lifestyle residential use. Figure B21 shows the nutrient input and outputs associated with a range of land uses integrated within the Torbay catchment.

The Torbay Catchment Group has a strong interest in coordinated weed management as a part of farming systems, including the impact of weeds on both productivity and the environment. The Weed Action Plan developed by the catchment group in 1999 and reviewed annually, identifies actions for control of Watsonia as a priority agricultural weed.

B2.5.1 Options for Managing Nutrients within Farming Systems

Nutrient management within farming systems considers input and output control as well as pathways for nutrient movement and loss from the farming system. There are also opportunities for nutrient retention (eg in tree crops) and assimilation (eg. by soil modification) within farming systems.

Figure B21 - Nutrient inputs and exports for land uses within the Torbay catchment.

Table B18 provides a preliminary analysis of the effectiveness and cost benefit for broad categories of management practices. This shows that adoption of perennial pastures and effective use of fertilisers are the preferred management options for farmers.

Management Practice	Phosphorus Removal %	Nitrogen Removal %	Productivity (Net Ongoing Cost)	Combined Cost Benefit
Perennial Pastures	High	Moderate	High Benefit	High
Effective Fertiliser use	Moderate	Low	High Benefit	High
Riparian Fencing & Revegetation	Low	High	High Cost	Low
Stock control/ water management in streams	Moderate	Low	Low Cost	Low-Moderate
Point source effluent management	High	Low	Low Cost	Moderate

(Source: adapted from Neville, 2003).

Table B18 - Effectiveness and cost benefit of practices for nutrient management.

An estimate of the current levels of implementation of best practice actions for nutrient reduction is provided in Table B19. This current level of implementation is estimated to result in a 10% reduction of total nutrient load (Weaver et al., 2003).

	Location	% Implementation
Perennial pasture in grazing	500-750 mm rainfall area	10%
	>750 mm rainfall area	50%
Effective fertiliser use	Grazing	30%
	Annual horticulture	25%
Stock control/ water managemen (Grazing)	Second order stream	10%
	Third order + stream	40%
Veg buffer/ filter strips	First order streams	5%
	Second order streams	10%
	Third order + streams	50%

(Source: Neville, 2003).

Table B19 - An estimate of the current level of adoption of practices for nutrient reduction in Torbay catchment.

Computer modelling for a range of management scenarios show that even with 100% adoption rates for best practice actions, the expected nutrient load reduction over the current effort would be 20-30% (Weaver, et al., 2003). From this analysis, a target nutrient load reduction of 38% for phosphorus and 24% for nitrogen is proposed. The estimated investment required for these actions is $1.5 million, but an annual net benefit over ten years to the landholders of $260,000 could be expected. Table B20 shows the respective nutrient load reductions, costs and net benefits for a range of management actions.

Best Management Practice	% reduction	
	N	P
First order Vegetated Stream Buffers	40	5
Second order Vegetated Stream Buffers	40	5
Third order + Vegetated Stream Buffers	40	5
Perennial pastures	20	20-30
Effective fertiliser use	5	5-10
First order stream stock control, water management	10	5
Second order stream stock control, water management	10	5
Third order stream stock control, water management	10	5
Dairy effluent management	75	75
Piggery effluent management	75	75
Alkaloam soil amendment (5 – 20 tonnes ha^{-1})	ND	30-60

(Source: Adapted from Weaver, 2003)

Table B20 - Estimated nutrient reduction for management actions proposed in Torbay catchment.

Based on the analysis, the focus for nutrient reduction management strategies should be on:

1. Effluent management for reduction from point-sources, for both N and P,
2. Perennial pastures and effective fertiliser use for phosphorus and nitrogen reduction, and
3. Vegetated stream buffers for further nitrogen reduction.

Vegetated stream buffers are shown to be effective for nitrogen reduction, but of only limited benefit for phosphorus reduction (McKergow et al., 2003). This indicates the importance of information about the extent to which algal blooms in the wetland systems are driven by N rather than P. If nitrogen is the key determinant of algal blooms, then a high priority should be attributed to establishment of vegetated stream buffers. If not, then the management emphasis should be on paddock management of pastures and fertilisers. For both Lake Powell and Torbay Inlet, both N and P are limiting nutrients. Therefore, strategies to reduce both are considered in this theme.

B2.5.2 Farming Systems: Target for Change

The Resource Condition Target for Theme One (Water quality and algal blooms) is for a reduction of algal blooms in Torbay Inlet, Lake Powell and Marbellup Brook by 2025. The extent to which farming system change will contribute to this change in resource condition remains uncertain. However, nutrient balance modelling indicates that significant reductions in nutrient export from point and diffuse sources within the Torbay catchment can be achieved.

The Target for resource condition change for Theme Five: Farming Systems is:

1. *By 2025 the total catchment nutrient load is reduced by 38% for nitrogen and 24% for phosphorus.*

The management action target and actions for reduction in point source nutrient loss are provided in Theme One (Water Quality and Algal Blooms).

B2.6 Theme Six: Land Use Planning

Land in the Torbay catchment is used mainly for primary production (agriculture and horticulture), however land use trends suggest more diversified use in the future, including farm forestry, public water supply, tourism, recreation and lifestyle residential use. Development of land use in the catchment is outlined in Section A3.1. The community is keen to retain a predominantly agricultural landscape character and has expressed concern about unplanned change within Torbay catchment. The Torbay Catchment Group is seeking opportunities to participate in land use planning at all levels to ensure that landscape change is compatible with the future vision for the catchment.

Goal (2025): Regional and local planning provides the policies and mechanisms to: implement new actions that are beneficial for natural resource condition; ensure that land is used according to its capability; and that further agricultural, industrial, commercial or residential development within the catchment does not compromise the environment.

Objectives:

- Future land use, including new development proposals, should not exceed the capability of land resources and should demonstrate net nutrient reduction compared to current landuse
- Landuse intensification and further residential development within defined floodplain and buffer areas for Lake Powell, Ewart Swamp, Lake Manarup and Torbay Inlet are controlled according to environmental management guidelines
- Construction of new public and private drains and maintenance of existing drains does not increase the risk of flooding, nutrient enrichment, acidification and sedimentation of waterways and wetlands
- Priority water resources are protected for beneficial use now and into the future
- Commercial tree plantations are controlled to ensure beneficial groundwater resources are not reduced and that the landscape visual amenity is maintained
- Future townsite growth within the catchment does not result in increased nutrient input to waterways and wetlands
- The area of reserves or other secure arrangements for wetland and biodiversity conservation are increased in priority locations
- The value of 'environmental services' to the City of Albany provided from the Torbay catchment is realised and arrangements are developed for payment by those that benefit
- The current landscape mosaic, characterised by agriculture and natural vegetation is maintained
- Rural lifestyle and social values, including passive and active recreation opportunities, are enhanced.

B2.6.1 Planning and Policy Mechanisms

There is a range of planning and policy mechanisms currently available. This includes statutory options through state and local government and non-statutory planning. The land use changes required to meet the resource condition change targets of the Watershed Torbay Catchment Restoration Plan may require institutional processes that exceed the capacity of current planning and policy mechanisms. Where this occurs, changes to institutional arrangements are proposed.

B2.6.1.1 Lower Great Southern Regional Planning Strategy

A draft document is being prepared by the Department of Planning and Infrastructure (DPI) to provide strategic direction for planning to meet future social, economic and environmental management requirements within the region. The regional planning strategy provides the basis for development of statutory land use planning by state and local government. A formal period of public comment on the draft regional planning strategy will occur during 2005.

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The regional planning strategy will provide guidance for more specific local planning outcomes and provide capacity for broad land use change. For Torbay catchment, there may be opportunities to define requirements for Regional Open Space (on public and private land where the priority for 'open space' is identified), priority agricultural use areas and increased public access, to provide guidance for inclusion of measures in the City of Albany Local Planning Strategy and Town Planning Scheme to address land use and management, and rehabilitation issues affecting the catchment.

B2.6.1.2 Local Planning Strategy and Town Planning Scheme

Local Government Authorities are required to develop a Local Planning Strategy (LPS) under the Town Planning and Development Act 1945 (Section A4). The City of Albany is currently preparing a Local Planning Strategy which is consistent with the direction of the Lower Great Southern Regional Planning Strategy.

The Local Planning Strategy will be implemented through non-statutory policies contained in the LPS and through statutory planning mechanisms in the Town Planning Scheme (TPS). The current TPS applicable to the majority of the rural areas of the Shire (including the Torbay catchment) was prepared in 1981, and incorporates only very limited measures for influencing land use and management in the catchment. The City's current Local Rural Strategy contains general and site specific policies and has been used to guide rural development, especially for Special Rural/Rural Residential developments.

Specific mechanisms of the current Local Rural Strategy include:

- Policies protecting natural resources (including options for revegetation, rehabilitation, fencing or ceding land) through re-zonings, subdivisions and development application processes
- Planning consent for intensive agricultural industry proposals require detailed assessment, based on soil types, fertiliser use, waste management practices. Nutrient management is a major policy area (Ref. GP4-GP7)
- Referral to DoE for assessment of impacts of proposals on water-bodies
- Specific rural residential policy relevant to the Torbay catchment
- Policy provision for protection of potato growing in an area adjacent to Lake Powell.

In formulating its new LPS and TPS the City of Albany will retain or improve the mechanisms of the current Local Rural Strategy. Formal public consultation and final documentation is expected to occur during 2005.

The LPS and TPS will contain two key land evaluation processes:

1. Land capability assessment – identification of land characteristics (requirements and limitations) for a range of land uses mapped on the basis of soil/landscape units, and
2. Land Use Class/Planning Zone matrix – an assessment of suitability and compatibility of land uses within planning zones.

The TPS has capacity through the use class–zoning matrix to prohibit a particular land use class from a zone. Other landuses may be permitted at the discretion of the Council subject to meeting certain performance criteria and/or trade offs (e.g. regarding flood risk, nutrient loss potential, retention and planting of vegetation, etc) which can be prescribed in a scheme provision. Scheme provisions outline controls and development requirements within a specified area, and may include (for example) implementation of stormwater management or revegetation plans. Statutory land use assessment and land evaluation processes also provide opportunities to promote water resource protection, including some aspects of drainage management.

B2.6.2 Referral of Development Applications

Under the TPS, proposals to establish certain land uses must be submitted to the City of Albany for approval. Certain proposals are referred to delegated authorities (e.g. the Department of Environment) for advice. Their advice is provided according to policies or management guidelines of the respective referral organisation. The CoA considers the advice provided and approves (with or without conditions) or rejects the proposal (with reasons for rejection provided). Approval conditions may include a range of requirements being met (e.g. compliance with Codes of Practice, natural vegetation protection orders, preparation of a Nutrient and Irrigation Management Plan, ceding Foreshore reserves and others).

The Development Application process provides an opportunity for there to be a presumption against a particular land use in one or more planning zones unless prescribed performance standards are met. In this situation, the proponent would be required to provide the information that shows how the proposal will be acceptable (i.e. the onus is on the proponent rather than the authorising agencies to nominate the actions that will be taken to avoid identified environmental risks).

B2.6.3 Town Planning Scheme Amendments

Changes to the TPS can occur during the period of it being effective via the Scheme Amendment process. Proposed changes are referred to delegated agencies (e.g. DoE, EPA) for advice. This function provides an opportunity to alter planning conditions based on additional information or improved understanding. This is particularly important for environmental management within Torbay catchment where there is ongoing research and the recommended management from the research outcomes may require statutory processes for effective implementation.

This function also provides an opportunity to improve the level of information used for assessment. In the Torbay catchment, information available for land capability assessment is more detailed that for other areas in the region. The TPS Amendment processes allow for revision of the land capability assessment.

B2.6.4 Land Subdivision Proposals

Proposals for land sub-division are made to the Western Australian Planning Commission (WAPC). The Commission sets the policy and guidelines under the Town Planning and Develop Act 1928 that are incorporated by local government authorities into Town Planning Schemes, strategies and policies and in providing comments of advice on sub-division proposals. Proposals are referred to relevant government authorities, including local government, for advice. The advice provided is based on policies and management guidelines of the respective organisations. For the CoA, the TPS provides the basis for advice.

Decisions for sub-division of rural land are guided by the WA Planning Commissions Statement of Planning Policy (SPP) 11 – Agriculture and Rural Land Use Planning. This is to be considered in conjunction with guidelines provided in Policy No DC 3.4 for specific sub-division circumstances (e.g. for conservation).

The major policy objectives are to protect agricultural land, provide for rural settlement, minimise land use conflict and carefully manage natural resources. Through local government Town Planning Schemes (TPS), 'Priority Agriculture Zones' are identified. Sub-division is not encouraged in these areas but could occur in the 'General Agriculture Zone'.

Policy No DC 3.4 identifies that there is a general presumption against sub-division of rural land but provides criteria for specific conservation purposes, including sub-division of natural vegetation from agricultural land for conservation purposes. This policy applies more specifically to the Wheatbelt Agricultural Policy Area, which includes the City of Albany and could be considered in formulating special planning provisions for stream and wetland foreshore management within the Torbay catchment. Such arrangements would provide opportunities for Conservation Covenants to be applied to priority areas of natural vegetation.

B2.6.5 Statements of Planning Policy

Statements of Planning Policy (SPP) are developed by the WAPC under Section 5AA of the Town Planning and Development Act 1928 to provide guidelines for land use planning in WA. Decision making authorities, including local government, are required to have due regard to these policies when preparing local planning strategies and determining applications. There are four that are directly relevant to the Watershed Torbay Catchment Restoration Plan.

SPP 2 – Environment and Natural Resources

The key features of this planning policy are:

- General policies on water resources protection, air quality, soil quality and contamination, biodiversity, mineral resources, landscape protection promoting environmental protection and positive environmental outcomes

- Guidelines to consider environmental, economic and social effects and land use change
- Includes support protection of biodiversity, remnant vegetation protection and consideration of ‘greenhouse’ gas emissions
- Requires consideration of catchment management strategies that are prepared by groups and are endorsed by State Government agencies.

A Guideline for the implementation of SPP 2 is currently being developed by the Department for Planning and Infrastructure for the WA Planning Commission.

SPP 2.5 – Agricultural and Rural Land Use Planning

The key features of this planning policy are:

- Priority Agricultural Areas are mapped in the TPS and there is a presumption against non-agricultural use in these areas. An Agricultural Impact Assessment is required for non-agricultural uses
- Development approval for intensive agricultural industries may be required in Priority Agricultural Areas but is always required in other zones
- Rural-Residential and Rural Smallholdings zonings are to be planned to cater for settlement growth
- Public Drinking Water Source Areas are identified and protected
- Revegetation/remediation can be required
- Flood risk areas are to be mapped (by DoE) as part of the TPS. Special Control Areas can be designated where planning approval is required for construction of dwellings, sheds, landfill, clearing and other proposed land use changes in this area.

SPP 2.7 – Public Drinking Water Source Policy

The key features of this planning policy are:

- Provides a focus on protection of declared Public Drinking Water Source Areas (PDWSA) for water quality and public health issues
- Requires use of a landuse compatibility table prepared by DoE
- Special Control Areas can be identified for some PDWSAs.

SPP 2.9 – Water Resources

The key features of this planning policy are:

- Provides broad policy protection of water resources, both quality and quantity considering the processes of erosion, sedimentation, nutrient enrichment, pollution and the requirements for foreshore vegetation. The policy promotes environmental repair and can require specific site rehabilitation (e.g. for foreshore vegetation or sedge lands) as a part of development applications
- Requires planning to recognise Natural Resource Management strategies, catchment strategies that are prepared by groups and endorsed by state agencies
- Ensure proposed land uses are compatible with available water resources
- Wetlands and waterways, and their associated values (as mapped by DoE) are to be protected and enhanced

- Water quality is not to deteriorate as a result of a development proposal, and
- Guidance for conservation planning including buffer areas and distances to protect priority areas.

B2.6.6 Water Resource Protection Plans

A Water Resource Protection Plan is to the prepared for the Marbellup Brook catchment within 2 years. The catchment and water resources are declared under the Country Areas Water Supply Act 1914.

Public Drinking Water Source Areas have three levels of water quality protection called priority classification areas:

Priority 1 (P1) - defined to ensure there is no degradation of the water resource. They cover land normally owned by the State where the provision of the highest quality drinking water is the prime land use value. P1 areas are managed with the principle of risk avoidance.

Priority 2 (P2) - defined to ensure that there is no increase in risk of pollution to the water source. P2 areas are declared over land where low intensity development (such as rural) already exists. Protection of public water supply sources is a high priority in these areas. P2 areas are managed in accordance with the principle of risk minimisation and so some development is allowed under specific guidelines.

Priority 3 (P3) - defined to limit the risk of pollution to the water source. P3 areas are declared over land where water supply sources need to co-exist with other land uses such as residential, commercial and light industrial developments. Protection of P3 areas is achieved through management guidelines rather than restrictions on land use. If the water source does become contaminated, then water supplies may need to be treated or an alternative water source found.

B2.6.7 Policies of State Government Agencies and Authorities

The Department of Environment and the Environmental Protection Authority have a range of relevant policies that are effective through provision of advice for statutory referral processes. The Draft Country Sewerage Policy recently developed by many agencies including the Department of Environment and the Department of Health contains guidance on the environmental requirements for on site wastewater disposal. These requirements are more restrictive within environmentally sensitive areas, defined as those areas within the capture zones of wetlands and watercourses. Such a definition could be applied to the Torbay area, and the policy will have application for further urban development within the Torbay catchment.

B2.6.8 Management Plans

Management Plans are prepared for nature conservation reserves and other public areas as required under various legislation such as the Conservation and Land Management Act 1985.

B2.6.9 Non-statutory Planning

Farm and catchment plans are an effective way for individual landholders to identify opportunities and threats to their properties as well as providing a structured approach for decisions about implementation of industry ‘best practice’ actions.

B2.6.10 Landuse planning: Target for Change

It has been identified that the local community values the rural landscape that dominates the Torbay catchment. This agricultural character of the landscape can be protected through a range of planning and policy mechanisms. The priority agricultural land, that classifies Torbay as a rich and productive landscape must also be protected from inappropriate development. The ability of the Local Rural Strategy to evaluate land capability will address the risk of new development contributing to the environmental degradation of the catchment.

The Target for resource condition change for Theme Six: Landuse Planning is:

1. *Landuse is matched to land capability within all local planning frameworks.*

B2.7 Theme Seven: Community Education and Information

The Watershed Torbay project is based on community-lead partnership arrangements that include local, state and federal governments and a range of organisations for a national demonstration of achieving a vision of a healthy environment with sustainable production. It is not an approach based on statutory regulation and control.

Success of a partnership-based approach depends significantly upon three key strategies:

- Developing a ‘shared Vision’ for the future,
- Engaging community and partners, and
- Communications and information management.

These are to be applied across the management themes.

Goal (2025): The community and partners understand the values of the catchment and are pro-active in implementing on ground works to achieve the shared vision for the catchment.

Objectives:

- All key stakeholders are willingly involved in implementing the restoration plan.

  A high level of community awareness about the values of the catchment and about the best practices for sustainable management.
- Further research in the catchment addresses priority issues, meeting community needs and is communicated to increase community understanding of environmental processes.
- There is a significant level of community involvement in reviewing the restoration plan on a five-yearly basis.

B2.7.1 Developing a ‘Shared Vision’

The Torbay Catchment Group has a vision for the future (Section A1.3). It is to have:

> "*an environmentally clean, balanced ecology supporting a prosperous community in which people respect each other's use of the catchment and waterways*".

The vision reflects many community values and represents requirements for change in attitudes and land use practices. The Restoration Plan provides direction for change towards the vision for the future through management targets and actions. Achieving the vision will require most people in the catchment and project partners understanding and ‘owning’ the change processes that it represents. This is required at a high level to ensure that the community commits to the processes and is proud of the achievements.

A social and economic ‘benchmark’ survey sent to the 580 landholders in the Torbay catchment during 2002-3 provides a robust basis for community understanding and commitment to components of the vision during early stages of the Watershed Torbay project (Unpublished report, Survey of Landholder land use and attitudes in the Torbay catchment, Aug 2003; Duxbury). The 30% survey response indicated a relatively high level of interest in the key issues of the project but also a relatively low level of previous involvement (72% of respondents have not previously volunteered community Landcare effort). This suggests an opportunity to build on the interest to gain greater involvement through engagement with the vision for the future.

B2.7.2 Engaging Community and Partners

The social benchmark survey (Duxbury, 2002) indicates there to be relatively strong interest by those who responded to the survey. However, it must be noted that 70% of landholders in the catchment did not respond to this survey, indicating the steps for engagement of most of the community will require specific awareness and extension actions that are suitable for the range of interest groups. The survey shows that a large proportion of the 580 land owners have small properties for residential use and earn most income off-farm. It also shows that the general level of education is relatively high but the key deterrents to involvement are available time and finances.

The diversity of cultures and interests of people living within the catchment needs to be recognised. Many enjoy a rural lifestyle and adopt principles of environmental heath and sustainable living but may know little about commercial farming. While some targeted information is required for commercial agriculture and horticulture, other information is required for those not commercially involved in primary production. Landcare is characterised by being focused on farmers. The Watershed Torbay project is an opportunity to broaden engagement for the whole community.

With significant public investment within the Torbay catchment expected for implementation of actions, there is a requirement to develop formal arrangements with partner organisations. This includes partners providing funds directly (investors) and those who provide information or services. Formal arrangements are to include commitments to funding and services during the implementation period of the project.

B2.7.3 Communications and Information Management

Engagement of interest and involvement by community and partner organisations is also dependent upon effective communications and efficient information management. Communicating information, knowledge and experience is often most effective by direct dialogue through field tours, local demonstrations, participatory research initiatives and other co-operative actions that facilitate informal experience development and information sharing.

Semi-structured communication processes have been developed during the Watershed Torbay project. An important part of these processes is maintaining a ‘Communications Learning Log’ in which group events are recorded and ‘new group learning’ is identified. This also provides a ‘track record’ of group development. Additional ‘social learning’ processes are required particularly for skills development, for example in soil testing, drain restoration works and other actions of the Restoration Plan.

Efficient information management is important for project effectiveness and for continued engagement of community and stakeholders. Information from previous research or trials should be readily accessible in a form suitable for adoption by management. A pre-requisite of future research and development (R&D) should be for science-based information to be related to local management based requirements. Researchers should also be encouraged to engage local community members within projects to increase the level of engagement and understanding and to ensure that local knowledge is contributed. Spatial information should also be easily accessible in both hardcopy (map) and digital formats.

B2.7.4 Community Education and Information: Target for Change

Engagement of the Torbay community is vital for the success of the Restoration Plan. Ultimately the community must own the project and be the drivers for change in their community. The range of education and communication objectives in the plan will address the need for the community to have a high level of awareness of the environmental values of the catchment, the environmental problems occurring in the catchment and the remediation occurring through the restoration plan.

The Target for resource condition change for Theme Seven: Community Education and Information is:

1. *By 2015 positive progress has been made to make restoration plan targets for improving catchment health measurable.*
2. *By 2008 further funds have been received for ongoing implementation of the catchment restoration plan.*